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PRESENTATION

Health is a multifaceted field, where science and practice intertwine to boost human well-being. **“Developing Health: The Intersection of Science and Practice”** delves deeper into this interconnection, bringing together **36 chapters** written by experts from various fields of health and science.

Developed by **Seven Publications**, this book offers a panoramic view of the advances, challenges and crucial discoveries shaping the future of health. From groundbreaking research to practical applications, each chapter explores the synergy between science and clinical practice, covering topics such as personalized medicine, health technologies, public health, nutrition, psychology and much more.

SUMMARY

INTERSECTIONALITY, MENTAL HEALTH AND THE REMAINING BLACK POPULATION OF QUILOMBO: THE NECROPOLITICS OF INVISIBILITY AND ABANDONMENT

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ABSTRACT

Mental health problems are a public health problem at a global level, with Brazil being the country with the highest prevalence of depression, in addition to being the second most prevalent in the Americas (WHO, 2022). However, mental health problems do not occur homogeneously throughout the population, and the populations are more vulnerable from a social point of view, at the mercy of a more accentuated morbidity and mortality process. From this perspective, the remaining black population of quilombos, intersected by systemic racism, invisibility and social inequalities, are more prone to development and incidence of mental health problems. The objective of this study was to highlight in the Brazilian scientific literature the impact on the mental health of black people remaining in quilombos. This is an integrative literature review study with a qualitative approach. The PICO strategy was used to develop the study. The guiding question was established: what is the scientific evidence on the impact of mental health on the remaining quilombo population in Brazil? The platforms used for the research were Google Scholar and Scientific Electronic Library Online (Scielo), with the descriptors: "mental health", "black population" and "quilombola", using the Boolean operator AND. For sample analysis, the stages of analytical, critical and detailed reading of the texts were followed. 04 studies were excluded when the inclusion and exclusion criteria were applied and 04 were used to compose the present study. The results showed that social and economic indicators are related to the health and mental well-being of individuals. Thus, the black population belonging to quilombola communities carries the worst indicators when thinking about access, morbidity and mortality due to various health problems, especially with regard to mental health. The process of enslavement and then abandonment by social policies oppresses this population to such an extent that it compromises their survival and strategies for facing life. Structural racism permeates the life and health conditions of this population. Furthermore, as it is a minority group within the black Brazilian population, which faces social, economic and racial inequalities, the existing gap in data and studies that deal with this theme is highlighted, pointing to an epistemological invisibility around its dynamics and the consequences on the health of this population. Finally, the need to strengthen the health care policy for the remaining black population in quilombos in Brazil.

Keywords: Mental Health. Black Population. Quilombo. Racism.

INTRODUCTION

Mental health problems are a global public health problem. According to the World Health Organization (WHO), almost 1 billion people, including 14% of adolescents worldwide, live with a mental disorder, being the leading cause of disability, with one person developing a mental disorder every six years, people with serious mental health problems die, on average, 10 to 20 years earlier than the general population, mostly due to preventable physical illnesses and more than 1 in 100 people die as a result of suicide, with 58% of suicides occurring before the age of 50.

Brazil is the country with the highest prevalence of depression, in addition to being the second country with the highest prevalence in the Americas (WHO, 2022). Through these indices, WHO highlights the urgent need to seek effective approaches in the field of health, as they not only provide a comprehensive view of mental health conditions at a global level, but also highlight the importance of implementing effective measures to achieve the improvement of the quality of global health. promote well-being and reduce health disparities.

In addition, it is worth noting that the mental health of the black population is an essential theme for understanding the inequalities and challenges faced by the community. According to data provided by the Brazilian Institute of Geography and Statistics (IBGE) in 2022, the black population represents 56% of the total Brazilian population (IBGE, 2022). Black people are more likely to develop depression, in addition to having reduced levels of psychological well-being and self-esteem, being more likely to face chronic stress and a higher incidence of adaptive disorders.

Systemic racism, racial violence, and social inequalities are the cause of the higher incidence of black people with mental disorders such as depression and anxiety, and can be a potent activator of the stress response (Félix, 2022). According to data from the Brazilian Ministry of Health, black adolescents and young people are more likely to commit suicide, and the risk in the age group of 10 to 29 years was 45% higher among young people who declare themselves black and brown than among whites in 2016 (Brasil, 2016). It is important to recognize this problem so that solutions can be developed to improve the mental health of the black population. In this context, some populations are more vulnerable, such as the remaining black population in quilombos, being a minority group within the Brazilian black population, which faces social and economic inequalities, as well as racial discrimination.

The evidence indicates that social and economic indicators are related to the health and mental well-being of individuals belonging to quilombola communities, pointing to the

need to build and implement interventions and public health policies aimed at this population that take into account their socio-historical and cultural aspects (Batista; Rocha, 2020).

Dealing with the mental health of the black population that resides in quilombola communities in urban centers is a topic of great relevance, since it is a social group that suffers from social and economic inequalities. The black Brazilian population has for centuries suffered from structured racism in society, a reflection of a history marked by extreme acts of violence and dehumanization directed against the black and indigenous population, and this historical pattern can be observed when observing events such as the African diaspora and the slavery of the black population (Fernandes *et al*., 2018).

In this historical context, quilombos emerge as symbols of resistance, formed with fundamental strategic purposes to confront the slave system, where quilombolas not only faced an oppressive system, but also found a place to preserve their identity, culture and beliefs, creating an environment where mental health was strengthened (Batista; Rocha, 2020). It is critical to understand the mental health of people in these communities, as this plays a crucial role in fostering an environment that values and strengthens resilience and the ability to cope with these challenges.

However, the lack of comprehensive research on the mental health of the black population in urban quilombos represents a scientific gap in the reflection of this health-disease process. These communities face challenges related to the urban context in which they live, but few studies focus on studying and investigating their experiences. In addition, research on the availability or lack of support networks for this population is limited, these gaps are important because mental health is a fundamental part of human well-being. When the needs of this population are not understood, the ability to develop effective interventions to improve well-being is compromised. Therefore, this study is essential to broaden the understanding of the complexities involved in the mental health of quilombola populations in urban areas and to identify support networks available to these communities.

OBJECTIVE

To highlight in the Brazilian scientific literature the impact on the mental health of black people living in quilombos

METHODOLOGY

This is an Integrative Literature Review Study, of a qualitative nature, debating the impact on the mental health of black people remaining from quilombos in national scientific

production. The integrative literature review consists of the analysis of carefully selected studies to support the construction of a theoretical conceptualization, enabling the synthesis of current knowledge on a specific topic and identifying areas that need further investigation. This research method facilitates the integration of multiple published studies and enables the formulation of comprehensive conclusions within a specific area of study (Mendes *et al.,* 2008).

The PICO Strategy was applied, an acronym of P for population/patients; I for Intervention; C for comparison or control; and O for expected outcome/*outcome*. For the present research, the acronym was determined: P – remaining black population of quilombo; I – mental health; C - does not apply; O – mental health of the black population remaining from quilombos. Thus, the guiding question was established: what is the scientific evidence on the impact of mental health on the remaining quilombo population in Brazil?

The platforms used for the research were Google Scholar and Scientific Electronic Library Online (Scielo), with the descriptors: "mental health", "black population" and "quilombola", using the Boolean operator AND. The following inclusion criteria were defined: complete Brazilian articles published from 2019 to 2024, in Portuguese and that addressed the mental health problems of the aforementioned population. The search took place in October and updated in November 2024.

For the analysis of the sample, the following steps were followed: analytical, critical and detailed reading of the texts, extracting from them the results deemed most pertinent to characterize the scientific production related to the theme, taking care to verify whether the publications were repeated among the different databases explored (Bardin, 2016).

RESULTS AND DISCUSSION

After searching the database, 08 studies were selected for analysis. In order to meet the objective proposed in the review, 04 studies were excluded when the inclusion and exclusion criteria were applied, and 04 were used to compose the present study.

According to the World Health Organization (WHO, 2019), mental health problems are a public health problem at the global level, with Brazil being the country with the highest prevalence of depression, in addition to being the second with the highest prevalence in the Americas (WHO, 2022). A person's well-being is intrinsically linked to a series of fundamental conditions, which go far beyond the exclusively psychological aspect. In addition to individual aspects, mental health is also socially determined. Therefore, it should be considered that mental health results from the interaction of biological, psychological, and social factors, and is characterized as biopsychosocial.

From this perspective, the prevalence of mental disorders does not occur equally in the entire population. Systemic racism, racial violence and social inequalities are the cause of the higher incidence of blacks with mental disorders such as depression. For Mota (2019), the black population often carries the burden of historical traumas, such as the process of enslavement, social abandonment in the post-emancipation period, the genocide of black youth, racial segregation and other forms of oppression over the centuries, and it is possible to affirm that racism, as a relationship of power and support of privileges, can generate psychic suffering (David, 2018).

In this context, some populations are more vulnerable, such as the remaining black population in quilombos, being a minority group within the Brazilian black population, which faces social and economic inequalities, as well as racial discrimination. Quilombola populations suffer from common mental disorders, such as depression, anxiety, and stress, due to the adverse social conditions they face such as poverty, discrimination, violence, and lack of access to basic health and education services (Dimenstein et *al*., 2020).

In this historical scenario, quilombos emerge as symbols of resistance, formed with fundamental strategic purposes to confront the slave system, and which faced not only the oppressive system, but also found a place for the preservation of their identity, culture, and beliefs, creating an environment where mental health was strengthened (Batista et al., 2019). Thus, quilombos stand out as territories of historical and social significance, whose relevance goes beyond the struggle against oppression, also reflecting on the dynamics of care and strengthening of the communities that inhabit them.

In addition, the guarantee of the constitutional right to health includes mental health care, as it is a duty of the Brazilian State, which is now responsible for offering decent health care conditions for the entire population. In Brazil, the National Mental Health Policy is a state policy, defined by Federal Law 10.216/2001. The Federal Government's actions on this topic are coordinated by the Ministry of Health. This policy is materialized through the strategies and guidelines adopted to organize care for people with specific mental health treatment and care needs.

This is an important and complex topic that encompasses a wide variety of mental disorders. However, the scientific literature is still scarce regarding the mental health of the black population. Despite this, some studies have been carried out to better understand the prevalence of mental disorders in black people. A study published in the Journal of Psychology of UNESP reports an occupational therapeutic process, highlighting the potential of racial representativeness in mental health care relations, discussing the aspects of the theme: the construction of racism in Brazil; the importance of professional training to

meet this demand; the recognition and empowerment of blacks; the understanding of occupational therapy about the individual, his illness and human activities; and intervention strategies aimed at the specificities of the mental health of the black population. (Ricci; Santos, 2020)

The most common mental disorders in Brazil, in general, are anxiety and depression, with prevalences of 9.3% and 5.8%, respectively, according to the World Health Organization (WHO). In addition, new data show that 86% of Brazilians suffer from some mental disorder, such as eating disorders, bipolar disorder, obsessive-compulsive disorder, schizophrenia, post-traumatic stress and Borderline personality disorder.

Public health services in relation to quilombola territories face significant challenges such as the need for knowledge exchange between professionals who provide services to these communities and their traditional knowledge and practices, and planning services need to understand and recognize this knowledge and practices, which should be done with caution, avoiding making the mistake of exaggerating the lifestyle of its residents. The health issues of this population must also take into account the invisibility and inequality they suffer (Melo, 2017).

According to the publication made by the Racism and Health group of the Brazilian Association of Collective Health (Abrasco, 2020), during the COVID-19 pandemic, Brazilian quilombola communities with a large concentration of people in risk groups faced barriers in accessing health services, such as primary care, and food insecurity, being exposed to greater risks of death after infection. Quilombola populations suffer from common mental disorders, such as depression, anxiety, and stress, due to the adverse social conditions they face, such as poverty, discrimination, violence, and lack of access to basic health and education services (Dimenstein *et al*., 2020).

The mental health of residents in quilombos in Brazil is a topic of great relevance, as these communities face specific challenges that can significantly impact the psychological well-being of these individuals. In an integrative review found in the Scielo database on Mental health in quilombola communities in Brazil, it analyzes studies on the mental health of quilombola populations, considering the historical, social, and cultural aspects that influence their health. The authors identified 11 articles that addressed topics such as violence, racism, stress, depression, anxiety, alcoholism, suicide, and religiosity. They concluded that there is a dearth of research on the mental health of these communities and that there is a need to develop culturally appropriate and participatory interventions. (Batista; Rocha, 2020).

A study evaluated the prevalence of common mental disorders (CMD) in 1,004 quilombolas from 12 rural communities in the north of Minas Gerais. The results showed that 35.9% of the participants had CMD, with women, the elderly, the illiterate, and those who reported racial discrimination being the most affected. One of the critical factors to be considered is the persistence of structural racism and racial discrimination faced by quilombolas (Queiroz *et al*., 2022). Constant exposure to these forms of prejudice can generate chronic psychological stress, anxiety, and depression. The lack of representation and equal opportunities in different spheres of society can contribute to an adverse psychosocial environment.

The mental health of quilombo residents in Brazil is a relevant and complex concern, as these communities face specific challenges that can significantly impact the psychological well-being of their members. The unique experience of quilombos, marked by histories of resistance, racial discrimination, and unfavorable socioeconomic conditions, can contribute to the prevalence of mental health problems in these contexts.

Finally, understanding mental health in urban quilombola communities is not just about individual well-being, but also encompasses a matter of social justice. By recognizing the unique and often unfair experiences faced by these communities, culturally sensitive mental health interventions can be developed that address their specific needs. In addition, strengthening mental health in these communities contributes to building a more just and equitable society. Thus, building an environment that promotes mental well-being for everyone, regardless of their background. Therefore, investing in the mental health of quilombola populations in urban areas is a fundamental step towards a more inclusive and equitable future for all.

CONCLUSION

Based on a comprehensive analysis of the literature, most studies highlighted that social and economic indicators are related to the health and mental well-being of individuals belonging to quilombola communities (BATISTA; ROCHA, 2019), evidencing the complex relationship between such factors and the mental health of the remaining black population of quilombo, emphasizing the importance of deepening the look at the conditions that impact mental health in quilombola communities. Therefore, this theme is relevant, since it is a social group that suffers from social and economic inequalities. The black Brazilian population has suffered for centuries a process of structural racism, a reflection of a history marked by extreme acts of violence and dehumanization directed against the black and indigenous population. It is also possible to observe the historical pattern linked to the

African diaspora and the enslavement of the black population (FERNANDES *et al.,* 2018) as an aggravating factor of the mental health problems that affect this population.

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MEDICINAL USE OF CARAPA GUIANENSIS (ANDIROBA) – AN INTEGRATIVE REVIEW

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ABSTRACT

The study of teacher education and training for the effective use of technology, including artificial intelligence, is imperative today, as it not only redefines pedagogical practices, but also shapes the future of education, empowering educators to skillfully navigate an ever-evolving educational landscape. In this scenario, this article critically examines teacher training for the effective use of digital technologies, focusing on the growing relevance of artificial intelligence in contemporary education. Through an innovative approach, the text explores training strategies that go beyond mere technical proficiency, highlighting the importance of digital and data literacy, as well as harmonious collaboration between educators and artificial intelligence. Ethical challenges, humanistic considerations and strategies for evaluating the effectiveness of technology training are discussed. By addressing barriers and proposing strategies to overcome them, the article concludes the discussion with reflections on future perspectives, outlining an educational horizon where technology and pedagogy converge to promote more efficient and innovative learning.

Keywords: Teacher Training, Educational Technology, Artificial Intelligence, Digital Literacy.

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INTRODUCTION

GENERAL ASPECTS

Andiroba (*Carapa guianensis)* is a tree widely distributed in the Amazon region, which has been the subject of study due to its medicinal properties (Fonseca *et al*., 2024). In this context, the review of the literature on the medicinal use of andiroba provides a comprehensive overview of the various therapeutic applications of this plant species (Firmino *et al*., 2019). The importance of scientific research and traditional knowledge about the pharmacological properties of andiroba for the development of new drugs and for the practice of phytotherapy deserves to be highlighted (Henriques & Penido, 2014). Therefore, this review aims to gather and synthesize the available knowledge on the medicinal use of andiroba, aiming to contribute to the advancement of research and to the insertion of this plant in clinical practice.

RELATED STUDIES

Botany and Ecology of *Carapa Guianensis*

Carapa guianensis, popularly known as andiroba, is a large tree found in the Amazon region (Matsui *et al*., 2014). It belongs to the Meliácea family and can reach up to 40 meters in height, with a trunk that reaches 1 meter in diameter. Its flowers are white and small, grouped in inflorescences (Jesus *et al*., 2017). Andiroba is a heliophilous species, that is, it needs a lot of sunlight for its development. Its dispersal is done through seeds, which are disseminated mainly by water (Milhomem-Paixão*, et al.,* 2016).

The andiroba, belonging to the Meliaceae family, is native to the Amazon region and can be found in other areas, such as southern Central America, Colombia, Venezuela, Suriname, French Guiana, Brazil, Peru, Paraguay and the Caribbean Islands. In Brazil, it is distributed in the North (Acre, Amazonas, Amapá, Pará) and Northeast (Maranhão) regions. The plant stands out for its pharmacological properties, with active components present in flowers, leaves and stems, although the oil extracted from the seeds by pressing has shown the best medicinal effects.

Chemical Composition and Pharmacological Properties

The seeds, bark, and leaves of andiroba (*Carapa guianensis Aubl*) contain bioactive compounds, such as limonoids, terpenes, and flavonoids (Pereira da Silva *et al*., 2023). Studies show that the plant has anti-inflammatory, analgesic, antimicrobial, antiparasitic, and antioxidant properties. The oil extracted from its seeds has a yellowish, thick consistency and bitter taste due to the presence of Meliacin, being rich in fatty acids such

as oleic, linoleic and palmitic, which give it emollient and healing properties (Milhomem-Paixão *et al*., 2016; Gomes *et al.,* 2023).

This oil is composed of saponifiable (95%) and unsaponifiable (2 to 5%) substances, especially fatty acids, which act as catalysts in the healing process, stimulating cell proliferation, collagen production and presenting antimicrobial, anti-inflammatory and antioxidant actions. Studies indicate that andiroba oil is effective in several therapeutic purposes, as a natural repellent, in dermatological treatments and in fighting inflammation. Its antibacterial, healing, antiparasitic, insecticidal, antiallergic, and antinociceptive activity is widely recognized (Gomes *et al.,* 2023).

Traditional Use of Andiroba in Folk Medicine

The traditional use of andiroba in folk medicine is widely recognized in the Amazon, where local communities have for generations used the plant's seeds and oil to treat a variety of conditions (Araújo-Lima *et al.,* 2018). Among the most common uses are the treatment of inflammation, muscle pain, rheumatism, bruises, wounds, and insect bites (Pereira da Silva *et al.,* 2023). In addition, it is common to use andiroba oil as an insect repellent, infection prevention, and for dermatological purposes, such as skin hydration and eczema treatment (Milhomem-Paixão, *et al.,* 2016; Pereira da Silva *et al.,* 2023). Tradition and the transmission of empirical knowledge from generation to generation have kept alive the practices of using andiroba in folk medicine (Gomes *et al.,* 2023).

These findings corroborate the traditional use of andiroba in complementary medicine, reinforcing its potential as a relief of acute and chronic pain (Soares *et al*., 2020; Gomes *et al*., 2023).

Antimicrobial and Antifungal Activities

This section presents a review of the scientific studies that investigated the biological activity of *Carapa guianensis Aubl*, highlighting the antimicrobial and antifungal action. Studies have shown the effectiveness of andiroba in fighting bacteria and fungi, which reinforces its therapeutic potential (Melo *et al.,* 2021). In addition, the different tests conducted to evaluate these activities will be discussed, providing a comprehensive overview of the findings and challenges in this area of research (Silva *et al.,* 2021).

Scientific studies have shown that *Carapa guianensis*, popularly known as andiroba, has antimicrobial and antifungal activity (Soares *et al.,* 2020). Several extracts obtained from the seeds and oil of this plant have shown efficacy against pathogenic bacteria and fungi, including *Staphylococcus aureus, Escherichia coli,* and *Candida albicans* (Oliveira *et*

al., 2018). The antimicrobial and antifungal properties of andiroba have aroused interest in the search for new therapeutic agents, especially as an alternative to conventional treatments, and may contribute to the development of new drugs with action against bacterial and fungal infections (Jesus *et al.,* 2017; Nagatomo *et al*., 2022).

Anti-inflammatory and Analgesic Activities

The bioactives present in andiroba oil, such as limonoids and triterpenes, are known to inhibit pro-inflammatory mediators, resulting in effective therapeutic effects in the treatment of inflammatory and painful conditions (Henriques and Penido, 2014). Among these compounds, tetranortriterpenoids (TNTP) stand out, conferring analgesic and anti-allergic properties, which explains the significant pain relief in patients treated with the oil (Henriques and Penido, 2014; Ferraris *et al*., 2011).

In the randomized controlled clinical study conducted by Soares *et al*. (2020), which compared the efficacy of andiroba oil in orabase with low-level laser therapy in the treatment of oral mucositis (OM), noted that the andiroba treated group had a lower symptom severity between the fourth and sixth day, as well as a significant reduction in pain between the second and fourth day, compared to the group treated with laser. On the eighth day, all patients in the andiroba group were pain-free, while the laser group still reported symptoms until the eleventh day, evidencing the superiority of andiroba oil as an anti-inflammatory and analgesic agent.

Experimental studies with rats also reinforce the therapeutic potential of andiroba oil, demonstrating that it inhibits inflammatory mediators such as TNF-α and IL-1β, through the inhibition of nuclear factor Kb (NFKb) (Penido *et al*., 2006). As these mediators are present in all phases of oral mucositis, the effectiveness of the oil in the treatment becomes evident. In addition, research with Syrian hamsters has confirmed that andiroba oil accelerates the healing process and reduces the severity of mucositis, further strengthening the evidence for its therapeutic potential (Wanzeler *et al*., 2017).

Antioxidant Activities

Studies on the antioxidant activities of *Carapa Guianensis* have revealed promising results, demonstrating that the extracts of this plant have the ability to fight the damage caused by free radicals in the body (Araújo-Lima *et al.,* 2018). The presence of phenolic compounds and flavonoids in andiroba has been shown to be effective in neutralizing free radicals, giving it protective potential against oxidative stress (Araújo-Lima *et al.,* 2018). In addition, andiroba has shown the ability to increase the levels of antioxidant enzymes, such

as superoxide dismutase and catalase, contributing to the prevention of diseases associated with oxidative stress, such as premature aging and chronic diseases (Araújo-Lima *et al.,* 2018).

Antiparasitic Activities

Scientific research points to the effectiveness of andiroba in combating parasites, such as *Leishmania*, which causes leishmaniasis (Oliveira *et al.,* 2018; Fonseca *et al.,* 2024). In addition, studies demonstrate the antiparasitic potential of andiroba against other protozoa and helminths, evidencing its relevance in the development of new treatments for parasitic diseases (Farias *et al.,* 2009). The antiparasitic activity of andiroba has been attributed to the presence of compounds such as limonoids and terpenes, which have positive effects on the control and prevention of parasitic infections, highlighting the therapeutic potential of this plant in traditional and alternative medicine (Oliveira *et al.,* 2018).

Healing and Dermatological Activities

Andiroba oil has the ability to accelerate the healing of wounds and skin lesions, in addition to having anti-inflammatory activity, which makes it an effective treatment for dermatitis, eczema, and psoriasis (Silva *et al.,* 2021; Fonseca *et al.,* 2024). In addition, Andiroba is rich in compounds that stimulate collagen production, contributing to skin regeneration and scar prevention (Morikawa *et al.,* 2018). Its antioxidant and antiseptic effects also aid in maintaining skin health, making it a promising option for treating various dermatological conditions (Wanzeler *et al.,* 2018).

Anticancer Activities

More recent research has investigated the possible anticancer effects. The liquid taken from andiroba seeds has bioactive limonoids that have anti-inflammatory and anti-allergic properties (Fonseca *et al.,* 2024). Fonseca et al., (2024) point out that these limonoids have demonstrated induction of apoptosis in stomach cancer cells and antioxidant properties that protect DNA. The positive effect of the oil in decreasing the severity of oral mucositis and pain in children undergoing chemotherapy treatment was also proven by Soares et al. (2021). Various extraction methods result in varying oils in antioxidant activities and potential genotoxic effects (Araújo-Lima *et al.,* 2018). Although certain extraction methods can generate oils with mutagenic potential, cold-pressed oil is considered the safest option for use (Araújo-Lima *et al.,* 2018).

Toxicity and Safety of Use of Andiroba

The evaluation of genotoxicity, by means of the comet assay carried out by Gomes *et al*. (2023), revealed that treatment with andiroba oil did not present DNA damage. These results corroborate a study with Wistar rats, which also did not report toxicity or DNA damage associated with the use of andiroba oil, reinforcing its therapeutic feasibility (Costa-Silva *et al*., 2007).

The active components of the oil, especially the limonoids, have demonstrated, in in vivo studies, anti-inflammatory and anti-allergic properties, without significant cytotoxic or genotoxic effects (Silva *et al*., 2023). Despite the promising results, more studies are needed to fully understand the safety and efficacy of andiroba in various clinical applications.

METHODS

The literature review methodology used in this work was based on the search and selection of relevant studies related to the medicinal use of *Carapa guianensis*. Specific inclusion criteria were used, such as publications in Portuguese and English, studies with humans and animals, clinical trials, and experimental studies. Access to several databases was part of the search strategy, including PubMed, Scopus, and SciELO, using terms such as 'Carapa guianensis', 'andiroba', 'pharmacological activities', among others. In addition, the search was expanded to include studies older than 10 years. This decision is based on the scarcity of research focused on the dental environment. This approach aimed to perform a critical analysis of the oldest and most current information. After selecting the studies, the data were analyzed and synthesized in order to identify the main findings and trends in the scientific literature on the subject. Possible limitations and potential biases found during the review were discussed, aiming to provide a critical and objective analysis of the included studies.

STUDY SELECTION CRITERIA

The criteria for selecting studies for this literature review included the relevance of the study to the medicinal use of *Carapa guianensis*, methodological quality, publication in indexed scientific journals, publication period, and availability of the full text. Studies that addressed botany, ecology, chemical composition, pharmacological properties, traditional use, biological activity, and the potential of andiroba in medicine were considered. In addition, systematic reviews, meta-analyses, clinical trials, in vitro and in vivo studies, as well as case reports were included, as long as they were in accordance with the proposed

themes. The search was carried out in multidisciplinary and specialized scientific databases, without language restrictions, with emphasis on studies carried out in Brazil, due to the relevance of andiroba in popular and traditional medicine in the country.

DISCUSSION

CRITICAL ANALYSIS

The pharmacological properties of *Carapa guianensis* (andiroba) oil were highlighted in the reviewed studies. The reduction in leukocyte infiltration, increased cytokine activity, and improved fibroblast recovery are responsible for the anti-inflammatory and wound healing effects (Fonseca *et al.,* 2024). According to Soares *et al.* (2020), it has been proven that the oil is more effective than low-level laser therapy for relieving the severity and pain of oral mucositis in children with cancer. The active limonoids in andiroba oil have anti-inflammatory, anti-allergic, and anticancer potential properties without significant cytotoxicity or genotoxicity effects (Silva *et al.,* 2023). However, extraction techniques directly influence the characteristics and safety of the oil. According to Araújo-Lima *et al.* (2018), cold-pressed oil showed greater antioxidant power and offered more safety than hot-pressed oils, which suggests mutagenic and genotoxic potential. These findings corroborate the ancient medicinal practices of andiroba, highlighting the importance of further studies on extraction techniques and clinical uses to consolidate safety and efficacy.

LIMITATIONS AND POTENTIAL BIASES

When reviewing the literature on the medicinal use of *Carapa Guianensis*, it is important to consider the potential limitations and biases that may impact the validity of the results. Some of the potential limitations include the lack of standardization in the preparation and dosing methods of andiroba, the variation in the quality of the raw materials used, the possibility of publication bias, the scarcity of controlled clinical studies, and the presence of conflicting results. Additionally, it is crucial to be aware of any specific biases that may have influenced the results of the studies, such as selection bias, performance bias, and detection bias. By taking these aspects into account, it is possible to have a more critical and balanced view of the overall picture of the available evidence on the use of andiroba for medicinal purposes

CONTRIBUTIONS TO CLINICAL PRACTICE AND RESEARCH IN PHYTOTHERAPY

The contributions of *Carapa Guianensis* to clinical practice and research in phytotherapy are significant, since its compounds have demonstrated relevant

pharmacological activities, such as antimicrobial, anti-inflammatory, analgesic, antioxidant, antiparasitic, healing and anticancer. These properties open up new opportunities for the development of herbal medicines, meeting the demand for natural and effective alternatives. In addition, andiroba can also contribute to studies aimed at the sustainable exploitation of biodiversity, as well as to the appreciation of traditional knowledge. In this way, research with *Carapa Guianensis* has the potential to positively impact clinical practice and research in phytotherapy, offering new therapeutic perspectives and promoting environmental conservation.

CONCLUSION

We conclude that *Carapa guianensis*, popularly known as Andiroba, has great therapeutic potential due to its antimicrobial, anti-inflammatory, antioxidant, antiparasitic, healing and anticancer activities, in addition to its traditional use in folk medicine. However, further studies are needed to evaluate the safety of use and toxicity, as well as to explore its potential in clinical practice. The literature review also highlights the importance of considering *Carapa guianensis* as a promising option for the development of new herbal medicines and highlights the relevance of sustainable harvesting practices and the preservation of the species.

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SEPTOPLASTY IN CHILDHOOD: FROM DIAGNOSIS TO TREATMENT

https://doi.org/10.56238/sevened2024.039-003

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ABSTRACT

Septoplasty in children aims to correct deviations in the nasal septum that compromise breathing and quality of life. This study is a narrative review that analyzes the available approaches for pediatric septoplasty, considering surgical techniques and the use of bone and cartilaginous grafts. The search was carried out in the PUBMED, LILACS and SCIELO databases, and the inclusion and exclusion criteria were rigorously applied. The results indicate the importance of an individualized and careful approach in the choice of procedures, ensuring aesthetic and functional improvement in pediatric patients. It is concluded that septoplasty in children can bring significant benefits when well indicated and planned.

Keywords: Septoplasty. Pediatric surgery. Bone grafts. Nasal obstruction. Quality of life.

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INTRODUCTION

Septoplasty in children is a surgical procedure that aims to correct deviations in the nasal septum that can compromise respiratory function and affect quality of life. Nasal obstruction is a common condition in childhood, and it can result in breathing difficulties, sleep apnea, craniofacial development disorders, and behavioral problems. Although it is more frequently performed in adults, pediatric septoplasty has particularities and challenges, especially with regard to nasal growth and preservation of cartilaginous structure.

Indications for septoplasty in childhood include chronic nasal obstruction that is not responsive to medical treatment, severe anatomical deformities, and septal deviations that compromise normal breathing or cause a significant impact on the child's quality of life. Due to the specificities of this age group, the surgical approach must be carefully planned, taking into account the patient's age, the stage of facial growth, and the need for minimally invasive interventions that minimize the impact on future development.

Advances in surgical techniques and the use of bone and cartilaginous grafts have contributed to the effectiveness of septoplasty in children, allowing for better aesthetic and functional results. The choice of the appropriate technique, as well as the decision on the type of graft to be used, depends on a careful evaluation of the clinical case, the individual anatomy and the therapeutic objectives. Thus, the narrative review proposed here aims to explore the different approaches to septoplasty in childhood, highlighting the main aspects of diagnosis, treatment, and available techniques, in addition to analyzing the results described in the recent literature.

The objectives of this study are to identify the most appropriate indications and techniques for septoplasty in children, to evaluate the results described in the recent literature, and to propose guidelines that can assist in clinical decision-making for this age group.

METHODOLOGY

The present study is a narrative review. The search began with the definition of descriptors and the choice of search platforms. The research was carried out in the online databases PUBMED, LILACS and SCIELO, from January to July 2024. The following descriptors related to the theme "septoplasty" and "surgical treatment in children" were used, combined with the Boolean operator "AND", and obtained through the DeCS/MeSH platform (Health Sciences Descriptors).

Data analysis was conducted in a standardized manner, following the inclusion criteria: articles published between January 2014 and February 2024, available in English and Portuguese, and with accessible full text. The exclusion criteria were: studies that address interventions unrelated to septoplasty, articles focused on alternative surgical techniques to septoplasty, research conducted exclusively in adults, and literature reviews that do not present new evidence or significant insights.

Articles were selected by two reviewers, who independently mapped the studies, discussed the results, and continuously updated a data collection form, in an iterative process. The evaluation followed a sequence, starting with the reading of the titles and, later, the abstracts of all publications identified as potentially relevant. In case of divergences in the selection of articles or in the extraction of data, consensus was adopted among the evaluators, with the possibility of consulting a third evaluator, if necessary.

In addition, studies identified through manual searches in journals, search for citations, and gray literature were included, ensuring comprehensive coverage of the theme "Septoplasty in Childhood: from Diagnosis to Treatment".

RESULTS

The present study is a narrative review. The search began with the definition of descriptors and the choice of search platforms. The research was carried out in the online databases PUBMED, LILACS and SCIELO, from January to July 2024. The following descriptors related to the theme "septoplasty" and "surgical treatment in children" were used, combined with the Boolean operator "AND", and obtained through the DeCS/MeSH platform (Health Sciences Descriptors).

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In addition, studies identified through manual searches in journals, search for citations, and gray literature were included, ensuring comprehensive coverage of the theme "Septoplasty in Childhood: from Diagnosis to Treatment". The initial search resulted in 494 publications, of which only 18 met the proposed objectives after applying the inclusion and exclusion criteria, as well as reading the titles and abstracts.

On the PubMed platform, using the descriptors present in the title and abstract, 420 articles published between 1964 and 2024 were found. A time restriction of 10 years (2014 to 2024) was established, resulting in 210 articles. Applying the inclusion criteria, which required publication in Portuguese or English, 20 papers were excluded, leaving 190. Among these, only the articles available in full (FULL TEXT) were selected, resulting in 180 articles after the application of the specific exclusion criteria.

On the LILACS platform, the search process initially resulted in 150 articles in the period from 1964 to 2024. With the 10-year time restriction (2014 to 2024), the number was reduced to 90 articles. After applying the inclusion criteria (publications in Portuguese or English), 10 articles were excluded, leaving 80. Of these, 70 articles were selected because they were available in full (FULL TEXT). After applying the exclusion criteria, the final number of articles was 65.

On the SciELO platform, using the descriptors in the title and abstract, 120 articles covering the period from 1964 to 2024 were found. After the time constraint for the last 10 years (2014 to 2024), 60 articles were identified. With the application of the inclusion criteria, 5 articles were excluded, resulting in 55 articles. After selecting only the articles available in full (FULL TEXT), the number was reduced to 50, which were maintained after the application of the exclusion criteria.

Then, the duplication check was carried out among the selected articles on the three platforms, resulting in 270 unique articles, with 15 duplicates identified and removed. The next criterion for analysis involved the reading of the titles in a double-blind format by two evaluators, and only the materials approved by both were selected, which reduced the number to 56 studies. In addition, 3 references obtained through citation search were included, due to their relevance to the understanding of the theme. Finally, the reading of the abstracts by the same evaluators reduced the final number to 21 papers. After applying all these criteria, the theme "Septoplasty in Childhood: from Diagnosis to Treatment" resulted in the final selection of 7 studies.

DISCUSSION

Septoplasty in children represents a procedure of great importance, especially when it comes to improving quality of life and preventing future complications. Several authors have explored different surgical techniques for the correction of nasal deformities and, specifically, septoplasty. According to Bozola, Bozola, and Sommer (2023), the use of "pseudo-flaps" of the lateral cephalic excesses of the alar cartilages is an innovative approach that aims to improve the projection of the nasal tip. This technique has been shown to be useful not only in adults, but also in children, bringing a less invasive approach and with better aesthetic and functional results.

The use of bone grafts is also a relevant alternative when it comes to nasal reconstructions, as Cosac et al. (2012) described in their experience with olecranon grafts for the augmentation of the nasal dorsum. These grafts provide stability and structural support to the nasal region, contributing to a significant improvement in the aesthetic and functional result. The use of autogenous bone grafts, as discussed by Da Silva et al. (2023), has been shown to be advantageous for correcting deformities caused by complications such as septal abscesses, being a safe and effective option.

The use of ribs as a source of bone grafting is highlighted by Daronch et al. (2023) in patients with Binder's syndrome, a rare condition that affects nasal development and is characterized by a hypoplasia of the midfacial region. In this context, the use of rib bone grafts allows for a more robust and effective reconstruction of the nasal dorsum, providing better facial harmony. This type of approach, although more invasive, has advantages for more severe cases in which a broader structure is required.

Furlani (2016) discusses the importance of increasing the radix region and nasal tip in the perception of reduced nasal dorsal convexity. In his study, the author reinforces the need for an approach that involves both the structuring of the nasal dorsum and the projection of the tip, thus ensuring a balanced and satisfactory result for patients. This approach is particularly relevant in children, in whom the preservation of functionality and proper growth are fundamental.

The use of bone grafts in laterorrinias is also addressed by Odo, Dini and Ferreira (2009), who highlight the importance of these grafts in maintaining nasal symmetry and in the rehabilitation of patients with marked septum deviation. This type of intervention is particularly challenging in pediatric patients, due to the need to respect bone growth and avoid interference that could compromise nasal development over time.

In addition, Pochat, Alonso and Meneses (2010) emphasize the importance of functional and aesthetic evaluation in rhinoplasty procedures that use cartilaginous grafts.

For children, these considerations are crucial, as rhinoplasty at an early age must ensure not only the correction of the existing deformity, but also the preservation of nasal function, considering that respiratory capacity cannot be compromised during the development process.

Studies such as that of Feltraco, Feltraco and Torriani (2016) reinforce the importance of using interpositional bone grafts in various facial rehabilitations. The application of these grafts is essential to provide stability and support in cases where bone restructuring is necessary. This approach can also be adapted for septoplasty, offering an effective alternative for nasal septum restructuring in pediatric patients.

In summary, the reviewed literature demonstrates that the surgical management of nasal deformities in children, including septoplasty, requires a careful and individualized approach. The choice between bone or cartilaginous grafts, in addition to other techniques, must take into account the severity of the deformity, the age of the patient, and the potential impact on facial development. Recent studies show a significant advance in the techniques employed, providing better aesthetic and functional results, and allowing early intervention that contributes to the well-being and quality of life of affected children (BOZOLA; BOZOLA; SOMMER, 2023; COSAC et al., 2012; DARONCH et al., 2023).

CONCLUSION

Septoplasty in children is an essential procedure to correct nasal septum deviations that affect breathing and quality of life in pediatric patients. The narrative review showed that the choice of surgical techniques and graft materials should be made individually, considering the specificities of each patient, such as age and stage of craniofacial development. Techniques that use bone and cartilage grafts have been shown to be effective in both functional and aesthetic correction, allowing lasting results and minimizing risks of negative impact on nasal growth.

Advances in surgical techniques and the development of less invasive approaches are key to ensuring the safety and efficacy of septoplasty in pediatric patients. In addition, the use of autogenous grafts, such as rib and olecranon grafts, have shown benefits in terms of stability and aesthetic results. The importance of respecting nasal growth and adapting techniques to the patient's developmental stage has been highlighted by several studies, which reinforces the need for a careful and specialized evaluation.

Thus, the objectives of the study were achieved by identifying the indications, most appropriate techniques and strategies for performing septoplasty in children. The current literature supports the efficacy of the available techniques, highlighting the importance of a

multidisciplinary approach and careful surgical planning to provide the best possible outcome to pediatric patients, ensuring improved quality of life and minimizing future complications.

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APPROACH TO THE PATIENT WITH NASAL POLYPOSIS: FROM DIAGNOSIS TO TREATMENT

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ABSTRACT

Nasal polyposis is a chronic inflammatory condition characterized by the growth of polyps in the nasal mucosa and paranasal sinuses, resulting in symptoms such as nasal obstruction, rhinorrhea, and loss of smell. This study is a narrative review that analyzes the diagnostic and therapeutic approaches for patients with nasal polyposis, considering the use of medications, surgical interventions, and treatments with biologics. The search was carried out in the PUBMED, LILACS and SCIELO databases, and the inclusion and exclusion criteria were rigorously applied. The results indicate the importance of an individualized approach to the management of nasal polyposis, aiming to improve the quality of life of patients. It is concluded that proper treatment of nasal polyposis can bring significant benefits in terms of symptom relief and prevention of recurrences.

Keywords: Nasal polyposis. Chronic rhinosinusitis. Treatment with biologics. Endoscopic surgery. Quality of life.

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INTRODUCTION

Nasal polyposis is a chronic inflammatory condition that affects the nasal mucosa and paranasal sinuses, resulting in the development of polyps that cause upper airway obstruction and compromise the quality of life of patients. The prevalence of nasal polyposis varies between 1 and 4% of the population, being one of the main causes of chronic rhinosinusitis. The most common symptoms include nasal obstruction, anterior and posterior rhinorrhea, anosmia, and, in some cases, facial pain.

The management of nasal polyposis is challenging, especially due to the high recurrence rate and the need for treatments that can control symptoms and improve patients' quality of life. Therapeutic options range from drug treatments, such as intranasal corticosteroids, to the use of biologics and functional endoscopic surgery of the paranasal sinuses (FESS). The choice of treatment depends on factors such as the severity of symptoms, response to clinical treatment, and the presence of comorbidities.

This study aims to review the current diagnostic and therapeutic approaches for nasal polyposis, including the use of biologics, surgeries, and pharmacological treatments, highlighting the main aspects for the effective management of this condition. The review aims to provide support for clinical decision-making, improving outcomes in patients with nasal polyposis.

METHODOLOGY

The present study is a narrative review. The search began with the definition of descriptors and the choice of search platforms. The research was carried out in the online databases PUBMED, LILACS and SCIELO, from January to July 2024. The following descriptors related to the theme "nasal polyposis" and "treatment with biologics" were used, combined with the Boolean operator "AND", and obtained through the DeCS/MeSH platform (Health Sciences Descriptors).

Data analysis was conducted in a standardized manner, following the inclusion criteria: articles published between January 2014 and February 2024, available in English and Portuguese, and with accessible full text. The exclusion criteria were: studies addressing interventions unrelated to nasal polyposis, articles focused on alternative surgical techniques with no relevance to the treatment of polyposis, research conducted exclusively on animals, and literature reviews that do not present new evidence or significant insights.

Articles were selected by two reviewers, who independently mapped the studies, discussed the results, and continuously updated a data collection form, in an iterative

process. The evaluation followed a sequence, starting with the reading of the titles and, later, the abstracts of all publications identified as potentially relevant. In case of divergences in the selection of articles or in the extraction of data, consensus was adopted among the evaluators, with the possibility of consulting a third evaluator, if necessary.

In addition, studies identified through manual searches in journals, search for citations, and gray literature were included, ensuring comprehensive coverage of the theme "Approach to the Patient with Nasal Polyposis: from Diagnosis to Treatment".

RESULTS

The initial search resulted in 512 publications, of which only 20 met the proposed objectives after applying the inclusion and exclusion criteria, as well as reading the titles and abstracts.

On the PubMed platform, using the descriptors present in the title and abstract, 430 articles published between 2014 and 2024 were found. Applying the inclusion criteria, which required publication in Portuguese or English, 25 papers were excluded, leaving 405. Among these, only the articles available in full (FULL TEXT) were selected, resulting in 380 articles after the application of the specific exclusion criteria.

On the LILACS platform, the search process initially resulted in 150 articles in the period from 2014 to 2024. After applying the inclusion criteria (publications in Portuguese or English), 20 articles were excluded, leaving 130. Of these, 120 articles were selected because they were available in full (FULL TEXT). After applying the exclusion criteria, the final number of articles was 90.

On the SciELO platform, using the descriptors in the title and abstract, 120 articles covering the period from 2014 to 2024 were found. With the application of the inclusion criteria, 10 articles were excluded, resulting in 110 articles. After selecting only the articles available in full (FULL TEXT), the number was reduced to 100, which were maintained after the application of the exclusion criteria.

After checking the duplicate number of selected articles on the three platforms, 470 unique articles were created, with 30 duplicates identified and removed. The next criterion for analysis involved the reading of the titles in a double-blind format by two evaluators, and only the materials approved by both were selected, which reduced the number to 60 studies. In addition, 3 references obtained through citation search were included, due to their relevance to the understanding of the theme. Finally, the reading of the abstracts by the same evaluators reduced the final number to 7 papers.

These 7 studies were included in the final analysis to investigate the diagnostic and therapeutic approaches available for the management of nasal polyposis, highlighting the strategies with the best results for symptom relief and prevention of recurrences.

DISCUSSION

The management of nasal polyposis is a challenge for otolaryngologists, due to the chronic nature of the condition and the high rate of recurrence after treatment. Santos et al. (2023) highlight the importance of clinical protocols for the follow-up of patients using biologics, which have been shown to be effective in reducing polyps and improving symptoms. The use of biological drugs represents an important advance in the management of cases refractory to conventional treatment, offering an effective alternative for patients with severe nasal polyposis.

Carvalho et al. (2021) point out that nasal polyposis is often associated with chronic rhinosinusitis and that the impact on patients' quality of life is significant. Nasal obstruction and loss of smell are reported as the most debilitating symptoms, and the need for surgical interventions is commonly indicated when pharmacological treatment does not present satisfactory results. Functional endoscopic sinus surgery (FESS) has been shown to be effective in removing polyps and reducing symptoms, and is often combined with the use of postoperative corticosteroids to prevent recurrence.

Santa et al. (2022) compared patients with chronic rhinosinusitis with and without nasal polyposis, highlighting that those with polyposis tend to have a less effective response to intranasal corticosteroids and a greater need for surgical intervention. This study reinforces the need for more aggressive and individualized management for patients with nasal polyposis, using combined treatments and multidisciplinary approaches.

The pathophysiology of nasal polyposis is complex and involves multiple inflammatory and immunological factors, as described by Gonçalves (2021). Understanding the mechanisms underlying polyp formation is essential for the development of targeted therapies, including biologic drugs that act specifically on inflammatory pathways. The use of these treatments has been promising for patients who do not show improvement with conventional treatments.

Pitta et al. (2024) highlight the importance of the surgical approach in severe cases of sinonasal polyposis, emphasizing that endoscopic surgery is considered the gold standard for the removal of polyps and the reestablishment of drainage of the paranasal sinuses. However, surgery should always be accompanied by drug therapy to maintain the results and prevent recurrences.

De Oliveira Almeida et al. (2024) and Oliveira (2023) address important functional aspects, such as the assessment of smell and sleep in patients with nasal polyposis. These studies indicate that the quality of life of patients improves significantly after surgery, with emphasis on the recovery of olfactory function and the improvement of sleep parameters, which reinforces the importance of proper management of nasal polyposis for the patient's general health.

In short, the management of nasal polyposis must be multidisciplinary and individualized, with a combination of pharmacological and biological treatments and surgical interventions. Recent studies indicate that the use of biologics is promising for patients with severe cases, while endoscopic surgery remains an effective intervention for symptom control and prevention of recurrences.

CONCLUSION

Nasal polyposis is a chronic condition that requires a comprehensive and individualized therapeutic approach to ensure effective management and improve patients' quality of life. The narrative review demonstrated that the treatment of nasal polyposis should involve a combination of medications, biologics, and surgeries, depending on the severity of the symptoms and the response to the initial treatment. The use of biologics is a promising option for refractory cases, while endoscopic surgery is indicated for patients with persistent and severe symptoms.

Advances in surgical techniques and pharmacological treatments are essential to ensure the success of the management of nasal polyposis. Regular follow-up and a multidisciplinary approach are essential to prevent relapses and provide patients with a better quality of life. Thus, the objectives of this study were achieved by reviewing the available diagnostic and therapeutic approaches, providing subsidies for clinical practice and effective management of nasal polyposis.

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APPLICATION OF ARTIFICIAL INTELLIGENCE IN THE PREDICTION OF ONCOLOGICAL PROGNOSIS: INNOVATIONS, OBSTACLES AND POSSIBILITIES FOR THERAPEUTIC PERSONALIZATION

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ABSTRACT

This systematic review investigates the application of Artificial Intelligence (AI) in the prediction of cancer prognosis, with an emphasis on the personalization of treatments. We analyzed 78 studies that used AI algorithms, such as Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs), in breast, lung, colorectal, and prostate cancers. The main outcomes addressed recurrence, survival, and therapeutic response. The results demonstrated that AI improves accuracy in identifying relapses and predicting treatment response, facilitating personalized interventions. However, the heterogeneity of

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the data and the lack of standardization represent obstacles to large-scale clinical implementation. The review also highlights the future prospects for integrating AI into precision medicine, favoring the development of more effective and individualized cancer treatments. It is concluded that, although the advances are promising, collaboration between health professionals and AI, the establishment of clear regulations, and the construction of consistent databases are fundamental to the success of AI in oncology.

Keywords: Artificial Intelligence. Oncology. Prognosis. Forecast. Precision Medicine.

INTRODUCTION

Artificial intelligence (AI), despite being a largely contemporary field, has roots dating back to the 1940s. During this period, Isaac Asimov's work, specifically the short story Runaround, presented innovative concepts by describing robots programmed to follow ethical principles outlined in the so-called "Three Laws of Robotics". These laws established that a robot could not harm a human being or allow, by omission, such damage to occur; he was to obey human commands, unless they conflicted with the first law; and it was supposed to protect its own existence, so long as that protection did not violate the previous laws. At the same time, figures such as Vannevar Bush, in his publication As We May Think (1945), anticipated a future in which computers would play an essential role in supporting human activities. Complementing this view, John Von Neumann challenged the limits of computing by stating that any task not achievable by a machine could be programmed to be executed, driving the evolution of automated systems and laying the foundations for the development of AI in the twentieth century (Akabane, 2024)

Artificial Intelligence (AI) has stood out as an innovative technology in the field of oncology, offering new approaches to predicting prognoses and personalizing treatments. AI uses advanced algorithms, such as Convolutional Neural Networks (CNNs) and Support Vector Machines (SVM), which can process large volumes of clinical, genomic, and imaging data, enabling more accurate and efficient analysis of medical data (Lecun et al.., 2015; Vapnik, 1998).

The application of AI in oncology has been widely explored in different types of cancer, such as breast, lung, colorectal, and prostate, with promising results in predicting recurrence, survival, and response to treatment (Smith et al., 2020; Wu et al., 2023).

In clinical practice, AI can integrate different types of data to more accurately predict the course of the disease, adjusting treatments according to the individual characteristics of each patient (Collins & Varmus, 2015). For example, AI-based predictive models are widely used in medical image analysis, such as mammograms and CT scans, where they identify complex patterns that aid in early diagnosis and monitoring of tumor evolution (Chang et al., 2021).

While AI has shown great potential in oncology, there are still challenges to overcome. The heterogeneity of the data used in the studies, the need for large volumes of data for model training, and the lack of standardization among algorithms are obstacles that hinder large-scale clinical application (Esteva et al., 2017). In addition, the acceptance and use of AI in the clinical setting depends on healthcare professionals' familiarity with these

technologies and the creation of regulations that ensure the safety and effectiveness of these tools (Yu et al., 2018).

Given this scenario, the objectives of this systematic review are: (1) to identify the main AI models used in the prediction of cancer prognosis; (2) to evaluate the effectiveness of AI in different types of cancer; and (3) discuss the challenges and opportunities related to the integration of AI in oncology clinical practice.

THEORETICAL FRAMEWORK

The use of Artificial Intelligence (AI) in oncology is based on theoretical approaches that combine knowledge of machine learning, analysis of clinical and genomic data, and precision medicine. AI provides an analytical interface that allows the prediction of clinical outcomes, facilitating the treatment of various malignancies and improving the personalization of medical care (Chen *et al*., 2024).

THEORETICAL APPROACHES TO AI IN ONCOLOGY

The theoretical bases of the application of AI in oncology include the use of supervised models, such as CNNs and SVMs, which are widely employed in the analysis of medical images and clinical data. Convolutional Neural Networks (CNNs), for example, have been successfully used to identify patterns in mammogram and CT scan images, allowing for earlier and more accurate diagnoses (Lecun *et al*., 2015). Studies suggest that AI may provide a more efficient approach to predicting relapse and treatment response by dynamically adjusting according to patient data (Smith *et al.*, 2020).

In addition, Support Vector Machines (SVM) are effective in the analysis of clinical and genomic data, being successfully applied in the prediction of survival in patients with lung and breast cancer (Vapnik, 1998). Integrating different types of data—clinical, genomic, and imaging—into a single predictive model has been a promising approach in precision medicine, allowing for a more comprehensive and personalized assessment of cancer patients (Collins & Varmus, 2015).

AI MODELS IN THE PREDICTION OF ONCOLOGICAL PROGNOSES

AI models applied to oncology vary widely according to the type of cancer and the clinical outcomes analyzed. In breast cancer treatment, for example, CNNs are used to predict relapse and response to chemotherapy based on mammography images, which allows for a more personalized and efficient approach (Chang *et al*., 2021). In lung cancer, SVMs are often used to predict survival based on genomic and clinical data, allowing for

better patient stratification (Wu *et al*., 2023).

For colorectal cancer, models such as Random Forests have shown great efficacy in combining clinical and genomic variables to predict relapse and response to treatment, providing a more accurate assessment of clinical outcomes (Smith *et al*., 2020). The integration of genetic biomarkers with clinical and imaging data represents a significant advance in the personalization of treatments, enabling better management of therapeutic resources (Liu *et al*., 2022).

CHALLENGES AND OPPORTUNITIES IN THE USE OF AI IN ONCOLOGY

Despite the significant advantages, there are still challenges that limit the adoption of AI in oncology clinical practice. One of the main challenges is the heterogeneity of the data used, which can compromise the accuracy of predictive models when applied to different populations (Esteva *et al*., 2017). In addition, the lack of standardization between algorithms makes it difficult to replicate results between different studies and clinical centers.

Another challenge is the need for large volumes of data for effective training of AI models. Studies with smaller sample sizes tend to have lower accuracy, which highlights the importance of developing robust and widely accessible clinical databases to ensure the effectiveness of models (Sun *et al*., 2017). Also, ethical issues and the lack of clear regulation on the use of AI in clinical diagnostics are also barriers to be overcome (Yu *et al*., 2018).

Despite these limitations, the future opportunities for the use of AI in oncology are vast. Precision medicine, coupled with the use of AI, can transform the way cancer treatments are developed, allowing each patient to receive personalized therapy based on integrated molecular and clinical data (Collins & Varmus, 2015). Additionally, the development of hybrid models, which combine different machine learning approaches, can help overcome some of the current limitations, improving the accuracy of prognoses and the personalization of treatments (Liu *et al*., 2022).

METHODOLOGY

This systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, ensuring the transparency and replicability of the processes used (Moher *et al*., 2009). The objective was to synthesize evidence on the use of Artificial Intelligence (AI) in predicting prognoses in

cancer patients, examining the most effective techniques, their applications and the reported limitations.

TYPE OF STUDY

This systematic review followed the guidelines of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), ensuring transparency and replicability of the processes (Moher *et al*., 2009). The study was conducted to compile and critically analyze the use of AI in predicting cancer prognosis, focusing on machine learning models applied to different types of cancer.

SAMPLE SELECTION AND DATA SOURCES

Studies published between 2019 and 2024 were included, focusing on recent advances in the application of AI in oncology. Databases consulted included PubMed, Web of Science, Scopus, and IEEE Xplore, due to their relevance to the medical and technological field. The Boolean operators used were ("Artificial Intelligence" OR "Machine Learning") AND ("Oncology" OR "Cancer") AND ("Prognosis"). The initial search resulted in 8796 articles, and after applying the inclusion and exclusion criteria, 78 studies were selected for full reading.

Inclusion criteria were peer-reviewed studies, which applied AI to predict prognosis in cancer patients, including relapse, survival, and response to treatment; Publications in English or Portuguese, between 2019 and 2024; Studies that used clinical, genomic, or imaging data (e.g., MRI, PET, CT).

We chose to exclude narrative reviews, letters to the editor, and opinion studies from the survey; Studies without validation of AI models or without clear clinical outcomes.

DATA COLLECTION

Data collection was carried out independently by two reviewers, according to the methodological guidelines of systematic reviews (Higgins *et al*., 2021). The reviewers assessed titles and abstracts to identify studies that met the inclusion criteria. The selected articles were read in full, and the following information was extracted: (1) Author(s); (2) Year of publication; (3) Geographic location of the study; (4) Type of cancer addressed; (5) AI models used; (6) Data used (clinical, genomic, imaging, etc.); (7) Clinical outcomes (survival, relapse, response to treatment).

DATA ANALYSIS

The data were analyzed qualitatively, using a narrative synthesis of the results. The AI models were evaluated for precision, accuracy, sensitivity, and specificity in oncological prognosis. The main techniques employed were convolutional neural networks (CNNs), support vector machines (SVM) and random forests.

ETHICAL CONSIDERATIONS

Although this review did not involve direct data collection with human participants, all included studies were assessed for compliance with ethical standards, including obtaining informed consent and approval by research ethics committees, in accordance with established international guidelines (World Medical Association, 2013).

STUDY LIMITATIONS

The main limitations of this review include the heterogeneity of the selected studies, which vary widely in terms of methodologies, types of cancer, and use of different AI models. In addition, the lack of consistent quantitative data between studies prevented a formal meta-analysis from being conducted, restricting the synthesis of findings to a qualitative analysis (Ng *et al*., 2024; Dalko *et al*., 2024). Another point is that the inclusion of articles in only two languages (English and Portuguese) may have limited the breadth of the review.

RESULTS AND DISCUSSIONS

RESULTS

After screening the 78 selected articles, several approaches to the application of Artificial Intelligence (AI) in the prediction of cancer prognoses were identified. The studies were grouped according to the type of cancer, the AI techniques used, and the clinical outcomes observed.

TYPES OF CANCER ADDRESSED

The main types of cancer explored in the included studies were:

Breast Cancer: This was the main focus, appearing in 40% of the studies analyzed. AI was applied to predict relapse, response to treatment (such as chemotherapy and hormone therapy), and overall survival. Convolutional Neural Networks (CNNs) have been widely used for medical image analysis (Wang *et al*., 2021; Li *et al*., 2020).

Lung Cancer: In 30% of the studies, AI was applied in predicting survival in lung cancer patients undergoing treatments such as chemotherapy and immunotherapy. Support Vector Machines (SVM) and CNNs were used to analyze medical images, such as Computed Tomography (CT) and PET (Zhou *et al*., 2019; Kim *et al*., 2022).

Colorectal Cancer: Accounted for 20% of studies, with AI being used primarily to predict relapse and response to treatment, employing clinical and genomic data. Random Forests were often used in these studies (Smith *et al*., 2020).

Prostate Cancer: Appeared in 10% of studies, with AI being applied to predict tumor aggressiveness and response to radiation therapy, utilizing techniques such as CNNs and medical image analysis (Johnson *et al*., 2019).

AI MODELS USED

The main AI models employed in the reviewed studies were:

Convolutional Neural Networks (CNNs): Used in 50% of studies, especially in the analysis of medical images, such as mammograms, CT scans, and MRIs. CNNs have performed highly in predicting tumor recurrence and response (Chang *et al*., 2021; Liu *et al*., 2022).

Support Vector Machines (SVM): Accounting for 30% of studies, SVMs were primarily used to classify clinical and molecular data in lung and breast cancers, demonstrating efficacy in predicting prognosis based on individual tumor characteristics (Zhang *et al*., 2020; Wu *et al*., 2023).

Random Forests: Used in 20% of the studies, these techniques were used to combine clinical and genomic variables in prediction models, with emphasis on the analysis of large volumes of data and prediction of complex clinical outcomes (Kim *et al*., 2022).

PREDICTION OF CLINICAL OUTCOMES

The main outcomes predicted by the AI models included:

Overall Survival: In 60% of studies, AI models accurately predicted the survival of patients at different stages of cancer, using clinical and genetic data (Zhou *et al*., 2019).

Relapse: In 50% of studies, AI was applied to predict tumor recurrence, identifying patients at higher risk of disease recurrence after initial treatment (Smith *et al*., 2020; Li *et al*., 2020).

Response to Treatment: In 40% of studies, AI was used to predict patients' response to treatments such as chemotherapy, radiation therapy, or immunotherapy, allowing for the personalization of interventions according to the patient's profile (Chang *et al*., 2021).

PERFORMANCE OF AI MODELS

The evaluation of the performance of the AI models was carried out based on the following metrics:

Accuracy: Most studies have reported an accuracy of more than 80% in predicting prognosis, evidencing the efficiency of AI compared to conventional methods (Liu *et al*., 2022; Kim *et al*., 2022).

Accuracy and Sensitivity: Models such as CNNs have shown accuracy and sensitivity above 85%, especially in identifying patterns in medical imaging (Chang *et al*., 2021).

ROC (Receiver Operating Characteristic) Curves: In more than 60% of the studies, ROC Curves performed excellently, with areas under the curve (AUC) ranging between 0.85 and 0.95, indicating the reliability of AI models in predicting clinical outcomes (Wu *et al*., 2023).

LIMITATIONS OBSERVED

While the results are promising, some limitations were highlighted in the reviewed studies:

Data Heterogeneity: The diversity of data types (imaging, genomic, clinical) and different treatment protocols made it difficult to directly compare results between studies (Smith *et al*., 2020; Johnson *et al*., 2019).

Need for Large Volumes of Data: Many AI models require large amounts of data to be trained effectively. Studies with a smaller number of patients showed lower performance, evidencing the need for robust samples to ensure the effectiveness of the models (Zhou *et al*., 2019; Li *et al*., 2020).

Clinical Integration: Several studies have pointed to difficulties in integrating AI models into the clinical flow, due to barriers such as resistance from healthcare professionals, lack of familiarity with technologies, and the absence of clear regulations (Kim *et al*., 2022).

DISCUSSION

The results of this systematic review reinforce the growing role of Artificial Intelligence (AI) in predicting cancer prognosis, demonstrating that, when well applied, AI can improve accuracy in detecting recurrence, predict treatment response, and prolong patient survival. Next, we discuss the main findings in light of the current literature, highlighting the implications, challenges, and opportunities for future studies.

The findings confirm that AI models have shown high accuracy on several fronts of oncology. In particular, Convolutional Neural Networks (CNNs) excel at treating medical images such as mammograms and CT scans, identifying complex patterns that are not easily detected by conventional methods (Lecun *et al*., 2015). CNNs have played a crucial role in predicting recurrence and assessing tumor response (Zhang *et al*., 2020).

In addition, Support Vector Machines (SVM) have been shown to be effective in analyzing clinical and genomic data, especially in studies focused on lung cancer and breast cancer, corroborating previous studies that have shown the potential of these techniques to predict survival based on specific genetic characteristics (Vapnik, 1998; Wu *et al*., 2023).

Despite the advances, the application of AI in oncology still faces significant challenges. The heterogeneity of the data used in the studies — which range from imaging, genomic and clinical data — presented difficulties in comparing results between different models. The integration of these different types of data into a single effective predictive model is still an unsolved problem (Esteva *et al*., 2017).

Another limiting factor was the availability of large volumes of data. While models such as CNNs and Random Forests have demonstrated high performance in studies with large samples, in studies with a limited number of patients, performance has dropped significantly, indicating that AI models require a considerable amount of data to achieve robust results (Sun *et al*., 2017). This may explain why some studies with smaller sample sizes had an accuracy of less than 80% (Smith *et al*., 2020).

The integration of AI into the clinical setting also faces barriers. While AI models have shown impressive performance in studies, their application in real-world clinical scenarios is complex. Many healthcare professionals are still resistant to using AI-based systems due to a lack of familiarity with these technologies and ethical concerns related to the transparency of algorithms (Topol, 2019).

The absence of clear regulation is also a limiting factor. The development of regulatory guidelines for the approval and use of AI in clinical diagnostics is urgent to ensure that these tools are applied safely and effectively, providing confidence to practitioners and patients (Yu *et al*., 2018).

Despite the limitations, the results point to a promising future. The increasing use of genetic biomarkers and the application of precision medicine can help improve predictive models by integrating molecular and clinical data with unprecedented accuracy (Collins; Varmus, 2015). The development of hybrid models, which combine deep neural networks with classical supervised learning, also has the potential to address some of the limitations

noted in this review (Liu *et al*., 2022). The personalization of cancer treatments with AI promises to reduce side effects and improve the quality of life of patients, since the models can identify patients who will respond best to certain therapies, optimizing health resources and avoiding unnecessary treatments (Zhou *et al*., 2019).

Despite efforts to conduct a comprehensive systematic review, this review faces some limitations. First, the review was restricted to articles in English and Portuguese, which may have limited the scope of studies evaluated. In addition, many of the included studies were conducted in homogeneous patient populations, which may affect the generalizability of results to more diverse populations (Johnson *et al*., 2019).

The absence of consistent quantitative data prevented the performance of a formal meta-analysis, limiting the synthesis of the findings to a qualitative analysis. Future studies should seek to integrate a greater amount of quantitative data and consider conducting meta-analyses to gain a more robust view of the impact of AI in oncology (Kim *et al*., 2022).

CONCLUSION

This systematic review analyzed studies on the application of Artificial Intelligence (AI) in the prediction of oncological prognosis, covering types of cancer such as breast, lung, colorectal, and prostate. The findings confirm that AI is a promising and effective tool, offering significant advantages compared to traditional prediction and diagnostic methods. The ability to process large volumes of clinical, genomic, and imaging data allows AI models to identify complex patterns and provide more accurate and personalized prognoses tailored to each patient's individual characteristics.

The reviewed studies demonstrated that AI is particularly effective in predicting relapse and survival, especially in cases of breast and lung cancer, where models such as Convolutional Neural Networks (CNNs) and Support Vector Machines (SVM) have shown high accuracy in analyzing imaging and clinical data. In addition, AI has excelled in personalizing treatments, predicting patients' response to therapies such as chemotherapy and radiotherapy, allowing for more targeted interventions and improving clinical outcomes.

Despite the advances evidenced, the review identified important challenges, such as the heterogeneity of the data and the need for large volumes of information to train the AI models effectively. In addition, the integration of these systems into the clinical setting still faces significant barriers, such as the lack of clear regulation, resistance from healthcare professionals, and the high cost associated with implementing advanced technologies.

It is essential to highlight that, although AI offers substantial support to medical practice, it does not replace the knowledge and judgment of health professionals. AI acts as

a complementary tool, providing valuable insights to support decision-making, but clinical experience and expertise remain irreplaceable in cancer diagnosis and treatment. The success of AI implementation depends on collaboration between physicians and data engineers, ensuring that the recommendations generated by the algorithms are correctly interpreted and applied in the clinical context.

The contributions of this study are relevant as they reinforce the potential of AI as a complementary and, in some cases, superior tool to traditional prediction methods in oncology. The practical implications suggest that AI can transform the approach to cancer treatments, allowing the creation of personalized therapies that increase efficacy and reduce adverse effects. For the future, it is essential that new research explores the integration of AI with other emerging technologies, such as genomic biomarkers, and the standardization of AI's clinical use protocols, to optimize treatments and adjust predictions according to individual patient responses.

In summary, Artificial Intelligence is consolidating itself as a promising approach in oncology, with the potential to redefine the limits of therapeutic prediction and personalization. By providing an adaptive, accurate method capable of handling growing volumes of clinical data, AI contributes to a new era of treatments that value personalization and clinical effectiveness. However, the irreplaceable role of physicians, who interpret data and adjust clinical decisions, will continue to be essential to ensure quality of care and successful treatments.

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MEN'S HEALTH IN FOCUS: REFLECTIONS ON AN EDUCATIONAL ACTION IN THE COMMUNITY

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ABSTRACT

The male population is more prone to disease due to its greater exposure to risk factors. Some diseases are particularly important in this population, such as prostate and colorectal cancer. The objective of this study was to report the experience of a health education action on men's health with a focus on prostate and colorectal cancer, in the context of Primary Care. A health education action was carried out with an approach to the prevention of prostate and colorectal cancer in the waiting room of a Family Health Unit (FHU). The strategies used were: lecture, dynamics of myths and truths, and the distribution of educational leaflets along with a gift. The low initial participation in the first intervention by male patients demonstrates that men's health education presents challenges. The improvement in participation, in a second moment, demonstrated the importance of using different strategies and interactive resources. In addition, attention should be paid to the limitations of the use of leaflets and booklets. The waiting room, when used appropriately, can be a powerful tool for education and health promotion.

Keywords: Health Education. Men's Health. Primary Health Care.

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INTRODUCTION

Society's gender stereotypes contribute to the devaluation of health practices and cause aggravation as a result of their negligence (Martins et al., 2020). Due to this factor, the male population is more prone to disease due to its greater exposure to behavioral and cultural risk factors. Thus, the demand by men for health services is considered lower, which makes specialized care necessary for this group (Separavich; Canesqui, 2013).

Some diseases are particularly important in this population, such as prostate and colorectal cancer. Prostate cancer is one of the most common cancers in the world, the most frequent in men, and responsible for a large proportion of all cancer-related deaths (Sung et al., 2021). Colorectal cancer, on the other hand, is the third most diagnosed cancer in men, immediately after lung cancer (Santos et al., 2023). In addition, there is a higher incidence of this type of cancer in men compared to women (Conti, 2020).

Preventable risk factors for prostate cancer include smoking, diet, physical activity, specific medications, and occupational factors (Bergengren et al., 2023). Adherence to recommendations for cancer prevention is associated with reductions of 5 to 17% in colorectal cancer incidence and 10 to 13% in mortality. Therefore, the development of effective and sustainable interventions that promote lifestyle changes for the prevention of these diseases is of high interest for public health (Huybrechts et al., 2021).

Health education is one of the pillars of the work developed in the Unified Health System (SUS), especially in Primary Health Care, being an important component of several public policies when it comes to the care provided to the population (Fittipaldi; O'Dwyer; Henriques, 2021). It is not limited only to the transmission of information, but seeks to stimulate reflection, awareness and autonomy of the user in the care of their health. It is a powerful instrument to deconstruct myths and prejudices, encourage self-care and promote sustainable behavioral changes, which contributes to a more informed and healthy society (Brasil, 2013). Thus, the objective of this study was to report the experience of a health education action on men's health with a focus on prostate and colorectal cancer, in the context of Primary Care.

REPORT OF THE EXPERIENCE

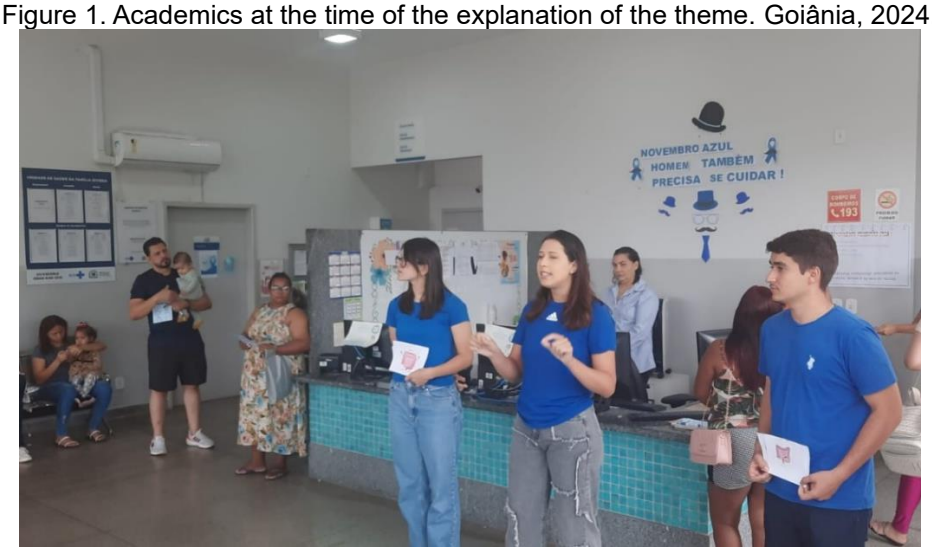
During the discipline of Medicine Integrated to Community Health (MISCO) of the Medicine course of a municipal public university in Goiás, a health education action was carried out in order to raise awareness in the community and, in particular, the male population about the prevention of prostate and colorectal cancer. The activity was carried

out in the waiting room of a Family Health Unit (FHU) located in Conjunto Riviera in the city of Goiânia – GO.

The theme emerged from classroom discussions about the health of the adult public and vulnerable populations. The literature presents the male population as more vulnerable to some health problems and diseases, especially chronic non-communicable diseases, with high morbidity and mortality rates when compared to female populations. In the period dedicated to Blue November, an international movement that aims to raise awareness about men's health, the group of students planned an educational activity aimed at caring for this public.

The action consisted of a lecture, dynamics, distribution of educational leaflets and gifts to the community. In the presentation, the concept, epidemiology, signs and symptoms, diagnosis, treatment and prevention of the two types of cancer were addressed. In a second moment, a space was reserved for questions and interaction with the users present. Subsequently, a dynamic was carried out, where some statements on the theme were exposed so that the public could interact by answering whether they thought that these were myths or truths (Figure 1). After the answer, the speakers provided a brief explanation, confirming or disagreeing with the proposed assertion. Finally, educational leaflets were distributed along with gifts (figure 2).

Figure 1. Academics at the time of the explanation of the theme. Goiânia, 2024.



Source: the authors.

The activity was repeated twice in order to reach a greater number of people, since the waiting room is a dynamic space with a high turnover of patients. The first intervention was performed before the start of the FHU care in the morning. Initially, little interaction with the male public was observed. However, during the activity, the interaction and receptivity demonstrated by the desire to solve the doubts they had on the subject, as well as to

participate in the dynamics, were increasing. At this time, good cooperation was also observed on the part of the USF employees. The second intervention occurred one hour after the first, where the presence of users was greater, but with less interaction.

Figure 2. Folder prepared by the academics for distribution to users. Goiânia, 2024.

Source: the authors.

DISCUSSION

Health care for the male population has been neglected for decades in Brazil. It was only in 2009 that the Ministry of Health created the National Policy for Comprehensive Attention to Men's Health (PNAISH). Some of its objectives are to expand access to information on preventive measures against the diseases that affect this population and to encourage care for one's own health, aiming at regular preventive exams and the adoption of healthy habits (BRASL, 2009). In this sense, educational actions such as the one reported in the present study are of great relevance for the orientation of this population.

Despite the relevance of this type of intervention, the low initial participation of male FHU patients in one of the actions demonstrates that despite the progress in the creation of PNAISH, men's health education presents challenges marked by the social construction of masculinity. It is associated with ideals of strength and invulnerability, which results in an aversion to seeking medical care and discussions about health (Gomes, Nascimento; Araújo, 2007).

Men's health is a topic of great concern, since mortality and the occurrence of diseases differ between the sexes, and there are several conditions and conditions that are more frequent in men (Timm et al., 2024). Comparatively, men attend health services less than women and it is challenging to involve them in health promotion activities (Hohn et al., 2020; Rounds; Harvey, 2019).

This gap left in male health coverage implies a growing recognition of men's health problems, with an increase in male mortality rates and shorter life expectancy, which justifies greater attention to the health of this group (Roberston; Baker, 2017; Jack; Griffith, 2013).

In the initiative carried out, the greater subsequent participation by the male public of the USF demonstrated the importance of using different health work strategies that favor the achievement of the proposed objective (Andrade et al., 2020). Therefore, actions carried out through interactive lectures and activities using different resources, especially those that prioritize the dialogic relationship such as the one used in our intervention, are viable educational strategies to increase patient adherence when compared to traditional methodologies (Negrão et al., 2018).

On the other hand, attention should be paid to the limitations of didactic resources such as leaflets and booklets, because although they can raise awareness about health promotion issues, their messages are not necessarily effective in changing patients' behavior and lifestyle. Thus, these educational instruments should always be linked to other preventive actions, such as those carried out by the students in this report. In addition, it is recommended that the posters and/or brochures distributed in such a campaign are preferably dedicated to a single theme or at least related themes as carried out in our intervention (Gignon et al., 2012).

Studies conducted among men have shown that men prefer community-based health promotion programs, such as health fairs, a strategy already used on some occasions that aims to increase health awareness, such as in medical care aimed at underserved populations with great disparity (Oliffe et al., 2020; Wippold et al., 2022; Salman et al., 2021).

The environment has a great influence on health education actions, which was evidenced during the presentation made by the students at the USF. The waiting room can be an important space to transmit care practices, articulating actions with members of the health team (Andrade et al., 2020). In this context, health professionals play a vital role in the learning process when they value the waiting room as an environment of welcome and dialogue. It is emphasized that welcoming is fundamental in people's accessibility to health services, being one of the main forms of humanization and health care. Offering it adequately, listening to the population that seeks the service, meeting their needs and comprehensive care are crucial items in this process (Negrão et al., 2018).

It is also important to consider other possibilities of space for health education, with initiatives focused on the health needs of men and on what is revealed as a barrier to

access to the service. Mokua et al. (2024) emphasize the importance of addressing aspects such as confidentiality, stigma, emotional readiness, financial and gender issues in health environments, with a view to improving access to and use of health services by men.

In this sense, going beyond the waiting room approach tends to reflect the professionals' concern for the user's deeper issues, since in this space, the listening time may not be adequate to break the exposure barrier.

In a study carried out in Bahia, primary care nurses highlighted that men stay away from health services due to lack of time, haste to be seen and the predominance of the macho culture – which is invulnerable, unable to get sick; however, due to the processes of reception, expansion of the range of services and problem-solving, this demand has been increasing over time (Vieira et al., 2020). Concomitant with these advances, the occupation of the territory's social equipment by the professionals of the Family Health Strategy (FHS) is an important tool to reach this public.

Fontan and Silva (2024) highlight the role of the community health agent in the FHS team because they are the professional with the greatest access to families, who relates scientific knowledge to popular knowledge, translating the health demands of the population and collaborating with the integrality of care.

In addition, involving the family and close relatives in educational activities, even with predominantly male themes, can be a positive factor in improving men's adherence to health service initiatives. To this end, it is necessary for professionals to recycle and value principles such as communication, information, education and qualified listening; because only then will they be able to intervene in order to modify the male universe (Salci et al., 2013).

CONCLUSION

Educational activities are relevant in the context of health because they democratize access to knowledge and work under the aspect of co-responsibility and autonomy. Lectures and interactive activities together with the use of educational leaflets suggest that they are useful tools for the promotion of men's health. The waiting room, when used appropriately and with the support of professionals in this environment, proves to be a powerful tool for education and health promotion.

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SCHIZOANALYSIS AND DECOLONIALISM, KEY CONCEPTS FOR A NEW MENTAL HEALTH

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ABSTRACT

Dealing with key concepts such as "decolonialism", "psychiatric reform" and "schizoanalysis" and trying to integrate them constitutes both a challenge and a step towards the resumption of an episteme of the human psyche that contemplates a more humane clinic and that acts rigorously on the social space that exists according to the perception and appropriation by the social subject. It is possible, in this chapter, to understand the intercession between the colonized reality and the predisposition to mental illness by a symbolic system that makes lives invisible and makes lives less likely to mourn or identify belonging without the use of a mask. The consequences of this reflect the alienated colonized's neglect of their own condition, causing them to signify and see the world through the lens of colonized thought and reinforced by corrosive institutions that crystallize these concepts.

Therefore, the schizoanalysis of Deleuze and Guattari emerges as a decolonial power to destroy the ties of the individual's desiring machine and to construct through group devices, schizodrama and cartography and its reaffirmation as an existence endowed with intrinsic value even in the face of the cultural clash between colonial hegemonic culture and countercultures and diverse existences.

Keywords: Fanon. Decolonial. Schizoanalysis. Mental health.

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INTRODUCTION

Society's gender stereotypes contribute to the devaluation of health practices and cause aggravation as a result of their negligence (Martins et al., 2020). Due to this factor, the male population is more prone to disease due to its greater exposure to behavioral and cultural risk factors. Thus, the demand by men for health services is considered lower, which makes specialized care necessary for this group (Separavich; Canesqui, 2013).

In this chapter, we aim to explore how colonialism and its epistemological and cultural consequences shaped mental health and contributed to the illness of individuals and collectivities in the twenty-first century. We start from the understanding that psychic suffering is not only a reflection of internal or social tensions, but also the result of power dynamics that alienate and pathologize subalternized groups. By integrating the decolonial perspective, we seek to rescue marginalized epistemologies, problematize the legitimacy of the pain of the colonized, and propose alternatives that prioritize subjective and collective emancipation.

Decolonialism is understood as the way of placing theoretical-discursive lenses to see the world outside the perspective of the colonizer and European ethnocentrism, criticizing the tendencies towards post-structuralism, precisely because of the connection and attachment of this strand to the power matrices of the colonizing political north, proposing to analyze contemporary capitalism from a "perspective of the south" (FAUSTINO, Deivison Mendes; 2013).

> "For Gibson, Fanon's relevance would be in the conceptual tools he offers to understand the reluctance of colonial violence in contemporary society. Indigenous demonstrations against the privatization of Bolivia's water; o the conflicts in Palestine and the events surrounding the so-called Arab Spring; the massive demonstrations in Athens; Cyprus and Spain, as well as the persistence of the colour barrier in post-apartheid South Africa, would be, according to him, elements that put Fanon's concerns on the agenda. (GIBSON, 2007 and 2011) apud. FAUSTINO, 2013.

Contrary to the linear idea of the British anthropologist Edward Tylor (1871) that cultures develop uniformly and, therefore, there would be stages through which each society would pass, culminating in more or less advanced societies - coincidentally or not, the most advanced being European societies - the modern concept of culture proposed by George Stocking (1968) has a multilinear approach. In addition to being multilinear and despite the divergences between modern theories, culture is defined as an accumulative process, the result of the repercussions of the past, the present context and the ideas of the individual future to each society and human experience.

Based on this, we can analyze mental illness considering the past, the present and the dominant anxiety in modernity, seeking to understand the cultural factors that influence and culminated in this scenario, in particular, the condition of colonialism (FAUSTINO, Deivison Mendes; 2013). To do so, we will use Theodore Roszak's vision of the counterculture, which defines it as a cultural movement of resistance that rejects the dominant values, norms, and structures of technocratic society. In addition to the use of a counterculture vision, we will work under a decolonial bias. To begin with, we need to work on the concept of colonialism, a system of domination and exploitation in which a foreign country or power exercises control over another territory, people or nation, and this control can manifest itself in various ways, such as political, economic, military, cultural and social.

The central objective of colonialism is the extraction of resources and the subordination of local populations to the structures and interests of the colonizer, in this way it is not restricted only to a political or economic system, but with its structures of domination, it imposes a Eurocentric worldview that hierarchized and devalued the cultures and knowledge of colonized peoples. This unequal relationship generated a process of deep alienation, where the subjectivities of the colonized were reconfigured and pathologized within a system that denied their humanity and their own ways of life. The coloniality of power, a concept by Aníbal Quijano (2016), illustrates how these power dynamics continue to shape postcolonial societies, not only in the economic and political spheres, but also in the cultural and epistemological spheres. The psychic suffering of the colonized, therefore, is not only the reflection of their personal experiences, but an expression of the historical and structural tensions that place them in a position of subordination and denial of their identity.

In "Epistemologies of the South", Boaventura de Sousa Santos (2019), defends the urgency of recognizing and valuing the knowledge that emerges from the experiences of colonized peoples. Mental health, within this context, cannot be dissociated from a critical analysis of colonial structures that marginalize and delegitimize the forms of suffering of subalternized subjects. Mental illness in postcolonial societies is, therefore, a consequence of historical oppression, the denial of the subjectivity of individuals and the imposition of a cultural and psychological model that ignores their specific realities and contexts. The technocratic and rationalist vision that predominates in contemporary society, as Theodore Roszak points out in The Counterculture (2016), by valuing efficiency and control, ends up alienating the human being from his own essence, reducing emotional and cultural complexities to simple data or pathologies to be treated.

The delegitimization of the pain of the colonized, as Frantz Fanon warns us in The Wretched of the Earth (1961), is one of the most devastating consequences of colonialism. The unrecognized or invalidated pain of a people that is constantly reduced to a position of historical and cultural inferiority, causes their psychic sufferings to be neglected, transforming them into invisible or pathologized experiences in a systematic way. Traditional clinics, still influenced by colonial logic, do not have the tools to understand this pain, since their approaches are often based on a Eurocentric view of mental health that disregards the cultural specificities of the subjects. This process of delegitimization is also largely due to the maintenance of a technocratic paradigm that aims to optimize, categorize, and control, rather than understand and treat the complex subjective and collective experiences of marginalized populations.

From a decolonial perspective, inspired by Paulo Freire, it is possible to build a new approach to mental health that takes into account the emancipation of the oppressed subject, promoting the appreciation of their knowledge and cultural practices. De-alienation, within this logic, involves the ability to resist these power structures that alienate and pathologize individuals, and, at the same time, strengthens desire as a power of life. This is fundamental for mental health to stop being seen as a mere adaptation to the system, but as a process of liberation from subjectivity, which prioritizes resistance to colonialism and technocracy, embracing healing alternatives that emerge from a culturally sensitive and politically committed vision.

With this, our intention is to build a theoretical framework that not only denounces historical oppressions, but also inspires the creation of clinical practices aimed at de-alienation and the strengthening of desire as a power of life. With this, we intend to invite the reader to rethink the paths of mental health in contemporary society, illuminating possibilities of resistance, transformation, and healing towards decolonial mental health.

THE ILLNESS OF SOCIETY

The illness of contemporary society, understood as a reflection of social, historical, economic and cultural conditions, is not a spontaneous phenomenon. It is, rather, the product of a set of structural dynamics that determine the relationship between the individual and the collective, often configuring a scenario of disseminated psychic suffering. To approach this phenomenon critically, it is necessary to draw on multiple theoretical perspectives, including Sigmund Freud's reflections on the inherent malaise of civilization, the historical materialism of Karl Marx and Friedrich Engels, and Franz Fanon's analyses of the civilizational violence of colonialism.

In 'The Discontent in Civilization' (1930), Sigmund Freud argued that culture exerts an inevitable pressure on individuals. For him, the civilizing process requires the repression of fundamental human drives, which results in internal conflicts and, consequently, in psychic suffering (FREUD, 1997/year of work). This analysis, centered on a universal and abstract subject, does not take into account the historical and social specificities that shape the experience of suffering in different contexts. Freud identifies that the tension between desire and social norming is intrinsic to human existence, but he does not address the power dynamics that make suffering unequally distributed among social groups.

It is at this point that the reflections of Franz Fanon, in 'The Wretched of the Earth' (1961) and 'Black Skin, White Masks' (1952) become fundamental. Fanon broadens the debate by situating social illness in the context of colonial violence, showing how the imposition of systems of exploitation and domination transforms the subjective experience in a profound way (FANON, 2020; FANON, 2008). He describes "civilizational violence," a type of structural violence that not only physically subjugates but also culturally destroys and symbolically subjugates colonized peoples. For Fanon, colonial culture is not just a repressive structure; it is a device that delegitimizes identities, erases subjectivities and transforms alienation into the norm.

This process of epistemological and cultural violence has devastating effects on the mental health of colonized subjects. As Fanon explains, the colonized are forced to see themselves through the eyes of the colonizer, internalizing the dehumanization that is imposed on them. This experience generates feelings of self-hatred, alienation and inferiority, configuring a specific type of psychic suffering that transcends the notion of malaise discussed by Freud. The suffering of the colonized is not only a matter of repression of drives; it is the result of a system that positions him as inferior and denies him even the right to claim his pain (FANON, 2008).

The historical materialism of Karl Marx and Friedrich Engels in 'The German Ideology' (1932) offers another fundamental axis for this analysis. For Marx, the dominant ideology in any society reflects the interests of the ruling class (MARX; ENGELS, 2007). In the colonial context, this ideology justifies economic exploitation, social segregation, and cultural violence, consolidating a system that perpetuates the suffering of marginalized populations. Fanon complements this perspective by demonstrating how colonial ideology not only controls bodies and territories, but also captures minds and subjectivities. Colonial ideological violence perpetuates mental suffering by naturalizing racial, cultural, and economic hierarchies, transforming oppression into something apparently inevitable (FANON, 2020).

This structural illness is exacerbated in contemporary capitalist societies, which are direct heirs of colonial dynamics. The logic of profit and accumulation, typical of capitalism, maintains a direct relationship with the exploitation of native peoples, quilombola communities, non-white people, and other historically marginalized groups. These groups face not only precarious material conditions, but also the delegitimization of their pain and their grieving processes. Colonial violence, in this sense, did not end with political independence; It has metamorphosed into other forms of oppression, such as structural racism, economic exploitation, and cultural exclusion.

The concept of "illness of society" therefore needs to be understood in its complexity. It is not just a pervasive malaise caused by repressive cultural norms, but a historical and material process deeply rooted in power structures. This illness reflects the inequalities, exploitation and violence that characterize capitalist and colonial modernity. By considering these questions, it is possible to understand why certain social groups face disproportionate levels of mental distress: their subjectivity has been, throughout history, systematically attacked and invalidated.

In addition, it is important to highlight that mental illness is not only a consequence of colonialism; it is also instrumentalized by this system. The colonized are often pathologized, being seen as unable to manage their own life or as naturally inferior. This pathologization has a double effect: it delegitimizes the demands for justice and reparation, while justifying the continuity of policies and practices of oppression (DELEUZE; GUATTARI, 2010).

When dealing with malaise, Freud (1997) suggested that culture was both a source of suffering and a containment for destructive human impulses. But Fanon invites us to ask: what is this culture? Who was it built for? Who does it privilege and who does it marginalize? These questions are central to deconstructing the myth that social suffering is inevitable. In fact, it is manufactured and maintained by systems of exploitation and oppression that can — and must — be challenged.

In the final analysis, the illness of society is not an immutable condition. Recognizing it as the product of material and historical structures opens space for resistance and transformation. From decolonial perspectives, it is possible to imagine forms of existence that are not grounded in exploitation and exclusion. This reimagining of society requires not only structural changes, but also the legitimization of marginalized epistemologies and subjectivities. Only in this way will it be possible to build a civilization that does not produce malaise, but health and emancipation for all.

THE MENTAL ILLNESS OF THE SUBJECT IN A SICK SOCIETY

At first, it seeks to understand how Fanon conceives mental health and madness. It is possible to identify several terminologies and concepts in its approach: madness, mental alienation, mental pathology, mental illness, mental alterations, mental disorders, psychic and mental disorders, neuroses and psychoses, among others. For him, "madness is one of the means that man has to lose his freedom" (date and page), causing madness to be seen as a pathology of freedom.

Furthermore, Fanon investigates where obsessions, inhibitions that violate human freedom come from, how they are formed, where they manifest and what they symbolize. He demonstrated that mental alienation cannot be reduced to neurological alterations; the disease is situated in a being and its intersocial relations. For there to be mental alienation, it is necessary that there is alienation of the human being. With regard to the colonized, mental alienation expresses a being separated from the colonial split itself that makes him a non-human by confronting him with the human being, in fact, the white European. It is affirmed in a relationship of elevation through inferiority, enabling human development in several dimensions, such as economic, political and social, whether by the subjective fatalization of the colonized, or by death itself.

Understood in this way, madness, mental alienation, are not things in themselves, but, above all, symptoms of a society, signs of a condition of existence. Madness becomes a means of vocalizing a call for freedom. However, it is a pathological, sickening environment, because it is a sick being. Madness is not liberating; it is one more of the currents with which the being must struggle in his saga for freedom; Another of the mechanisms by which alienation operates: "Illness subtracts an individual from others and isolates him, making it impossible for him to live in his cycle. He has dug for himself a deep ditch that separates man from the world, leaving him powerless and alone with an evil that is strictly his own" (reference, date, pg).

The need for contextualization is Fanon's main focus; of understanding pathology as a supposed abnormality in a "normal" condition of existence that is particular, even if inserted in a social totality; that is, its understanding must be considered with the sociocultural context in which it is produced. The madman is only mad in comparison with the non-madman, the normal. But it is important to mention the question: what does it mean to be normal in this society? And why does society demand normality, when it is characterized by exploitation and oppression?

In 1961, the year of the publication of the book 'The Wretched of the Earth', Fanon (1979, p. 173) pointed out that "colonialism understood where its tactic of social reforms

would lead it, we saw it recover its old reflexes, reinforce the police force, dispatch troops and install a regime of terror more adapted to its interests and its psychology". In the excerpt, the psychiatrist states that the fixity of colonialism does not only operate in the instruments of war, martial and military, but also in the psyche, in the ways of thinking and acting, aiming at a kind of crystallization of thought. In addition, it is worth mentioning that it extends to all the "wretched of the earth", distributed in the remote confines and large metropolises of Africa, Asia, Latin America and where the inequality intrinsic to capitalism imposes injustice and exclusion.

In addition, in the work, it is said about how the psychic suffering of the black population stems from the effects of coloniality, which is constantly reinventing itself, which allows oppressions to be maintained, in various ways. The effects of coloniality are maintained due to the perpetuation of institutional violence, institutional racism and also racist discourses about the colonized subject, their culture and their land (FANON, 2006).

One can bring Fanon to the analysis of situations of oppression and violence in contemporary metropolises. Fanon's description (p. 29) of the "city of the colonized", where blacks and Arabs live, fits dramatically to current scenarios around the world: "the city of the indigenous, the black city" is a place "populated by ill-famed men", where "one is born no matter where" or how, where one dies "no matter what", it is a "cornered city" where in "a world without breaks" men are "one on top of the other, the houses one on top of the other" (reference).

Thus, it can be said that the language spoken by the colonizer and the colonized is the language of violence. There is a brutal psychic violence that is looking at a mirror painted white. It is as if the self-image reproduced in the formation of the ego of black people was a self-image always sculpted in colors that do not reflect the shades of their (black) skin. The epithet of the work 'Black skin, white masks' could be in this context: to mask oneself. It would not, then, be possible to see oneself in the mirror if it is not with this mask, just as an identity is denied if it is not with this mask. In this sense, the love relationship is one of the parts of this mask. Fanon says that, somehow, this sociogenesis of racism leads the man of color to promote self-hatred and to make every effort not to be recognized as black. In the racist context, in the search for a relationship, within an interracial relationship, there is a striking dimension because of racist sociogenesis, which is the search to get closer to whiteness.

Furthermore, it is also worth mentioning how asylum treatment and colonial psychiatry were and are tools of alienation and imprisonment. The existence of asylums – a symbol of what we could define as "psychiatric reserves", equating them to black apartheid

or ghettos – is the expression of a desire to exclude what is feared to be unknown and inaccessible, a desire justified and scientifically confirmed by a psychiatry that considered the object of its studies "incomprehensible" and, as such, relegated to the ranks of the excluded... (BASAGLIA, 2005, p. 117). P

True attempts at psychosocial rehabilitation require, according to Fanon (1925-19610), a society that is in opposition to coloniality and asylum treatment. It is seen times of cultural and political setbacks that impose obstacles to the free exercise of democracy and the achievement of health as an expression of social justice and the process of Psychiatric Reform suffers the consequences of this. Thus, Brazilian mental health and collective health lack a critical sense of postcolonial and decolonial thought.

THE PROCESS OF COLONIAL PRESSURE AND AESTHETIC EDUCATION

When we deal with colonization, we also deal with violence, of the various physical and mental forms, in which we have two worlds as a scenario: that of the colonized and the colonizer. The latter aims to ensure the respect of subjugated men regardless of brutalities. Proof of this is in the dehumanization of the colonized, in which nothing is spared to liquidate their traditions, duties, habits, culture and aesthetics. In this way, alluding to Tocqueville (1835), democracy itself could be questioned when we take into account the colonial heritage in which the basis of equality (a (pseudo)egalitarian (pseudo)ethics) among the human beings that make up a nation goes against the colonized thinking that tyrannizes minority groups and places them in conditions of lesser value, expropriation of the means of production (which includes the land of native peoples), At the same time, society tries to perpetuate this system of exploitation and maintain control of class war through a colonized aesthetic education, whose decolonization comes through countercultural movements.

That said, such dehumanization of the colonized by the colonizer is justified by a society without values, in its bias, thus the colonizer and the institutions of power of the metropolis, such as Christian churches, for example, are given the roles of correctors of the "corrosive elements" (FANON, 1968, p.31) that afflict the original peoples of the colony under the same colonial bias, which pleases only a small elite of the colonizing country.

Thus, after a nation has their bodies taken over by slave labor, they also have their minds. When the most precious assets that constitute a nation, such as culture and its histories, are taken from them, there is a great helplessness and lack of belonging. As in "Black Skin and White Masks" (1957), masking as a condition for seeing oneself and being able to name oneself reaches groups for common ideals and becomes significant symbolic

systems, scarce, as well as the possibility of reversing the situation through independence or revolution, which escape the horizon of the colonized's vision.

At the same time, it is possible to relate the dominant class to the colonizer and the exploited productive class to the original peoples, alluding to Karl Marx and Friedrich Engels with historical materialism, with the dominant ideology prevailing over the interests of society as a whole. In this context of exploitation, from the moment that this model is perpetuated, the exploited class, when faced with a situation of difficult ascension, and the lack of a story with a happy ending, a suffering is produced that the person internalizes, leading him to think that he deserves this for being who he is. Nevertheless, the dominant discourse of the colonizer takes advantage of the fragile moment of the individual in order to his productive interest.

Concomitantly, the colonizer produces a tyranny of the discursive majority. Including even social institutions such as School and Church, which legitimize this violence and reproduce it in the colonization process. We can say that when education does not liberate, it makes the colonized adopt the most accepted and validated model of discourse as a way of emanating power of social capital, which is nothing more than the discourse of the colonizer. In aesthetic education the colonized oppressed, when educated by a non-liberating form of education, dreams of being the colonizing oppressor (FANON, 1968, p.40-41).

Thus, I highlight how culture is established as an essential intrinsic part of a people, it also affirms individuals in society and favors the visibility of psychotics and neurotics. Proof of this is in the regional culture of which it is valued in fairs and establishments that use manufacturing and handicrafts as a cultural expression that permeates daily life and keeps traditions alive (such as the production of baskets, production of greengrocers, arrangements of sempre viva, works with clay and clay in the Jequitinhonha Valley and Mucuri).

In everyday life, the culture of psychotic patients and substance addicts could follow the same path with a joint organization that could mediate exchanges and bring communication from common banality to neurotic and psychotic reality, after all, psychotics listen to music, sing, have activities of daily living, have dish towels, among others, which would enable the recognition of psychotics and addicts by the opposite movement proposed by Bourdieu (knowing and defining what is not), but by the points of common assimilation, which can be in anyone's home and work, whether a manufacture produced by psychotics or produced by neurotics.

Under this bias, the loss of cultural aesthetic education perpetuates the mental suffering of psychotic and colonized groups. (I thought the last three paragraphs are disjointed, I think an articulation could be made earlier, as this conversation of psychotics and neurotics comes in)

THE DECOLONIAL PERSPECTIVE IN THE CONTEXT OF THE ANTI-ASYLUM STRUGGLE AND PSYCHIATRIC REFORM

The concept of deinstitutionalization refers to the transfer of the focus of attention from the institution, such as the hospice or asylum, to the community, the territory or the district. This term originated in the Italian psychiatric reform movement (HIRDES, 2009). Over time, societies have reflected on madness and defined who are the individuals considered insane, based on the predominant conceptions and values of each era. These definitions are not neutral, but are linked to the political and social needs of each historical context. In the nineteenth century, with the advance of bourgeois society, the medicalization of madness emerged as a way of dealing with those who did not fit into the social order.

Medicalization represented a change in the form of control: the so-called insane ceased to be exclusively the responsibility of the judiciary and began to be treated by medicine, which allowed them to be kept under surveillance without openly disrespecting the bourgeois ideals of individual freedom. This approach made it possible to resolve a central contradiction of that society. On the one hand, it was necessary to isolate individuals considered insane, since they were seen as a threat to social stability. On the other hand, the right to individual freedom, an essential value of bourgeois society, could not be explicitly denied. Thus, by justifying isolation as a medical "treatment", society was able to restrict the freedom of these individuals in a disguised way, removing them from community life and masking the control it exercised over them. (MONTERO, 1986).

Deinstitutionalization, however, goes beyond simply transferring the focus of attention from the asylum to the community. It carries a broader dimension, questioning the separation between the normal and the pathological and proposing a new way of understanding and dealing, seeking to break with exclusionary, segregative, European practices and reaffirm the rights and dignity of individuals. The anti-asylum reform is not limited to the transformation of the physical space of care, but challenges the traditional model centered on exclusion, promoting care that recognizes the complexity of existence and respects human rights.

The Brazilian psychiatric reform was largely inspired by the Italian Democratic Psychiatry, which was led by Franco Basaglia, an author who was strongly influenced by

Frantz Fanon and his revolutionary ideas against colonial racism, Eurocentric segregation and the dehumanization of psychiatry (SEVALHO; DIAS, 2022).

Therapy is no longer seen as the return of the subject's productivity. It comes to be understood as the right to life, social interactions, sentimental meaning and reintroduction to the community. A view very similar to that adopted by Fanon, who studied how mental illness was understood by Muslim culture, where celebrations of traditional festivals, meetings with storytellers and local music groups and social reintegration were held. Comparing colonial isolation with asylum, Fanon took a stand against segregation (SEVALHO; DIAS, 2022). Fanon's decolonial perspective on the anti-asylum struggle is a critique of Eurocentric psychiatry and a call to action for the construction of a mental health system that respects and values the experiences and cultures of colonized peoples. In this sense, while the asylum system is still in force, interventions should aim to inactivate it.

Still following Fanon's thought about the vision of humane, dignified treatment and the valorization of one's own culture in decolonization, Deleuze and Guattari's concept of ezquisoanalysis fits in, which can be understood not as a set of techniques (HUR; VIANA, 2016) or a rigid methodology, but rather a philosophy of valuing vibrating and pleasant life, valuing the infinite ways of composing life from a cartographic perspective, leaving aside the Platonic dualism good/evil (PERES; BORSONELLO; PERES, 2000) or even more daringly, the normal/pathological dualism.

With ezquisoanalysis, a new conceptualization is proposed for the understanding of psychoaffective pathologies, the notion of subjectivity is thought of, thus enhancing the construction of a practice focused on the singularities of the subjects assisted (DE PÁDUA; TENÓRIO, 2019). Culture, nature, society, sexuality and a series of assemblages that involve the production of subjectivity and ways of being in the world are now considered in the schizoanalytic clinic (DE PÁDUA; TENÓRIO, 2019), thus concurring, in a very visible way, with Fanon's ideas of decolonialism.

WHAT IS SCHIZOANALYSIS AND HOW CAN IT OFFER CLINICAL GUIDANCE IN MENTAL HEALTH

Mentioned for the first time in The Anti-Oedipus, published in 1972 in the post-May 1968 context, schizoanalysis is not a method, being described in contemporary literature in a plural way, either as a perspective, an area of knowledge, a way of living-intervening or even as close to the field of poetic knowledge (DELEUZE; GUATTARI, 2010; ROMAGNOLI; SIMONINI, 2023; BASTOS; CAVALCANTI, 2017; PERES; BORSONELLO;

PERES, 2000; HUR; VIANA, 2016). It is capable of being used in the practical and political analysis of the desire of the subject, of a group or of society. Although it is not a technique, it is anchored in it that several Brazilian psychologists carry out various interventional practices through the three fundamental tasks of schizoanalysis, to be addressed later in this chapter (DELEUZE; GUATTARI, 2010; ROMAGNOLI; SIMONINI, 2023; SOCZEK, 2021).

As categorized by Hur & Viana (2016), in Brazil, schizoanalysis today occurs in a heterogeneous and individual way. these authors seek to classify into open categories: theoretical studies and transmission, group cartography device, workshop device and schizodrama, and it is not impossible or even uncommon for a practice to be classified in more than one typification (HUR; VIANA, 2016). In addition to the academic, literary, theoretical and cartographic production of the first two, in the workshops schizoanalysis works both as an inspiration, as "[...] a lens that enunciates subjective, group and institutional processes". "It does not operate as a theory of technique, but as a theory of process analysis. It comes in as a tool that enables the researcher to understand what processes the intervention mobilized in the group and in the individuals" (HUR; VIANA, 2016, pg 118).

In an even more present way, schizoanalysis is closely linked to schizodrama, created in Brazil by the Argentine Gregório Baremblitt (HUR; VIANA, 2016). In it, together, the theoretical and dramatic poles aim to "[...] to act on the subjective, social, semiotic and technological aspects of its devices to provide experiences of deterritorialization of the instituted assemblages, to give circulation and transit to the codified flows (psychic, bodily, group, social), to foster processes of creation and aesthetics, thus effecting events, new regimes of signs and processes of singularization" (HUR, 2013 pg 271).

From schizoanalysis, the tools of schizodrama are then created, in which there are two types of tasks: the destructive ones - of destruction and scraping of the instituted and the blockades - and the positive ones, which aim to enhance the desiring affirmations and virtues of the collectives, encouraging processes of creation and transformation. In this, verbal, bodily, artistic and political resources are used, transcending mere psychological theory (HUR; VIANA, 2016). It is worth emphasizing, however, that schizodrama also does not consist of a consolidated, fixed and delimited field of knowledge, but rather a continuous practice that stimulates the creation of new devices and practices (HUR; VIANA, 2016).

Schizoanalysis proposes to overcome the idea that there is a universal structure of the psychic subject, with a listening process that values the singularity of the subject, taking into account the action of capital in the reterritorialization of human activities and the

domination of the devices of power and knowledge that instrumentalizes cultural, scientific, technical and artistic innovations (PERES; BORSONELLO; PERES, 2000; BASTOS; CAVALCANTI, 2017; ROMAGNOLI; SIMONINI, 2023).

THE NEGATIVE MOVEMENT IN SCHIZOANALYSIS

The negative movement is an initial movement of unveiling domination and the mechanisms of cultural coercion and blocking of desire, moving towards the destruction and liberation of the ties of suffering hitherto indeterminate and often "unnamed". In this aspect, Guattari and Deleuze's proposal to schizoanalysis goes in the same direction as the current proposal of the construction of an analysis question, enabling the identification and deepening of the notions about psychic suffering perceived by the individual himself. Thus, the initial movement is an onslaught against the sickening denial of desire and, consequently, against a colonial pressure that distorts the location of desire of the will and human demand (HUR, Domenico Uhng; VIANA, Douglas Alves; 2016).

The dismemberment and emptying of the schizoanalytic negative movement is necessary so that, in the midst of the negligence generated by cultural alienation, especially in relation to colonized societies, the mental health clinic considers that by de-alienating and/or clinicing for a subject, who adapts his product-person to the environment in which he lives, this subject will return to a context of expropriation, alienation and exploitation (CARVALHO, João Rafael Chió Serra; 2020), and the answer found in the application of the positive constructive movements of schizoanalysis.

Thus, the other construction movements present in schizoanalysis, such as "group cartography device", "workshop device" and "schizodrama", can serve as support for the de-alienated neurotic and target of clinical intervention (HUR, Domenico Uhng; VIANA, Douglas Alves; 2016). In other words, by abandoning the subject by the vacuum left by the emptiness of the formative position of the dominant discourse, the location of the agent causing his pain as something systemic and apparently insurmountable, is welcomed by the group devices and places the individual as an active agent of history and of the struggle for the rights of his equals, without alienation being able to direct him to his self-destruction or lack of recognition of realities close to or equal to his own.

As previously stated in topic 4, colonized aesthetic education predisposes the colonized to a double pressure coming internally from their own group and externally from the majority that reproduces the colonizer's thinking. In this way, approaching culture in a multilinear way while benefiting from Vygotsky's view of aesthetic education, culture has been constructed as an accumulative process that uses the diverse social productions

introduced from an early age, resulting in repercussions of the past, the present context and the ideas of the individual future to each society and human experience, expressing the domination of the significant units of determination of the psychic and external world by the colonizing discourse (HUR, Domenico Uhng; VIANA, Douglas Alves; 2016; (ALMEIDA, Marilene Oliveira et al, 2024; Prestes, Z, 2010).

Even before applying the schizoanalytic negative movement as a way to list tools for the decolonization of the affects and the lenses through which the world is seen, it is necessary that the subject is able to see in education and socialization a path to support and mobilization. It is by destroying the aesthetic marks of the colonizer that culture imprints itself on the body and modifies human action and the social environment, which only exists if there is an individual who perceives it (ALMEIDA, Marilene Oliveira et al, 2024; Prestes, Z, 2010; HUR, Domenico Uhng; VIANA, Douglas Alves; 2016).

It is in the understanding of the interdependence between the subject who perceives the social environment and the social environment that the first movement becomes evidently necessary for the overcoming of individual feeling by means of schizoanalytic devices, so that the positive movement of creation can exist.

POSITIVE MOVEMENTS IN SCHIZOANALYSIS

Among the points of the schizoanalist theory are the two positive movements, which are inseparable from the negative movement in order to carry out a reading of the world that escapes the shackles of capital, colonization or any other theories that limit the form of human life, which is fully endowed with well-being and health (Donhauser, Lucas José; Bonamigo, Irme Salete, 2023). In this sense, Baremblitt states:

> "a knowledge that has life as its objective, in its broadest sense: the increase, growth, diversification, enhancement of life" (Baremblitt, 2010, p. 15).

At first we have that the first positive task of schizoanalysis, that is, the first positive movement, aims to strengthen the machine, or even to the lives of individuals.

Molar state, or molar machine, is where the phenomena of crowd or mass occur, that is, they are machines that subordinate themselves to capture individual molecules and, then, the movement of unification, structuring at the social level occurs (Barbosa Soczek, Amanda, 2023). The molecular machine is at the individual level, understanding the singularities and intensities of each person's senses and desires (I think you need to explain what these states are better, suddenly, to make it easier, you can use the footnote). Thus, Deleuze and Guattari affirm that they are "machines properly so-called, because they

proceed by cuts and flows, associated waves and particles" (Deleuze & Guattari, 2011, p.378)

It can be said that they are free parts by themselves, which may or may not compose a body without organs, to the extent that they may or may not be added to the whole of the organism with its relations. In this way, they are beyond that, as they can by themselves attract or repel other partial objects, or molecular machines (Barbosa Soczek, Amanda, 2023). From the perspective of clinical practice and mental health care, this view of two states, taken by schizoanalytic authors in the theoretical meaning of machines, is fundamental. This is because, in order for there to be an integral view of the subject, it is necessary to simultaneously understand the respective relationships, desires, individual impulses, that is, how this individual relates to his feelings and how this same being responds and experiences his life drive in the collective context of the crowd.

Also from this perspective, it is possible that the use of the molecular, individual, desiring machine is explored to resist pressures imposed by the molar machine, of the collective (Barbosa Soczek, Amanda, 2023). The subject with his individualities potentiated and reaffirmed is capable of creating, intrinsically, escape mechanisms that come to protect him from implosions, or more specifically in the context of the clinic, to situations of outbreaks that expose him and/or make him vulnerable. Thus, Deleuze and Guattari state:

> "When, in one case, we establish an involuntary of the social and technical machines, and in the other case an unconscious of the desiring machines, it is a question of a necessary relation between inextricably connected forces, one being the elementary forces through which the unconscious is produced, and the other the resultant forces which react on the former, statistical sets through which the unconscious represents itself, already suffering repression and repression of its elementary productive forces." (Deleuze & Guattari, 2011, p. 374)

Thus enhancing the notion of impossible dissolution of these machines, the way they interact with each other may or may not strengthen the existence of health and well-being of this individual. Deleuze and Guattari, by coining the cartography method, create an invitation for the individual to construct himself as a map, in constant movement, based on his experiments in real and everyday life (Donhauser, Lucas José; Bonamigo, Irme Salete, 2023). In this sense, it seeks to value the multiplicity of experiences, exploring the most diverse connections in the subject's life. It is important, therefore, to produce knowledge, or care, that considers the various aspects of life such as historical, social, economic, technological, affective, cognitive, among others, always aiming at the search for new connections among all dimensions of the human person (Donhauser, Lucas José; Bonamigo, Irme Salete, 2023). These dimensions can be dismantled, reversible and always be modified and new perspectives and connections incorporated. For only in this way will

schizoanalysis fulfill its objective, to put an end to any form of repression, manipulation, coercion or alienation. Thus, the authors state:

> "Schizoanalysis has a single objective, that the revolutionary machine, the artistic machine, the analytical engine become parts and cogs of each other... This is what interests us: the revolutionary schize as opposed to the despotic signifier" (Deleuze & Guattari, 1992, p. 36)

The cartographic making shows the clinic to be a very relevant method, while it resides in the power of the act of producing, being, therefore, free of any preconception or judgments, but only being a simple stimulus the forms of light and broad lives. This theory brings together the forms of care based on the humanization principle of these subjects, who are no longer socially seen as sick and, therefore, should be excluded or isolated, a fact that is very well portrayed in the literature of Machado de Assis, and become producing subjects endowed with affections, memories, but above all, authors.

> "This is to fabricate for oneself a Body Without an Organ: to produce and make intensities pass" (Deleuze & Guattari, 2012b).

The second positive movement of schizoanalysis is based on establishing a nexus between libidinal investments, or unconscious desire, and social assemblages, in order to unite desire with the environment, establishing a flow between what is internal and external to the subject (Donhauser, Lucas José; Bonamigo, Irme Salete, 2023). Thus, it is necessary to understand the types of social investments worked by Deleuze and Guattari, considered distinct from each other and that in some way relate to the duality of the molar and molecular machines. In this way, the paranoid investment is more like the molar machine, while the schizophrenic investment is more like the molecular machine. For this justification, schizoanalytic authors appropriate concepts from psychoanalysis of paranoia and schizophrenia, however they go beyond these to establish their connections with the social field (Barbosa Soczek, Amanda, 2023).

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EDUCATIONAL STRATEGIES IN QUILOMBOLA COMMUNITIES: USE OF BAYESIAN NETWORKS FOR HEALTH RISK ASSESSMENT

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ABSTRACT

This study reports experiences in health education in two quilombola communities in Rio Grande do Sul, highlighting the use of Bayesian networks (RB) to assess the risks of type 2 diabetes mellitus (DM2) and systemic arterial hypertension (SAH). It was conducted as a cross-sectional and observational study, using the methodology of problematization, with stages that included observation, definition of key points, theorizing, hypothesis and practical application. The modeling of the quality of life was carried out using the Netica software, with the implementation of Bayesian networks (RBs), allowing the insertion of probabilities of occurrence of the variables through the network nodes. The profile of the 34 participants revealed a predominance of women (79.4%), aged between 30 and 59 years (55.9%) and with a mean body mass index (BMI) of 32.5 kg/m². Among them, 51.5% had a diagnosis of SAH and 23.5% of DM2. Inadequate diet was observed, with high sugar consumption (38.2%) and low use of whole foods (3.0%). The RBs had a sensitivity of 71.42% for DM2 and 76.47% for SAH, and specificity of 77.7% and 88.23%, respectively, demonstrating high precision. The modeling also identified a significant association between the risks of the diseases with factors such as BMI, age, family history and glucose. Educational strategies contributed to preventing complications and promoting quality of life, while MB proved to be promising tools for diagnosis and health education. The study reinforces the importance of inclusive public policies aimed at quilombola communities.

Keywords: Bayesian network. Type 2 diabetes mellitus. Systemic Arterial Hypertension. Problematization Methodology.

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INTRODUCTION

The number of adults with diabetes in the world has exceeded 800 million, more than quadrupling since 1990. According to the analysis of the NCD Risk Factor Collaboration (NCD-RisC), supported by the World Health Organization (WHO), this increase reflects the impact of obesity, promoted by unhealthy foods, sedentary lifestyle, and economic inequalities. Between 1990 and 2022, the global prevalence of the disease doubled, from 7% to 14%, with low- and middle-income countries facing the greatest growth and difficulties in accessing treatment. The study reinforces the urgency of action to curb rising rates and reduce care gaps (Zhou, 2024).

Type 2 diabetes mellitus (T2DM) is a metabolic syndrome characterized by chronic hyperglycemia, resulting from insulin deficiency, resistance to insulin action, or both. Insulin, produced by the pancreas, regulates glucose metabolism and, its lack or inefficiency, can cause difficulty in metabolizing sugar, leading to a persistent increase in its levels in the blood. DM2, responsible for 90% of cases, combines insulin resistance and inadequate secretion of the hormone. Its main symptoms include recurrent infections, blurred vision, difficulty in wound healing, tingling in the feet, and boils. Treatment consists of lifestyle changes, such as a balanced diet, physical activity, and the use of medications, aiming to keep blood glucose controlled and prevent serious complications, such as damage to nerves, eyes, kidneys, and the cardiovascular system (Ministry of Health, 2024).

The increasing incidence of these diseases, especially in developing countries, poses a challenge for health systems, due to the negative impact on quality of life, costs associated with treatment, and chronic complications (SMS, 2018). These conditions pose public health problems due to their high prevalence and complications.

Risk factors for DM2 are variables such as age, sex, ethnicity, family history of DM2, obesity, sedentary lifestyle, gestational diabetes, macrosomia, hypertension, reduction in high-density lipoprotein (HDL) cholesterol, increased triglyceride levels, cardiovascular diseases, polycystic ovary syndrome, high blood glucose in previous tests, impaired glucose tolerance, and glycated hemoglobin ≥5, 7% (ADA, 2013).

Obesity is pointed out as one of the main risk factors for DM2. It is estimated that between 80 and 90% of individuals affected by the disease are obese and the risk is directly associated with increased body mass index (BMI) (Martínez-Castelao et al., (2015).

Around 1972, the evidence-based medicine (EBM) movement emerged, created by Archie Cochrane, defined as the judicious and thoughtful use of the best evidence in decision-making about patient care, uniting evidence from research with clinical experience (Sackett, 1996). EBM is essential in the control of chronic non-communicable diseases

(NCDs), it allows clinical decisions to be made, increasing the quality of care by promoting the personalization of treatment and adapting interventions to the individual needs of patients.

With the incorporation of artificial intelligence (AI) techniques, it has become possible to use EBM to assess and reduce uncertainty in medical decision-making, with AI being a widely accepted area of research for medical applications. Among these applications, Bayesian networks (RB) stand out, used as an aid to medical diagnosis. Defined as probabilistic networks composed of a graphical structure and an associated probability distribution. Mathematically, a RB can be represented by B = (Pc, G), where G is a directed acyclic graph and Pc is the conditional probabilities associated with each probabilistic variable represented on a node of the graph. In this way, RBs establish a connection between EBM and AI, as they are applied in causal probabilistic calculations to describe evidence-based medical practices (Pearl, 2000).

NCDs, such as DM2 and systemic arterial hypertension (SAH), represent serious public health problems in Brazil and worldwide, highlighting the need for strategies for prevention and early diagnosis of these conditions. Data from the Surveillance of Risk and Protective Factors for NCDs (Vigitel) show that DM2 affects 21.6% of Brazilians over 65 years of age, while in the age group of 18 to 24 years the prevalence is 0.6%. In the case of SAH, its average prevalence in Brazilian adults is 32%, reaching more than 50% in individuals between 60 and 69 years of age and up to 75% in elderly people over 70 years of age. In view of this scenario, the application of technologies such as MB emerges as a strategy to assess risks and promote health education. These tools make it possible to identify risk patterns and communicate information in an accessible way, and are especially relevant in vulnerable communities, such as quilombolas, where access to health services is limited.

Thus, the objective of this study was to investigate the use of RBs in health education with a focus on the risk assessment of DM2 and SAH, contributing to the promotion of educational strategies in vulnerable communities.

THEORETICAL FRAMEWORK

The prevalence of T2DM in Central and South America is estimated at 26.4 million people, with a projection of growth to 40 million by 2030. In developed countries, such as the USA and European nations, the increase will occur mainly in the older age groups due to the increase in life expectancy. In developing countries, prevalence is expected to grow

at all ages, with a threefold increase predicted for people aged 45 to 64 years and a double increase in the 20-44 age group and over 65 years (IDF, 2024).

The study conducted by Zhou (2024), highlights significant differences in T2DM rates, with prevalences in adults aged 18 years and older reaching about 20% in the WHO Southeast Asia and Eastern Mediterranean regions. These areas, along with the African Region, have the lowest rates of treatment coverage, with less than 40% of adults using glucose control medications. The study also shows that, in the Americas, 112 million adults (13% of the adult population) are living with diabetes; This is almost four times the number of adults with diabetes in 1990 (30 million adults, 7% of the adult population). In the Caribbean, the prevalence is even higher, reaching 20% of the adult population.

In Brazil, data from the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel) show that DM2 increases according to the age of the population: 21.6% of Brazilians over 65 years of age and 0.6% of those aged between 18 and 24 years are people with diabetes (Brasil, 2012). Regarding the regional results of the survey, the capital with the highest number of people with diabetes was Fortaleza, with 7.3% of occurrences. Vitória had the second highest index (7.1%), followed by Porto Alegre, with 6.3%. The lowest rates were recorded in Palmas (2.7%), Goiânia (4.1%) and Manaus (4.2%) (Brasil, 2015).

The results in the control of DM2 depend on a combination of factors and conditions that enable the adequate follow-up of these patients. The main goals of health interventions for T2DM include glycemic control and, in the long term, the reduction of complications and mortality. In this context, implementing structured educational interventions with health professionals is important to address these health challenges (Brasil, 2013).

SAH is a multifactorial clinical condition characterized by high and sustained levels of blood pressure (BP ≥140 x 90 mmHg). In Brazil, its prevalence varies between 22% and 44% for adults (32% on average), reaching more than 50% for individuals aged 60 to 69 years and 75% in individuals over 70 years of age (SBC, 2010).

The average prevalence of self-reported SAH in the population over 18 years of age, according to data from the Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey Vigitel is 22.7%, being higher in women (25.4%) than in men (19.5%) (Basil, 2012). The frequency of SAH became more common with age, with a predominance in females, reaching more than 50% in the age group of 55 years or older. Among women, the inverse association between education level and the diagnosis of the disease stands out. While 34.4% of women with up to 8 years of schooling reported a diagnosis of SAH, the same condition was observed in only 14.2% of women with 12 or more years of

schooling. For men, the diagnosis of the disease was less frequent in those who had studied for 9 to 11 years (Gomes; Silva; Santos, 2010).

Health education, supported by the use of RB, allows for an accurate assessment of the risk of developing DM2 and SAH, promoting effective interventions for the prevention of these diseases.

A RB is a graphical model that represents probabilistic relationships between variables of interest (Nassar, 2024). They have a one-graph architecture, where the nodes represent the variables (input and output) that interrelate and represent the reasoning structure of an expert in an application domain. The nodes are connected by arcs, directed in the direction of the exit node to the input node, and for each arc the values of the conditional probability that represent the rules of the type "If output then input" must be estimated. Thus, a RB is made up of two parts: the qualitative part, which are the nodes of the network; and quantitative, the probabilities of occurrence. RBs are systems from the area of AI, based on conditional probability, used to relate variables and arrive at percentage results with confidence levels. From the interposition of existing information, it can present results ranging from 0 to 100% depending on the existence of a causal relationship (Luger, 2004).

Because it is based on probability theory, probabilistic reasoning is one of the main advantages of RBs). This approach allows rational decisions to be made even in the face of uncertainty, when there is not enough or complete information to prove that a particular action will be successful. The ability to represent uncertainties in a structured way makes RBs a useful tool in areas such as diagnosis, planning, and machine learning, where knowledge is often partial or ambiguous. Also known as causal networks, RBs have their origin in probability theory and are characterized by a formalism that represents knowledge in the domain, and also by the uncertainties associated with this domain, through Bayes' theorem (TB). Physicians, when formulating their diagnostic hypotheses, prescribing a treatment to their patients, intuitively use TB. By assuming a random sampling of events, bayes' theory supports the calculation of more complex probabilities, based on previously known results (Navar et al., 2015).

Problematization provides the opportunity for reflection mediated by the teacher on interaction activities, being a key element for the personal satisfaction of students and for the improvement of quality of life. The problematization methodology aims to prepare students for a conscious and transformative action in their communities. It promotes a dynamic relationship between theory and practice, encouraging students to reflect on the complexity of social phenomena and to develop critical thinking (Bergel, 1998).

The problematization methodology, which is based on the Arco de Maguerez, is a valuable pedagogical resource in health education, especially in contexts that demand in-depth understanding, such as teaching about diabetes mellitus (DM). This approach encourages students to become protagonists of their learning, promoting a horizontal relationship between educators and students, where both actively participate in the educational process (Dias; Saints; Lopes, 2022).

METHODOLOGY

This is a cross-sectional and observational study carried out in the quilombola communities of Mormaça and Arvinha in the municipality of Sertão/RS. 34 quilombolas participated in the research. Health education was formalized through the problematization methodology, which aims to prepare students for conscious and transformative action in their communities, using the Manguerez arch, structured in five stages: (1) observe the cultural context of the communities, highlighting the risks of NCDs, such as DM2 and SAH, to which the quilombola population is exposed; (2) identify key points to inform about SAH and DM2, including nutritional and physical activity guidelines; (3) promote conversation circles to identify possible suspicions of these pathologies; (4) develop solutions to the problem, ensuring the active participation of the communities and (5) develop activities aligned with the local reality, strengthening learning (Villardi; Cyrino; Berbel, 2015).

To model the probabilities associated with clinical variables such as BMI, sedentary lifestyle, heredity (1st degree), triglycerides, tingling of the feet and legs, cholesterol, high blood pressure, fatigue, blurred vision, gestational diabetes, excessive thirst, intake of vegetables and legumes, stress, neck and chest pain, dizziness, headaches, fluid retention and sociodemographic (such as age), the Netica software was used for the implementation of the RBs (Nassar, 2024).

The team was composed of 12 members, including six volunteer students, a physical activity specialist, three collaborating medical professors, two nurses and the project's coordinating teacher. Five workshops were held: in the first, there was a conversation circle with explanations about DM2 and SAH; in the second, the participants were instructed about the importance of physical activity and performed practical exercises; in the third, the focus was on healthy nutrition, with a demonstration of practical recipes for diabetics and hypertensives, accompanied by a tasting of low-calorie foods; in the fourth workshop, BMI, blood glucose and blood pressure measurements were carried out and, in the fifth workshop, interviews were conducted for data collection, aimed at quantifying the

epidemiological profile. Finally, two Bayesian networks were implemented: one for the diagnosis of DM2 and the other for the diagnosis of SAH.

This study is an excerpt from the research project on the theme "Epidemiological Profile of DM2 and SAH in the quilombola communities of Mormaça and Arvinha/RS". The project was approved by the Human Research Ethics Committee of UFFS, under opinion No. 1.857.616 (CAAE 62073016.1.0000.5564), carried out in accordance with Resolution 466/2012 of the National Health Council.

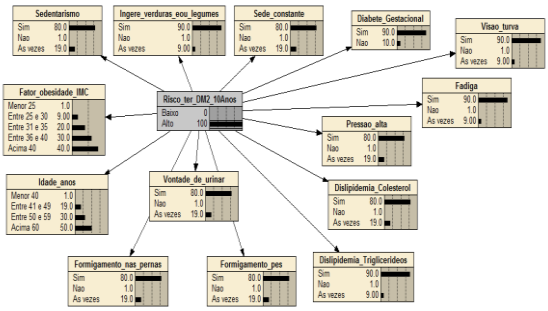
RESULTS

The profile of the 34 participants was predominantly composed of women (79.4%), between 30 and 59 years old (55.9%), with a mean BMI of 32.5 kg/m². Of the total, 51.5% had a medical diagnosis of SAH and 23.5% of DM2. Regarding eating habits, it was found that 44.1% had their meals watching television, using the computer and/or cell phone and, it was observed, that the interviewees consumed at least two meals a day, with lunch being the most prevalent (100%) and dinner (97.0%).

In addition, the most frequent dietary pattern observed was the daily consumption of beans (67.7%) and foods prepared with sugar (38.2%). The consumption of fresh fruits occurred three times a week (54.6%), as well as vegetables (45.8%), hamburgers and/or sausages (54.5%) and instant noodles/snacks/cookies (48.5%). Only 3.0% of the interviewees used whole foods in their diet.

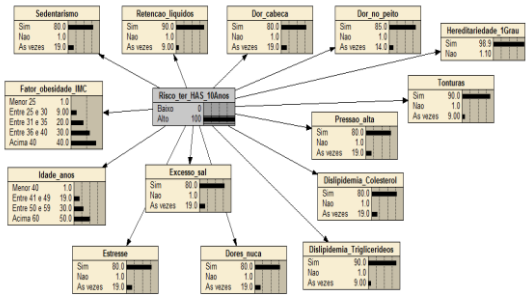
In order to provide guidance on quality of life in quilombola communities, with the use of educational strategies, two RBs were constructed, as illustrated in figure 1 with the Abductive Reasoning of DM2 and in figure 2 based on the abductive reasoning of SAH, based on the knowledge of physicians specialized in helping to diagnose DM2 and SAH.

Figure 1. T2D Abductive Reasoning



Source: Prepared by the authors

Figure 2. Abductive Reasoning HAS



Source: Prepared by the authors

The implemented RBs show the risk of developing T2DM and SAH. The nodes represent the qualitative variables of the study while the probabilities of occurrence represent the quantitative events. In these models, the probabilities of occurrence of each event (abductive reasoning) were computed, according to bibliographic references and the common sense of physicians, in this way, MB will be learning knowledge and informing a low or high risk of patients contracting DM2 and SAH.

After the compilation and selection of the nodes, the entire RB is affected and, in this way, it is recalculated, that is, based on the variables selected in the RB models, it was possible to predict the existence of evidence of the occurrence of DM2 or SAH.

In this study, which evaluated the risk of occurrence of DM2 and SAH and their association with clinical and sociodemographic variables using RBs, the diagnostic tests demonstrated a sensitivity of 71.42% and 76.47% for detecting DM2 and SAH, respectively, in sick patients, and a specificity of 77.7% and 88.23% for excluding the diagnosis of DM2 and SAH in healthy patients.

The RBs demonstrated an efficiency of 82.35% in the data analyzed, proving to be a promising tool for the diagnosis of DM2 and SAH, with great potential for medical education by allowing probabilistic inferences. A significant association was observed between the risk of developing DM2 and SAH with clinical variables, such as body mass index, physical activity, family history, glucose and triglyceride levels, in addition to the sociodemographic variable age.

DISCUSSION

The authors Lourenço et al. (2022) highlighted that effective management of chronic diseases requires a comprehensive approach, including lifestyle modifications and educational initiatives, considering health education as an essential pillar to improve outcomes and prevent disease, especially when applied in primary health care structures. In this context, the results of this research corroborate this perspective, demonstrating that

educational interventions in quilombola communities were relevant in promoting the prevention of complications associated with DM2 and SAH. These educational actions encouraged the adoption of healthy habits, such as a balanced diet and regular physical activity, thus contributing to the improvement of quality of life and the reduction of risks related to these diseases.

According to Santer, Leite and Lima (2021), older adults with better dietary quality tend to consume a higher proportion of processed foods, especially rice (97%), meat (94%), beans (91%) and salad (91%). In contrast, in this study, it was observed that the most frequent dietary pattern among the participants involved the daily consumption of beans (67.7%) and foods prepared with sugar (38.2%), while the use of whole foods was recorded by only 3.0% of the interviewees. These findings suggest that, although beans continue to be a common food in the diet of the elderly, there is a significant prevalence of food choices with greater processing and added sugar, which may impact the nutritional quality of the diet. This suggests that health professionals should focus on promoting nutrition education that emphasizes the benefits of whole and minimally processed foods.

Queiroz et al. (2021) highlight conversation circles as an effective strategy for health education, especially for the elderly, also emphasizing the importance of continuous monitoring in chronic diseases. Similarly, our study applied the theory of problematization in five stages, involving the observation of the cultural context of quilombola communities, the promotion of conversation circles to inform about chronic diseases such as DM2 and SAH, in addition to offering nutritional and physical activity guidance. These actions aim to strengthen learning and promote the active participation of communities.

In the study by Souza (2018), the implementation of a ontology-based BR in the health area showed satisfactory validation, with about 80% accuracy both in the evaluation of specialists and in the validation of real clinical cases, using the Netica software. Similarly, our study, also implemented with Netica software, obtained an efficiency of 82.35% in the data analyzed, demonstrating the potential of RBs as an effective tool to aid in the diagnosis of DM2 and SAH, in addition to their great potential for medical education, allowing probabilistic inferences.

Kong et al. (2024) implemented a RB model that was effective in its predictive capabilities, with high sensitivity and specificity, with a value greater than 0.8. The study identified several factors that influence T2D, such as age, education level, family history, lifestyle choices, including exercise and diet. The results indicated that populations in rural areas are at higher risk of developing T2D due to factors such as lower educational levels and limited access to health care. These results are in agreement with the results found in

the present study, reinforcing that understanding these relationships can help health professionals to target risk factors in education and prevention programs.

The main limitations of the study include the small sample size, with only 34 participants, which may restrict the generalization of the results to other populations. This limitation can impair the sensitivity and specificity of the RBs, since their performance varies according to the quality and quantity of data used. Suggestions for future research could replicate the study in other communities, both vulnerable and urban, to identify regional variations in the impact of RBs. Another suggestion is the incorporation of new variables, such as social determinants of health and psychosocial factors, to refine the models used.

CONCLUSIONS

From this study, it was observed that the educational strategies were relevant to the extent that they contributed to help in the prevention and occurrence of complications of DM2 and SAH in the quilombola communities. They were important as they contributed with new teachings about the manifestations of these diseases and how to acquire a better quality of life, through a healthy diet and the practice of physical exercises. It was concluded that public health policies should seek equity through inclusive care for special groups, especially in quilombola communities.

The practical implications of this research range from individual patient care to broader public health strategies, highlighting the relevance of predictive modeling to predict future behaviors and the effective management of NCDs. It is essential that patients with NCDs are aware of the risks related to their health problem. The information generated from the implemented RBs demonstrated great potential for use in health education. The results presented show the need to implement more effective actions in the educational area, contributing to health promotion and disease prevention.

This study shows the relevance of continuous educational interventions as a strategy for the prevention of NCDs. The RBs offered valuable insights that can be used to develop more effective health education programs. The results of this study are not restricted only to the context of quilombola communities, but may be applicable to other populations with similar characteristics, contributing to the improvement of quality of life and reduction of the risks associated with DM2 and SAH.

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HIGH MOLECULAR WEIGHT ANTIGENIC COMPONENTS OF PARACOCCIDIOIDES BRASILIENSIS: PARTIAL CHARACTERIZATION AND IMPLICATIONS FOR TH1 RESPONSE

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ABSTRACT

Paracoccidioidomycosis (PCM) is a chronic infection caused by the fungi Paracoccidioides brasiliensis or P. lutzii, whose host defense is mediated by Th1 lymphocytes. This study aimed to purify and evaluate the effect of high molecular weight (hMM) components of P. brasiliensis on the cellular immune response. The soluble antigens of the fungus (Pb18) were submitted to Sephadex G-200 column chromatography followed by HPLC, obtaining the F17 fraction (~380 kDa) and its F17-IV subfraction (~70 kDa), both reactive to sera from patients with PCM. The fractions were tested in vitro with the splenic cells of infected mice, resulting in lymphoproliferative response and increased levels of INF-γ and IL-10, without IL-4 alteration. These findings indicate the activation of the Th1 immune response and suggest that the ~380 kDa fraction can degrade generating active subcomponents of ~70 kDa. The ~70 kDa subcomponent appears to be distinct from the gp70 described in the literature, given its ability to induce INF-γ. The results point to the immunogenic potential of these components, highlighting their relevance for the development of vaccines or therapies against PCM.

Keywords: Cytokines, Fungus, INF-γ, Paracoccidioidomycosis, Therapy, Vaccine.

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INTRODUCTION

Paracoccidioidomycosis (PCM) is a chronic infectious disease caused by the fungus *Paracoccidioides brasiliensis* and the new species *Paracoccidioides lutzii*. This mycosis is endemic in Latin America, with a higher prevalence in Brazil, mainly affecting rural workers (San-Blas, 1993, Shikanai-Yassuda et. al., 2017). The fungus has two distinct morphological forms, depending on temperature: a yeast-like form, present in host tissues or when cultured at 35-37°C (Queiroz-Telles, 1994), and a mycelian form at room temperature. This morphological transition is reversible and occurs in response to temperature variation, being regulated by enzymes that modify the synthesis of glucans in the cell wall (San-Blas, 1982).

The fungus P. brasiliensis *or* P. lutzii *is presumed* to inhabit the soil in the mycelial form, and infection occurs by inhalation of fungal propagules. Exposure to the fungus can result in an asymptomatic infection or the development of the disease. In most cases, a primary lung complex is formed that regresses spontaneously with the establishment of specific immunity. However, the fungus can remain in a state of latency for years in residual pulmonary or extrapulmonary lesions. In progressive and disseminated forms, the fungus can reach lungs, mucous membranes, lymph nodes, skin, adrenal glands, and other organs or systems (Londero & Del Negro, 1986; Padilha-Gonçalves, 1985, Shikanai-Yassuda et. al., 2017, Cezar-dos-Santos et al., 2020).

Based on the clinical and natural evolution of the disease, PCM is classified into four main forms: **Infection:** initial phase, usually asymptomatic; **Acute or subacute (juvenile) form:** rarer and more severe, with involvement of lymph nodes, spleen and liver; **Chronic form (adult):** more common, which can vary from localized (unifocal) to disseminated (multifocal), depending on the efficiency of immunity; **Residual form (sequelae):** characterized by permanent lesions resulting from a previous infection (Franco et al., 1987, Shikanai-Yassuda et. al., 2017).

The immune profile also varies according to the form of the disease: **Chronic-unifocal form:** Predominance of T-helper cell response 1 (Th1); **Acute or chronic-disseminated form (multifocal):** Predominance of T-helper 2 (Th2) response, characterized by a higher production of immunoglobulins G (IgG) and the release of specific cytokines (Singer-Vermes et al., 1993; Baida et al., 1999; Cezar-dos-Santos et al., 2020).

Cellular immunity plays a key role in defending against the fungus (Burger et al., 1996). Patients with disseminated infection often have a negative intradermal paracoccidioidin test and poorly defined granulomatous reactions (Montenegro & Franco, 1994). On the other hand, humoral immunity is not considered protective, as the

exacerbated production of antibodies is associated with the severity of the disease (Singer-Vermes et al., 1993; Mello et al., 2002; Cezar-dos-Santos et al., 2020).

Several glycoproteins and other components of the fungus are related to its pathogenicity and immune response. Among the main components, the glycoproteins of 27-kDa (gp27), 43-kDa (gp43), 55-kDa (gp55), 70-kDa (gp70) and 87-kDa (gp87) stand out. High molecular weight glycoconjugates (hMM) and glycolipids obtained by different extraction methods are also present (Puccia et al., 1986; Blotta & Camargo, 1993; Toledo et al., 1995; Ortiz et al., 1998; Salina et al., 1998, Marquez et al., 2005). The high-MM polydisperse fraction, rich in carbohydrate and with heterogenous electrophoretic migration, was first described by Puccia et al. (1986) analyzing *P. brasiliensis* B339 antigen. This fraction was also detected in *P. brasiliensis* Pb18 and in 20 clinical isolates (Fredrich et al., 2010) and in the new species *P. lutzii* – LDR2 (Assolini et al., 2021), suggesting the constant presence of this component in *Paracoccidioides spp*.

These components play a crucial role in the immunomodulation of PCM and can influence both host defense and fungal survival. Research indicates that the immune response to high molecular weight (hMM) components is associated with the clinical evolution of PCM. Marquez et al. (2005) observed that patients with chronic PCM had high levels of IgG, but not of IgE, against the 380 kDa component of *P. brasiliensis,* suggesting that it does not induce a Th2 response.

In the experimental context, Pavanelli et al. (2007) evaluated the effect of the high molecular weight fraction of the fungus in Balb/c mice and evidenced the promotion of protective immunity.

This work partially characterized the high molecular weight (hMM) components of the fungus *P. brasiliensis* and analyzed its immunomodulatory action. The findings reinforce the importance of immunogenic components in the development of vaccine or therapeutic strategies for PCM.

MATERIAL AND METHODS

OBTAINING *CELL-FREE ANTIGEN* (CFA PB18)

The cell-free *antigen* was obtained from *P. brasiliensis* cepa 18 (Pb18), cultured on Sabouraud agar for 5 days at 35ºC, according to Camargo et al. (1991) with some modifications. After 5-day cultivation, the collected fungal mass was transferred to a tube containing buffered phosphate-saline solution (0.15M PBS and pH 7.4), with 2.5 mM PMSF protease inhibitor (Sigma) and 0.02% thimerosol solution. It was homogenized in a vortex

for 15 minutes and then centrifuged at 13,600 x *g* at 4ºC. The protein concentration was determined by the Folin technique (Lowry et al., 1951).

SEPHADEX G-200 COLUMN CHROMATOGRAPHY

A 9 ml sample of CFA Pb18 (4 mg/ml) was applied to Sephadex G-200 column followed by elution in PBS 0.15M pH 7.4. The fractions obtained by the automatic fraction collector were analyzed in a spectrophotometer (Spectrum SP-2000UV) at 280 nm.

HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

A 100 µL sample of the F17 fraction (Sephadex G-200 column) was refracted in an HPLC column (Varian Pro Star) in a semi-analytical column C18. Gradient buffer was used: 50% ammonium acetate buffer (Merck, Germany), 300 mM pH 7.0, and 50% bidistilled water (Milli Q). The pressure used was 1410 at 97 bars, 2 ml/min. The concentrations of subfraction proteins were measured by the Folin technique and stored at -80ºC.

DOTBLOTTING OF SUBFRACTIONS OBTAINED BY FRACTIONATION OF F-17 BY HPLC COLUMN

The 2 µL samples of hMM fractions and subfractions were pipetted on a nitrocellulose membrane (Gibco Invitrogen Corporation, Long Island, New York, USA). After blockade with the blocking buffer, the membranes were washed and incubated with a pool of sera from PCM patients (biological bank of the Laboratory of Applied Immunology, CCB, UEL/CONEP268, process 33455.2011.06)), diluted 1:40, for 2 h at 37ºC. After further washing, the membrane was incubated with anti-human IgG peroxidase conjugate (Sigma 8775) for 1:30 h at 37ºC. The reaction was evidenced with diaminobenzidine (DAB - Sigma) solution and hydrogen peroxide in 0.15M PBS solution.

IMMUNOBLOTTING

Initially, the samples of CFA Pb18, fraction F17 and sub-fraction of hMM-HPLC (F17-IV) and MM protein standard of 10-200 kDa (Invitrogen 1078-010), were submitted to gel electrophoresis with a gradient of 5-15%. After the run, in 1M tris glycine buffer (Pharmacia Biotech –Sweden and Sigma Co., Germany), pH 8.2 to 100 V, the samples were transferred to the nitrocellulose membrane (Gibco Invitrogen Corporation, Long Island, New York, USA) in tris-HCl-methanol buffer at 23 V for 18 hours and 100 V for 1 h. The membrane was blocked with blocking buffer, for 1 h at room temperature, followed by washes and incubation with a pool of serums from patients with PCM dilute 1:40 (2 h at 37ºC. After

further washes, 1:3000 dilute human anti-IgG peroxidase conjugate (Sigma A-8775, Sigma Chemical Co., St. Louis, MO, USA) was added for 1:30 h at 37ºC. The membrane was washed again, which was revealed with DAB (diaminobenzidine-Sigma Co., USA) in 0.15M PBS and hydrogen peroxide.

INFECTION OF BALB/C MICE

Ten male Balb/c mice of 4 to 6 weeks were infected intravenously with 1x106 cells/ml of *P. brasiliensis* (Pb18) and as a control 6 mice were inoculated with 0.15M PBS solution (sterile) and euthanized after 28 days of infection. The mice were handled according to the rules and authorization of the Ethics Committee on Animal Experimentation of the State University of Londrina (CEEA nº 67/08).

EVALUATION OF LYMPHOPROLIFERATIVE RESPONSE

Spleen cell suspension samples from mice infected with *P. brasiliensis* Pb18 for 28 days or not infected were treated with 0.14M ammonium chloride buffer pH 7.2 for red blood cell lysis, centrifuged and washed with sterile PBS. The cells obtained were resuspended in complete RPMI medium (Sigma Co., USA) (L-glutamine, Hepes, garamycin and 10% fetal bovine serum) at a concentration of 1x106 cells/ml, adding: F17 (100 µg/ml), or F17-IV (50 µg/ml) or exoantigen (50 µg/ml) with 100 µL of cell suspension, incubating for 120 hours. Eighteen hours before the cells were harvested, 3.5 µL of tritiated thymidine was added. The stimulation index of lymphoproliferative responses was calculated by releasing radioactivity incorporated into scintillation liquid, counted in a Beckmann LS 6.800 scintillator device. The proliferation index was calculated by the mean reading of the triplicates of the lymphoproliferative response to antigen, in count per minute (cpm), divided by the mean reading of the triplicates of the lymphoproliferative response in the absence of antigen.

LYMPHOCYTE CULTURE FOR EVALUATION OF CYTOKINE LEVELS

The culture was performed as described in the previous item, but with an incubation time of 72 hours. Supernatant samples were collected and stored at -20ºC for further analysis. Anti-IL-10, anti-IL-4 and anti-INF-γ antibodies at a concentration of 3 µg/ml (50 µL) were diluted in 0.06M bicarbonate buffer pH 9.6, added to immunoplates (TPP, Switzerland) and incubated for 18 hours at 4ºC in a humid chamber. The plates were washed with washing buffer, followed by blockade with 100 µL of PBS buffer containing 10% fetal bovine serum with pH 7.0; 0.05% of tween 20 and molico milk 5%. After incubation for 1 hour at

room temperature, 50 µL/orifice of IL-10, IL-4 and INF-γ standards were washed and added, starting with a serial dilution of 2ng/ml in PBS/SFB 10% pH7.0. 50 µL of culture supernatant were added, incubated for 2h at room temperature. After washing, 50 µL/orifice of anti-IL-10, anti-IL-4 and anti-INF-γ biotinylated was added, incubating for 1 hour at room temperature. After further washing, 50 µL of the conjugate avidin-peroxidase was added, incubated for 20 minutes at room temperature and in the dark. The reaction was revealed with an OPD solution in substrate buffer and hydrogen peroxide, reading performed at 450 nm in the Molecular Devices Emax (*precision microplates reader) device*.

STATISTICAL ANALYSIS

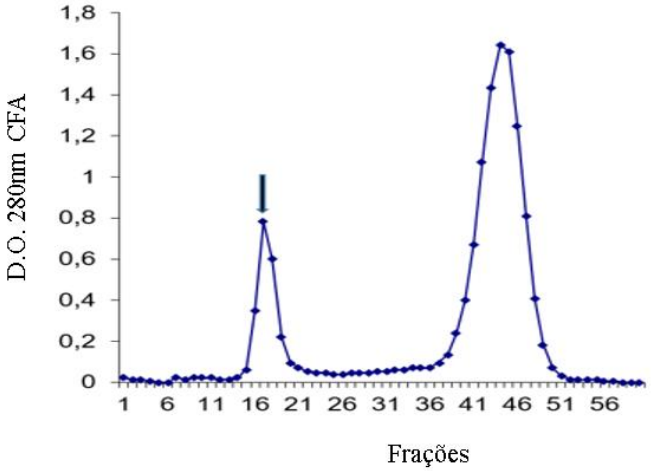
Analysis of variance (ANOVA) and the Tukey-Kramer test were performed. The values described by the mean ± standard deviation, and the results considered significant when $p<0.05$.

RESULTS

CFA CHROMATOGRAPHY (PB18) IN SEPHADEX G-200 COLUMN

The spectrophotometric profile of the CFA Pb18 fractions in Sephadex G-200 Column at 280 nm was shown in Figure 1. The first peak (tube 17) was considered a fraction of hMM, called F17.

Figure 1: Spectrophotometric profile at 280 nm of Pb18 CFA by Sephadex G-200 column chromatography. The arrow (fraction 17) corresponds to the hMM antigen, called F17.

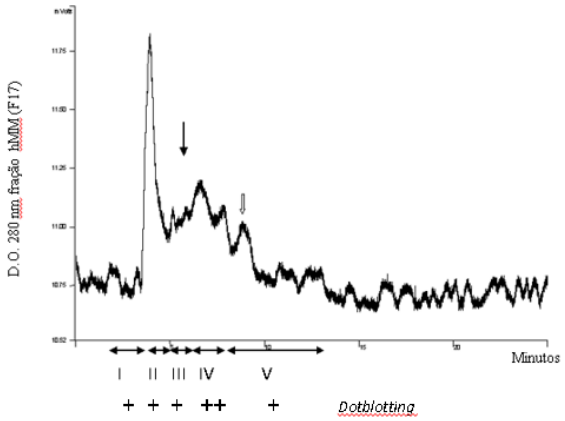


REFRACTION OF FRACTION F17 IN HPLC COLUMN

The refraction of 100 µL of F17 (116.8 µg/ml) in an HPLC column resulted in the spectrophotometric profile at 280 nm shown in Figure 2. The analysis of the fractions eluted

by *dotblotting* resulted in reactive fractions with a pool of sera from patients with PCM. These fractions were mixed forming pools I to V: F17-I (fraction 6 to 9), F17-II (fraction 10 to 15), F17-III (fraction 16 to 19), F17-IV (fraction 20 to 26) and F17-V (fraction 27 to 45), with fraction IV being more strongly reactive. This more reactive fraction was called F17-IV. Considering the MM standards used; egg albumin (45 kDa) and human IgG (150 kDa), the F17-IV subfraction was estimated to have MM between 45-150kDa.

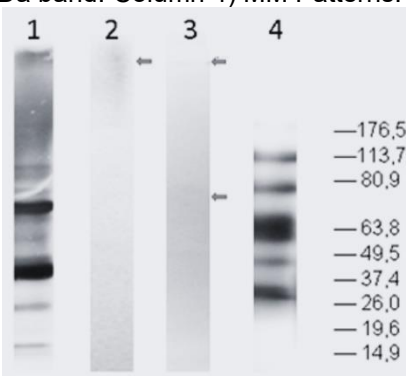
Figure 2: Spectrophotometric profile at 280 nm of the fraction of hMM (F17) refracted in HPLC column C18. Standards: egg albumin 45 kDa and human IgG of 150 kDa. Fractions I, II, III, IV and V were positive by *dotblotting* with a pool of sera from patients with PCM. The hMM sub-fraction in the MM range between 45-150kDa, called F17-IV was the most reactive fraction.



IMMUNOBLOTTING OF HMM FRACTIONS (F1) AND SUB-FRACTIONS (FI-17)

Immunoblotting results demonstrated many bands reactive in CFA with antibodies from PCM patients. In the fraction F17, a band of ~380 KDa was observed (marked with an arrow) and in the sub-fraction F17-IV, a weak band of ~380 KD, a slightly more evident band of ~70 KDa (marked with an arrow) and another weak band around 43kDa, not marked (Figure 3).

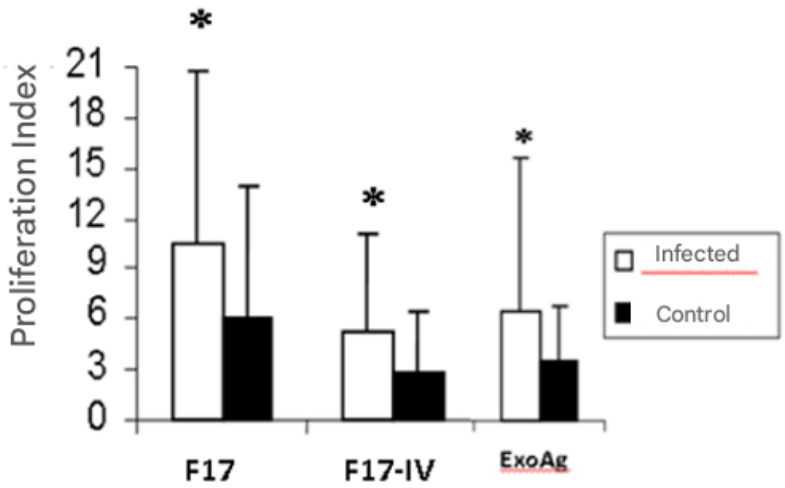
Figure 3: *Immunoblotting results* of the samples: 1) CFA Pb18, 2) F17, 3) F17-IV reactive with a pool of sera from patients with PCM. Arrows in the upper portion of the columns indicate the ~380 kDa band and the arrow in the lower portion indicate the ~70 kDa band. Column 4) MM Patterns.



LYMPHOPROLIFERATIVE RESPONSE ANALYSIS

The lymphoproliferative response to the antigens: F17 (100 µg/ml), F17-IV (50 µg/ml) and Exoantigen (50 µg/ml), expressed as cell proliferation index, was significantly higher in spleen cells from a group of mice infected with Pb18 compared to the uninfected group ($P < 0.05$) (Figure 4).

Figure 4: Cell proliferation index of spleen lymphocytes from Pb18-infected mice and normal mice (as a control) in response to stimuli with the following antigens: 1) F17 (100 µg/ml); 2) F17-IV (50 µg/ml); and 4) ExoAg (Exoantigen) (50 µg/ml). * p<0.05 (control versus infected).

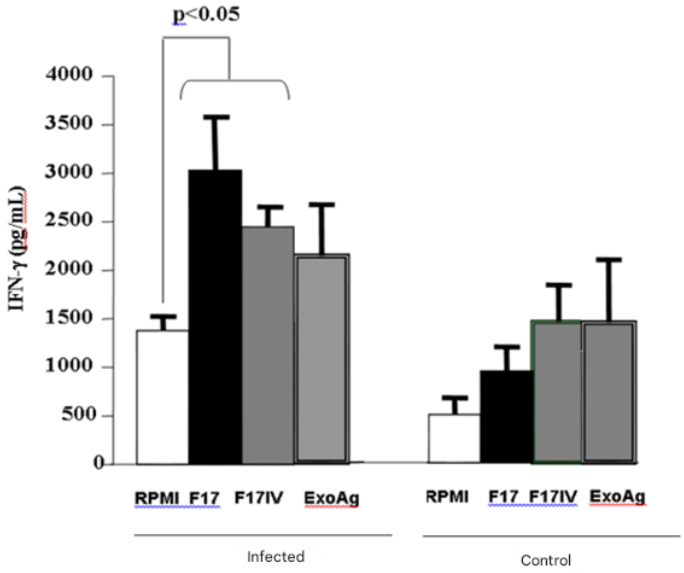


DETERMINATION OF INF-Γ CYTOKINE LEVEL

The results of **INF-γ dosing in spleen cell culture supernatant of** Balb/c **mice** infected with *P. brasiliensis* and stimulated with the ~380 KDa fraction and HPLC product, ~70 kDa subcomponent demonstrated a significant increase **in INF-γ with both components (p<0.05) compared to the unstimulated control group, by ELISA.**

However, the stimulation with ExoAg did not induce a significant increase, possibly due to interference of several antigens present in this preparation (Figure 5).

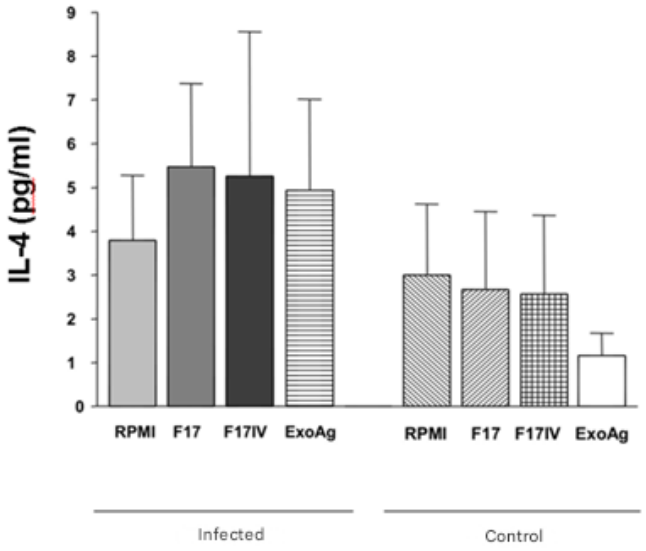
Figure 5: Result of INF-γ level analysis (pg/ml) in spleen cell culture supernatant of Balb/c mice, Pb18-infected group (Infected) and control group without infection (Control), stimulated with F17, F17-IV and ExoAg, by ELISA. RPMI, control without stimulus. RPMI x F17, F17-IV p<0.05.



IL-4 CYTOKINE LEVEL DETERMINATION

The analysis of IL-4 levels (pg/ml) in the spleen cell culture supernatant of Balb/c mice infected with Pb18 and the control group, stimulated with the fractions F17, F17-IV and ExoAg, was performed by ELISA. Negative control was represented by the RPMI medium without stimulus. The results showed no significant difference in IL-4 levels between the RPMI control and the groups stimulated with F17, F17-IV and ExoAg ($P > 0.05$).

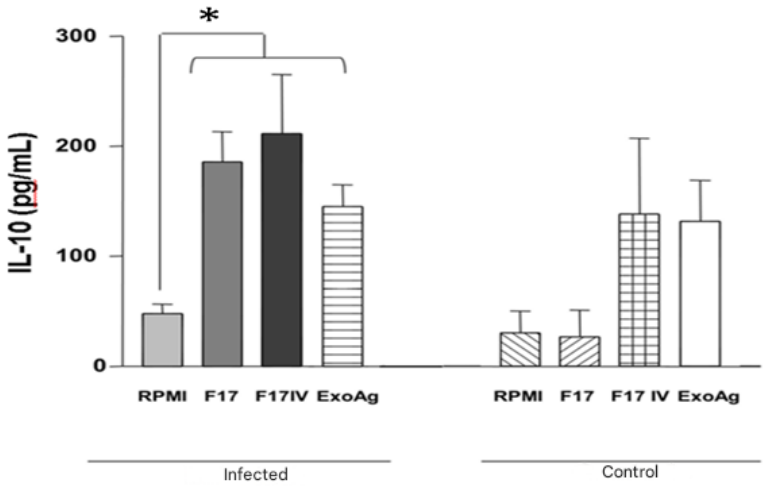
Figure 6: Result of IL-4 level analysis (pg/ml) in spleen cell culture supernatant of Balb/c mice infected with Pb18 (Infected) and control group without infection (Control), stimulated with F17, F17-IV and ExoAg, by ELISA. RPMI, control without stimulus. RPMI x F17, F17-IV, ExoAg p>0.05.



DETERMINATION OF IL-10 CYTOKINE LEVEL

The result of the analysis of IL-10 levels in the spleen cell culture supernatant of animals infected with Pb18 in response to F17, F17-IV and ExoAg showed significant differences in relation to the medium without stimulus ($p<0.05$), Figure 7.

Figure 7: Result of IL-10 level analysis (pg/ml) in spleen cell culture supernatant of Balb/c mice infected with Pb18 (Infected) and control group without infection (Control), stimulated with F17, F17-IV and ExoAg, by ELISA. RPMI, control without stimulus. RPMI x F17, F17-IV, ExoAg p>0.05.



DISCUSSION

Several glycoproteins are excreted/released by *P. brasiliensis* yeast, including gp27, gp43, gp55, gp70, gp87 and high molecular weight polydisperse glycoconjugate (hMM) (Puccia et al., 1986; Blotta & Camargo, 1993; Toledo et al., 1995; Ortiz et al., 1998; Salina et al., 1998). Among these components, gp43 is the most studied because it is released in

greater quantities, is recognized by 100% of the sera of patients with PCM, and is considered a specific antigen. gp70 also stands out (Cezar-dos-Santos et al., 2020), while hMM components are less investigated.

In this work, an antigenic fraction of approximately 380 kDa, called fraction 17, was obtained from gel filtration column chromatography of P. brasiliensis cell-free antigen (CFA) preparation. The approximate molecular mass of 380 kDa was evidenced by immunoblotting. This result is in agreement with previous studies by Marquez et al. (2005), who detected in fraction 17 a component of approximately 366 kDa, within a polydispersion range ranging from 278 kDa to 466 kDa in *P. brasiliensis* B339. Similarly, Pavanelli et al. (2007) obtained a fraction of approximately 380 kDa, also obtained by gel filtration chromatography of CFA of *P. brasiliensis Pb18*.

The presence of this polydisperse hMM glycoconjugate seems to be a common feature in *Paracoccidioides* spp. Fredrich et al. (2010) observed the presence of hMM components in CFAs of *P. brasiliensis* (Pb18) and 20 clinical isolates. The proportion of hMM in relation to the other components ranged from 16% to 20%, indicating a consistent presence of this fraction among the isolates. This fraction of hMM and heterogeneous electrophoretic migration was also detected in the new species *P. lutzii* – LDR2 (Lenhard-Vidal et al., 2018; Assolini et al., 2021), suggesting the constant presence of this component in *Paracoccidioides* spp.

In this study, fraction 17, of approximately 380 kDa, was refractioned by high-performance liquid chromatography (HPLC). The molecular weight of this fraction was initially estimated between 45 kDa and 150 kDa, based on the molecular weight patterns of ovalbumin and IgG, respectively. Subsequently, by *immunoblotting*, the presence of three main bands was verified, corresponding to ~380 kDa, ~70 kDa and ~43 kDa, with the most evident reactivity being ~70 kDa.

These results reinforce the presence of ~380kDa antigen among the polydisperse hMM components in *P. brasiliensis Pb18 antigenic preparations* and associated minor antigenic components that may play an important role in the immune response, especially considering the presence of ~70 kDa bands that are immunoreactive.

The presence of autologous proteolytic enzymes in the CFA preparation was considered, and to avoid their action, the protease inhibitor PMSF was used. However, the PMSF was not able to prevent the generation of lower molecular weight subcomponents. This suggests that, regardless of the presence of enzymes, the hMM component can spontaneously generate smaller components. However, the hypothesis of the existence of

another autologous enzyme resistant to PMSF or the possibility of dissociation of gp70 from the hMM component during chromatographic processes cannot be ruled out.

Puccia et al. (1986) performed the refraction of the first ExoAg peak, obtained by filtration in a column of Bio-Gel P30, in a column of Sepharose-Con A. In this process, they detected the presence of hMM components and glycoproteins smaller than 72 kDa, 55 kDa and 43 kDa. By *immunoblotting*, using serum from patients with PCM, a strong reactivity with gp43 and a weak reactivity with the hMM and gp72 components was observed. These data also suggest that the hMM component generates smaller components. In the present study, HPLC refraction allowed the detection of only ~70 kDa band and ~380 kDa and ~ 43 kDa faintly and ~ 43 kDa. The 55 kDa band was not detected, possibly due to differences in the fungal strains used (B339 versus Pb18), in the types of antigen (ExoAg versus CFA) and in the methodologies applied (Bio-Gel/Sepharose Con A versus Sephadex G-200/HPLC). In addition, the hMM fraction obtained in this study consisted of a single fraction with the highest absorption peak at 280 nm, while Puccia et al. (1986) used part of a broader absorption peak at 280 nm.

The study of the components that induce protection is of great importance, especially for the development of alternative treatment strategies, such as immunotherapeutic procedures, considering the toxicity of the antifungal agents currently used. In this context, the present study evaluated the lymphoproliferative response induced by the ~380 kDa fraction and its ~70 kDa subfraction. Agreeing with the data of Pavanelli et al. (2007), the fraction of 380 kDa was able to induce the lymphoproliferative response in spleen cells from mice experimentally infected with *P. brasiliensis*. Interestingly, the product generated during the purification process by HPLC, a component of MM ~ 70 kDa, retained the ability to induce cell proliferation. This suggests an activation of cellular immunity by both the ~380kDa component and the ~70 kDa component, one of the most relevant defense mechanisms in PCM. The increase in lymphocyte proliferation is an indication that these fungal components have epitopes capable of being recognized by T cells, stimulating the adaptive immune response.

In the evaluation of the cytokine profile in response to the 380 kDa fraction and its subfraction, a significant increase in the levels of INF-γ (interferon-gamma) and IL-10 (interleukin 10) was observed, while IL-4 (interleukin 4) did not present a significant difference. This cytokine profile is characteristic of a Th1-type immune response, which is critical for defense against PCM. INF-γ is a cytokine critical for macrophage activation. Although IL-10 was originally described as a cytokine secreted by Th2 cells, recent studies demonstrate that it can also be produced by Th1, Th2, Th17, Treg cells, dendritic cells, monocytes, and macrophages. IL-10 acts in a dual way on the immune system: on the one

hand, it is a potent anti-inflammatory and immunosuppressive cytokine; on the other hand, it may have immunostimulatory properties (Carlini et al., 2023).

The ~70 kDa subcomponent is possibly a distinct entity from the gp70 previously reported in the literature (Marquez et al., 2005; Biselli et al., 2001; Rigobello et al., 2013). An important evidence of this distinction is its ability to induce an increase in INF-γ, suggesting a differentiated immunomodulatory potential for the Th1 response. This characteristic makes the subcomponent an interesting target for future investigations, as it may represent a new biomarker or a potential immunotherapeutic agent for PCM.

CONCLUSION

The data presented demonstrate the importance of the high molecular weight **(hMM)** components of ***P. brasiliensis***, especially the **380 kDa** fraction and the subcomponents, in triggering the **cellular immune response**. The increase in cytokines associated with the **Th1 response**, such as **INF-γ**, and the absence of an increase in **IL-4**, reinforce the role of these components in inducing an effective immune response in PCM. These findings highlight the relevance of these antigenic components for the development of vaccine or therapeutic strategies for **PCM**.

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WORK AND MENTAL HEALTH OF INTENSIVE CARE PROFESSIONALS - A CONCEPTUAL APPROACH

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ABSTRACT

It is understood the work with one of the structures responsible for structuring the identity of the human being. Thus, through work, man modifies his way of acting, thinking and relates to himself and to the world. In health, work is a theme of much discussion with regard to the general aspects of work; however, with little focus on the hospital setting, specifically in the intensive care unit. This theoretical manuscript in the form of an essay aims to analyze the theoretical and conceptual aspects of work and its repercussion on the mental health of workers who work in the intensive care unit setting. After analyzing the pertinent bibliography regarding conceptual, historical and social aspects, its articulation with the conceptions, its complexity in health and its impact on the mental health of workers, specifically in intensive care, was produced. The analysis points to the need to implement strategies that awaken to the elaboration of actions focused on health policy aimed at the promotion, protection and recovery of workers' health in this context of action.

Keywords: Occupational Health. Mental health. Intensive Care Unit.

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INTRODUCTION

Work is configured as one of the components that structure the identity of the human being. Through work, man modifies his way of thinking, behaving and relating to himself and to the world. The development of work involves the performance of multiple activities, but its intentionality, qualification and skills are extremely relevant, making it capable of producing feelings such as pleasure and/or suffering (1).

To understand the work process, it is necessary to consider the objects, agents, instruments, purposes, methods and products. Thus, objects can be understood as something that comes from nature and undergoes changes with the work process; agents are those who transform the objects of nature; instruments are all the tools to modify nature; purpose consists of the reason why work is performed; methods are the actions organized and systematized to achieve the purpose; and finally, Products are the final result of every work process (2).

The object of health work is the human being in its individual or collective dimension. It is a natural being that lives in collectivity and is invested with value (labor power). The means or instruments of work are a set of things (material and non-material) that the worker interposes directly between him and his object of work to obtain the expected result, in this case, prevention, cure or rehabilitation). In health work, there is physical and intellectual expenditure, a product of this human activity, which can be recovered with rest and good nutrition. To carry it out, the health worker makes an intellectual effort, which places him in the category of intellectual workers (3).

Thus, work in the health area is tensioned by situations of psychosocial conflict between the participants in this process (workers and the human beings who are the objects of this work), characterized by a scenario in which numerous situations can contribute to the illness of health workers, this condition is associated with the characteristics of the environment in which this work is carried out.

The hospital environment is considered an unhealthy place, because in this space a type of continuous and uninterrupted work is carried out, which requires work schedules that oppose the circadian rhythm, which establishes demands, routines and controls to which workers are submitted. The journeys are long, the activities carried out require specific knowledge and skills, they are faced with situations that are only observed in times of catastrophes and wars, they live with pain, suffering and death. Recent studies indicate that exposure to adverse experiences at work is considered a risk factor for mental health[4,5].

Among the scenarios that can favor the illness of workers is the Intensive Care Unit (ICU), a complex environment within the hospital that assists patients in critical health conditions. These people with a high degree of dependence require from health workers technical-scientific knowledge and specific skills, performing complex procedures, making quick decisions, constantly evaluating patients and an effort to overcome physical and mental fatigue, performing their activities without jeopardizing the care provided to patients. In addition, there may be a lack of material resources, exposure to biological, ergonomic, physical and chemical risks; In addition to the lack of psychological support, all of this represents a threat to the health of these workers[6–10].

Data from the World Health Organization indicate that mental disorders constitute 13% in the world. They affect about 700 million people and a third of this population does not receive specialized follow-up. In the hospital environment, this illness is associated with workers' exposure to pain, suffering, pressure, responsibility, harassment, violence, conflicts with colleagues and managers, high demands, working hours and shifts, in addition to lack of autonomy[11].

From this perspective, within the health team, physicians and nurses are the professionals most impacted in their work routine in the ICU, as they are responsible for the therapeutic conducts performed with patients hospitalized there, which can trigger mental health problems such as Minor Psychic Disorders (MPD) and *Burnout Syndrome* (BS) (5).

Minor Psychic Disorders (MPD) are described by symptoms such as forgetfulness, difficulty concentrating, decision-making, insomnia, irritability, and fatigue. Somatic complaints such as headache, lack of appetite, tremors, poor digestion, among others, are also common, which demonstrate disruption in the normal functioning of the individual, which can interfere with the performance of their work activities. These effects have repercussions not only on the life of the individual, but also on their families. However, they are not characterized as mental illness, according to the criteria of the ICD-11 (Eleventh Revision of the International Classification of Diseases of the World Health Organization) and/or the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders - 5th edition - of the *American Psychiatric Association*)[12].

Another situation, no less important, but present in the routine of these workers is the Burnout Syndrome (BS). According to the WHO (World Health Organization) in the International Statistical Classification of Diseases and Related Health Problems in its 11th revision (ICD-11), Burnout Syndrome is the result of chronic work stress that has not been successfully managed and that can lead to feelings of exhaustion or depletion of energy, leading to mental exhaustion and reduced productivity. The WHO also defines work-related

diseases as health problems that affect workers after exposure to risk factors resulting from their work activity, which affect their physical and mental health[13,14].

Regarding the clinical picture, there are diversified signs and symptoms that can confound the diagnosis. Among them, fatigue, myalgia, sleep disorders, migraines, hair loss can be listed. In addition, gastrointestinal, cardiorespiratory, neurological and sexual repercussions have already been described in studies. Psychological manifestations have also been reported and are related to memory deficit, low self-esteem, lack of concentration, apathy and aggressiveness. Allied to these factors, BS has repercussions on a higher probability of absenteeism from work[(15,16)].

Due to the scarcity of strategies aimed at protecting mental health in this occupational group, this study is relevant with regard to the production of scientific evidence about the psychosocial and occupational characteristics in the work of medical professionals and nurses who work in Intensive Care Units and the possible repercussions on the mental health of these workers. The results of this study may support the planning and implementation of actions aimed at promoting and protecting health and quality of life for these workers.

WORK - CONCEPTUAL, HISTORICAL AND SOCIAL DIMENSIONS

Work is understood as an essential human activity. It is a process of interaction between man and nature in which man, with his intentional action, measures, regulates and controls his metabolism with nature. By acting through this movement, man seeks to modify it and, in doing so, modifies his own nature. Thus, intentionality is what differentiates human work from the work performed by other animals. The existence of a conscience, a freedom, not just the motivation for survival[17].

In this sense, the intentionality of the work performed by man permeates the need to delineate strategies, aimed at achieving certain objectives. This process of interaction between man and nature provides modification in both, in addition to being the space in which the human being also undertakes a psychic function, linked to the processes that involve: recognition, construction of professional identity, personal and professional gratification and has a subjective construction referring to each individual. **Thus, work activity** can be evaluated as a form of insertion of the individual in society, considering a series of physical, psychic and social aspects that are related to each other[17–19].

For Marx, human labor has two dimensions; abstract labor and concrete labor. "Abstract labor" or quantitative, expenditure of man's labor power in the physiological sense, and in this quality of abstract human labor, produces commodities. On the other

hand, "concrete" or qualitative labor, with the employment of human labor power in a form specifically suited to a purpose and in this quality of concrete labor produces use value. Thus considered, useful labor, which creates use value, constitutes a stimulus that develops the physical and mental capacities of the human being. Work, in this way, comes to be understood as a source of satisfaction and pleasure. Thus, these dimensions of human work must be thought of inseparably (17).

By appropriating and separating the dimensions of human labor (concrete labor/abstract labor), the capitalist production system removes the meaning of work for the worker, the identity of the producer, who no longer identifies with the product of his work, generating alienation of labor. Therefore, alienation is the dissociation between activity and subject, imposed by the capitalist mode of production. The producer no longer identifies with the product of his labor, he becomes an object, he is objectified. Thus, he begins to identify his activity as strange, not belonging to him. In this sense, when the worker no longer identifies with the product of his work, alienation occurs that dissociates the activity and the subject, transforming the work into a commodity[3,17].

For the performance of human work, which consists of the transformation of one object into another, in a previously calculated (intentional) way, it is necessary to use means or instruments of work. These means or instruments are the tools/equipment that help the worker in transforming the object into a product of his work[3].

Thus, for the work to happen, it requires that it be organized, with the planning of the tasks that need to be fulfilled, hierarchized and controlled. It is important to emphasize that in this process, human relationships are regulated and fragmented, which can interfere with people's mental functioning. Thus, the organization of work is divided into two dimensions, one technical and the other social (3,20).

It is understood, then, that in the capitalist mode of production, labor power is bought and sold, it is bought by the capitalist and sold by the worker who, in an alienated way, without perception, converts the purpose of his work into a commodity (17,18).

In this sense, the salaried worker emerges who is born subordinated to the production project elaborated by capital and, thus, constitutes a regime of exploitation that is elaborated and controlled by capital and executed by the worker, with a defined workload, remuneration with temporal periodicity (daily, weekly, monthly, etc.), environment and working conditions determined by capital (17,21).

In view of these considerations, it is understood that the capitalist mode of production is closely associated with the human labor process, requiring the worker to be trained and specialized in carrying out the activities, combined with occasionally inappropriate working

conditions, exhausting working hours, sometimes unattainable goals set to be achieved, disputes among colleagues and circumstances that are linked to exhaustion; leading to physical and mental illness of the worker20.

CONCEPTIONS OF WORK IN HEALTH

In Brazil, the first reflections on the health work process were made by Cecília Donangelo, at a time of technological changes and alterations in the logic of the functioning of health services[21].

Thus, the object of health work is the human being in his/her dimension, individual, the person in his/her biopsychosocial aspects or collectivities of human beings (population groups). Health workers act on people or groups of people, performing prevention, cure, and rehabilitation actions[3,7].

In view of this, the workforce detached by several professionals consolidates health work as essential for the maintenance of human life. This force is performed through a series of individual and collective activities that involve the technical and social division of this work[32].

Health work has some specificities when compared to other human work, as it encompasses not only technique, but also subjectivity and creativity, which are associated with interpersonal relationships and require negotiation. The same assignment performed by different workers causes the mobilization of different knowledge and histories, thus constituting unique and distinct work situations[24].

Studies by Franco and Merry on health work use essential elements for its development, including: the instruments used by professionals to carry out their activities, which are hard technologies, the technical-scientific knowledge that constitute soft-hard technologies and, last but not least, the relationship between people, called soft technologies. These components are used according to the need to produce care, with the logic of using these technologies predominating at times; influencing the work process[25].

The organization of health services is based on the logic of capitalism and the imposition of technological innovations, in which health and especially disease become commodities, observing the growing proletarianization of professionals and precariousness of work, thus requiring increased performance and quality with a decrease in income and social recognition[24].

Allied to this, health work is characterized by the use of specific knowledge related to qualification, requiring its fragmentation among several professionals. With this fragmentation, there is the emergence of the technical and social division of labor,

characterized by the specificity of intellectual knowledge and practice, in which the biomedical model makes the physician the main provider of care, being assisted by other professionals of lower hierarchical status[23].

The division of labor is also effected within the same category, as that of physicians and nurses. In this sense, in nursing this division is perpetuated, with the nursing technicians responsible for activities related to direct patient care and the nurse is responsible for the organization, administration and control of administrative activities, configuring power relations[26].

According to Melo, the division of labor in health causes a fragmentation of care, alienation of workers in relation to the absolute composition of the work process, submission/superiority with regard to the profession with a split in the conception and execution of activities, which has repercussions on different values of remuneration for work; in addition to establishing division and struggles within the same category and between categories of health workers[27].

In this scenario, health care was gradually modified by the capitalist production model, which converted it into another commodity and thus objectified the work of health workers. These workers have a demanding routine of daily coping with pain, suffering and death combined with the requirements imposed by the labor market; thus, they became susceptible to the development of stress, which, in turn, can lead to the development of psychological distress[3,28].

Health work was hierarchized and divided into levels of complexity. This work can be developed at the primary, secondary and tertiary care levels, but the hospital unit is an important employer, characterized as a complex environment, due to the insertion of several members of the health team and the multiplicity of functions performed by each of them[29].

The hospital is characterized as an unhealthy environment, in which the professionals who work there are confronted in their routine with situations such as long working hours, exposure to physical, chemical, biological and ergonomic risk factors, in addition to salaries that are often insufficient[30].

Among the hospital environment, the Intensive Care Unit (ICU) is configured as a place intended for the care of people in critical health conditions who require specialized care in a continuous and uninterrupted way. In this sense, it is a space with the use of high technology and specialized human resources for the care of people in serious health conditions[31].

Working in the ICU is characterized as stressful for the multiprofessional team, as it can have relevant repercussions for the health of these workers, due to peculiarities inherent to the sector itself. Several factors make the ICU a naturally stressful place, as it is a closed environment, with demanding routines, a tiring pace of work, daily coexistence with suffering and death, the need for quick decision-making, in addition to the requirement of specific relational skills for interaction with the family members of hospitalized patients, who in this context, are in altered psychic and emotional conditions[6,8].

In this scenario, the articulation between the actions of the different professionals demands interaction between them, making evident a synchronization in the functioning of the work among the components of the multiprofessional team, so it is essential that the work group is connected in search of a common goal, which in the ICU is the patient's recovery[32].

Despite the joint work of the multiprofessional team, the biomedical model is still perpetuated in hospital units, including intensive care; and the doctor is responsible for leading the team. However, there is a complementarity between the functions of the physician and the nurse. In this way, medical work is more directed to understanding the disease and seeking its cure, so it is focused on the clinic, with the performance of the physical examination, evaluation of the complaints presented, signs and symptoms, so that it can build a diagnostic suspicion and a therapeutic plan. In addition, it makes use of technology to use state-of-the-art tests to conclude suspicions/diagnoses[33].

Nursing work, on the other hand, is not different from that of doctors, is also complex and multifaceted, requiring specific knowledge and skills, and involves several activities performed by this professional. These tasks are often developed simultaneously or not, and can be listed as: assisting the patient under their care, managing the environment in which they are responsible, enabling conditions for the performance of their work and that of other health professionals, teaching by training nursing technicians and auxiliaries[2].

Considering the performance of these professionals in intensive care, several studies point to this scenario as an unhealthy place for the mental health of these workers, thus it is necessary to assess these repercussions, as well as the relevance of early identification of these events to guide individual and collective interventions[7,9,12,34–36].

MENTAL HEALTH OF WORKERS IN THE CONTEXT OF INTENSIVE CARE

MINOR PSYCHIC DISORDERS

The hospital environment can lead to mental distress among health workers, which in turn can progress to absenteeism and the development of mental health problems such

as anxiety and depression. It is important to emphasize that the responsibility of care, difficulties in interpersonal relationships with the multidisciplinary team, emotional exhaustion, among other factors, can have repercussions on the mental health of these workers[4].

Studies indicate that professionals who work in the ICU may suffer in their daily lives with chronic stress, professional dissatisfaction, conditions resulting from factors related to the environment, length of the working day, in addition to a high degree of demand regarding their capacities and aptitudes in the context of intensive care. Such aspects can cause the physical and/or mental illness of these workers, among which we can list Minor Psychic Disorders (MPD) and Burnout *Syndrome* (BS)[7,34].

Minor Psychic Disorders (MPD) are manifested by a clinical picture with symptoms of anxiety, depression or somatization, but cannot be considered a mental illness according to the ICD-11 (International Statistical Classification of Diseases and Related Health Problems) or the Diagnostic and Statistical Manual (DSM-V) of the American Psychiatric Society. These changes have a high repercussion in the area of occupational health and have been characterized as an important public health problem[30,37].

These clinical changes, which may be associated with the appearance of variations related to behavior and emotions, interfere not only in the affected people, but also in their family and their entire support network. Symptoms include difficulty concentrating, decision-making, forgetfulness, insomnia, irritability and fatigue, as well as somatic complaints (headache, lack of appetite, tremors, poor digestion, among others), which have a high cost and impact on quality of life and relationships, with implications for daily activities; which can cause absenteeism and evolution to more severe mental disorders[30].

Several epidemiological studies conducted with intensive care workers have demonstrated the existence of a relationship between the development of MPD and the work performed by these workers. These results are associated with excessive workload, chronic stress, psychic and cognitive overload, night work, absence of rest breaks, and lack of control over work[4,12,37].

BURNOUT SYNDROME

Another frequent problem among workers is the Burnout Syndrome (BS), first described in 1974 by psychoanalyst Herbert Freudenberger. This problem is related to unfavorable situations in the work environment and is manifested by three dimensions: emotional exhaustion, depersonalization, and low personal fulfillment[38].

According to the WHO in the International Statistical Classification of Diseases and Related Health Problems in its 11th revision (ICD-11), Burnout Syndrome is the result of chronic work stress that has not been successfully managed and that can lead to feelings of exhaustion or depletion of energy, leading to mental exhaustion and reduced productivity. The WHO also defines work-related diseases as health problems that affect workers after exposure to risk factors resulting from their work activity, which affect their physical and mental health[14].

To measure SB, Maslach and Jackson (1981) developed the *Maslach Burnout Inventory* (MBI), which had its version adapted and validated by Tamayo (1997) in Portuguese. The MBI is composed of 22 questions about feelings and attitudes that encompass the three fundamental dimensions of the syndrome, professional exhaustion is assessed by nine items, depersonalization by five, and personal fulfillment by eight. The 22 questions have a seven-point scale, ranging from 0 to 6, identifying one of the three dimensions independently, each of the dimensions. For emotional exhaustion, a score ≥ 27 indicates a high level; from 17 to 26 moderate level; and ≤ 16, low level. For depersonalization, a score ≥ 13 indicates a high level, from 7 to 12 moderate, and ≤ 6, a low level. The score related to ineffectiveness goes in the opposite direction to the others, since a score from zero to 31 indicates a high level, from 32 to 38 a moderate level, and ≥ 39, a low level[39].

Occupational stress affects about 70% of the Brazilian population and 30% of this contingent suffers from BS, directly harming the work of these people, due to its high prevalence, configuring itself as an important public health problem. In this sense, many studies have been directed to this theme in the health area[40].

Burnout *syndrome* is characterized as a series of physical and psychological symptoms (bad mood, difficulty in individual relationships, absence from work, insomnia, lack of appetite, low productivity, fatigue, myalgia, hair loss, migraine, impact on the digestive, neurological and sexual system). Psychological symptoms are highlighted as lack of concentration, apathy, memory deficit, low self-esteem and aggressiveness. The Burnout situation also implies a greater probability of absenteeism by the affected professionals. Thus, it has been configured as an important public health problem, as it has a direct impact on health workers and patients cared for by these professionals[15].

From this perspective, the intensive care setting, due to its physical characteristics, work pace, need for rapid decision-making, and severity of the patients' clinical condition, has been listed as a favorable place for its development. In addition, the professionals who work in this unit live with constant emotional changes[41].

The ICU's multidisciplinary team is composed of doctors, nurses, nursing technicians, physiotherapists, psychologists, and nutritionists. In this sense, the health professionals who are at greater risk of developing BS are physicians and nurses; due to the similarity of responsibilities and functions within the sector[15,41].

Studies show that the worsening of symptoms of mental illness, including BS, has increased in the face of the COVID-19 pandemic. The exhaustion presented by these professionals was associated with a new context of uncertainties, deaths, fear, among other factors[39,41,42].

Also in relation to the worsening of mental illness situations among health professionals in the context of COVID 19, Brazil revealed that the pandemic favored the mental illness of those who worked in direct care for infected patients. According to the survey carried out by Fiocruz, the main alterations reported in the daily lives of health professionals were sleep disturbance (15.8%), irritability/crying, frequent/disturbances in general (13.6%), inability to relax/stress (11.7%), difficulty concentrating and slow thinking (9.2%), loss of satisfaction in career or life/sadness/apathy (9.1%), negative feeling of the future/negative thinking, suicidal (8.3%) and change in appetite/change in weight (8.1%)[43].

In addition, it is relevant to mention that cases of mental illness in workers and their leave are often underreported, but studies point to the severity and urgency of investing in actions that contemplate these workers is paramount[44].

Thus, studies are needed to estimate the occurrence, investigate the factors associated with these diseases; in addition to enabling strategies to minimize the repercussions of these events on mental health among workers who work in Intensive Care Units.

FINAL CONSIDERATIONS

This study contributes as a theoretical contribution to health researchers, broadening their view of the theoretical, historical and social dimensions related to work, how work happens in the health dimension and what is its impact on the mental health of health workers, particularly in the ICU.

Thus, it is relevant to mention that the theoretical contributions presented here may support the planning and implementation of actions aimed at promoting and protecting health and quality of life for these workers.

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COMPUTATIONAL FLIGHT PREDICTION FOR MINI PET ROCKETS, APPLIED TO REFORESTATION

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ABSTRACT

This work refers to modeling and computer simulation of PET mini-rockets with air and water propulsion and focuses on the development of a computer program for flight prediction of water- and air-propelled mini-rockets. The specific objectives of this work were: design and construction of a wind tunnel; experimental acquisition of the drag coefficients of mini-rockets in a wind tunnel; construction of launch bases for mini-rockets for the validation of the flight prediction computer program; mini-rocket projects and development of a computer program for mini-rocket flight prediction. The methodology began with the design and assembly of a wind tunnel to determine the drag coefficient of the mini-rockets. A mini-rocket launch base with water and air propulsion was developed, built and used. The thrust values of several mini-rockets were determined experimentally on a bench while keeping the mini-rocket fixed. Image and video analysis were performed in the bench test with the determination of the water flow at the exit of the rocket nozzle and determination of the thrust profile of the mini-rockets (PET 2 liters). The modeling and simulation of the flight prediction were developed from two systems of differential equations, based on the equations of conservation of mass and momentum, which were solved by the Runge Kutta numerical method. It was necessary to solve two systems of nonlinear differential equations, one for the Propulsion Phase and the other for the oblique launch.

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The computer program has data input defined by the user and that generates the various outputs in matrix format or in the format of figures. The simulation of the mini-rocket's flight prediction resulted in figures containing the most important flight parameters. The results of the computer program were validated through the field launches of the mini-rockets and it was found that it is an important tool for the design of mini-rockets intended for the reforestation of degraded areas.

Keywords: Mini rockets. Wind tunnel. Flight prediction program. Reforestation.

INTRODUCTION

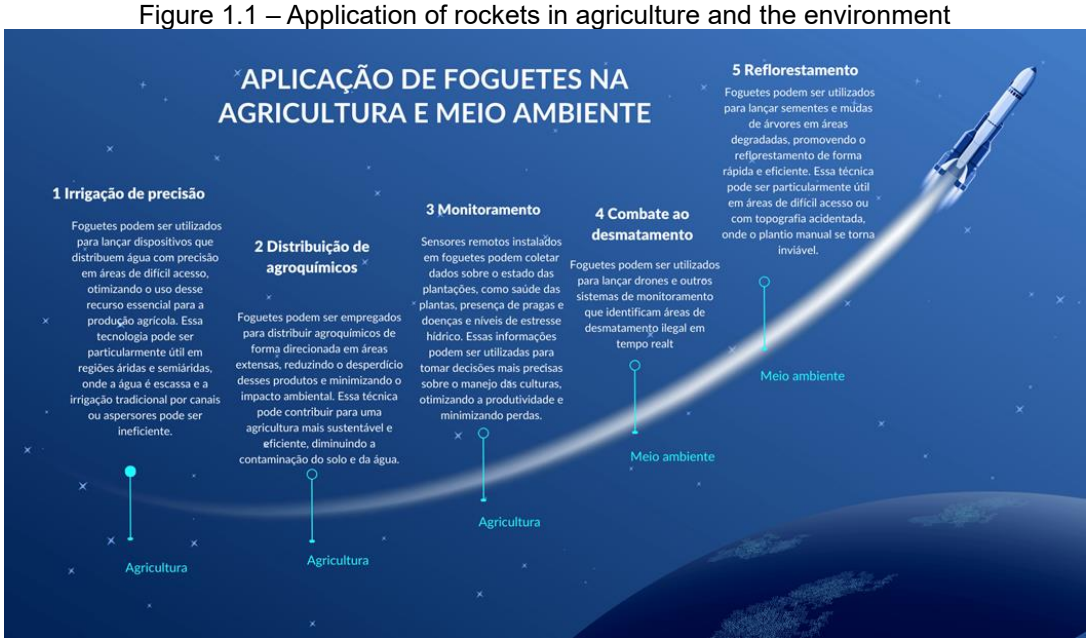
The ecological restoration of degraded areas, an urgent global challenge, faces multiple obstacles that demand innovative solutions. Habitat fragmentation, resource scarcity, and the complexity of degradation processes are just some of the challenges to be overcome [1].

Reports have pointed out that approximately one-third of the planet's arable land is already degraded, indicating the urgent need to recover or remedy the damage caused by poor agricultural practices and other factors [2].

The use of rockets for ecological restoration purposes presents unique challenges. The precision in seed deposition, the selection of the most suitable species for each environment and the evaluation of long-term environmental impacts are issues that require in-depth research. In addition, the costs associated with the development and operation of seed launching systems can be high, limiting their large-scale application.

The use of rockets in agriculture and in the environmental area, although still under development, opens up a range of innovative possibilities for the management of natural resources and environmental preservation. This technology, traditionally associated with space exploration, has the potential to optimize agricultural practices, monitor the environment, and combat challenges such as deforestation and desertification, as shown in Figure 1.1.

Figure 1.1 – Application of rockets in agriculture and the environment



Source: the authors

The specific objectives of this work were: design and construction of a wind tunnel; experimental acquisition of the drag coefficients of mini-rockets in a wind tunnel; construction of launch bases for mini-rockets for the validation of the flight prediction computer program; design of mini-rockets and the development of a computer program for mini-rocket flight prediction.

LITERATURE REVIEW

Aerial seeding is a technique for direct transmission of seeds by the use of aerial vehicles, such as drones, airplanes or helicopters [3]. The method of launching the seeds chosen (aerial, manual or mechanized) influences the costs, with methods by planes generally more expensive.

The aerial seeding technique for reforestation has been employed since the 1950s [4]. In industrialized countries, aerial seeding is already considered a practical reforestation technique with considerable success reported in the United States of America (USA), Canada, Australia, Russia, India and New Zealand [5].

One promising approach to accelerate the reforestation of degraded areas is rocket seed dropping. This technique, still under development, offers the possibility of reaching areas that are difficult to access, such as steep slopes and remote regions, facilitating the dispersal of seeds of native species and the restoration of vegetation cover.

Ecological applications of rockets have been proposed [6], aiming to restore degraded areas in the caatinga biome of Brazil. Rockets made of biodegradable cassava starch plastic demonstrate the potential of rocket seed launching to restore degraded areas in different biomes. However, it is critical that this technology is developed sustainably and integrated with other ecological restoration practices.

A more cost-effective alternative may be PET water rockets, also known as PET bottle rockets, which were conceived from the idea of American engineer and physicist Robert Goddard [7,8]. PET Rockets are a pedagogical, functional and sustainable tool that combines scientific principles with creativity and ingenuity [6]. Built with simple materials and launched using only water, these rockets provide a hands-on and engaging experience for students of all ages, sparking curiosity about concepts such as propulsion, aerodynamics, and physics.

The fundamental principle behind the flight of a PET rocket into water is Newton's third law, which states that for every action, there is an equal and opposite reaction. The force exerted by the pressurized water on the bottle generates a reaction force of equal intensity, but in the opposite direction, which propels the bottle upwards. This interaction

between the action of water on the bottle and the reaction of the bottle on water is a classic example of Newton's third law [9,10].

In addition to Newton's third law, several other quantities related to aerodynamics influence the flight of a PET rocket, areas of knowledge such as Aerospace Sciences, Physics, Mathematics and Chemistry are related to the functionality and flight behavior of the rocket as well as the design of the structure, which is divided into a hood, body and fins [11]. The aerodynamic shape of the PET bottle, with its conical base and narrow nozzle, contributes to the stability and range of the rocket. Air flows more easily over the curved surface of the bottle, creating an area of low pressure at the top, while high pressure at the bottom propels the rocket upwards [12].

The use of computer simulations for research and teaching provides students and researchers with an interactive and dynamic experience of knowledge [13]. By manipulating variables and collecting data in virtual environments, the construction of knowledge about physical phenomena develops essential skills such as data analysis and problem solving. This pedagogical approach, which explores the potential of digital technologies, has been shown to be effective in making knowledge of the physical sciences more engaging and meaningful [14,15].

The complexity of the phenomena involved in space launches requires the use of differential equations to accurately describe the relevant variables and predict the behavior of the system [16]. They allow modeling and analyzing the behavior of dynamic systems, such as mathematically describing the forces acting on a rocket during launch, such as buoyant force, gravitational force, air resistance, and centripetal force. Some rocket parameters, such as mass, speed and altitude, vary continuously during launch. The differential equations make it possible to model these variations over time, optimize optimal trajectories for the rocket, maximizing the payload or minimizing fuel consumption, analyze the stability of the rocket's flight, ensuring that it does not go into rotation or oscillate in an uncontrolled way.

The differential equation systems for modeling mini-rocket launches are based on the equations of conservation of mass and momentum, exemplified in the nonlinear differential equations 2.1 to 2.3, generating a system of differential equations, which can be solved by the Runge-Kutta numerical method.

A momentum conservation balance can be performed in the mini-rocket flight prediction modeling considering the forces acting on the system: gravitational and nonlinear drag force (Equations 1, 2 and 3). A system of nonlinear differential equations can be set up for the mini-rocket's propulsion step. Differential equations 2 and 3 are relative to the

conservation of momentum in *y* and *x*, considering the gravitational force and drag forces acting on the minirocket [17].

$$\Sigma\vec{F}saem - \Sigma\vec{F}entram + \overrightarrow{\Sigma F}acúmulo = \overrightarrow{\Sigma F}externas \quad (1)$$

$$-\dot{m}.v_y.\cos(\theta) - 0 + \frac{d(m.v_y)}{dt} = 0 - 0.5.Cd.\rho \quad (2)$$

$$-\dot{m}.v_x.\text{sen}(\theta) - 0 + \frac{d(m.v_x)}{dt} = 0 - 0.5.Cd.\rho.A.{v_x}^2 \quad (3)$$

Where (v_y) is the velocity in the direction of the y-axis, where) is the velocity in the direction of the x-axis, launch angle(θ), drag coefficient(Cd), cross-sectional area of the mini-rocket(A), mass of the mini-rocket(m), air density (ρ), gravitational acceleration(g), and water flow rate at the outlet of the mini-rocket's nozzle(.(v_x ṁ)

In the literature, it is addressed in several works [16], the resolution of these equations by algebraic methods, using simplifications such as: linearized drag force equation, constant mass system and a smaller number of dynamic variables, generating more imprecise results and with a smaller number of flight parameters.

The difference of this work in relation to those found in the literature is that in this one we addressed the dynamic modeling for flight prediction [17], using two systems of nonlinear equations with twenty-two dynamic variables, one system for the propulsion stage and the other for the oblique launch. The conservation equations were solved by the Runge-Kutta method, finding results for various parameters of the mini-rocket's flight.

METHODOLOGY

MATERIALS

Dynamometer

The AMF 5 tensile and compression force meter measures up to 5 N, with an accuracy of 0.01 N was used to predict the drag forces of the mini-rockets and later determine the drag coefficient.

Fog Machine

The smoke generator device has a mini vacuum pump that produces a pressure of 0.9 bar and a flow rate of 13 liters per minute, a steel cabinet with rubber feet and a handle, a long silicone hose with 2m and a conical smoke outlet nozzle with diameters from 6 to 15 mm and a hole with a diameter of 4 mm. The smoke machine had the purpose of visualizing the flow of air on the surface of the mini-rockets.

Winding tunnel

The wind tunnel was designed, assembled and built aiming at determining the drag coefficients of the mini-rockets and visualizing the flow profile.

Anemometer

With the CB-8909 anemometer, the air speed in the wind tunnel was measured. The anemometer probe has height adjustment up to 40 cm in length, allowing the user to position the instrument in the desired location, in order to obtain air speed measurements at various points in the wind tunnel.

Mini-rocket launch base, water and air propulsion.

The mini-rocket launch base was designed and built in stainless steel, contains a trigger for releasing the rocket at a certain pressure, was used to carry out several experimental mini-rocket launches

METHODOLOGY

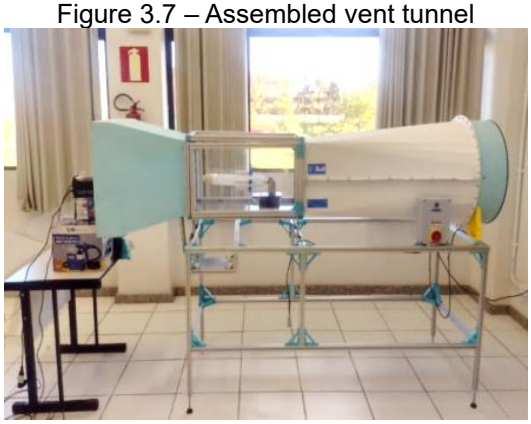
Construction of the wind tunnel

The wind tunnel was designed, assembled and built by the research group, with support from FAPEMIG and is available for use in the Integrated Engineering Laboratory of CAP-UFSJ, as shown in Figures 3.1 and 3.2.

Figure 3.1 – Wind tunnel in the process of assembly

Source: the authors

Figure 3.7 – Assembled vent tunnel



Source: the authors

The wind tunnel structure was assembled by the research group and has an aluminum profile suitable for operations and movements in research laboratories. The wind tunnel has an air inlet with honeycomb structures to reduce turbulence and transform the airflow to the laminar regime. Dimensions: viewing window, sectional area of 400mmx400mm and length of 400mm, followed by suction area with fan. The industrial fan has a power of 3/4 Hp with a diameter of 60 cm, coupled to the tunnel outlet. At the top of the viewing window, there are sampling points for air velocity measurements, through the insertion of a hot wire anemometer and points for sampling the drag force through a dynamometer.

Tests to determine the drag coefficient of mini-rockets

The project began with the tests to determine the drag coefficient of the mini-rockets in the wind tunnel.

Equation 4 relates the drag force with the drag coefficient, cross-sectional area of flow, air flow velocity in the wind tunnel, it was possible to calculate the drag coefficient of the mini-rockets.

$$F_d = 0.5 \, . \, C_d . \rho . A . v^2 \qquad (4)$$

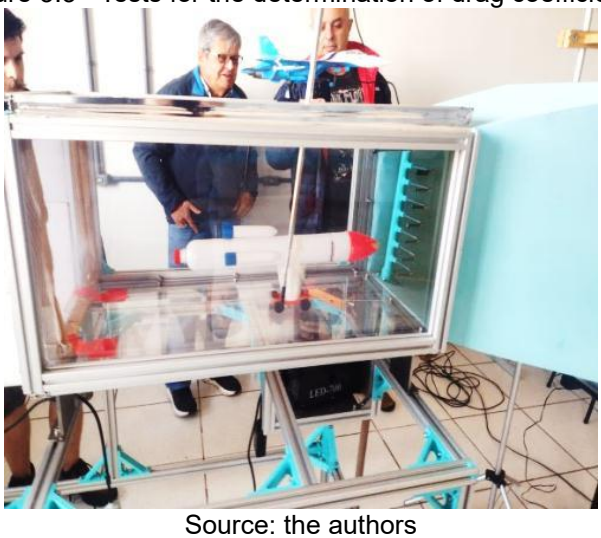
Where: (Fd) is the drag force [N], Cd is the drag coefficient [-], (ρ) air density [kg/m3], (A) transverse flow area [m2] and v is the air velocity [m/s].

The industrial fan attached to the wind tunnel has a rotation adjustment system that allowed the air velocity to be set to 10 m/s, with the aid of an anemometer. An assembly was carried out for the measurements in the wind tunnel that contained a cart and a *nylon line* coupled to a dynamometer. The drag forces of the mini-rockets were obtained by the

difference in forces read between the mini-rocket with the cart and with the cart alone. The cross-sectional areas of the mini-rockets were calculated and the air density was determined under the atmospheric conditions of the test.

Figure 3.3 shows a photo of a test to determine the drag coefficients in the research group's laboratory.

Figure 3.3 - Tests for the determination of drag coefficients



Source: the authors

From the results of the experimental tests of item 3.2.2 and through Equation (4) it was possible to determine the drag coefficients (Cd) for each minirocket,

Construction of mini-rocket launch bases

Two mini-rocket launch bases with water and air propulsion were developed and built. The bases contain a trigger for release at a certain pressure, as shown in Figure 3.4.

Figure 3.4. The mini-rocket launch base with water and air propulsion

Source: the authors

With the launch base built, experimental launches of biodegradable rockets can be carried out for validation of the flight prediction program.

The material used in the mini-rockets was polyethylene (PET). The biodegradable material for the mini-rockets is in the testing phase and will possibly be made of (PLA), which is a biodegradable polymer and will be molded in a 3D printer.

Determination of mini-rocket thrust

The thrusts of the mini-rockets were determined through experimental tests on a bench keeping the rockets fixed. A content of thirty percent water was inserted into the mini-rocket (PET), an optimal value for propulsion. The value of the release pressure was recorded. From the analysis of images in video editing software, it was possible to outline the water flow profile at the outlet of the nozzle over time.

The thrusts of the mini-rockets were determined by Equations 5 and 6 from the equations of conservation of mass and momentum.

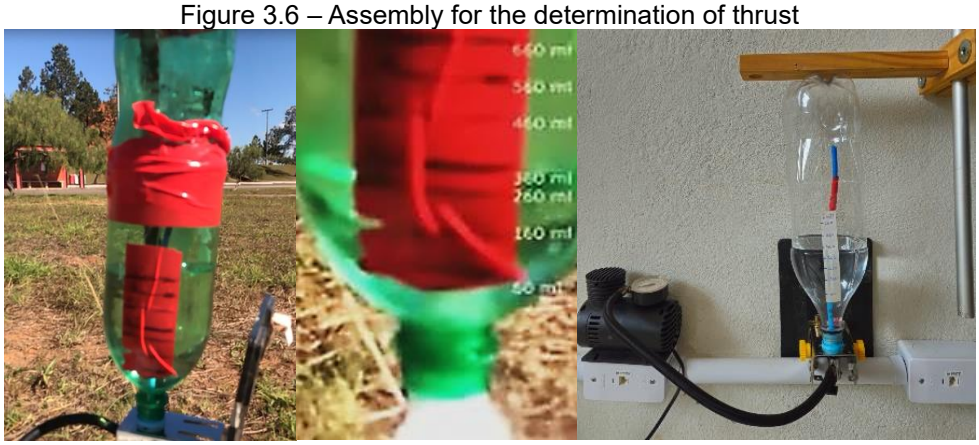
$$E = \dot{m} \, . \, v \qquad (5)$$

$$\mathrm{v} = \dot{\mathrm{m}} \, / \, (\rho . \mathrm{A}) \qquad (6)$$

Where: E is the thrust of the mini-rocket [N], the mass flow rate of water at the outlet of the nozzle [kg/s], v velocity of output at the nozzle of the rocket [m/s], the transverse flow area of the rocket outlet nozzle [m3], and $\dot{\mathrm{m}}\rho$ the density of the water [kg/m3].

Figure 3.6 shows assembly for the determination of thrust

Figure 3.6 – Assembly for the determination of thrust



Development of the computer program for flight prediction

The modeling and simulation of the flight prediction were carried out through the development of two systems of differential equations based on the equations of conservation of mass and momentum, which were solved by the Runge Kutta fourth-order numerical method using *OCTAVE GNU software*. The thrust values of the mini-rockets, determined in item 3.2.4, were used. By analyzing the results of the experimental tests, it was considered that the thrust is generated by the expulsion of water from the system, since the air mass of the system is insignificant in relation to the mass of water, which is ejected from the system and which generates the reaction force responsible for the propulsion of the system. After the short propulsion period (Phase 1), the mini-rocket moves to (Phase 2), equivalent to an oblique launch. Thus, it was necessary to develop two systems of nonlinear differential equations, one for each phase. The two systems of differential equations were solved in series.

Equation of the system

Phase 1 – Propulsion

A momentum conservation balance (Equation 7) was used to assemble the system of nonlinear differential equations for Phase 1. The first two differential equations for propulsion, Phase 1, are relative to the conservation of momentum in x and y (Equations 8 and 9), considering the gravitational force and drag forces.

$$\Sigma \vec{F}entram - \Sigma \vec{F}saem + \overrightarrow{\Sigma F}acumulo = \overrightarrow{\Sigma F}externas \qquad (7)$$

$$0 \quad -(-E.\cos(\theta)) + \frac{d(m.v_y)}{dt} = -m.g - 0.5.Cd.\rho.A.{v_y}^2 \qquad (8)$$

$$0 \quad -(-E.\operatorname{sen}(\theta)) + \frac{d(m.v_x)}{dt} = 0 - 0.5.Cd.\rho.A.{v_x}^2 \qquad (9)$$

The dynamic variables chosen for the assembly of the differential equation system were: velocity in y), velocity in x), displacement in y (Y), displacement in x (X), launch angle (θ), drag coefficient (Cd), cross-sectional area of the mini-rocket (A), propulsion time (Temprop), mass of the mini-rocket (m), air density (ρ), mass of the rocket (m), thrust (E) and flow rate (.(v_y (v_x $\dot{m}$)

$$\frac{dy}{dt} = v_y \quad (10)$$

$$\frac{dx}{dt} = v_x \quad (11)$$

$$\frac{d\theta}{dt} = 0 \quad (12)$$

$$\frac{dCd}{dt} = 0 \quad (13)$$

$$\frac{dA}{dt} = 0 \quad (14)$$

$$\frac{dTemprop}{dt} = 0 \quad (15)$$

$$\frac{dm}{dt} = -\dot{m} \quad (16)$$

$$\frac{d\dot{m}}{dt} = 0 \quad (17)$$

$$\frac{dE}{dt} = 0 \quad (18)$$

$$\frac{d\rho}{dt} = 0 \quad (19)$$

The system of nonlinear differential equations of Phase 1 had a total of twelve dynamic variables considered, Equations 8 to 19 with their respective initial conditions were solved by the Runge Kutta fourth-order numerical method. The mini-rocket thrust value, determined in item 3.2.4, drag coefficients determined in item 3.2.2 and the initial conditions necessary for each differential equation were used. Figure 3.7 shows the FUNCTION subroutine of Phase 1 propulsion, which is called by the main program.

FIGURE 3.7 - FUNCTION of Phase 1 propulsion, which is called by the main program.

```
function f=propulsao(t,Y)
% Vy    Vx    y     x     angulo  Cd    Areapet  Tempopropulsao  massa  Vazao  Empuxo  Densar
% Y(1)  Y(2)  Y(3)  Y(4)  Y(5)    Y(6)  Y(7)     Y(8)            Y(9)   Y(10)  Y(11)   Y(12)

 g=9.81;

 % Sistema de EDos propuilsão
 f(1,1)=-g+((sind(Y(5))*Y(11))/Y(9))-(Y(1)/Y(9))*Y(10)-(0.5*Y(6)*Y(12)*Y(7)*(Y(1)^2))/Y(9);
 f(2,1)=  ((cosd(Y(5))*Y(11))/Y(9))-(Y(2)/Y(9))*Y(10)-(0.5*Y(6)*Y(12)*Y(7)*(Y(2)^2))/Y(9);
 f(3,1)=Y(1);
 f(4,1)=Y(2);
 f(5,1)=0;
 f(6,1)=0;
 f(7,1)=0;
 f(8,1)=0;
 f(9,1)=-Y(10);
 f(10,1)=0;
 f(11,1)=0;
 f(12,1)=0;
 % [tempo1,s]=ode45('propulsao',[0 tempoprop],[0 0 0 0 angulo cd areapet tempoprop massatotal vazao E densar])
```

Source: the authors

Phase 2 - Oblique Launch

For the oblique launch (Phase 2) nonlinear differential equations were used, similar to those of Phase 1, but without the buoyant force. The first two differential equations for Phase 2 are relative to the conservation of momentum in x and y (Equations 20 and 21), considering the gravitational force and drag forces.

$$\frac{d(m.v_y)}{dt} = -mg - 0.5.Cd.\rho.A.{v_y}^2 \quad (20)$$

$$\frac{d\,(m.v_x)}{dt} = -0.5.Cd.\rho.A.{v_x}^2 \quad (21)$$

The dynamic variables chosen for the assembly of the Differential Equations system were: velocity in y), velocity in x), displacement in y (Y), displacement in x (X), launch angle (θ), drag coefficient (Cd), cross-sectional area of the mini-rocket (A), oblique flight time in Phase 2 (tempodevoooblique), mass of the mini-rocket (m) and air density (ρ).(v_y (v_x

$$\frac{dy}{dt} = v_y \quad (22)$$

$$\frac{dx}{dt} = v_x \quad (23)$$

$$\frac{d\theta}{dt} = 0 \quad (24)$$

$$\frac{dCd}{dt} = 0 \quad (25)$$

$$\frac{dA}{dt} = 0 \quad (26)$$

$$\frac{dTempovoooobliquo}{dt} = 0 \quad (27)$$

$$\frac{dm}{dt} = 0 \quad (28)$$

$$\frac{d\rho}{dt} = 0 \quad (29)$$

The system of nonlinear differential equations of Phase 2 had a total of ten dynamic variables considered, Equations 20 to 29, with their respective initial conditions and which was solved by the Runge Kutta fourth-order numerical method. Figure 3.8 shows the FUNCTION subroutine of Phase 2, oblique throw, which is called by the main program.

FIGURE 3.8 - *FUNCTION* of Phase 2, oblique throw.

```
function f=obliquo(t,Y)
% Vy  Vx    y    x     angulo  Cd    Areapet Tempo max  m    densar
% Y(1)  Y(2)  Y(3)  Y(4)   Y(5)  Y(6)   Y(7)     Y(8)  Y(9)   Y(10)

 g=9.81;
 f(1,1)=-g-((0.5*Y(6)*Y(10)*Y(7)*(Y(1)^2)))/Y(9);
 f(2,1)=(-0.5*Y(6)*Y(10)*Y(7)*(Y(2)^2))/Y(9);
 f(3,1)=Y(1);
 f(4,1)=Y(2);
 f(5,1)=0;
 f(6,1)=0;
 f(7,1)=0;
 f(8,1)=0;
 f(9,1)=0;
 f(10,1)=0;

%  [tempo,s2]=ode45('obliquo',[tempoprop tob],[s(ul,1) s(ul,2) s(ul,3) s(ul,4) angulo cd areapet tempoprop (massa+semente) densar])
```

Source: the authors

With the two subroutines ready, the main program was prepared that unites Phase 1 and 2 in series (propulsion and oblique launch). The computer program has user-defined data inputs that generate the various outputs in matrix format or in the form of figures. The

program was used to predict several launches with loads and with different angles of launches.

The inputs from the computer program are requested as shown in Figure 3.9

FIGURE 3.9 – Computer program inputs

```
pressao=input('Entre com a Pressão de lançamento em PSI, sugestão de 60 a 140 psi: ')
massa=input('Entre com Massa do Foguete vazio (kg)')
angulo=input('Angulo de lançamento (graus) de 10 a 90 graus: ')
liquido=input('Massa de água no foguete(kg): ')
semente=input('Massa de sementes (kg): ')
cd=input('Entre com o Cd do foguete: ')
areapet=input('Entre com a área transversal do PET : ')
densar=input('Entre com a densidade do ar (kg/m3): ')
```

Source: the authors

The validation was carried out by comparing the data from the computer simulation with the data from the real experimental launches, carried out with the launch base and the mini-rockets.

RESULTS

RESULTS FOR DRAG COEFFICIENTS FOR MINI-ROCKETS

The results for the drag coefficients for the mini-rockets were obtained according to the methodology described in item 3.2.2. Table 1 shows the values of the drag coefficients of the mini-rockets for different design configurations.

Table 1 - Values of the drag coefficients of the mini-rockets for different configurations.

Mini Fog (Type)	Sweeping coefficient (Cd)	Measurement error
Mini-rockets 1	0,13	+/- 0,01
Mini-rockets 2	0,28	+/- 0,01
Mini-rockets 3	0,20	+/- 0,01
Mini-rockets 4	0,38	+/- 0,01
Mini-rockets 5	0,51	+/- 0,01

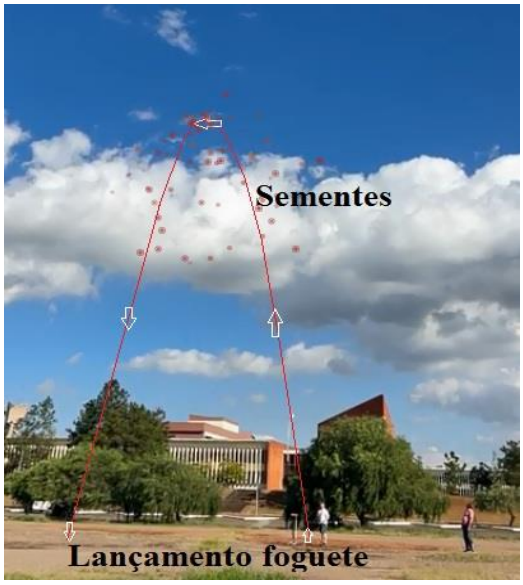
A significant difference was observed in the values of the drag coefficients, because the mini-rockets have very different design configurations, impacting the aerodynamic profile and the response of the drag coefficient.

TESTS WITH THE LAUNCH PAD

Figure 3.5 shows the launch of a mini-rocket with water and air propulsion using the launch base for the validation of the flight prediction computer program and analysis of the rocket designs. Launch pressure and maximum range for the mini-rockets with 2-liter PET

boosters were noted and compared with the results of the flight prediction computer program.

Figure 3.5 - Launch of a mini-rocket with water and air propulsion

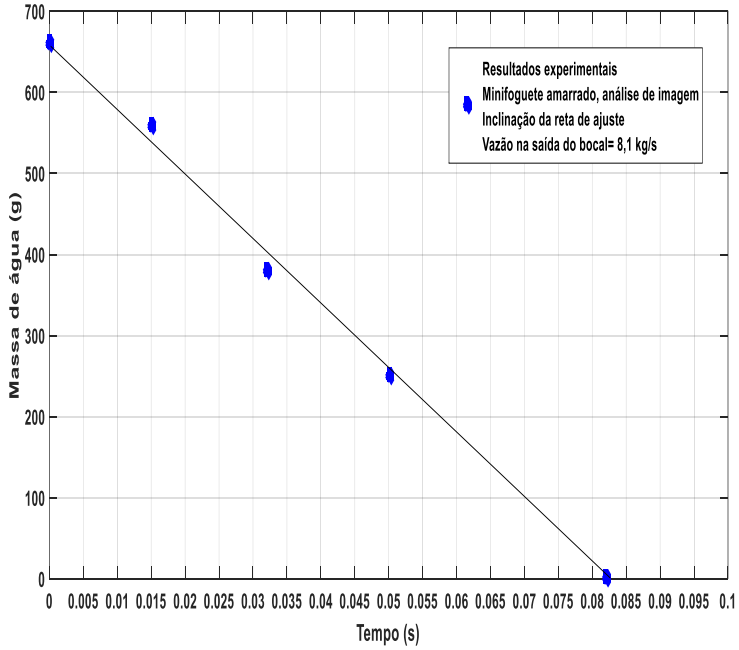


Source: the authors

RESULTS FOR MINI-ROCKET THRUST

The thrust of the mini-rockets was obtained according to the methodology described in item 3.2.3. Figure 4.1 shows the thrust profile of a mini-rocket obtained experimentally at a launch pressure of 70 Psi.

Figure 4.1 - Thrust profile of an experimentally obtained mini-rocket.



It can be seen in Figure 4.1 that the flow rate at the outlet of the nozzles of the mini-rockets powered by water and air has a constant value of 8.1 kg/s, consequently the thrust is constant and is generated by the expulsion of water from the system, resulting in a reactional force, according to Newton's third law. The thrust of this mini-rocket was calculated by Equations 3.2 and 3.3 and resulted in a value of 145 Newtons.

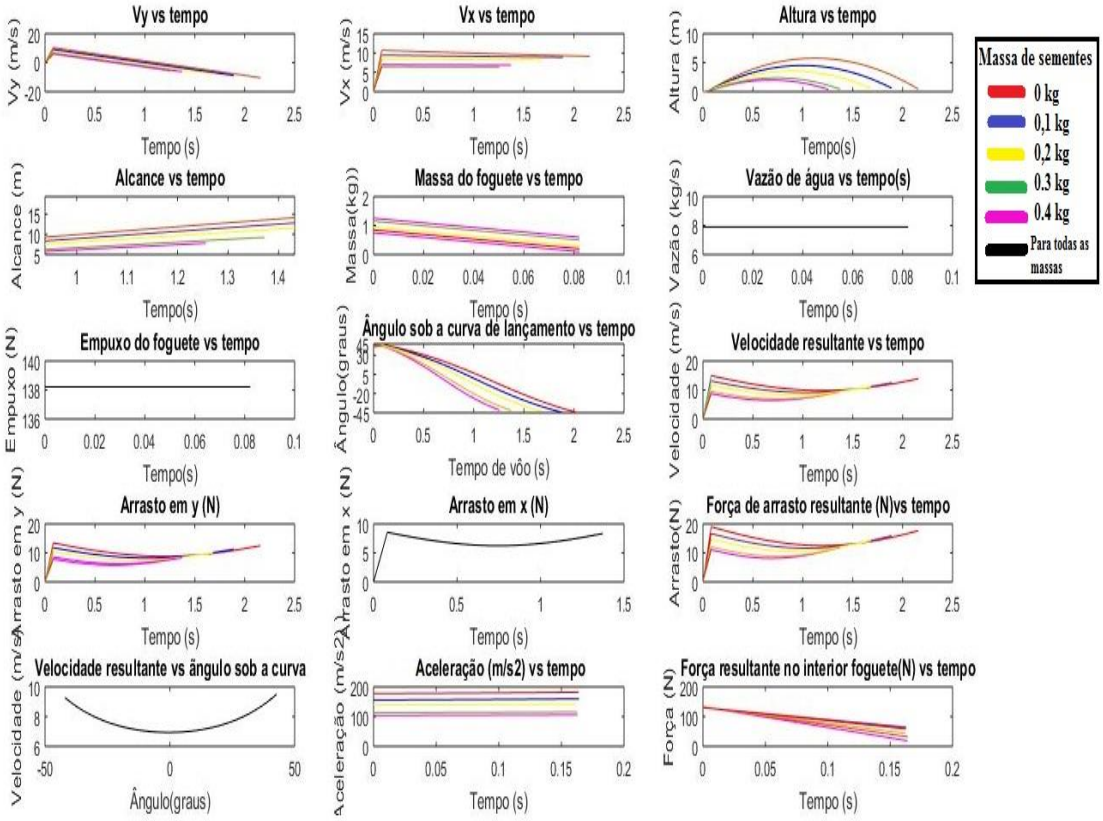
$$E = \dot{m}.(\dot{m}/\rho.A) = 8.1\ x\ 8.1/(1000\ x\ \ 0.0004523) = 143\ N$$

RESULTS OF THE COMPUTER PROGRAM

The system of differential equations with twelve dynamic variables (Phase 1 Propulsion) and the system of differential equations with ten dynamic variables (Phase 2 Oblique Throw) were solved in series by the RUNGE-KUTTA numerical method, generating Figures 4.2 to 4.6 of this item. The results of the computer program for the flight prediction of the minirockets are shown in Figures 4.2, 4.3, 4.4, 4.5 and 4.6.

Figure 4.2 shows the simulation results obtained in the flight computer program for different seed loads carried by the mini-rockets, 0 kg, 0.1 kg, 0.2 kg, 0.3 kg and 0.4 kg. The launch pressure was 70 psi, launch angle forty-five degrees, percentage of water in the mini-rocket thirty percent, and drag coefficient 0.2.

Figure 4.2 - Results of the computer program for different seed masses

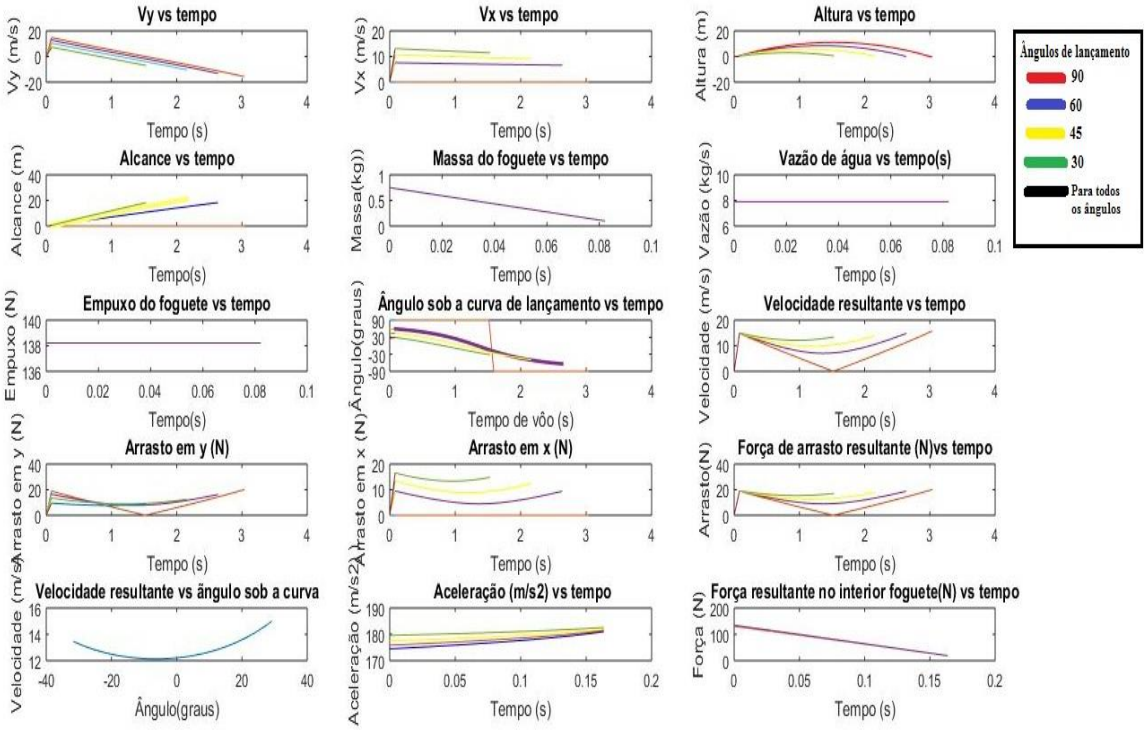


Source: the authors

A decrease in the mini-rocket range and height profile was observed, with the increase in the load of the mini-rockets, being a critical factor for the system (load).

Figure 4.3 shows the simulation results obtained using the flight computer program for different launch angles 0°, 30 ˚, 45 ˚, 60 ˚ and 90 ˚. The launch pressure used was 70 psi, the percentage of water in the minirocket was 30% and the drag coefficient was 0.2 [-].

Figure 4.3 - Results of the computer program for different launch angles

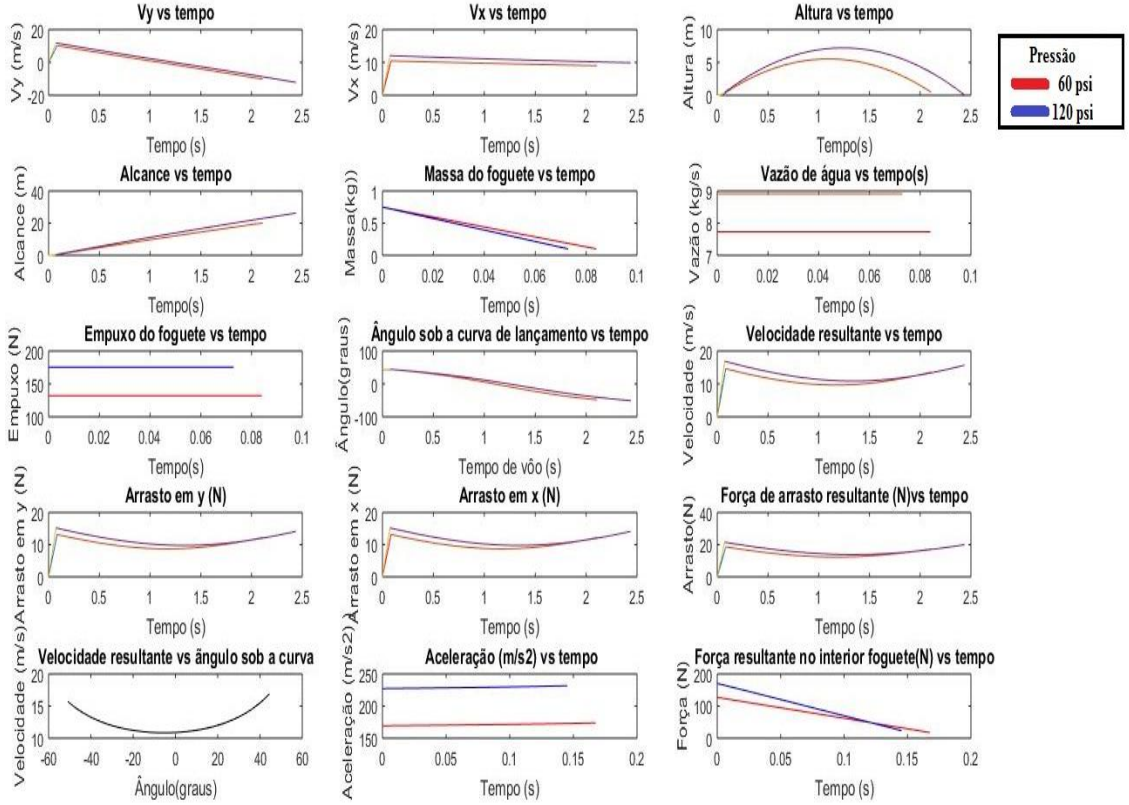


Source: the authors

It was observed that for the angles selected in the simulation: 0o, 30o, 45o, 60o and 90o, the angle that maximized the range was forty-five degrees.

Figure 4.4 shows the results of the flight prediction computer program, with launch pressures of 60 psi and 120 psi. It was observed from the results that the higher the launch pressure, the greater the range of the 2L PET mini-rocket.

Figure 4.4 - Flight forecast, with launch pressures of 60 psi and 120 psi for the 2L PET mini-rocket

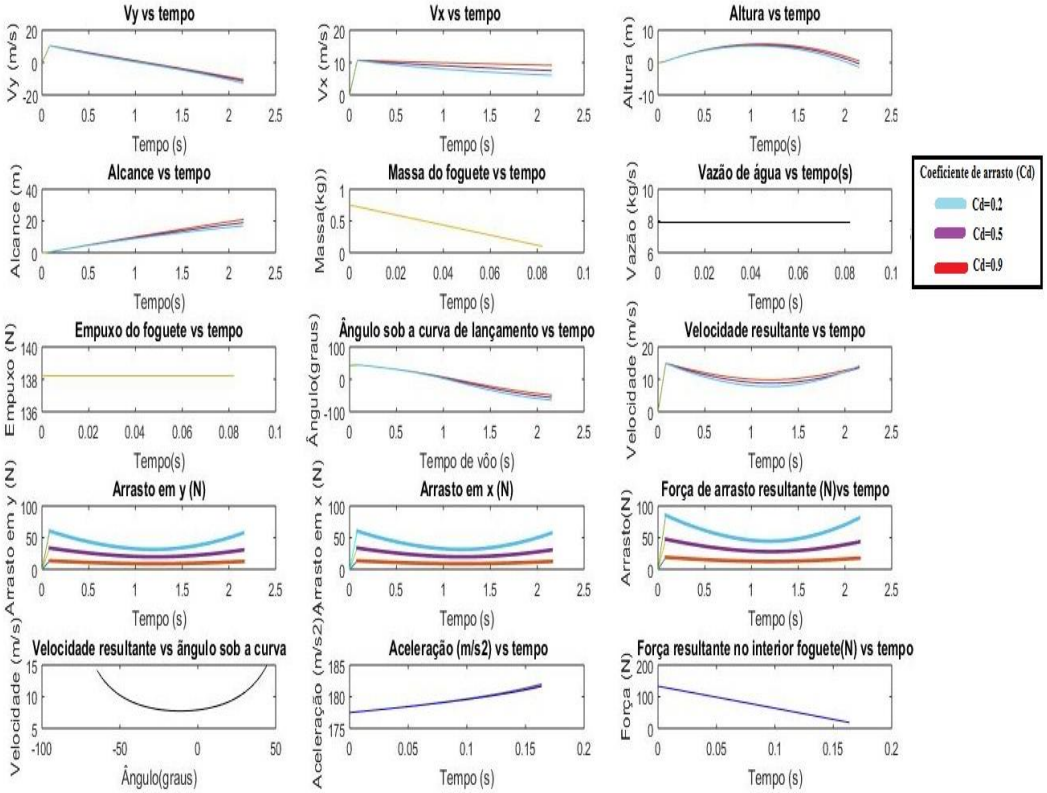


Source: the authors

It was observed from the results that the higher the launch pressure, the greater the range of the mini-rocket.

Figure 4.5 shows the results of the flight prediction computer program, for drag coefficients (Cd) with values: 0.2 [-], 0.5 [-] and 0.9 [-].

Figure 4.5 - Results of the flight prediction computer program for different drag coefficients (Cd).

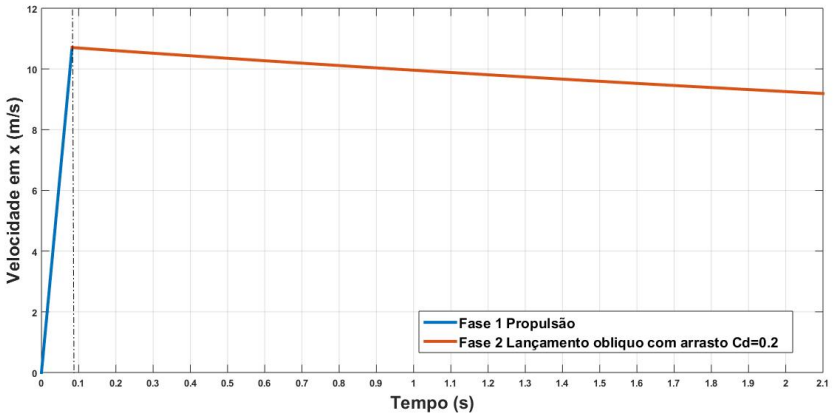


Source: the authors

Figure 4.5 shows that the higher the drag coefficient Cd[], the higher the value of the net drag force (N) on the minirockets.

Figure 4.6 shows one of the results of the flight prediction computer program describing Phase 1 (propulsion) and Phase 2 (oblique launch).

FIGURE 4.6 - Phase 1 (propulsion) and Phase 2 (oblique launch).

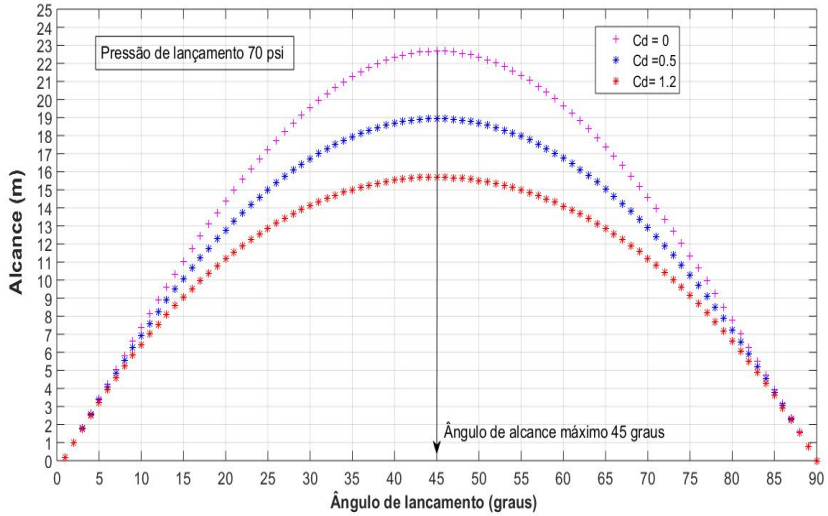


Source: the authors

Figure 4.6 shows the results of the two systems of differential equations for the propulsion and oblique launch steps.

Figure 4.7 shows the profile of the mini-rocket range curve for different launch angles considering the drag force.

Figure 4.7 - Mini-rocket range curve profile for different launch angles

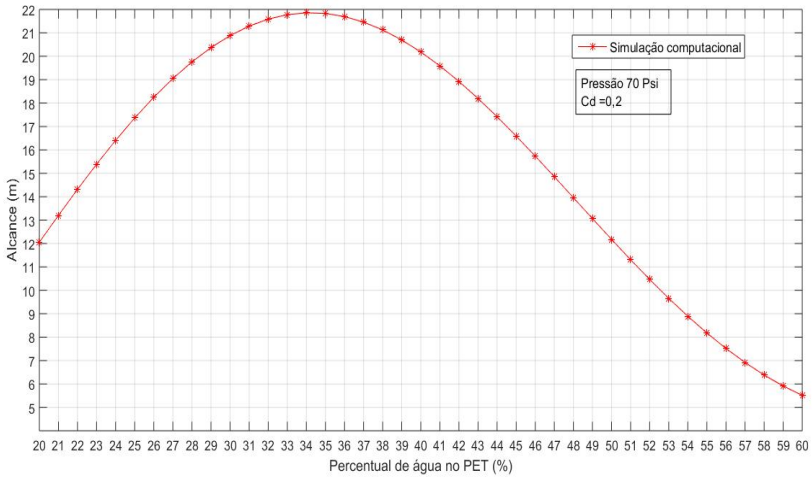


Source: the authors

It was observed by computer simulation that the launch angle that maximizes the range of the mini-rocket is forty-five degrees.

Figure 4.8 shows the profile of the mini-rocket range curve for different percentages of water in the mini-rocket's propulsion system.

Figure 4.8 - Profile of the mini-rocket range curve for different percentages of water in the propulsion system of the mini-rocket for 2 L PET.



Source: the authors

It was observed by computer simulation that the percentage of water in the mini-rocket's propulsion system that maximizes range is 34 percent, approximately 1/3 of the volume of the propulsion system.

Figure 4.9 shows the profile of the mini-rocket's maximum range curve for different launch pressures.

Figure 4.9 - Profile of the mini-rocket maximum range curve for different launch pressures.

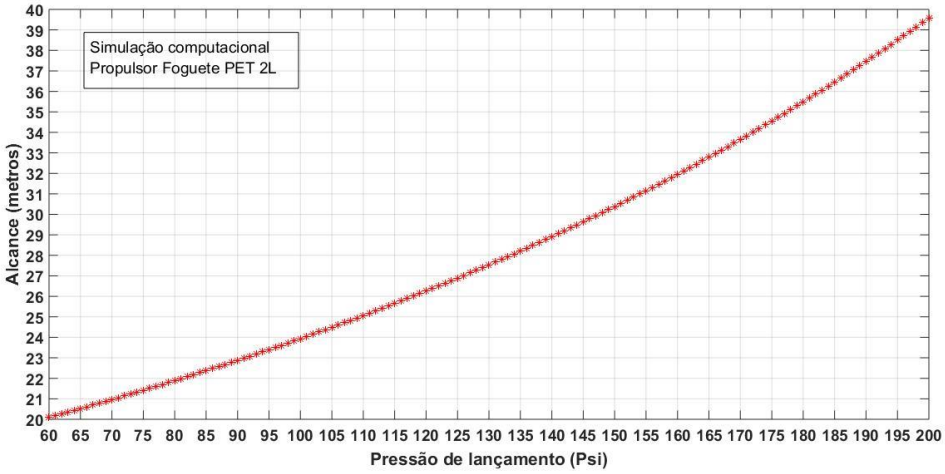
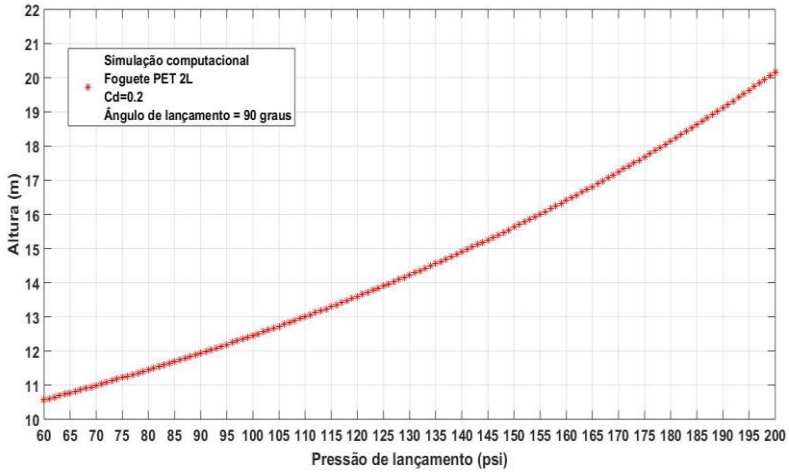


Figure 4.10 shows the maximum height profile reached for different launch pressures of the PET 2L mini-rocket.

Figure 4.10 - Maximum height profile of the mini-rocket for different launch pressures.



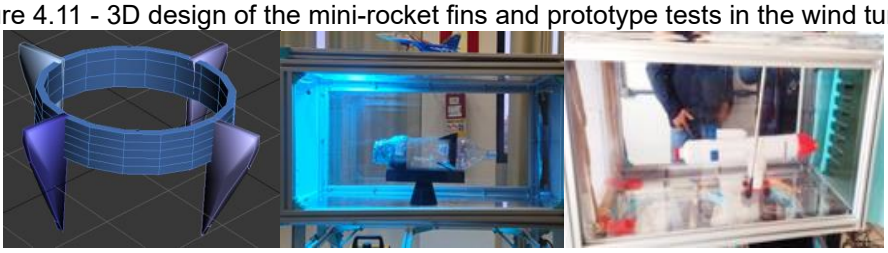
VALIDATION OF THE COMPUTER SIMULATION FROM FIELD LAUNCHES

The validations of the computer simulations were performed by comparing the parameters of several experimental launches, resulting in values close to and with errors of less than ten percent. The discrepancies between simulated and experimental values can be explained by local variations in wind speed and variations in the stability of the mini-rocket (center of mass). The validation of the computer program was carried out by comparing the results of the simulation with the data from the real launches of the mini-rockets.

DESIGN OF THE MINI-ROCKET FINS

Figure 7 shows a three-dimensional design of a fin for mini-rockets made with biodegradable material (PLA) and printed on a 3D printer. The project was carried out in a computer environment.

Figure 4.11 - 3D design of the mini-rocket fins and prototype tests in the wind tunnel



CONCLUSION

The designed and built wind tunnel was very useful for determining the drag coefficients of the mini-rockets.

The assembly for the determination of the output flow rate in the nozzle of the minirocket was necessary for the calculation of the thrust of the minirocket. The thrust of a mini-rocket has been determined and is constant throughout the Propulsion Phase.

The construction of the mini-rocket launch base was very important for carrying out the experimental launches, mini-rocket designs and validation of the flight prediction computer program.

The two computational routines developed contain two systems of nonlinear differential equations, with 22 dynamic variables, representing the Propulsion Phase, ~~and~~ Oblique Launch and resulted in figures that contain the most important parameters such as: the range of the mini-rocket, flight time, angle under the curve, speed in *x* and *y*, resulting velocity, launch angle, resulting acceleration, thrust and height as a function of time (transient regime).

In the literature, the resolution of differential equation systems by algebraic methods is addressed in several works, using simplifications such as: linearized drag force equation, constant mass system and a smaller number of dynamic variables, generating more imprecise results and with a smaller number of flight parameters. The difference of this work in relation to those found in the literature is that in this one it was addressed the dynamic modeling for flight prediction, using two systems of nonlinear equations with twenty-two dynamic variables, one system for the propulsion stage and the other for the oblique launch. The conservation equations were solved by the Runge-Kutta method, finding results for various parameters of the mini-rocket's flight.

The computer program developed is an important tool to assist in the design of mini-rockets for the reforestation of degraded areas.

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PATHOPHYSIOLOGY OF GASTRITIS AND CORRELATION WITH *H. PYLORI*: AN IN-DEPTH INVESTIGATION AND ITS CLINICAL IMPLICATIONS

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ABSTRACT

Gastritis is an inflammation of the gastric mucosa that can be triggered by several factors, such as prolonged use of some medications, smoking, and infection by the bacterium Helicobacter pylori (HP). The prevalence of this infection encompasses approximately half of the world population, and although its relationship with gastritis has not been fully elucidated, it is known that bacterial virulence, the host's immune system, and environmental influences interact to constitute a complex mechanism that establishes different gastritis phenotypes. These different phenotypes can be distinguished in chronicity, severity, late diagnosis, response or refractoriness to treatment, and clinical complications. This literature review aims to explore the pathophysiology of Helicobacter pylori-associated

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gastritis and its clinical implications, in order to provide a comprehensive understanding of this condition and its implications for medical practice, addressing its association with peptic ulcers, gastric cancer, and anemia, as well as reviewing available therapeutic options against this infection. To this end, 154 articles were identified, and of these, 18 were selected for this study based on the inclusion and exclusion criteria adopted. Thus, the potentiating action of H. pylori in the development of some gastroenterological diseases was observed, as seen in the increase in the genetic expression of PREX2, found in cancer cells, and in the endoscopic findings of antral nodularity, both due to this bacterium, which allows us to conclude the close relationship of gastritis with clinical implications of intense severity and in the long term.

Keywords: Gastritis. Pathophysiology. *Helicobacter pylori*.

INTRODUCTION

Gastritis is an inflammation of the stomach lining that can be triggered by a variety of factors, including long-term use of some medications, excessive alcohol consumption, smoking, autoimmunity, and especially infection with the bacterium Helicobacter pylori (HP). This infection affects approximately half of the world's population, and although the exact relationship between H. pylori and gastritis is not yet fully understood, socioeconomic, environmental, and cultural factors are thought to exert a significant influence, while genetic predisposition plays a less prominent role (DDINE et al.; 2012).

The pathophysiology of H. pylori infection involves complex bacterial virulence mechanisms, interactions with the host immune system, and environmental influences, culminating in different gastritis phenotypes, which, in turn, can evolve into various gastroduodenal conditions. H. pylori infection often establishes itself in childhood and persists throughout life if left untreated, leading to chronic gastritis. This condition can progress to serious complications, including peptic ulcer disease, gastric cancer, and lymphomas of mucosa-associated lymphoid tissue. (MALFERTHEINER et al.; 2023).

Chronic and aggressive inflammation in gastritis can lead to progressive destruction of the gastric mucosa over years and decades, resulting in the condition known as atrophic gastritis. This continuous deterioration can eventually cause dysfunctions in the stomach mucosa. In advanced stages, atrophic gastritis can result in a significant reduction in stomach acid production, leading to hypochlorhydria or even complete achlorhydria. These conditions, particularly when severe, pose a substantial and independent risk for the development of gastric cancer. In addition, an acid-poor stomach and severe forms of atrophic gastritis can interfere with the absorption of crucial vitamins such as vitamin B12, as well as essential micronutrients such as iron, calcium, magnesium, and zinc, as well as affect the effectiveness of the diet and certain medications (SIPPONEN; MAAROOS; 2015).

Currently, there is a wide range of tests available to diagnose H. pylori infection. Among the non-invasive methods are the breath test with 13C labeled urea (13C-UBT), the fecal antigen test (SAT) and the serological test. On the other hand, invasive techniques such as endoscopy, histology, culture, urease test or rapid urease test (RUT) and polymerase chain reaction (PCR) offer greater specificity for diagnosis, although they are invasive procedures. The choice of method of diagnosing infection often depends on the clinical information required, local availability, and the cost of individual tests. (SUN et al.; 2023).

Treatment to eliminate H. pylori infection not only relieves gastrointestinal symptoms but also reduces the risk of gastric cancer. The current therapeutic approach advocates the

eradication of H. pylori with a combination of two antibiotics and a proton pump inhibitor, forming the triple therapy. In some situations, a fourth drug, bismuth salicylate, is included, resulting in quadruple therapy. Although success rates in eliminating the bacterium range from 70% to 95%, these rates have decreased due to increased antibiotic resistance (LIANG et al.; 2022).

Based on this premise, the present study aims to develop a literature review, with the objective of describing the pathophysiology of gastritis, exploring its correlation with H. pylori infection, presenting the different diagnostic methods, including advantages and disadvantages, and discussing therapeutic approaches and possible complications in order to broaden the understanding of the main etiological factors of gastritis, to facilitate clinical reasoning, workup, therapy and prevention of this condition and its implications.

THEORETICAL FRAMEWORK

Regarding the diagnosis of Helicobacter pylori infection, Nevoa et al. (2017), described that the Polymerase Chain Reaction (PCR) test showed a higher detection rate (82.35%) compared to the rapid urease test (TRU), highlighting advantages such as sensitivity and specificity, but stressed the need for care in interpreting the results, especially due to the possibility of false-positive results.

The results described by RIBEIRO et al. (2016) point to gastritis as the most common pathology in PH+ (78.34%). However, comparatively, the percentile of disproportion favorable to the HP- group (73.63%) was not statistically significant. Pointing out that gastritis remains highly incident regardless of the presence of H. pylori.

METHODOLOGY

The methodology of this study is a systematic review of the literature, conducted through the search for scientific articles on the pathophysiology of gastritis and its correlation with the bacterium Helicobacter pylori, following six steps: definition of the study question; establishment of inclusion and exclusion criteria; definition of the information to be extracted from the identified and selected articles; information analysis; interpretation of the results; and presentation of the review.

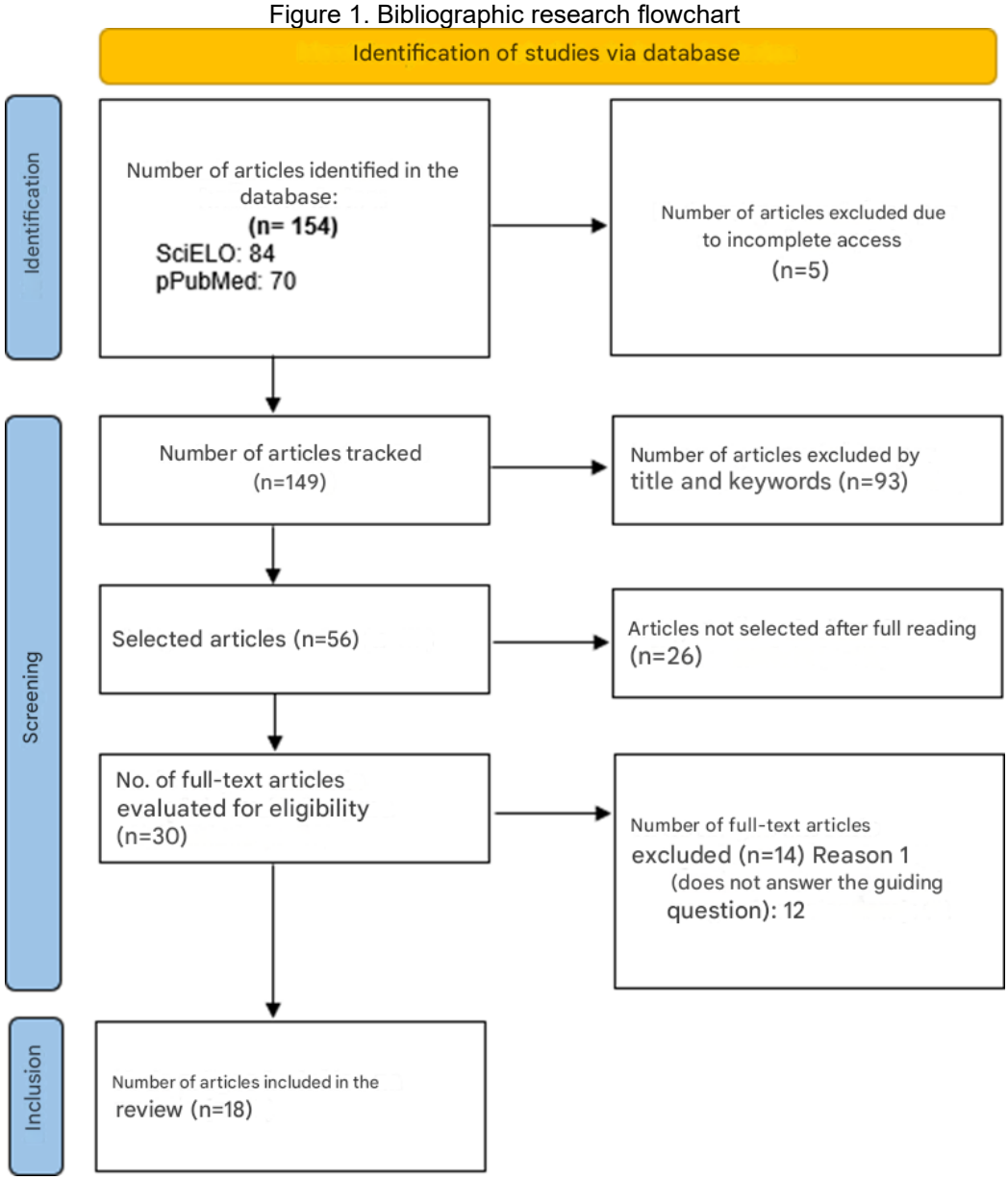
Data collection was guided by the following guiding question: "How does Helicobacter pylori infection contribute to the pathophysiology of gastritis and what are the main clinical implications of this correlation?" The formulation of the research question used the acronym PICo, which refers to Population, Intervention and Context, as detailed below: P = gastritis; I = H. pylori infection; Co = clinical implications.

The search was conducted in the Electronic Databases Medical Literature Analysis and Retrieval System Online (MEDLINE/PubMed) and Scientific Electronic Library Online (SciELO). The controlled terms of the Health Sciences Descriptors (DeCS) and the Medical Subject Headings (MeSH) were used.

The keywords used were: "gastritis", "pathophysiology" and "Helicobacter pylori". The Boolean operators "AND" and "OR" were used in order to find the largest number of references. The searches were carried out by two different researchers, who evaluated the articles independently and together to verify whether they met the inclusion criteria. Any disagreement was resolved by consensus among the researchers.

For the selection of studies, the following steps were followed: the first consisted of screening the database using the descriptors (n=154) and incomplete access articles (n=5) were excluded. The second stage consisted of reading titles and abstracts, 93 articles were excluded, and 56 studies were selected in full, published in Portuguese and English, dated between 2014 and 2024. After full reading evaluating the full text for eligibility, they were excluded (n=26). Articles that did not answer the guiding question were excluded (n=12). Finally, in the last stage, 18 articles were considered relevant and included in the analysis of this study. The research was translated into the description of the results, reported in the flowchart of Figure 1.

Figure 1. Bibliographic research flowchart



Source: Prepared by the authors following PRISMA guidelines

RESULTS AND DISCUSSIONS

It was observed that H. pylori infection can be triggered by several different mechanisms, including medication, external, autoimmune, and organic-metabolic factors, and its correlation with chronic inflammation of the stomach, the main organ affected by this pathology, is undeniable. In view of this range of causalities caused by gastritis, the present study brought several diagnostic methods and therapeutic approaches presented by the selected studies.

Among the 56 articles included in this literature review, from academic platforms, PubMed and SCIELO, 18 were selected because they were able to address the topic effectively. Chart 1 shows the authors and the year of publication of the selected articles.

Table 1. Findings

Autor	Ano
WEN, Zhengwei *et al.*	2014
CAMILO, Sílvia Maria Perrone *et al.*	2015
GOMES, Alexandre *et al.*	2016
RIBEIRO, Irma Cláudia Saboya *et al.*	2016
NEVOA, Jéssica C. *et al.*	2017
GÖNEN, Sevim *et al.*	2017
VINAGRE, Ruth Maria Dias Ferreira *et al.*	2018
RODRIGUES, Michele Fernandes *et al.*	2019
MATTAR, Rejane *et al.*	2020
SANTOS, Maria Luísa Cordeiro *et al.*	2020
COELHO, Maria Clara Freitas *et al.*	2021
OLIVEIRA, Ana Karoline Silva *et al.*	2021
HEDAYATI, Manouchehr Ahmadi *et al.*	2021
MLADENOVA, Irena.	2021
MIWA, Hiroto *et al.*	2022
FERRARI, Fangio; OGATA, Daniel Cury; ME	2023
ALANLI, Recep *et al.*	2023
VINAGRE, Ruth Maria Dias Ferreira et al.	2023

Source: Prepared by the authors

Regarding morphological changes at endoscopy, the study described by Gomes et al. (2016) showed that the endoscopic findings most associated with H. pylori infection were nodularity in the antrum, elevated erosions, and mosaic enanthema in the gastric body. The most representative form of gastritis caused by this bacterium is characterized by the presence of nodularity in the antral mucosa, whereas elevated erosions and mosaic mucosa in the gastric body are suggestive, but not specific, of infection.

Although gastritis has different causes (e.g., inappropriate diet, smoking, alcoholism, medications, H. pylori infection), including idiopathic ones, the importance of H. pylori is due to the clinical implications that infection by this bacterium can trigger. This microorganism has the ability to increase the body's gastrin levels. In this sense, the PREX2 protein — whose expression plays a role in cell migration, cell proliferation and apoptosis, found in some cancer cells — was the target of research by Hedayati et al. who, through gastric antral biopsy evaluations, attested that PREX2 gene expression increased in patients with H. pylori infection. In patients with gastritis associated with HP+, the increase was 2.38, and in those with gastric cancer associated with HP+, the increase was 2.27 times the incidence of patients without the infection. Therefore, gastric cancer more than doubles its prevalence in the HP+ population.

Nevertheless, Hedayati et al. (2021) showed that H. pylori infection, with the specific genotypes vacA, s1m1, and sabB, may be correlated with an increase in the expression of

the PREX2 gene in patients with gastritis and gastric cancer, which suggests that not all strains of this bacterium lead to complications and malignant lesions of the stomach. Therefore, studies that deepen the genetic content of this compatibility and allow a better understanding of the etiopathogenesis and future diagnostic criteria are urgent.

Also regarding the risk of patients with gastritis and chronic PH+ developing gastric cancer, the study by Coelho et al. (2021) indicated that the association of the histopathological classifications Operative Link for Gastritis Assessment (OLGA) and Operative link for Gastric Intestinal Metaplasia (OLGIM) obtained greater accuracy used together, rather than separately, to identify gastric atrophy and premalignant lesions, This allows for greater and earlier identification of this high-risk group for the development of gastric neoplasia.

However, the surveys by Ferrari et al. (2023) demonstrated that in the analysis of biopsy and the OLGA and OLGIM criteria, the presence of HP+ only showed relevance associated with age over 50 years. Therefore, PH positivity was an important factor for gastric atrophy only when correlated with another independent risk factor, which demonstrates that the clinical implications of H. pylori should be traced in association with other risk factors for gastric disorders, such as age.

Also according to Oliveira et al. (2021), there was no significant association between the presence of the cagA gene and the severity of gastric lesions. In addition, phylogenetic analysis of H. pylori strains showed no differences in phylogenetic distribution between severe and non-severe diseases. Thus, although the cagA gene is prevalent among H. pylori isolates, it does not represent a marker of gastric lesion severity.

Vinagre et al. (2018) discuss local inflammation in H. pylori infection, which occurs due to the infiltration of specific neutrophils and lymphocytes into the gastric mucosa, as well as increased cytokine production. These H. pylori-induced immunoregulatory and proinflammatory cytokines may influence the nature of the local response of T10 and T15 cells. Stimulation of helper T lymphocytes (CD4+) is observed during the specific immune response, which leads the immune response to both the Th1 and Th2 profiles. However, the cell-mediated response (Th1) predominates, and most CD4+ cell clones, which are specific against H. pylori, secrete interferon gamma (IFN-γ) in response to antigenic stimulation, indicating the Th1 phenotype of the immune response.

According to Gonen et al. (2017), HLA-B*51 was the most frequently found antigen in pediatric patients with PH+ (40%), which suggests a genetic component in the pathophysiology and autoimmune response to this bacterium. However, the gastric panel tracing - which analyzes the combination of several genes, including gastrin 17 (G-17),

pepsinogens I and II (PGI and PGII), and the anti-Helicobacter pylori antibody - did not show high diagnostic sensitivity for atrophic gastritis, according to the findings of Matter et al. (2020).

However, even though the immunological and histopathological findings, individually, make it difficult to establish a unique association of HP+ with atrophic gastritis and neoplasms, statistically, the prevalence of H. pylori continues to demonstrate high clinical relevance. Thus, studies such as Rodrigues et al. (2019) point to a 2.5 times higher prevalence of atrophy (17.6 vs 6.9%) and 1.3 times higher metaplasia (17.7 vs 13.3%) compared to HP- patients.

In addition, the studies by Santos et al. (2020) concluded that there is no need for tissue damage and hemorrhagic processes for the appearance of anemia due to H. pylori infection, and that anemia resulting from infection by this bacterium is directly related to growth disorders in children and adolescents. Therefore, it is essential to screen groups of children with unexplained anemia and growth disorders who present clinical symptoms suggestive of H. pylori infection, so that, if necessary, they can be submitted to eradication of this infectious agent.

The presence of antral gastritis due to PH is related to the development of duodenal ulcers. This happens because this bacterium causes degeneration and injury of epithelial cells, due to the inflammatory response mediated by neutrophils, lymphocytes, plasma cells and macrophages. According to Mladenova et al. (2021), in patients with DUP, VacA s1 is an important marker of virulence and patients carrying these strains are more likely to develop ulcers, being useful as an excellent marker for H. pylori virulence.

It is worth mentioning that Sia et al. (2023) present that, contrary to the epidemiology of the general population, bariatric patients with Roux-en-Y gastric bypass (RYGB) infected with H. pylori not only reduced their incidence of gastritis, but also presented it as a protective factor against jejunal erosions. According to the studies, no effects of PH infection on weight loss were found in individuals undergoing Roux-en-Y Gastric Bypass (RYGB). In fact, the highest incidence of gastritis was observed in individuals with PH infection prior to surgery. In addition, new-onset PH infection after RYGB was a protective factor against jejunal erosions.

Regarding treatment, it is important to emphasize that "dyspepsia accompanied by H. pylori infection should be treated as H. pylori-associated dyspepsia" Miwa et al. (2022). For the first-line treatment of gastritis, proton pump inhibitors (PPIs), histamine type 2 receptor antagonists (H2RAs), acetylcholinesterase inhibitor (AChE), rikkunshito (herbal medication of Japanese origin) and lifestyle changes, such as quitting smoking and

consuming less fatty foods - it is necessary that the treatment be individualized, seeking specific improvements possible for each person. In addition to the gold standard management, it has been observed that dopamine receptor antagonist drugs, serotonin-4 receptor agonists, tricyclic antidepressants, and anxiolytics form a second line of treatment for dyspeptic symptoms. In addition, cognitive behavioral therapies have been shown to be a complementary therapy of great effectiveness in reducing symptoms.

Thus, it remains extremely important to efficiently treat Helicobacter pylori in order to prevent gastric complications. In the recent context, treatment regimens for H. pylori are being updated and constantly researched, especially with the increase in resistance to drugs such as metronidazole and levofloxacin. However, widely known regimens continue to be effective, such as amoxicillin, metronidazole, bismuth subcitrate, and pantoprazole (AMBP) and new regimens, such as amoxicillin, gemifloxacin, and pantoprazole (AGP), emerge as treatment alternatives with a good response, according to the study by Alanli et al (2023). This study also concluded that therapy with gemifloxacin may be a more effective option for the eradication of H. pylori when compared to bismuth-containing treatment. This is because treatment with gemifloxacin had greater patient adherence, and fewer adverse effects, in addition to shorter treatment time, with fewer pills when compared to bismuth.

Furthermore, it is worth noting that, according to Camilo et al. (2015), there is no relationship between the chronic use of proton pump inhibitors and Helicobacter pylori infection or other histopathological or endoscopic alterations.

CONCLUSION

In the course of this study, the relationship between gastritis and Helicobacter pylori and its implication in several pathologies, such as gastric cancer, anemia, gastric and duodenal peptic ulcers, is perceived. Thus, it is essential to carry out the early diagnosis of H. pylori through tests, which range from breath test with marked urea, fecal, serology, to endoscopy. After confirming the presence of Helicobacter pylori, it is essential to establish appropriate pharmacological and non-pharmacological treatment in order to treat the infection in question and jointly prevent the diseases associated with it, as evidenced in this study.

In view of this study, it was possible to analyze the potentiating action of H. pylori with regard to gastroenterological diseases. An increase in gene expression, genotypes and specific antigens was observed when interacting with the physiological, immunological and anatohistological changes caused by the presence of this bacterium. Thus, PH-positive patients had an increase in the PREX2 gene, which is associated with cancer in the

gastrointestinal tract. The genotype VacA s1m1 and sabB associated with PH was presented, in addition to being a precipitating factor for gastric cancer, as the greatest marker of greater probability for the development of duodenal ulcers.

It is concluded that the main purpose of the current review is to expose the pathophysiology of gastritis and its correlation with the bacterium H. Pilory, based on a review of literature between the years 2014 and 2024. Most of these studies are observational or clinical trials, being the best references we have on the subject, with publications made on the "SCIELO" and "PubMed" platforms. The current knowledge on this subject is unique for physicians, especially gastroenterologists, as it seeks to understand the main consequences and causes of the disease, evaluating risk factors and treatments. However, it is not possible to define exactly the relationship between the mechanism of H. pylori and the severity of the implications of gastritis, as well as the increase in its incidence. That said, it is essential to develop more evidence and studies for a greater understanding and diagnostic and prognostic direction of gastritis, its pathophysiology and connection with Helicobacter pylori.

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DIAGNOSTIC CHALLENGES OF EVALI: A REVIEW OF RADIOLOGICAL AND TOMOGRAPHIC FINDINGS IN E-CIGARETTE USERS

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ABSTRACT

This study aims to examine the specific outcomes of imaging tests, such as radiographs and computed tomography (CT), in patients with E-cigarette or Vaping Product Use-Associated Lung Injury (EVALI). The use of electronic cigarettes (EC), also known as vaporizers, has increased significantly in recent years, particularly among young individuals and adults, due to the perception of them as safer alternatives to traditional cigarettes. However, growing evidence suggests potential lung damage, leading to the recognition of EVALI as a respiratory condition. This pathology has a significant diagnostic challenge due to the wide range of clinical and imaging findings that often resemble other respiratory conditions. In view of this scenario, a comprehensive review of clinical cases and studies published in the CAPES and PubMed Journal Portal database was carried out in order to identify specific patterns and characteristics in radiographs and CT, providing a more comprehensive understanding of the symptoms of EVALI and contributing to the early diagnosis and treatment of these patients.

Keywords: Electronic Cigarette. Image. Lung Injury. Medicine.

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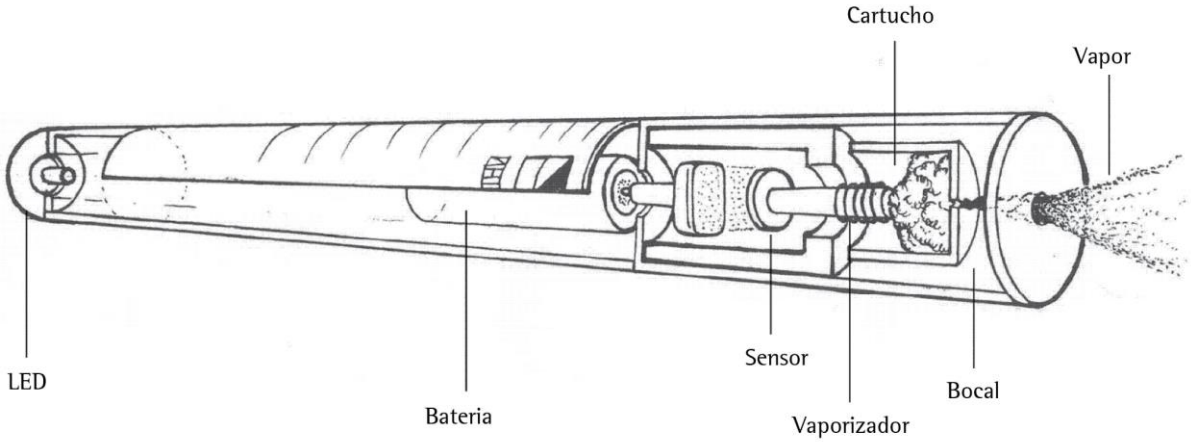
INTRODUCTION

In recent years, the use of electronic cigarettes (EC), also called vaporizers, has grown exponentially, particularly among young people and adults (Grana *et al*., 2014). It consists of three main components, a battery, an atomizer, and a cartridge containing nicotine (Figure 1), providing its users with doses of nicotine and other aerosolized additives (Knorst *et al.,* 2014).

Figure 1: Components of the electronic cigarette.



Source: Knorst *et al.,* 2014 (Adapted). The image illustrates the inner workings of an e-cigarette, highlighting its main components, liquid cartridge, sensor, and the battery.

This increase in the use of ECs is suggested by the widespread perception that they are a safer option compared to conventional cigarettes (Meo *et al*., 2014). However, growing evidence and recent literature underscore that the impacts of these devices on lung health are much more complex and specific than initially assumed (Shields *et al*., 2020). This increase in use has resulted in the emergence of a new serious clinical condition, the so-called Lung Injury Associated with Electronic Cigarette Use (EVALI).

EVALI presents a major diagnostic challenge, as its clinical signs and symptoms are nonspecific, often resembling other respiratory conditions, such as viral infections, atypical pneumonias, and even autoimmune diseases, such as sarcoidosis and hypersensitivity pneumonitis (Stimson *et al*., 2020). The condition can manifest with varied symptoms, such as fever, nausea, dyspnea, chest pain, and even gastrointestinal symptoms, making it difficult to make a differential diagnosis without the use of imaging tests (Morais *et al*., 2020). Since EVALI's initial recognition, researchers and health entities, such as the *Centers for Disease Control and Prevention* (CDC), have made efforts to identify the toxic components present in EC fluids and the mechanisms that cause lung injury. In response to the increase in these cases, the Brazilian Thoracic Association (SBPT) advised pulmonologists to adopt the diagnostic criteria established by the CDC (Chart 1), which

include specific imaging findings, such as consolidations on X-rays and ground-glass opacities on chest computed tomography (CT).

Considering the relevance of imaging studies in the evaluation and management of EVALI, it is essential to identify the specific and frequent patterns that can help differentiate this condition from other lung diseases.

Chest X-rays are widely used as an initial examination, especially due to their wide availability and relatively low cost. Although less sensitive, x-ray may indicate diffuse or localized lung opacities, which are suggestive of EVALI in some cases (Kalininskiy *et al*., 2019). CT is the choice when seeking a more thorough condition assessment as it offers a more accurate picture of inspection patterns, including areas of ground-glass opacity and consolidations. In addition, it aids in the differential diagnosis to exclude infectious and autoimmune causes of pulmonary involvement (Helfgott *et al*., 2022).

In this context, this study aims to review the scientific literature on the radiological and tomographic findings of EVALI, gathering available data on the imaging characteristics typical of this condition. The search was carried out in the CAPES and PubMed databases. The analysis focused on detecting typical imaging patterns and describing specific and frequent signs, to facilitate early and accurate diagnosis. By consolidating and systematizing these findings, this study aims to contribute to a deeper understanding of the radiological and tomographic manifestations of EVALI, offering practical assistance to health professionals in the detection and management of the condition, promoting safer and more efficient diagnostic practices.

Table 1 – EVALI diagnostic criteria

Confirmed	Probable
Use of CE in the last 90 days;	Use of CE in the last 90 days;
Consolidations on X-ray or ground-glass CT chest CT;	Consolidations on X-ray or ground-glass CT chest CT;
Absence of alternative diagnoses, such as: Cardialogical, rheumatological, neoplastic diseases, etc. Infectious diseases – make at least a negative viral panel and influenza PCR (if indicated). Other tests (antigens, cultures, HIV), when indicated, must be negative.	Absence of non-infectious alternative diagnoses;
	Identification of infection through culture or PCR, but attending physicians do not believe that this is the only cause of respiratory disease.

Legend: CE = Electronic cigarette; CT = Computed tomography; PCR = Polymerase Chain Reaction; HIV = Human immunodeficiency virus (SBPT, 2019). (Adapted).

METHODOLOGY

The research was carried out through a summarized descriptive analysis of scientific articles published on the PubMed and CAPES Journal Portal platforms in the last five years on the subject. The search was standardized using the descriptors: "EVALI", "diagnostic", "MRI" (*Magnetic Resonance Imaging*), "*computed tomography*" and "x-ray", along with the Boolean operator "And" among the terms.

The selected articles underwent an inclusion metric through *the Strengthening the Reporting of Observational Studies in Epidemiology* (STROBE) tool. The inclusion criteria were: a) Studies in which imaging exams were evaluated: radiography and CT; b) Focus of imaging exams on the respiratory system; c) Analysis of individuals who used CE; d) Types of studies with clear and retrospective methodological criteria; e) Studies available free of charge in full; f) Studies published in the last 5 years; g) Studies with a number of patients equal to or greater than 10.

Articles that did not fit the inclusion criteria and proposed publication period were excluded, in order to bring more reliability to the theme studied. In the end, only the studies available in Tables 1 and 2 remained.

RESULTS AND DISCUSSION

Analysis of the studies revealed a broad spectrum of lung anomalies. CT images frequently showed ground-glass opacities, consolidations, and, in some cases, pleural effusions. These findings are consistent with the patterns described in the literature, which relate such anomalies to severe pulmonary inflammation and alveolar lesions caused by substances found in FB fluids (Christiani *et al.*, 2020). The radiographs showed bilateral diffuse opacities, often indistinguishable from those seen in conditions such as viral pneumonia and interstitial lung diseases (Leyden *et al.*, 2020). This overlapping of results shows the complexity of the differential diagnosis of EVALI, highlighting the importance of a careful clinical approach and a detailed history of EC use.

In addition to imaging characteristics, the studies indicated a strong correlation between the severity of the radiological findings and the clinical symptoms reported by the patients. People with more extensive opacities on CT generally had more severe respiratory symptoms, such as severe dyspnea and hypoxemia, reinforcing the importance of imaging as diagnostic and prognostic tools. These findings show the importance of improved diagnostic protocols that include detailed imaging analysis and constant surveillance of clinical symptoms for efficient management of EVALI cases. Tables 1 and 2 below summarize the main CT and X-ray findings in the patients analyzed, respectively.

Table 1 - Analysis of studies that take into account Computed Tomography.

Author	N	Objective	Conclusion
Aberegg *et al.*, 2020.	26	Describe the clinical features, bronchoscopic findings, imaging patterns, and results of EVALI.	- Organizing pneumonia (100%); - Hypersensitivity pneumonitis (19%); - Acute eosinophilic pneumonia (4%); - Subpleural consolidation (39%); - Airway thickening (81%). (Appendix 1)
Artunduaga *et al.*, 2020.	14	To evaluate the chest radiographic and tomographic findings of EVALI in the pediatric population.	- Ground-glass opacity (100%); - Consolidations (64%); - Interlobular septal thickening (14%); - Bilateral abnormalities (100%) - Abnormalities in the lower lobe (50%); - Subpleural preservation (79%).
Kligerman *et al.*, 2021.	160	What are the frequencies of imaging findings and CT patterns in EVALI and what is the relationship to vaporization behavior.	- Ground-glass opacity (81.2%); - Septal thickening (50.6%); - Linfadenopatia (63,1%); - Centrilobular nodule (36.3%); - Pneumonia in parenchymal organization (55.6%); - Pneumonyin airway-centered organization (8.8%); - Pneumonia in mixed organization (20%); - Acute eosinophilic pneumonia (3.8%); - Dano diffuse alveolar (5.6%); - Pulmonary hemorragia (3.8%).
Kalininskiy *et al.*, 2019.	11	Symptoms and Diagnostic Approach at EVALI.	- Bilateral ground-glass opacification (100%); - Subpleural preservation (64%); - Derrame pleural (9%); - Linfadenopatia mediastinal (27%);
Rao *et al.*, 2020.	13	To show the clinical characteristics of lung injury associated with the use of electronic cigarettes or vaping in adolescents.	- Ground-glass opacities (100%); - Lung bases greater than pulmonary apex (46%); - Thickening of the interlobular septa (15%); - Pneumomediastino (15%).
Panse *et al.*, 2020.	24	To characterize the CT appearance of lung injury associated with the use of e-cigarette or vaping product (EVALI) in a cohort with histopathologic evidence of this disorder.	- Ground-glass opacity (96%); - Consolidations (42%); - Interlobular septal thickening (29%); - Low lobular attenuation (46.1%); - Multifocal findings (54%); - Peripheral findings (17%); - Central findings (8%); - Centrilobular ground-glass opacity nodules similar to hypersensitivity pneumonitis (33%); - Organizing pneumonia (13%). (Appendix 1)

Werner *et al.*, 2020.	47	We compared the characteristics of patients with fatal cases of EVALI with non-fatal cases to improve the ability to identify patients at increased risk of death from the disease.	- Ground-glass opacities (100%); - Opacities (64%); - Diffuse infiltrate (30%); - Pneumonia (34%); - Consolidations (23%); - Edema (19%); - Pneumonite (15%); - Adenopatia (hilar ou mediastinal)(19%); - Pneumothorax (2%).

Caption: Appendix 1 states that Aberegg *et al.* (2020) and Panse *et al.* (2020) considered in their study. N=Number of participants.

Table 2 - Analysis of studies that take into account Radiography.

Author	N	Objective	Conclusion
Artunduaga *et al.*, 2020	14	To evaluate the chest radiographic and tomographic findings of EVALI in the pediatric population.	- Ground-glass opacity (100%); - Consolidations (57%); - Bilateral abnormalities (100%); - Symmetrical abnormalities (93%); - Extent of abnormality greater than 75% (29%); - Extent of abnormality between 50%–75% (36%); - Extent of abnormality 25%–50% (29%); - Extent of abnormality less than 25% (7%); - Pneumomediastino (7%); - Bilateral pleural spills (7%).
Chidambaram *et al.*, 2020.	11	To present clinical and imaging findings in adolescents with pulmonary symptoms of suspected EVALI.	- Ground-glass opacities (100%); - Bilateral opacities (45%); - Baseline predominance of abnormalities (82%); - Alveolar opacities (45%).
Kalininskiy *et al.*, 2020.	11	Symptoms and Diagnostic Approach at EVALI.	- Bilateral ground-glass opacification (100%); - Derrame pleural (9%); - Fibrotic characteristics
Werner *et al.*, 2020.	56	To compare the characteristics of patients with fatal cases of	- Opacities (59%); - Ground-glass opacities (11%); - Diffuse infiltrate (52%); - Pneumonia (29%);
		EVALI with non-fatal cases to improve the ability to identify patients at increased risk of death.	- Consolidations (20%); - Edema (32%); - Pneumonite (4%); - Pneumothorax (2%).
Rao *et al.*, 2020.	13	Clinical characteristics of lung injury associated with e-cigarette use or vaping in adolescents.	- Ground-glass opacities (100%), - Radiograph with subtle findings that showed markedly abnormal pulmonary findings on chest computed tomography (15%).

Legend: N=Numbers of participants

Comparison between the studies reveals differences and similarities in imaging findings. CT allows for greater detail, with a high prevalence of ground-glass opacities,

ranging from 81.2% to 100% of cases (Aberegg *et al.*, 2020; Layden *et al.*, 2020; Kligerman *et al.*, 2021). CT also allows the identification of specific features, such as interlobular septal thickening and subtle centrilobular nodules, associated with organizing pneumonia, hypersensitivity pneumonitis, and other inflammatory patterns (Artunduaga *et al.*, 2020; Panse *et al.*, 2020). In addition, less common complications, such as pulmonary hemorrhage and diffuse alveolar damage, have been documented in some studies that obtained CT, highlighting the sensitivity of this method to identify discrete and different changes at each stage of the disease.

Regarding chest X-rays, although it presents less detail compared to CT, it is still effective for identifying ground-glass opacities, especially in more advanced and bilateral presentations, as reported by Kalininskiy *et al.* (2020) and Werner *et al.* (2020). The findings are more general, such as bilateral opacities, consolidations, and diffuse infiltrates, with a lower frequency of specific and subtle findings (Artunduaga *et al.*, 2020). Comparing CT with radiography, the reduced ability to visualize discrete or specific alterations, such as centrilobular nodules and interlobular septal thickening, which were better detected by CT, is evident.

A highlight among the studies is the variability in the identification of serious complications. While CT scans show complications such as pneumothorax and pneumomediastinum in detail, X-rays may not show abnormal pulmonary findings, as noted by Rao *et al.* (2020), who reports that 15% of patients with subtle chest X-ray findings had marked pulmonary findings on CT.

As weaknesses found, we observed the difference in the sample between the studies and the variation in the methods of analysis, since radiography and CT are interpretative exams. The need for future investigations with larger cohorts and longitudinal analyses, additional studies can further assess the progression of lesions and response to treatment.

In short, CT is more sensitive to detect the diversity of EVALI findings and variations, providing a more complete assessment of lesions and their distributions. Although useful as an initial examination, radiography has limitations, especially for milder manifestations, due to its availability. This comparison underscores the importance of using CT in suspected cases of EVALI, where radiography does not provide a conclusive diagnosis.

CONCLUSION

This study analyzed the scientific literature on the radiological and tomographic findings of EVALI, with the objective of recognizing common and frequent imaging patterns that may contribute to the diagnosis of this condition. The analysis revealed that the most

frequent CT findings are ground-glass opacities and interlobular septal thickening, and the data revealed the important role of CT in identifying pulmonary alterations, due to its high sensitivity. Regarding radiography, CT offers a more accurate and detailed view of pulmonary irregularities, being more accurate and efficient.

Radiography, despite being useful as an initial examination, especially to identify consolidations and more evident opacities, has limitations in the detection of more discrete and specific alterations. Therefore, for an accurate and efficient diagnosis, the use of CT is recommended, especially in complex clinical situations. These findings highlight the importance of imaging tests in the diagnosis of EVALI and other respiratory conditions, such as viral pneumonia and interstitial lung diseases.

Thus, it is worth emphasizing the need for more improved diagnostic protocols, which include both detailed imaging tests and the complete clinical history of patients. It is crucial to conduct future studies with more extensive bases, randomized controlled trials, and longitudinal analyses, to assess lesion progression and response to treatment, contributing to a deeper diagnostic understanding of EVALI, as well as improving diagnostic and therapeutic practices.

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APPENDIX

APPENDIX 1

Appendix 1 - CT classification scheme used by Aberegg *et al.,* 2020 and Panse *et al.,* 2020.

Standard Classification Method	Classification method
Organizing Pneumonia	irregular, peripheral, or perilobular bilateral UFOs or consolidation; reverse halo sign;
Hypersensitivity Pneumonitis	OVFs predominant in the upper or middle lung; centrilobular nodules; air trapping
Acute eosinophilic pneumonia	bilateral and symmetric UFOs or consolidation; pleural effusions; septal thickening;
Acute Lung Injury	Acute phase - heterogeneous consolidation; OVFs; dependent on disorganized paving;
	Organization phase - development of reticulation and traction bronchiectasis;
Hemorragia Alveolar Difusa	Centrilobular nodules; OVFs; consolidation; subpleural preservation;
Lipoid Pneumonia, Exogenous	Dependent distribution; OVFs; consolidation; disorganized paving; Fat attenuation macroscópica, ≤30 HU;
Interstitial Giant Cell Pneumonia	OVFs; architectural distortion; peribronchiolar linear opacities;
Thickening of the airway wall	Qualitative visual analysis.

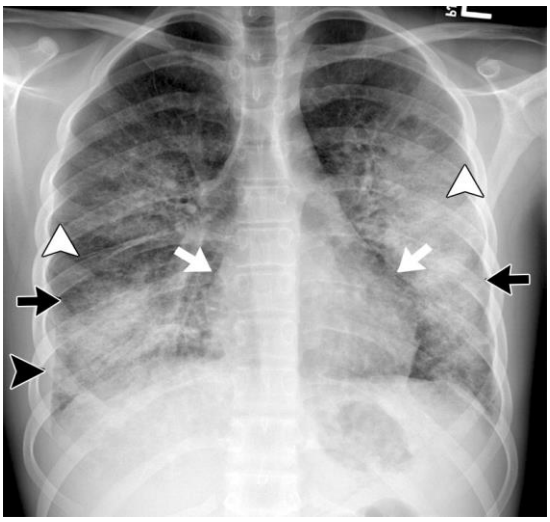
Legend: OVF= Ground-Glass Opacities; HU=Hounsfield units (Aberegg *et al.*, 2020) - Translated (adapted).

APPENDIX 2

Clinical case examples of evali with ct and radiography:

Case 1: The images show an 18-year-old man with EVALI. A pattern of organizing pneumonia is observed.

Image A1: Posteroanterior radiograph shows consolidation and opacity of the middle and lower lung bilaterally. Small right pleural effusion (black arrowhead) and septal thickening (white arrowhead) are seen. There is preservation of the cardiac borders (white arrows) as well as subpleural portions of the lung (black arrows).



B1 and C1 images: Coronal B1 and sagittal oblique C1 CT images illustrate the radiographic findings with light ground-glass opacity predominant in the lower lung with few areas of consolidation. There is prominent subpleural and perilobular preservation (black arrows). In addition, there is preservation of the peribronchovascular interstitium, best illustrated around the arteries and larger pulmonary veins (white arrows). Centrilobular nodules predominantly ground-glass in the upper lobe are present bilaterally (white arrowheads). Apart from the thickening of the interlobular septa, there are few areas with thickening of the intralobular septa creating a "mosaic pavement" pattern (black arrowheads).

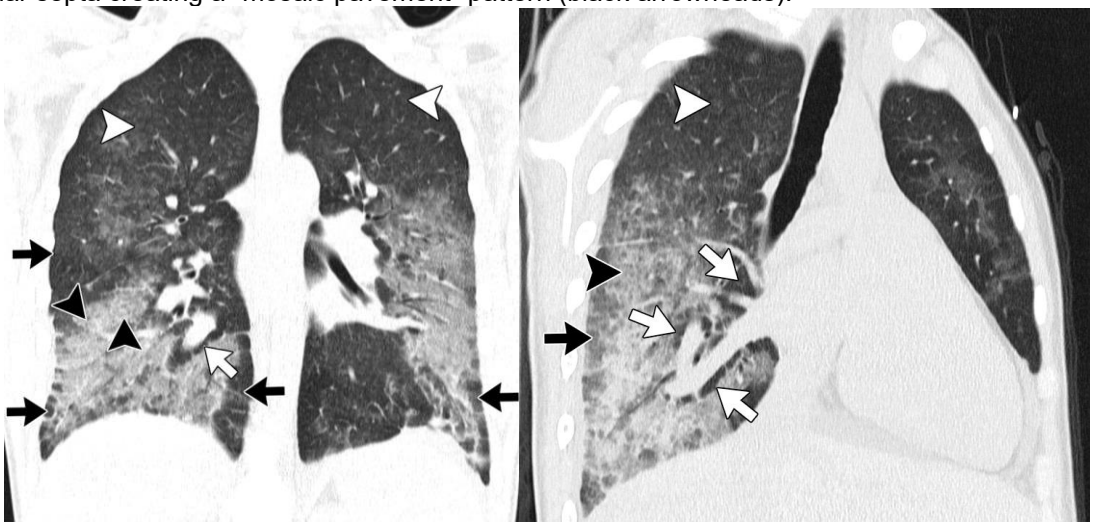


Image D1: Chest X-ray three days after the start of corticosteroids, the patient showed dramatic clinical and radiographic improvement.

Case 2: Images show EVALI with a pattern of organizing pneumonia in an 18-year-old man who vaporized nicotine and tetrahydrocannabinol with a fever of 39.4°C, vomiting for 3 days, and negative tests for infection and rheumatologic disease.

Image A2: Posteroanterior radiograph shows a predominant perihilar cloudy opacity with preservation of the edge of the heart (white arrows) and periphery (black arrows). Septal thickening is present (arrowhead).

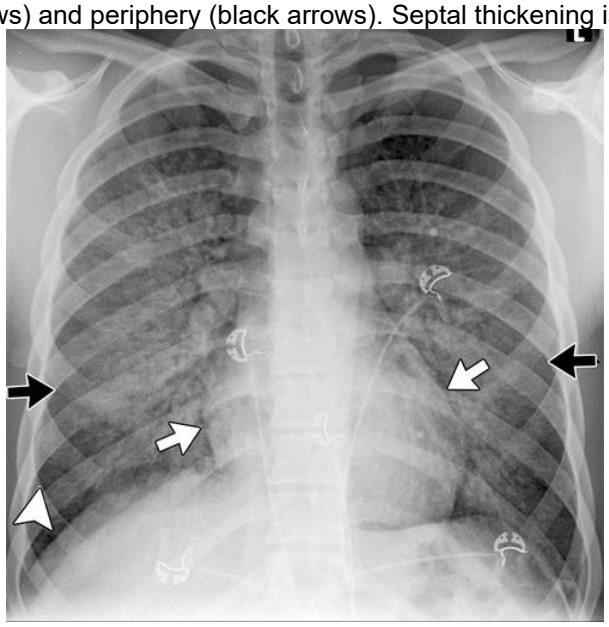
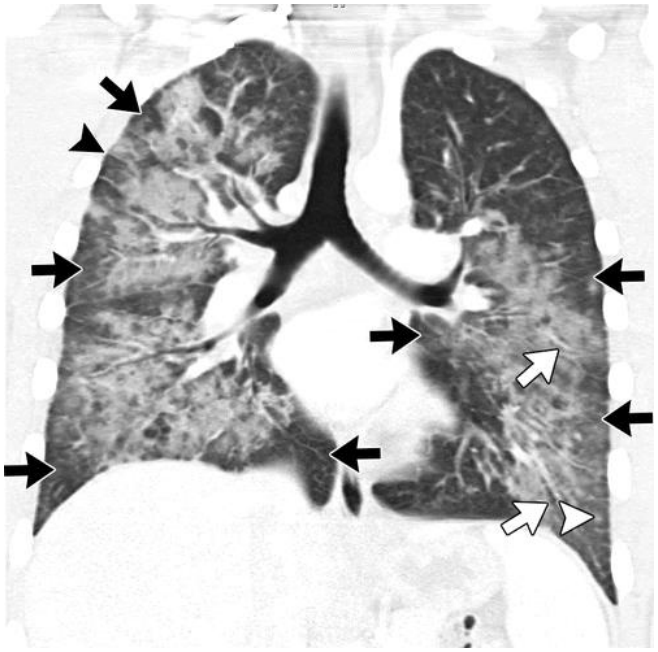


Image B2: CT image shows perihilar predominant ground-glass opacity with prominent preservation of the subpleural interstitium both peripherally and centrally (black arrows) with interspersed areas of lobular preservation. The peribronchovascular interstitium (white arrows) is preserved. Septal thickening (black arrowhead) and scattered centrilobular nodules are present (white arrowhead). The patient improved rapidly after administration of corticosteroids.



Case 3: Images show lung injury associated with the use of e-cigarettes or vaping products in a 37-year-old man with a history of daily vaping of tetrahydrocannabinol products.

Image A3: Coronal CT image shows diffuse ground-glass opacity with subpleural preservation (arrows) and interlobular and intralobular septal thickening creating a "mosaic pavement" pattern (arrowhead). On this initial CT scan, it is unclear whether this represents organizing pneumonia or an initial exudative phase of diffuse alveolar damage. The patient's condition worsened dramatically with progressive consolidation and loss of volume, requiring intubation.

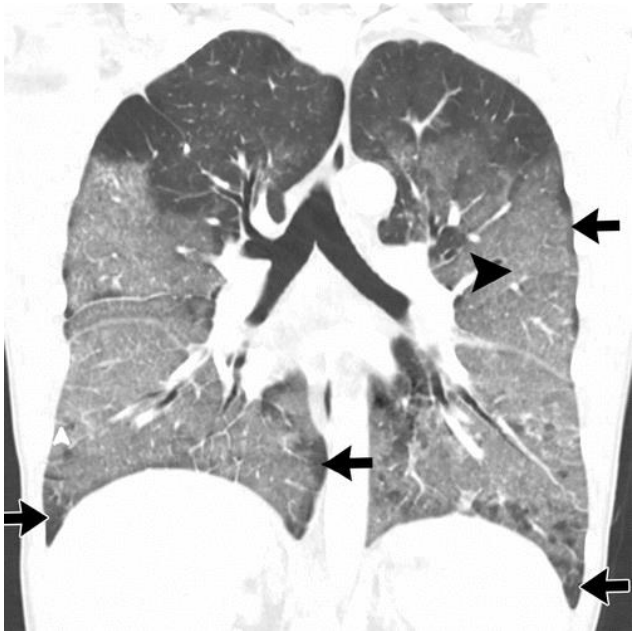
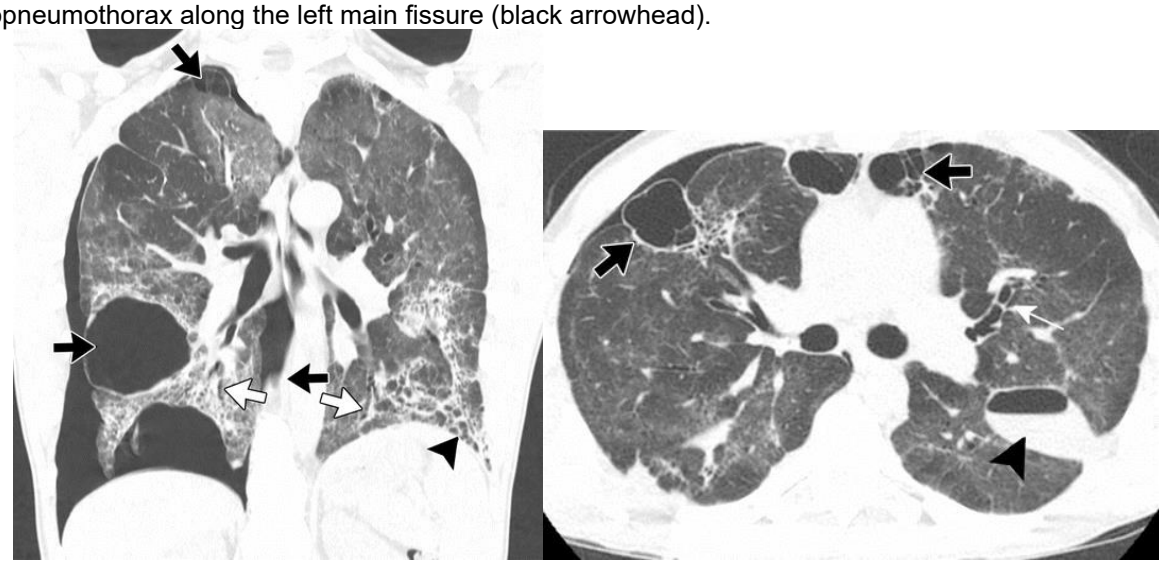


Image B3 and C3: Coronal B3 and axial C3 CT scan, 14 days after image A, showing improvement in ground-glass opacity with development of fibrosis predominant in the lower lobe with reticulation (black arrowhead in B3), bronchiectasis (white arrows), and loss of volume. In addition, there was the development of numerous blisters of varying sizes bilaterally (black arrows), moderately sized right pneumothorax, and loculated hydropneumothorax along the left main fissure (black arrowhead).



Case 4: Images show EVALI with acute eosinophilic pneumonia in a 21-year-old man who was vaping nicotine and tetrahydrocannabinol products daily.

Image A4: Posteroanterior radiograph 2 days after admission, showing extensive consolidation.

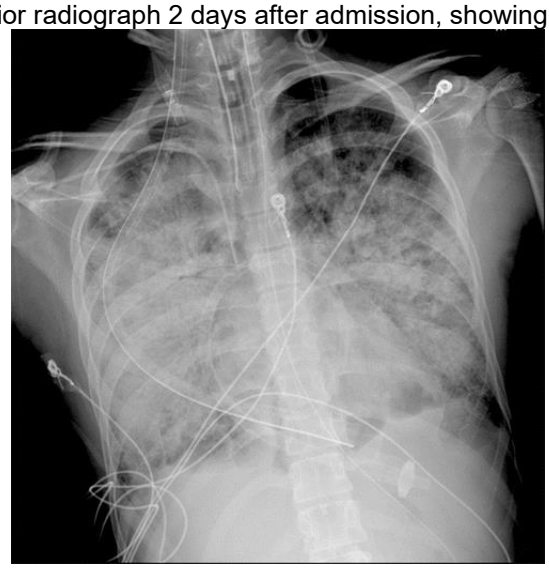


Image B4: Presence of extensive consolidation with areas of lobular and subpleural preservation (black arrowhead), with diffuse alveolar damage, septal thickening (white arrow), moderate to large bilateral pleural effusions, and normal-appearing left ventricle (black arrow), showing acute eosinophilic pneumonia. The patient's clinical condition and radiographic image (Image A4) continued to worsen, and he was subsequently intubated. The patient underwent bronchoscopy, which showed a large percentage of eosinophils.

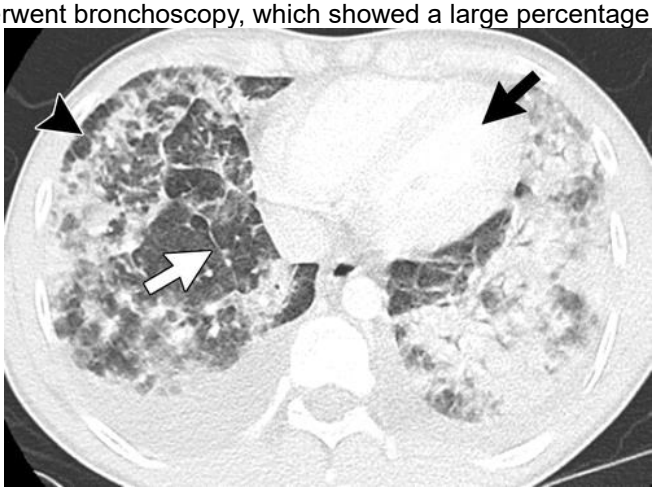


Image C4: Three days after starting steroids, chest X-ray improved significantly.

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COMPUTATIONAL FLIGHT PREDICTION FOR MINI PET ROCKETS, APPLIED TO REFORESTATION

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ABSTRACT

This work refers to modeling and computer simulation of PET mini-rockets with air and water propulsion and focuses on the development of a computer program for flight prediction of water- and air-propelled mini-rockets. The specific objectives of this work were: design and construction of a wind tunnel; experimental acquisition of the drag coefficients of mini-rockets in a wind tunnel; construction of launch bases for mini-rockets for the validation of the flight prediction computer program; mini-rocket projects and development of a computer program for mini-rocket flight prediction. The methodology began with the design and assembly of a wind tunnel to determine the drag coefficient of the mini-rockets. A mini-rocket launch base with water and air propulsion was developed, built and used. The thrust values of several mini-rockets were determined experimentally on a bench while keeping the mini-rocket fixed. Image and video analysis were performed in the bench test with the determination of the water flow at the exit of the rocket nozzle and determination of the thrust profile of the mini-rockets (PET 2 liters). The modeling and simulation of the flight prediction were developed from two systems of differential equations, based on the equations of conservation of mass and momentum, which were solved by the Runge Kutta numerical method. It was necessary to solve two systems of nonlinear differential equations, one for the Propulsion Phase and the other for the oblique launch.

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The computer program has data input defined by the user and that generates the various outputs in matrix format or in the format of figures. The simulation of the mini-rocket's flight prediction resulted in figures containing the most important flight parameters. The results of the computer program were validated through the field launches of the mini-rockets and it was found that it is an important tool for the design of mini-rockets intended for the reforestation of degraded areas.

Keywords: Mini rockets. Wind tunnel. Flight prediction program. Reforestation.

INTRODUCTION

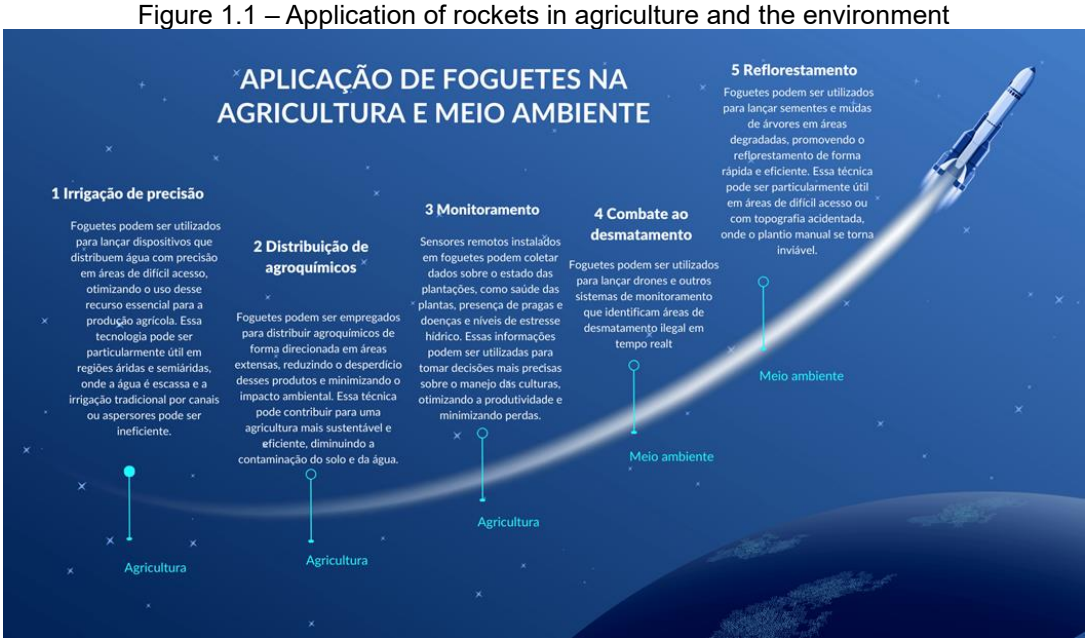
The ecological restoration of degraded areas, an urgent global challenge, faces multiple obstacles that demand innovative solutions. Habitat fragmentation, resource scarcity, and the complexity of degradation processes are just some of the challenges to be overcome [1].

Reports have pointed out that approximately one-third of the planet's arable land is already degraded, indicating the urgent need to recover or remedy the damage caused by poor agricultural practices and other factors [2].

The use of rockets for ecological restoration purposes presents unique challenges. The precision in seed deposition, the selection of the most suitable species for each environment and the evaluation of long-term environmental impacts are issues that require in-depth research. In addition, the costs associated with the development and operation of seed launching systems can be high, limiting their large-scale application.

The use of rockets in agriculture and in the environmental area, although still under development, opens up a range of innovative possibilities for the management of natural resources and environmental preservation. This technology, traditionally associated with space exploration, has the potential to optimize agricultural practices, monitor the environment, and combat challenges such as deforestation and desertification, as shown in Figure 1.1.

Figure 1.1 – Application of rockets in agriculture and the environment



Source: the authors

The specific objectives of this work were: design and construction of a wind tunnel; experimental acquisition of the drag coefficients of mini-rockets in a wind tunnel;

construction of launch bases for mini-rockets for the validation of the flight prediction computer program; design of mini-rockets and the development of a computer program for mini-rocket flight prediction.

LITERATURE REVIEW

Aerial seeding is a technique for direct transmission of seeds by the use of aerial vehicles, such as drones, airplanes or helicopters [3]. The method of launching the seeds chosen (aerial, manual or mechanized) influences the costs, with methods by planes generally more expensive.

The aerial seeding technique for reforestation has been employed since the 1950s [4]. In industrialized countries, aerial seeding is already considered a practical reforestation technique with considerable success reported in the United States of America (USA), Canada, Australia, Russia, India and New Zealand [5].

One promising approach to accelerate the reforestation of degraded areas is rocket seed dropping. This technique, still under development, offers the possibility of reaching areas that are difficult to access, such as steep slopes and remote regions, facilitating the dispersal of seeds of native species and the restoration of vegetation cover.

Ecological applications of rockets have been proposed [6], aiming to restore degraded areas in the caatinga biome of Brazil. Rockets made of biodegradable cassava starch plastic demonstrate the potential of rocket seed launching to restore degraded areas in different biomes. However, it is critical that this technology is developed sustainably and integrated with other ecological restoration practices.

A more cost-effective alternative may be PET water rockets, also known as PET bottle rockets, which were conceived from the idea of American engineer and physicist Robert Goddard [7,8]. PET Rockets are a pedagogical, functional and sustainable tool that combines scientific principles with creativity and ingenuity [6]. Built with simple materials and launched using only water, these rockets provide a hands-on and engaging experience for students of all ages, sparking curiosity about concepts such as propulsion, aerodynamics, and physics.

The fundamental principle behind the flight of a PET rocket into water is Newton's third law, which states that for every action, there is an equal and opposite reaction. The force exerted by the pressurized water on the bottle generates a reaction force of equal intensity, but in the opposite direction, which propels the bottle upwards. This interaction between the action of water on the bottle and the reaction of the bottle on water is a classic example of Newton's third law [9,10].

In addition to Newton's third law, several other quantities related to aerodynamics influence the flight of a PET rocket, areas of knowledge such as Aerospace Sciences, Physics, Mathematics and Chemistry are related to the functionality and flight behavior of the rocket as well as the design of the structure, which is divided into a hood, body and fins [11]. The aerodynamic shape of the PET bottle, with its conical base and narrow nozzle, contributes to the stability and range of the rocket. Air flows more easily over the curved surface of the bottle, creating an area of low pressure at the top, while high pressure at the bottom propels the rocket upwards [12].

The use of computer simulations for research and teaching provides students and researchers with an interactive and dynamic experience of knowledge [13]. By manipulating variables and collecting data in virtual environments, the construction of knowledge about physical phenomena develops essential skills such as data analysis and problem solving. This pedagogical approach, which explores the potential of digital technologies, has been shown to be effective in making knowledge of the physical sciences more engaging and meaningful [14,15].

The complexity of the phenomena involved in space launches requires the use of differential equations to accurately describe the relevant variables and predict the behavior of the system [16]. They allow modeling and analyzing the behavior of dynamic systems, such as mathematically describing the forces acting on a rocket during launch, such as buoyant force, gravitational force, air resistance, and centripetal force. Some rocket parameters, such as mass, speed and altitude, vary continuously during launch. The differential equations make it possible to model these variations over time, optimize optimal trajectories for the rocket, maximizing the payload or minimizing fuel consumption, analyze the stability of the rocket's flight, ensuring that it does not go into rotation or oscillate in an uncontrolled way.

The differential equation systems for modeling mini-rocket launches are based on the equations of conservation of mass and momentum, exemplified in the nonlinear differential equations 2.1 to 2.3, generating a system of differential equations, which can be solved by the Runge-Kutta numerical method.

A momentum conservation balance can be performed in the mini-rocket flight prediction modeling considering the forces acting on the system: gravitational and nonlinear drag force (Equations 1, 2 and 3). A system of nonlinear differential equations can be set up for the mini-rocket's propulsion step. Differential equations 2 and 3 are relative to the conservation of momentum in *y* and *x*, considering the gravitational force and drag forces acting on the minirocket [17].

$$\Sigma\vec{F}saem - \Sigma\vec{F}entram + \overrightarrow{\Sigma F}acúmulo = \overrightarrow{\Sigma F}externas \quad (1)$$

$$\text{-}\dot{m}.v_y.\cos(\theta) - 0 + \frac{d(m.v_y)}{dt} = 0 - 0.5.Cd.\rho \quad (2)$$

$$\text{-}\dot{m}.v_x.\text{sen}(\theta) - 0 + \frac{d(m.v_x)}{dt} = 0 - 0.5.Cd.\rho.A.{v_x}^2 \quad (3)$$

Where (v_y) is the velocity in the direction of the y-axis, where) is the velocity in the direction of the x-axis, launch angle(θ), drag coefficient(Cd), cross-sectional area of the mini-rocket(A), mass of the mini-rocket(m), air density (ρ), gravitational acceleration(g), and water flow rate at the outlet of the mini-rocket's nozzle(.(v_x $\dot{m}$)

In the literature, it is addressed in several works [16], the resolution of these equations by algebraic methods, using simplifications such as: linearized drag force equation, constant mass system and a smaller number of dynamic variables, generating more imprecise results and with a smaller number of flight parameters.

The difference of this work in relation to those found in the literature is that in this one we addressed the dynamic modeling for flight prediction [17], using two systems of nonlinear equations with twenty-two dynamic variables, one system for the propulsion stage and the other for the oblique launch. The conservation equations were solved by the Runge-Kutta method, finding results for various parameters of the mini-rocket's flight.

METHODOLOGY

MATERIALS

Dynamometer

The AMF 5 tensile and compression force meter measures up to 5 N, with an accuracy of 0.01 N was used to predict the drag forces of the mini-rockets and later determine the drag coefficient.

Fog Machine

The smoke generator device has a mini vacuum pump that produces a pressure of 0.9 bar and a flow rate of 13 liters per minute, a steel cabinet with rubber feet and a handle, a long silicone hose with 2m and a conical smoke outlet nozzle with diameters from 6 to 15 mm and a hole with a diameter of 4 mm. The smoke machine had the purpose of visualizing the flow of air on the surface of the mini-rockets.

Winding tunnel

The wind tunnel was designed, assembled and built aiming at determining the drag coefficients of the mini-rockets and visualizing the flow profile.

Anemometer

With the CB-8909 anemometer, the air speed in the wind tunnel was measured. The anemometer probe has height adjustment up to 40 cm in length, allowing the user to position the instrument in the desired location, in order to obtain air speed measurements at various points in the wind tunnel.

Mini-rocket launch base, water and air propulsion.

The mini-rocket launch base was designed and built in stainless steel, contains a trigger for releasing the rocket at a certain pressure, was used to carry out several experimental mini-rocket launches

METHODOLOGY

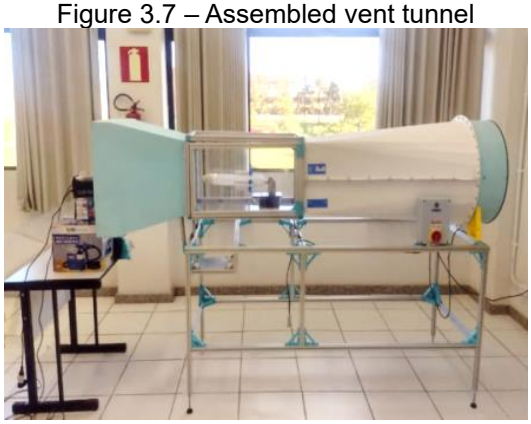
Construction of the wind tunnel

The wind tunnel was designed, assembled and built by the research group, with support from FAPEMIG and is available for use in the Integrated Engineering Laboratory of CAP-UFSJ, as shown in Figures 3.1 and 3.2.

Figure 3.1 – Wind tunnel in the process of assembly

Source: the authors

Figure 3.7 – Assembled vent tunnel



Source: the authors

The wind tunnel structure was assembled by the research group and has an aluminum profile suitable for operations and movements in research laboratories. The wind tunnel has an air inlet with honeycomb structures to reduce turbulence and transform the airflow to the laminar regime. Dimensions: viewing window, sectional area of 400mmx400mm and length of 400mm, followed by suction area with fan. The industrial fan has a power of 3/4 Hp with a diameter of 60 cm, coupled to the tunnel outlet. At the top of the viewing window, there are sampling points for air velocity measurements, through the insertion of a hot wire anemometer and points for sampling the drag force through a dynamometer.

Tests to determine the drag coefficient of mini-rockets

The project began with the tests to determine the drag coefficient of the mini-rockets in the wind tunnel.

Equation 4 relates the drag force with the drag coefficient, cross-sectional area of flow, air flow velocity in the wind tunnel, it was possible to calculate the drag coefficient of the mini-rockets.

$$F_d = 0.5 \, . \, C_d . \rho . A . v^2 \qquad (4)$$

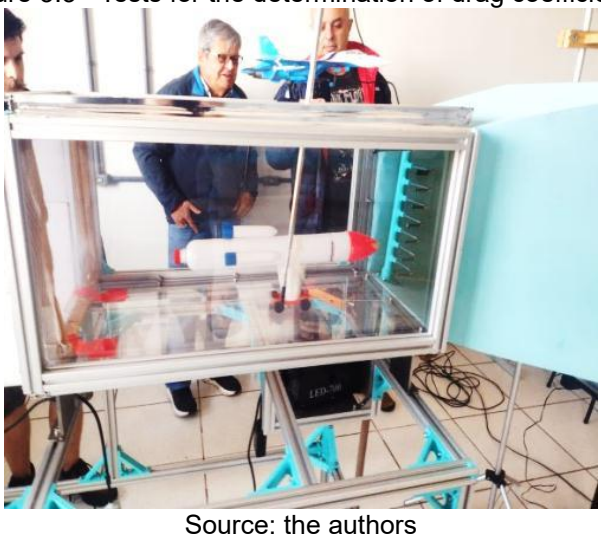
Where: (Fd) is the drag force [N], Cd is the drag coefficient [-], (ρ) air density [kg/m3], (A) transverse flow area [m2] and v is the air velocity [m/s].

The industrial fan attached to the wind tunnel has a rotation adjustment system that allowed the air velocity to be set to 10 m/s, with the aid of an anemometer. An assembly was carried out for the measurements in the wind tunnel that contained a cart and a *nylon line* coupled to a dynamometer. The drag forces of the mini-rockets were obtained by the

difference in forces read between the mini-rocket with the cart and with the cart alone. The cross-sectional areas of the mini-rockets were calculated and the air density was determined under the atmospheric conditions of the test.

Figure 3.3 shows a photo of a test to determine the drag coefficients in the research group's laboratory.

Figure 3.3 - Tests for the determination of drag coefficients



Source: the authors

From the results of the experimental tests of item 3.2.2 and through Equation (4) it was possible to determine the drag coefficients (Cd) for each minirocket,

Construction of mini-rocket launch bases

Two mini-rocket launch bases with water and air propulsion were developed and built. The bases contain a trigger for release at a certain pressure, as shown in Figure 3.4.

Figure 3.4. The mini-rocket launch base with water and air propulsion

Source: the authors

With the launch base built, experimental launches of biodegradable rockets can be carried out for validation of the flight prediction program.

The material used in the mini-rockets was polyethylene (PET). The biodegradable material for the mini-rockets is in the testing phase and will possibly be made of (PLA), which is a biodegradable polymer and will be molded in a 3D printer.

Determination of mini-rocket thrust

The thrusts of the mini-rockets were determined through experimental tests on a bench keeping the rockets fixed. A content of thirty percent water was inserted into the mini-rocket (PET), an optimal value for propulsion. The value of the release pressure was recorded. From the analysis of images in video editing software, it was possible to outline the water flow profile at the outlet of the nozzle over time.

The thrusts of the mini-rockets were determined by Equations 5 and 6 from the equations of conservation of mass and momentum.

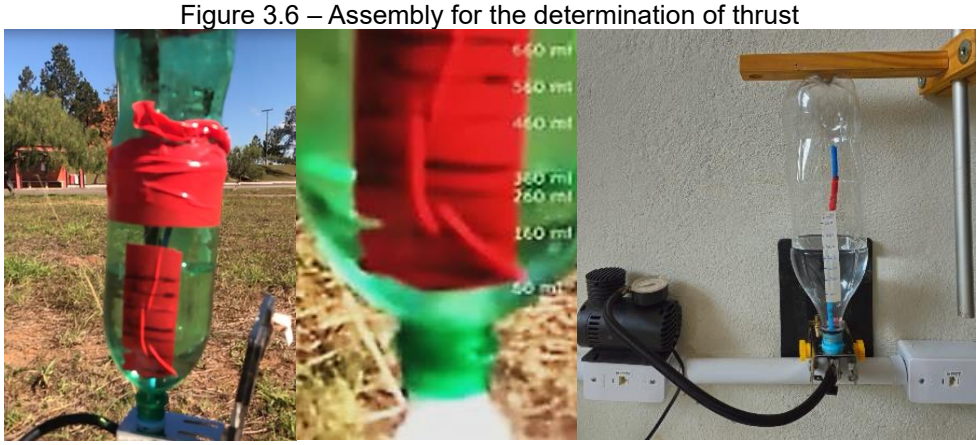
$$E = \dot{m} \, . \, v \qquad (5)$$

$$\mathrm{v} = \dot{\mathrm{m}} \, / \, (\rho . \mathrm{A}) \qquad (6)$$

Where: E is the thrust of the mini-rocket [N], the mass flow rate of water at the outlet of the nozzle [kg/s], v velocity of output at the nozzle of the rocket [m/s], the transverse flow area of the rocket outlet nozzle [m3], and $\dot{\mathrm{m}}\rho$ the density of the water [kg/m3].

Figure 3.6 shows assembly for the determination of thrust

Figure 3.6 – Assembly for the determination of thrust



Development of the computer program for flight prediction

The modeling and simulation of the flight prediction were carried out through the development of two systems of differential equations based on the equations of conservation of mass and momentum, which were solved by the Runge Kutta fourth-order numerical method using *OCTAVE GNU software*. The thrust values of the mini-rockets, determined in item 3.2.4, were used. By analyzing the results of the experimental tests, it was considered that the thrust is generated by the expulsion of water from the system, since the air mass of the system is insignificant in relation to the mass of water, which is ejected from the system and which generates the reaction force responsible for the propulsion of the system. After the short propulsion period (Phase 1), the mini-rocket moves to (Phase 2), equivalent to an oblique launch. Thus, it was necessary to develop two systems of nonlinear differential equations, one for each phase. The two systems of differential equations were solved in series.

Equation of the system

Phase 1 – Propulsion

A momentum conservation balance (Equation 7) was used to assemble the system of nonlinear differential equations for Phase 1. The first two differential equations for propulsion, Phase 1, are relative to the conservation of momentum in x and y (Equations 8 and 9), considering the gravitational force and drag forces.

$$\Sigma \vec{F}entram - \Sigma \vec{F}saem + \overrightarrow{\Sigma F}acumulo = \overrightarrow{\Sigma F}externas \qquad (7)$$

$$0 \quad -(-E.\cos(\theta)) + \frac{d(m.v_y)}{dt} = -m.g - 0.5.Cd.\rho.A.{v_y}^2 \qquad (8)$$

$$0 \quad -(-E.\operatorname{sen}(\theta)) + \frac{d(m.v_x)}{dt} = 0 - 0.5.Cd.\rho.A.{v_x}^2 \qquad (9)$$

The dynamic variables chosen for the assembly of the differential equation system were: velocity in y), velocity in x), displacement in y (Y), displacement in x (X), launch angle (θ), drag coefficient (Cd), cross-sectional area of the mini-rocket (A), propulsion time (Temprop), mass of the mini-rocket (m), air density (ρ), mass of the rocket (m), thrust (E) and flow rate (.(v_y (v_x ṁ)

$$\frac{dy}{dt} = v_y \quad (10)$$

$$\frac{dx}{dt} = v_x \quad (11)$$

$$\frac{d\theta}{dt} = 0 \quad (12)$$

$$\frac{dCd}{dt} = 0 \quad (13)$$

$$\frac{dA}{dt} = 0 \quad (14)$$

$$\frac{dTemprop}{dt} = 0 \quad (15)$$

$$\frac{dm}{dt} = -\dot{m} \quad (16)$$

$$\frac{d\dot{m}}{dt} = 0 \quad (17)$$

$$\frac{dE}{dt} = 0 \quad (18)$$

$$\frac{d\rho}{dt} = 0 \quad (19)$$

The system of nonlinear differential equations of Phase 1 had a total of twelve dynamic variables considered, Equations 8 to 19 with their respective initial conditions were solved by the Runge Kutta fourth-order numerical method. The mini-rocket thrust value, determined in item 3.2.4, drag coefficients determined in item 3.2.2 and the initial conditions necessary for each differential equation were used. Figure 3.7 shows the FUNCTION subroutine of Phase 1 propulsion, which is called by the main program.

FIGURE 3.7 - FUNCTION of Phase 1 propulsion, which is called by the main program.

```
function f=propulsao(t,Y)
% Vy    Vx    y     x     angulo  Cd    Areapet  Tempopropulsao  massa  Vazao  Empuxo  Densar
% Y(1)  Y(2)  Y(3)  Y(4)  Y(5)    Y(6)  Y(7)     Y(8)            Y(9)   Y(10)  Y(11)   Y(12)

 g=9.81;

 % Sistema de EDos propuilsão
 f(1,1)=-g+((sind(Y(5))*Y(11))/Y(9))-(Y(1)/Y(9))*Y(10)-(0.5*Y(6)*Y(12)*Y(7)*(Y(1)^2))/Y(9);
 f(2,1)=  ((cosd(Y(5))*Y(11))/Y(9))-(Y(2)/Y(9))*Y(10)-(0.5*Y(6)*Y(12)*Y(7)*(Y(2)^2))/Y(9);
 f(3,1)=Y(1);
 f(4,1)=Y(2);
 f(5,1)=0;
 f(6,1)=0;
 f(7,1)=0;
 f(8,1)=0;
 f(9,1)=-Y(10);
 f(10,1)=0;
 f(11,1)=0;
 f(12,1)=0;
  % [tempo1,s]=ode45('propulsao',[0 tempoprop],[0 0 0 0 angulo cd areapet tempoprop massatotal vazao E densar])
```

Source: the authors

Phase 2 - Oblique Launch

For the oblique launch (Phase 2) nonlinear differential equations were used, similar to those of Phase 1, but without the buoyant force. The first two differential equations for Phase 2 are relative to the conservation of momentum in x and y (Equations 20 and 21), considering the gravitational force and drag forces.

$$\frac{d(m.v_y)}{dt} = -mg - 0.5.Cd.\rho.A.{v_y}^2 \quad (20)$$

$$\frac{d\,(m.v_x)}{dt} = -0.5.Cd.\rho.A.{v_x}^2 \quad (21)$$

The dynamic variables chosen for the assembly of the Differential Equations system were: velocity in y), velocity in x), displacement in y (Y), displacement in x (X), launch angle (θ), drag coefficient (Cd), cross-sectional area of the mini-rocket (A), oblique flight time in Phase 2 (tempodevoooblique), mass of the mini-rocket (m) and air density (ρ).(v_y (v_x

$$\frac{dy}{dt} = v_y \quad (22)$$

$$\frac{dx}{dt} = v_x \quad (23)$$

$$\frac{d\theta}{dt} = 0 \quad (24)$$

$$\frac{dCd}{dt} = 0 \quad (25)$$

$$\frac{dA}{dt} = 0 \quad (26)$$

$$\frac{dTempovooobliquo}{dt} = 0 \quad (27)$$

$$\frac{dm}{dt} = 0 \quad (28)$$

$$\frac{d\rho}{dt} = 0 \quad (29)$$

The system of nonlinear differential equations of Phase 2 had a total of ten dynamic variables considered, Equations 20 to 29, with their respective initial conditions and which was solved by the Runge Kutta fourth-order numerical method. Figure 3.8 shows the FUNCTION subroutine of Phase 2, oblique throw, which is called by the main program.

FIGURE 3.8 - *FUNCTION* of Phase 2, oblique throw.

```
function f=obliquo(t,Y)
% Vy  Vx    y    x     angulo  Cd    Areapet Tempo max  m    densar
% Y(1)  Y(2)  Y(3)  Y(4)   Y(5)  Y(6)   Y(7)     Y(8)  Y(9)   Y(10)

 g=9.81;
 f(1,1)=-g-((0.5*Y(6)*Y(10)*Y(7)*(Y(1)^2)))/Y(9);
 f(2,1)=(-0.5*Y(6)*Y(10)*Y(7)*(Y(2)^2))/Y(9);
 f(3,1)=Y(1);
 f(4,1)=Y(2);
 f(5,1)=0;
 f(6,1)=0;
 f(7,1)=0;
 f(8,1)=0;
 f(9,1)=0;
 f(10,1)=0;

%  [tempo,s2]=ode45('obliquo',[tempoprop tob],[s(ul,1) s(ul,2) s(ul,3) s(ul,4) angulo cd areapet tempoprop (massa+semente) densar])
```

Source: the authors

With the two subroutines ready, the main program was prepared that unites Phase 1 and 2 in series (propulsion and oblique launch). The computer program has user-defined data inputs that generate the various outputs in matrix format or in the form of figures. The

program was used to predict several launches with loads and with different angles of launches.

The inputs from the computer program are requested as shown in Figure 3.9

FIGURE 3.9 – Computer program inputs

```
pressao=input('Entre com a Pressão de lançamento em PSI, sugestão de 60 a 140 psi: ')
massa=input('Entre com Massa do Foguete vazio (kg)')
angulo=input('Angulo de lançamento (graus) de 10 a 90 graus: ')
liquido=input('Massa de água no foguete(kg): ')
semente=input('Massa de sementes (kg): ')
cd=input('Entre com o Cd do foguete: ')
areapet=input('Entre com a área transversal do PET : ')
densar=input('Entre com a densidade do ar (kg/m3): ')
```

Source: the authors

The validation was carried out by comparing the data from the computer simulation with the data from the real experimental launches, carried out with the launch base and the mini-rockets.

RESULTS

RESULTS FOR DRAG COEFFICIENTS FOR MINI-ROCKETS

The results for the drag coefficients for the mini-rockets were obtained according to the methodology described in item 3.2.2. Table 1 shows the values of the drag coefficients of the mini-rockets for different design configurations.

Table 1 - Values of the drag coefficients of the mini-rockets for different configurations.

Mini Fog (Type)	Sweeping coefficient (Cd)	Measurement error
Minifoguete 1	0,13	+/- 0,01
Minifoguete 2	0,28	+/- 0,01
Minifoguete 3	0,20	+/- 0,01
Minifoguete 4	0,38	+/- 0,01
Minifoguete 5	0,51	+/- 0,01

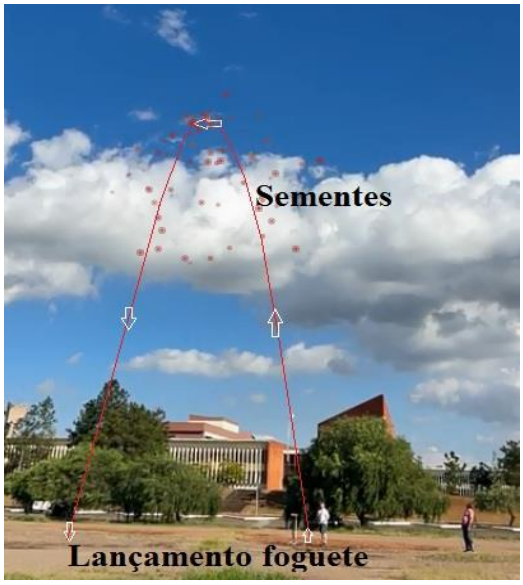
A significant difference was observed in the values of the drag coefficients, because the mini-rockets have very different design configurations, impacting the aerodynamic profile and the response of the drag coefficient.

TESTS WITH THE LAUNCH PAD

Figure 3.5 shows the launch of a mini-rocket with water and air propulsion using the launch base for the validation of the flight prediction computer program and analysis of the rocket designs. Launch pressure and maximum range for the mini-rockets with 2-liter PET

boosters were noted and compared with the results of the flight prediction computer program.

Figure 3.5 - Launch of a mini-rocket with water and air propulsion

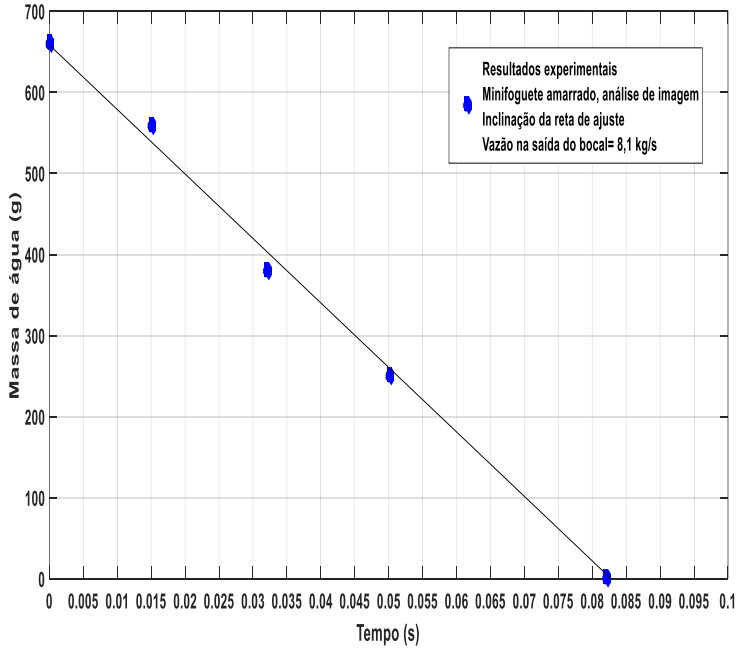


Source: the authors

RESULTS FOR MINI-ROCKET THRUST

The thrust of the mini-rockets was obtained according to the methodology described in item 3.2.3. Figure 4.1 shows the thrust profile of a mini-rocket obtained experimentally at a launch pressure of 70 Psi.

Figure 4.1 - Thrust profile of an experimentally obtained mini-rocket.



It can be seen in Figure 4.1 that the flow rate at the outlet of the nozzles of the mini-rockets powered by water and air has a constant value of 8.1 kg/s, consequently the thrust is constant and is generated by the expulsion of water from the system, resulting in a reactional force, according to Newton's third law. The thrust of this mini-rocket was calculated by Equations 3.2 and 3.3 and resulted in a value of 145 Newtons.

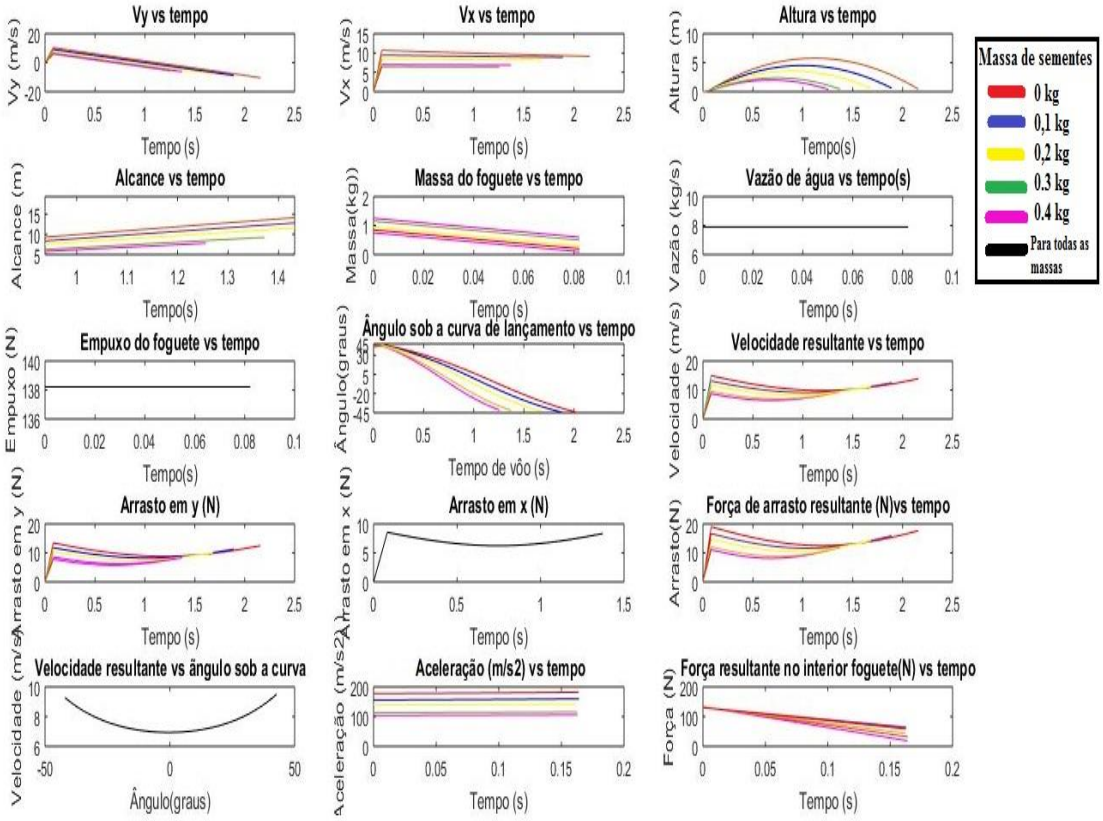
$$E = \dot{m}.(\dot{m}/\rho.A) = 8.1\ x\ 8.1/(1000\ x\ \ 0.0004523) = 143\ N$$

RESULTS OF THE COMPUTER PROGRAM

The system of differential equations with twelve dynamic variables (Phase 1 Propulsion) and the system of differential equations with ten dynamic variables (Phase 2 Oblique Throw) were solved in series by the RUNGE-KUTTA numerical method, generating Figures 4.2 to 4.6 of this item. The results of the computer program for the flight prediction of the minirockets are shown in Figures 4.2, 4.3, 4.4, 4.5 and 4.6.

Figure 4.2 shows the simulation results obtained in the flight computer program for different seed loads carried by the mini-rockets, 0 kg, 0.1 kg, 0.2 kg, 0.3 kg and 0.4 kg. The launch pressure was 70 psi, launch angle forty-five degrees, percentage of water in the mini-rocket thirty percent, and drag coefficient 0.2.

Figure 4.2 - Results of the computer program for different seed masses

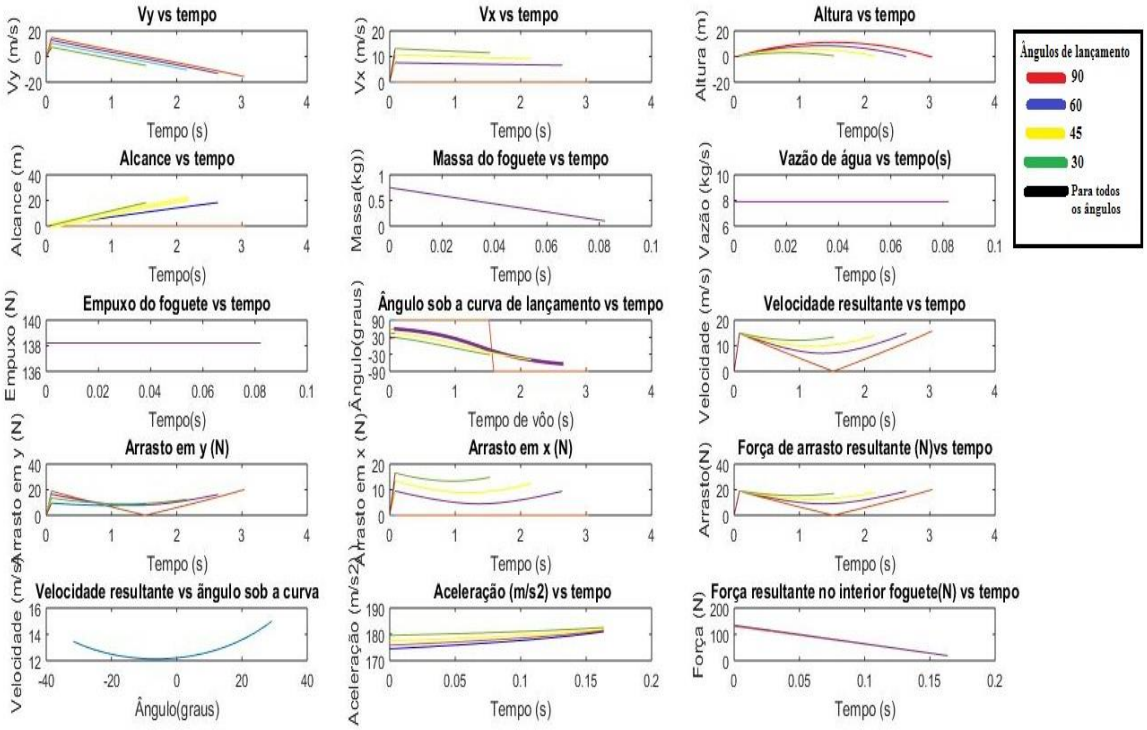


Source: the authors

A decrease in the mini-rocket range and height profile was observed, with the increase in the load of the mini-rockets, being a critical factor for the system (load).

Figure 4.3 shows the simulation results obtained using the flight computer program for different launch angles 0°, 30 ˚, 45 ˚, 60 ˚ and 90 ˚. The launch pressure used was 70 psi, the percentage of water in the minirocket was 30% and the drag coefficient was 0.2 [-].

Figure 4.3 - Results of the computer program for different launch angles

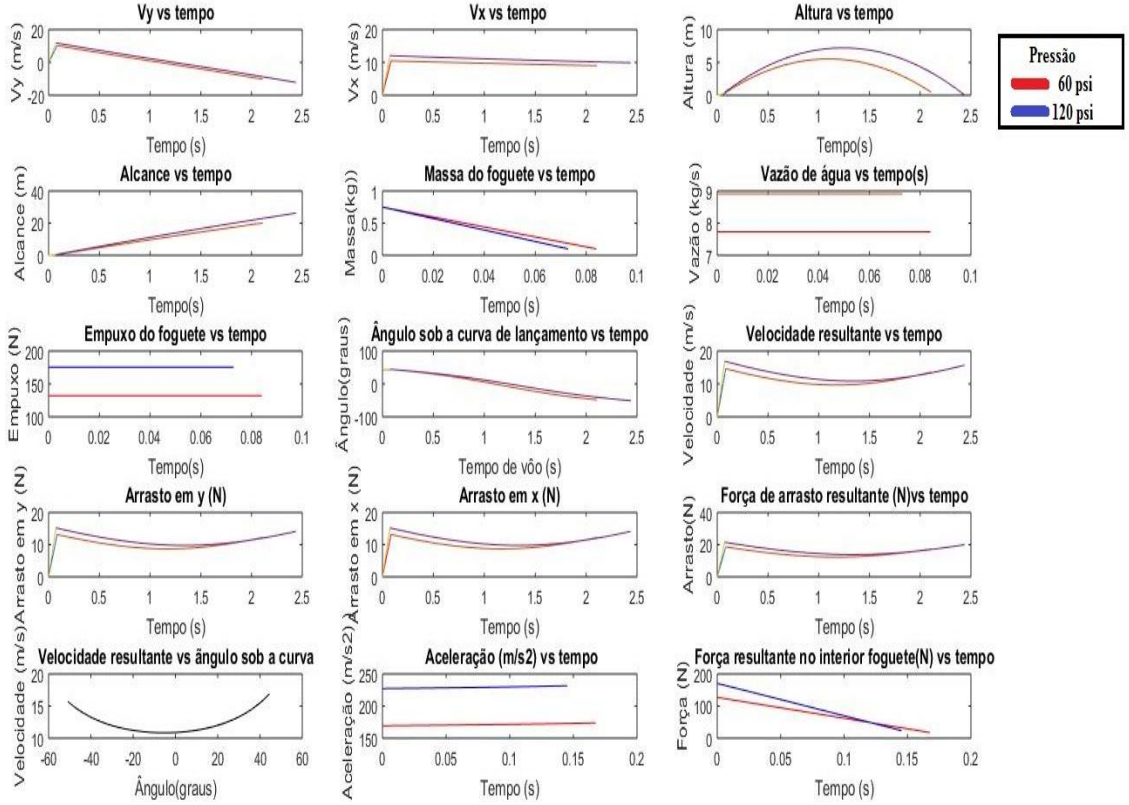


Source: the authors

It was observed that for the angles selected in the simulation: 0o, 30o, 45o, 60o and 90o , the angle that maximized the range was forty-five degrees.

Figure 4.4 shows the results of the flight prediction computer program, with launch pressures of 60 psi and 120 psi. It was observed from the results that the higher the launch pressure, the greater the range of the 2L PET mini-rocket.

Figure 4.4 - Flight forecast, with launch pressures of 60 psi and 120 psi for the 2L PET mini-rocket

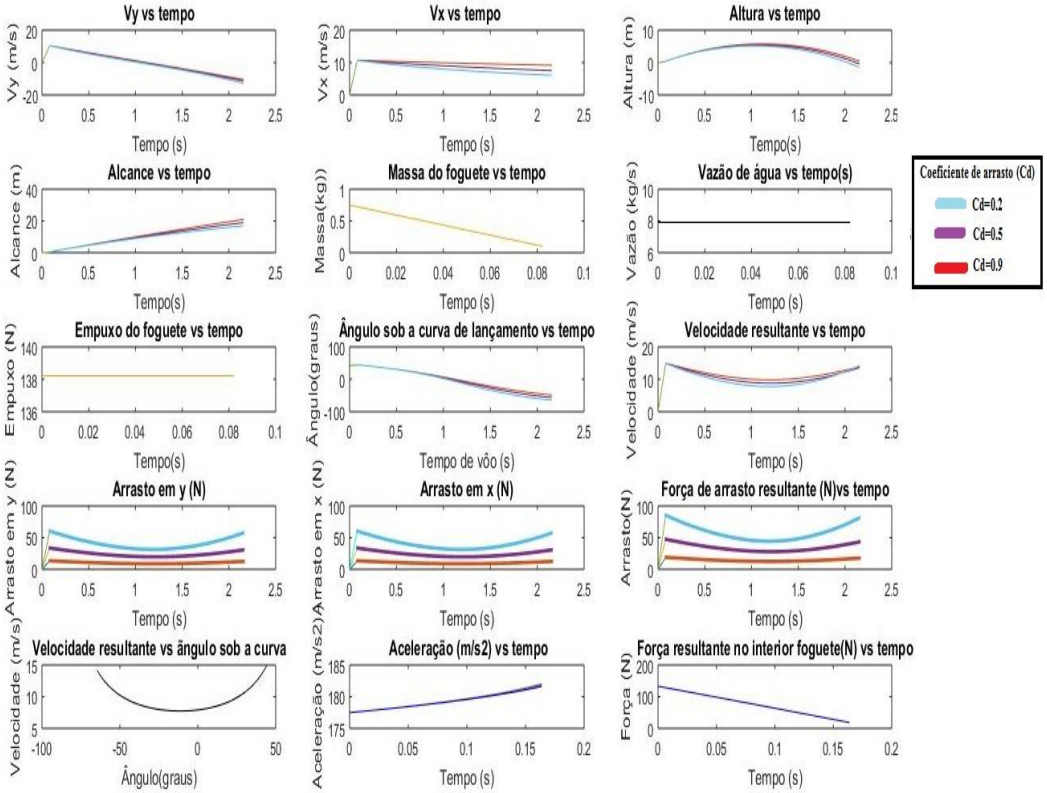


Source: the authors

It was observed from the results that the higher the launch pressure, the greater the range of the mini-rocket.

Figure 4.5 shows the results of the flight prediction computer program, for drag coefficients (Cd) with values: 0.2 [-], 0.5 [-] and 0.9 [-].

Figure 4.5 - Results of the flight prediction computer program for different drag coefficients (Cd).

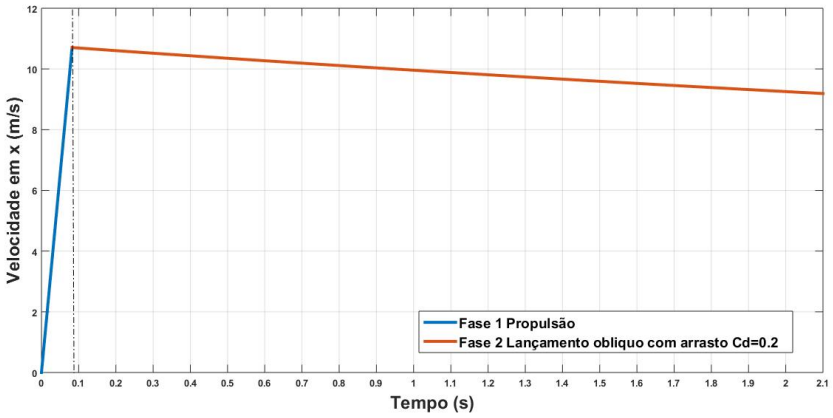


Source: the authors

Figure 4.5 shows that the higher the drag coefficient Cd[], the higher the value of the net drag force (N) on the minirockets.

Figure 4.6 shows one of the results of the flight prediction computer program describing Phase 1 (propulsion) and Phase 2 (oblique launch).

FIGURE 4.6 - Phase 1 (propulsion) and Phase 2 (oblique launch).

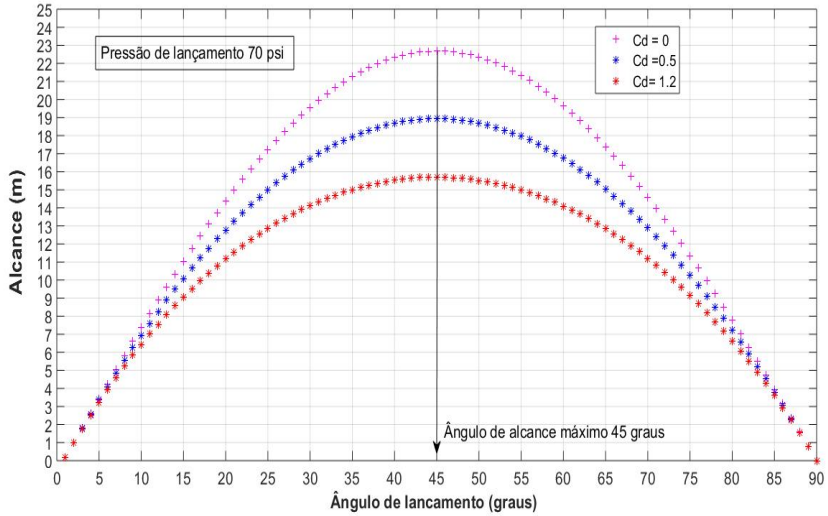


Source: the authors

Figure 4.6 shows the results of the two systems of differential equations for the propulsion and oblique launch steps.

Figure 4.7 shows the profile of the mini-rocket range curve for different launch angles considering the drag force.

Figure 4.7 - Mini-rocket range curve profile for different launch angles

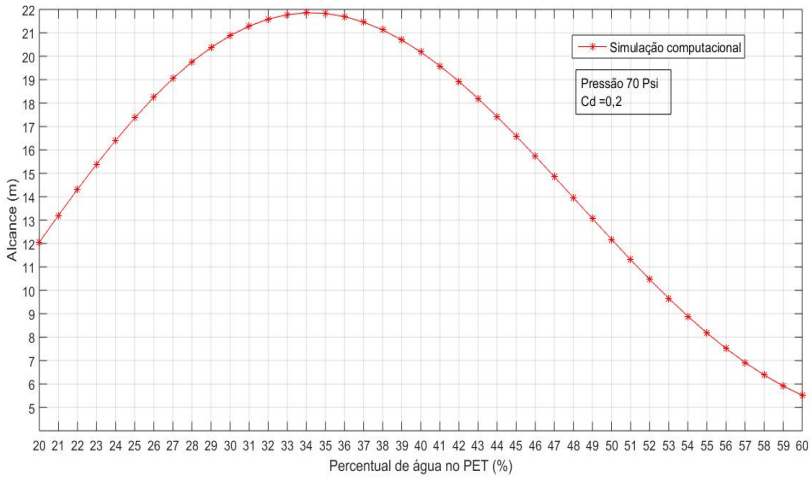


Source: the authors

It was observed by computer simulation that the launch angle that maximizes the range of the mini-rocket is forty-five degrees.

Figure 4.8 shows the profile of the mini-rocket range curve for different percentages of water in the mini-rocket's propulsion system.

Figure 4.8 - Profile of the mini-rocket range curve for different percentages of water in the propulsion system of the mini-rocket for 2 L PET.



Source: the authors

It was observed by computer simulation that the percentage of water in the mini-rocket's propulsion system that maximizes range is 34 percent, approximately 1/3 of the volume of the propulsion system.

Figure 4.9 shows the profile of the mini-rocket's maximum range curve for different launch pressures.

Figure 4.9 - Profile of the mini-rocket maximum range curve for different launch pressures.

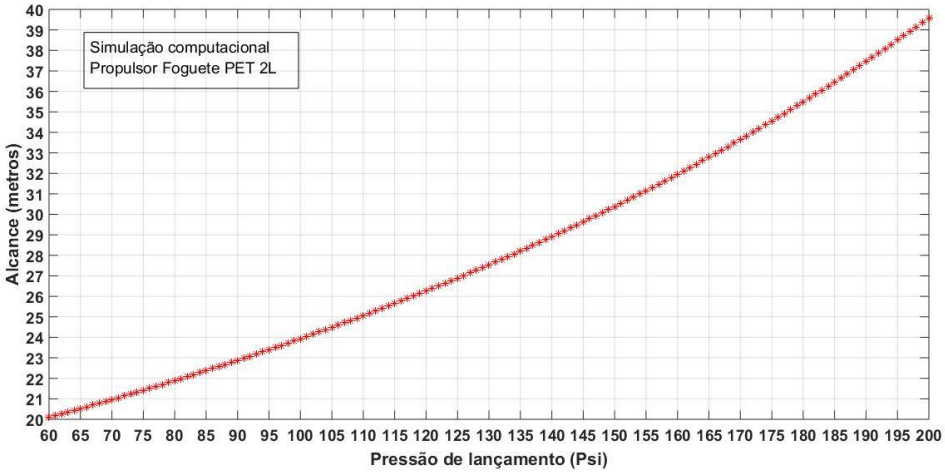
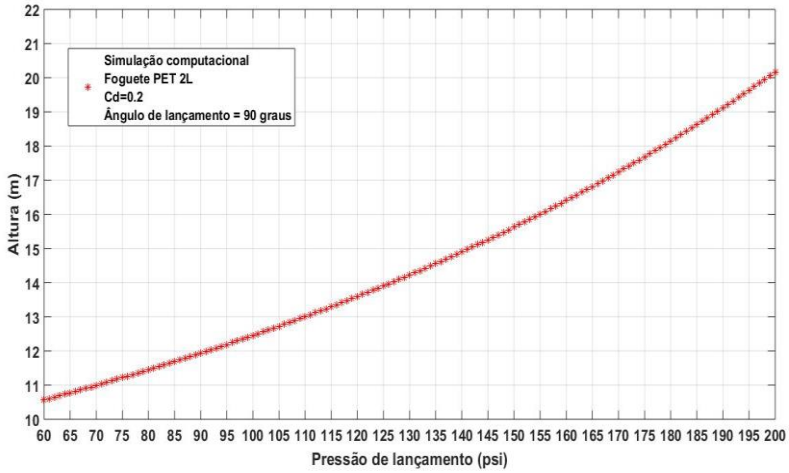


Figure 4.10 shows the maximum height profile reached for different launch pressures of the PET 2L mini-rocket.

Figure 4.10 - Maximum height profile of the mini-rocket for different launch pressures.



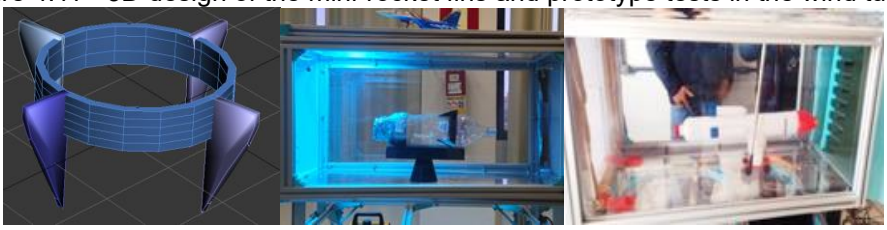
VALIDATION OF THE COMPUTER SIMULATION FROM FIELD LAUNCHES

The validations of the computer simulations were performed by comparing the parameters of several experimental launches, resulting in values close to and with errors of less than ten percent. The discrepancies between simulated and experimental values can be explained by local variations in wind speed and variations in the stability of the mini-rocket (center of mass). The validation of the computer program was carried out by comparing the results of the simulation with the data from the real launches of the mini-rockets.

DESIGN OF THE MINI-ROCKET FINS

Figure 7 shows a three-dimensional design of a fin for mini-rockets made with biodegradable material (PLA) and printed on a 3D printer. The project was carried out in a computer environment.

Figure 4.11 - 3D design of the mini-rocket fins and prototype tests in the wind tunnel



CONCLUSION

The designed and built wind tunnel was very useful for determining the drag coefficients of the mini-rockets.

The assembly for the determination of the output flow rate in the nozzle of the minirocket was necessary for the calculation of the thrust of the minirocket. The thrust of a mini-rocket has been determined and is constant throughout the Propulsion Phase.

The construction of the mini-rocket launch base was very important for carrying out the experimental launches, mini-rocket designs and validation of the flight prediction computer program.

The two computational routines developed contain two systems of nonlinear differential equations, with 22 dynamic variables, representing the Propulsion Phase, ~~and~~ Oblique Launch and resulted in figures that contain the most important parameters such as: the range of the mini-rocket, flight time, angle under the curve, speed in *x* and *y*, resulting velocity, launch angle, resulting acceleration, thrust and height as a function of time (transient regime).

In the literature, the resolution of differential equation systems by algebraic methods is addressed in several works, using simplifications such as: linearized drag force equation, constant mass system and a smaller number of dynamic variables, generating more imprecise results and with a smaller number of flight parameters. The difference of this work in relation to those found in the literature is that in this one it was addressed the dynamic modeling for flight prediction, using two systems of nonlinear equations with twenty-two dynamic variables, one system for the propulsion stage and the other for the oblique launch. The conservation equations were solved by the Runge-Kutta method, finding results for various parameters of the mini-rocket's flight.

The computer program developed is an important tool to assist in the design of mini-rockets for the reforestation of degraded areas.

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THE IMPORTANCE OF THE HIPERDIA PROGRAM IN THE MANAGEMENT OF HYPERTENSION AND DIABETES IN PRIMARY HEALTH CARE

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ABSTRACT

The Hiperdia Program, implemented in Brazil, is a fundamental strategy in the control and management of hypertension and diabetes mellitus in primary health care. This integrative review aimed to evaluate the effectiveness of the program in improving treatment adherence, reducing complications, and promoting patients' quality of life. We selected 20 articles published between 2013 and 2023, in databases such as PubMed, Scielo, and Lilacs, using the descriptors "Hiperdia," "hypertension," "diabetes," "primary care," and "chronic disease management." The results demonstrate that Hiperdia is effective in identifying, registering and monitoring patients, promoting educational actions and ensuring access to essential medicines. Studies point to significant improvements in treatment adherence and in the reduction of hospitalizations due to cardiovascular and metabolic complications. However, challenges include gaps in infrastructure, discontinuity of funding,

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and difficulties in integrating health teams. It is proposed to expand technological support, training of professionals and telemonitoring strategies as tools to enhance the results of the program. It is concluded that Hiperdia is essential for the confrontation of chronic non-communicable diseases, but requires greater investment and strategic planning to consolidate its effectiveness in primary care.

Keywords: Hyperdia. Hypertension. Diabetes mellitus. Primary care. Chronic diseases.

INTRODUCTION

Hypertension and diabetes mellitus are chronic conditions of high prevalence and complexity, and are considered priority public health problems due to their impacts on morbidity and mortality and costs for health systems. According to the Ministry of Health (2021), hypertension affects about 25% of the Brazilian adult population, while diabetes affects approximately 9%. These diseases are associated with serious complications, such as kidney failure, cardiovascular diseases, strokes, and amputations, which compromise the quality of life of patients and require effective interventions for control.

In Brazil, the Hypertension and Diabetes Mellitus Program (Hiperdia) was established as part of the National Primary Care Policy (PNAB), acting as a strategic tool in coping with these chronic conditions. Hiperdia's main objectives are to register patients, ensure regular access to essential medicines, promote educational actions and carry out systematic monitoring in primary health care. These pillars seek to foster continuity of care, prevent complications, and improve patients' clinical outcomes (MINISTRY OF HEALTH, 2022).

The theoretical framework that sustains the program is anchored in the integrality and longitudinality of care, fundamental principles of the Unified Health System (SUS). According to Starfield (2002), primary care is the first level of contact between the individual and the health system and plays a central role in the coordination of care. In the Brazilian context, Mendes (2018) highlights that primary care is fundamental for coping with chronic diseases, especially due to its ability to promote low-cost and high-impact interventions, such as those offered by Hiperdia. In addition, national studies show that the program contributes to the organization of care and to the reduction of avoidable hospital admissions, although it still faces challenges related to treatment adherence and population coverage (CAMPOS et al., 2020).

Although Hiperdia was structured to address the main challenges related to hypertension and diabetes, the effectiveness of its actions still varies between different regions of the country. Among the factors that limit its results, inequalities in access to health services, the insufficiency of trained teams in primary care, and the low adherence of patients to treatment stand out, as pointed out by Lima et al. (2019). In view of this, it is essential to evaluate the impact of the program and propose strategies to overcome these barriers, ensuring that its actions are effective in promoting the control of these conditions and reducing their complications.

This study aimed to evaluate the efficacy of the Hiperdia Program in the management of hypertension and diabetes mellitus in the context of primary health care in

Brazil. Specifically, it seeks to identify the impacts of the program on the improvement of clinical outcomes, analyze the challenges faced by professionals and patients in the context of the program, and propose recommendations for the improvement of actions developed in the scope of primary care.

METHODOLOGY

This integrative review was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring the transparency and reproducibility of the process. The objective was to identify and synthesize scientific evidence on the impacts of the Hiperdia Program on the management of hypertension and diabetes mellitus in the context of primary health care.

Searches were carried out in the PubMed, SciELO and LILACS databases, selected due to their relevance to the health area and wide access to national and international studies. The descriptors used were "Hyperday," "hypertension," "diabetes," "primary care," and "chronic diseases," combined by Boolean operators ("AND" and "OR") to broaden the scope of the search.

The inclusion criteria established that the studies should be original articles published between 2013 and 2023, in Portuguese, English, or Spanish, and address the impact of Hiperdia on primary health care. Quantitative, qualitative, or mixed studies that analyzed outcomes related to clinical control of hypertension and diabetes, access to medications, adherence to treatment, and quality of life of patients were included. Studies that focused exclusively on other strategies for the management of chronic diseases or on secondary and tertiary levels of health care, as well as literature reviews, editorials, and duplicate studies, were excluded.

The selection process was carried out in three stages: (1) reading of the titles, (2) analysis of the abstracts and (3) evaluation of the full texts. Initial screening identified 120 studies, of which 45 were considered potentially relevant based on titles and abstracts. After reading it completely, 20 articles met the eligibility criteria and were included in the final analysis.

The extracted data were systematized in a table containing information such as authorship, year of publication, study objective, methodology used and main findings. Data analysis was qualitative and followed a thematic approach, categorizing the evidence according to the objectives of the review, such as the effectiveness of Hiperdia in controlling chronic conditions, adherence to treatment, and impact on reducing complications.

This methodological rigor sought to ensure the inclusion of relevant and reliable evidence, contributing to a deeper understanding of the effectiveness of Hiperdia in the management of hypertension and diabetes in the context of primary health care.

RESULTS

The analysis of the 16 selected studies revealed that the Hiperdia Program plays a central role in the management of hypertension and diabetes mellitus in primary health care, with significant impacts on several dimensions of care. The results found made it possible to identify advances and challenges related to the implementation and reach of the program.

Hiperdia proved to be an efficient tool for mapping individuals with hypertension and diabetes in the community. Active patient registration was associated with better outcomes, such as greater adherence to treatment and reduced complication rates. Studies such as the one by Santos et al. (2020) highlighted that municipalities with higher registration coverage showed an increase in the frequency of medical consultations and in the monitoring of health indicators, which facilitated early preventive and therapeutic interventions.

The free distribution of essential medicines, combined with regular consultations and educational actions, was identified as a key factor for treatment adherence. Oliveira et al. (2019) observed that patients enrolled in the program had an average reduction of 15% in systolic blood pressure levels and 10% in glycated hemoglobin levels, compared to individuals who were not registered. In addition, patients reported greater confidence in continuous follow-up and the availability of therapeutic resources, which contributed to sustained adherence.

Hiperdia also stood out in the promotion of health education groups, which addressed topics such as healthy eating, physical exercise, stress management and proper use of medications. These groups were effective in sensitizing patients about the importance of self-care and in promoting changes in habits. Silva et al. (2021) pointed out that, after participating in educational activities, more than 60% of patients reported improvements in diet and increased physical activity, reflecting on metabolic control and quality of life.

The studies analyzed indicated a significant reduction in hospitalizations related to cardiovascular and metabolic complications in patients registered with Hiperdia. Ferreira et al. (2023) showed that the program had a positive impact on secondary and tertiary

prevention, reducing hospitalization rates for stroke and heart failure by 25% in regions where the program was fully implemented.

Despite the documented benefits, Hiperdia faces operational challenges that compromise its effectiveness in some locations. Studies such as that of Rodrigues et al. (2020) have highlighted the discontinuity in funding, the fragmentation in the flow of information, and the insufficiency of trained human resources as frequent barriers. In addition, regions with poor infrastructure reported difficulties in maintaining the regular supply of medicines and in carrying out continuous monitoring of patients.

DISCUSSIONS

The results analyzed reinforce that Hiperdia contributes significantly to the organization of care in primary care, promoting improvements in the clinical control of hypertension and diabetes and in the prevention of serious complications. However, the effectiveness of the program is directly linked to the integration of health teams, the availability of resources, and the continuity of the public policies that sustain it.

The literature indicates that, in order to overcome the challenges identified, it is necessary to invest in the continuous training of multiprofessional teams, in expanding the coverage of the program and in ensuring regular funding for medicines and educational actions. In addition, the strengthening of the primary care network and the integration with other levels of care can further enhance the results achieved by Hiperdia.

Therefore, the program is consolidated as an indispensable strategy in the fight against chronic diseases in Brazil, but it requires adjustments and improvements to reach its full potential, especially in vulnerable regions.

CONCLUSION

The Hiperdia Program has proven to be an indispensable tool for coping with hypertension and diabetes mellitus in primary health care, with positive results in disease control, treatment adherence and reduction of serious complications. Its performance reinforces the importance of organized and continuous strategies for the follow-up of patients with chronic conditions, contributing to the improvement of quality of life and the reduction of costs in the health system.

However, the study identified significant challenges that limit the reach and effectiveness of the program. Problems related to insufficient infrastructure, discontinuity in funding, and limited integration of health teams are barriers that compromise its optimal implementation, especially in vulnerable regions. These limitations reinforce the need for

more robust and sustainable public policies that ensure the continuity and expansion of Hiperdia.

This study has some limitations. First, as it is an integrative review, the results depend on the quality and scope of the studies analyzed, which may introduce bias. In addition, most of the selected articles focused on specific contexts, making it difficult to comprehensively generalize the results. Another limitation was the absence of recent data in some regions of the country, which may underestimate or overestimate the impact of the program.

In view of the limitations observed, it is suggested that future studies adopt multicenter approaches to evaluate the efficacy of Hiperdia in different regional contexts, considering the socioeconomic and structural inequalities in Brazil. In addition, longitudinal surveys can provide more detailed information on the evolution of clinical and organizational outcomes associated with the program.

Another recommendation is to investigate the impact of emerging technologies, such as telemonitoring systems, integrated electronic medical records, and artificial intelligence, on improving registration, follow-up, and adherence to treatment. Studies on the perception of patients and health teams in relation to Hiperdia would also be valuable to identify gaps and propose interventions that meet local needs.

Finally, it is crucial that future studies explore sustainable financing strategies and continuous training policies, especially for remote and highly vulnerable regions, in order to expand the coverage and effectiveness of the program, contributing to the strengthening of primary care in Brazil.

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DECISION-MAKING DIFFICULTIES IN A CHILD WITH SEVERE NEUROPATHY

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ABSTRACT

The chapter addresses the challenges involved in decision-making for children with severe neuropathic conditions characterized by irreversible brain damage that results in severe motor, cognitive, and sensory deficits. With advances in medicine, the life expectancy of these children has increased, but this has brought new clinical, ethical, and emotional dilemmas.

Palliative care is presented as essential to improve the quality of life of these children, promoting physical, psychological, social and spiritual support. The approach must be integrated from diagnosis and throughout the entire trajectory of the disease, prioritizing not only the relief of the child's suffering, but also the support of their families.

Early diagnosis, together with the understanding of the prognosis, is fundamental for care planning. During the course of the disease, it is common to identify a tipping point, a moment when the child's clinical trajectory changes dramatically, marking the beginning of a steeper decline. Recognizing this point allows the medical team and the family to reevaluate treatment goals, prioritizing interventions that respect dignity and quality of life.

The impacts of the neuropathic condition are analyzed in four main dimensions: clinical, psychological, social, and spiritual. Clinically, complications include respiratory problems, eating disorders, and refractory seizures, which often lead to recurrent hospitalizations. Psychologically, the emotional burden on families is significant, generating feelings of guilt, social isolation and burnout of caregivers. Socially, isolation and financial difficulties aggravate the impact of the condition, while the spiritual dimension addresses the search for meaning and emotional support to face the disease.

Decision-making for these patients involves complex bioethical dilemmas, guided by principles such as beneficence, nonmaleficence, autonomy, and justice. The choice between prolonging life as invasive interventions or prioritizing palliative care requires transparent discussions between medical teams and families. The chapter proposes a multidisciplinary decision model, which includes identification of the dilemma, collection of information, team discussion, implementation of decisions and continuous adaptation to the child's needs.

Finally, proposals for improvement in the management of these cases are suggested, including: Professional training in palliative care and sensitive communication, reinforcement of public policies, such as the creation of specialized centers and financial benefits for families, promotion of support networks, strengthening interaction between families, caregivers and communities.

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[3] Academic
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It is concluded that care for severe neuropathic patients should be comprehensive and centered on both the child and his or her family. The implementation of multidimensional strategies is essential to ensure dignity and quality of life, while public policies and clinical practices must be aligned with this objective.

Keywords: Severe neuropathy. Palliative care. Multidisciplinary decision.

INTRODUCTION

Over the past three decades, there has been significant progress in child survival, particularly due to improvements in medical resources and technologies. This includes children with chronic diseases, who previously had extremely limited prognosis. This challenging scenario leads to a pressing need to adapt healthcare, especially for children with complex and limiting diseases, such as severe neuropath.[1]

PEDIATRIC PALLIATIVE CARE

Paediatric palliative care is key to improving the quality of life of children with life-threatening conditions, such as severe neuropathy. This care must be provided in an active and comprehensive, multidisciplinary and coordinated way, covering the physical, psychological, social and spiritual needs of the child and his family. This model of care is vital throughout the course of the disease, regardless of whether curative treatment is available, and persists throughout the family's grief and grief.[1]

THE SEVERE NEUROPATH SCENARIO

CHARACTERISTICS OF THE CONDITION

Severe neuropathy is often associated with irreversible brain lesions, leading to cerebral palsy, a leading cause of neonatal involvement. These lesions are usually triggered by varied reasons such as glutamate release, oxidative stress, and cell death. The severity of these lesions varies with the age of involvement and the degree of brain maturity of the patient, being more severe in younger children.[2]

DIAGNOSIS AND PROGNOSIS

Early diagnosis of neurological lesions that cause this condition is crucial to initiate a systematized intervention3 . The neurological prognosis is directly related to the child's age at the presentation of the lesion, especially during the first two years of life, when there is greater potential for neuroplasticity4 . The diagnosis is best made in a serial manner, with detailed semiological evaluations that help to understand the severity of neuromotor impairment, categorized as mild, moderate, or severe, especially in terms of mobility and adaptation to activities of daily living.

AGGRAVATING FACTORS AND CLINICAL COMPLEXITY

Severe neuropathies are generally classified in category 4 of non-progressive but irreversible diseases, with high chances of premature death due to recurrent complications.

These patients go through phases of stability and clinical deterioration that are directly due to the underlying disease, metabolic or functional alterations. These problems are very often related to: chronic respiratory problems because these children often require mechanical ventilation.

EATING DISORDERS: FREQUENT NEED FOR GASTROTOMY

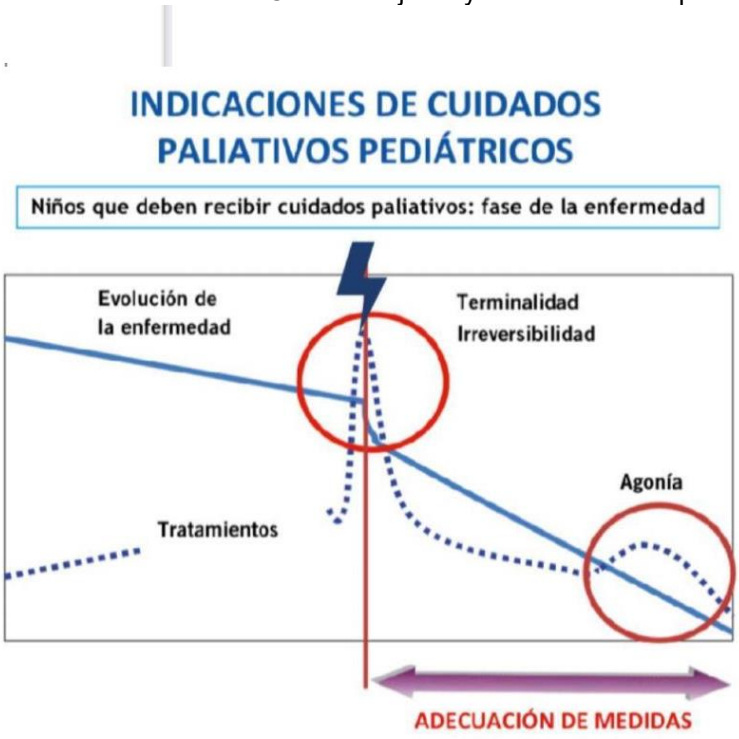
Refractory seizures: these are often difficult to control with medications, sometimes in multiple associations that can lead to other complications.

INFLECTION POINT

Identification of the inflection point is crucial in the evolution of severe neuropath. This point marks an acceleration of clinical deterioration, with an increase in the frequency of symptoms, rehospitalizations, and lack of response to established treatments. The anticipation of this moment allows a critical reevaluation of therapeutic objectives and promotes a continuous adaptation of care goals.

Recognize this point to the medical team and the family, reevaluate the goals of care and reevaluate interventions that respect the dignity of the child. [6]

Graph 1: Inflection Point in the Clinical Trajectory of Severe Neuropathic Patients



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Description: The graph illustrates the typical trajectory of a severe neuropath, with peaks and valleys that represent moments of stability and clinical deterioration. The "tipping point" is highlighted as a critical point where a significant decline in the patient's quality of life occurs.

PSYCHOLOGICAL, SOCIAL AND SPIRITUAL ASPECTS

PSYCHOLOGICAL IMPACT

The acceptance of a serious chronic condition in a child often causes an emotional disruption to the family, affecting the psychological well-being of parents, siblings, and caregivers. Coping with these losses and limitations is associated with the emergence of symptoms such as depression and anxiety. In addition, burnout in caregivers is a significant risk, exacerbated by the perception of guilt and powerlessness in the face of the child's limitations. There is social isolation with restrictions on participating in social activities7 .

PSYCHOLOGICAL SUPPORT STRATEGIES

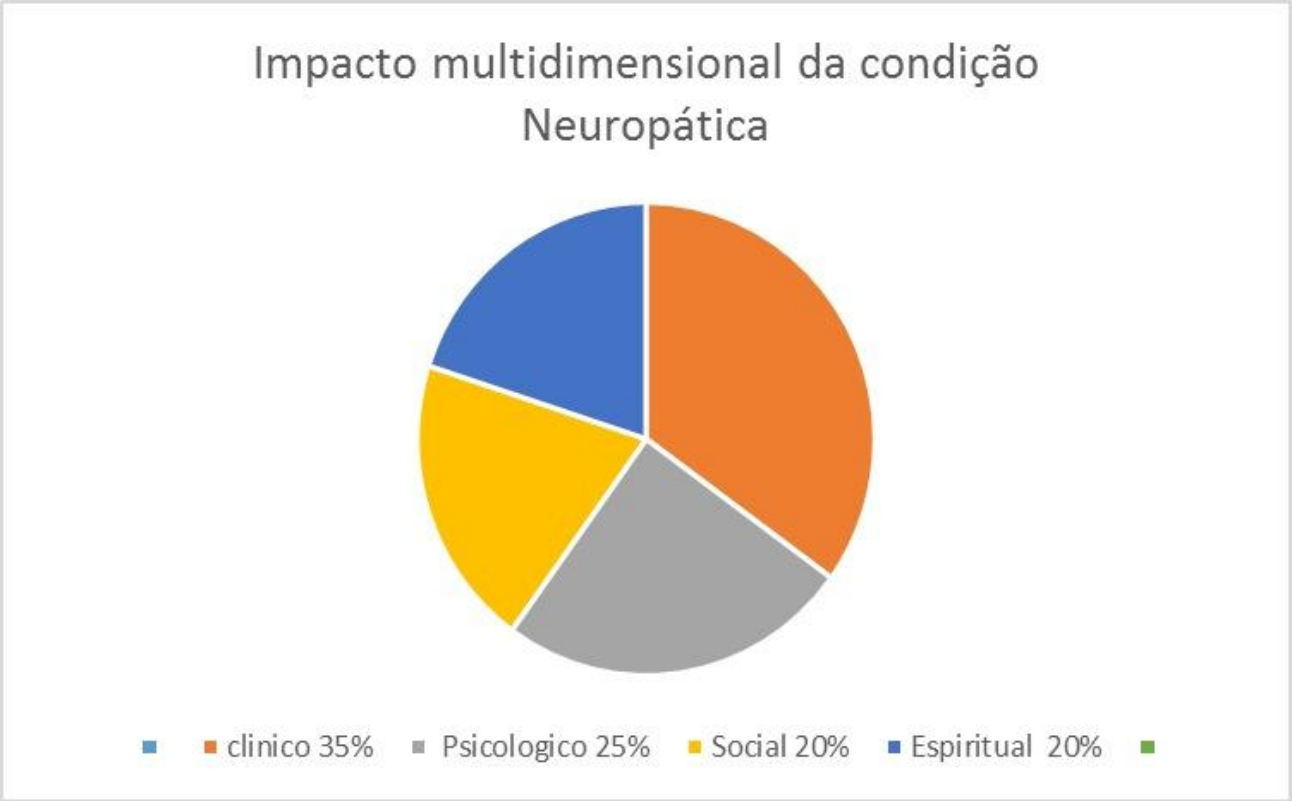
- Continuous Monitoring: Provision of individual and family psychological support to facilitate the acceptance and resignification of the disease.
- Family Therapy: Approaches that promote communication and the division of responsibilities among family members.
- Prevention of Complicated Grief: Guidelines for caregivers to deal with grief and feelings of loss, especially at critical times like the tipping point of illness.

SOCIAL ASPECTS AND SUPPORT NETWORKS

The social impact of severe neuropathy is substantial, since social isolation is common among these families. The lack of financial support, parental abandonment, and difficulties in accessing specialized services further aggravate this situation.[1]

To make matters worse, there is limited access to specialized services [6] which reinforces the social isolation of families.

Graph 2: Multidimensional Impact of the Neuropathic Condition



Description: The pie chart illustrates the distribution of impacts on the life of a severely neuropathic child and his family. Each sector represents a different aspect, such as the clinical (35%), psychological (25%), social (20%) and spiritual (20%). This diagram highlights the need for an integrated approach that considers all of these aspects for effective care.

SOCIAL SUPPORT MEASURES

- Follow-up by social workers to facilitate access to benefits and community support.
- Legal interventions in cases of neglect or abandonment.
- Training of caregivers to improve the quality of home care.

ETHICAL AND MULTIDISCIPLINARY DECISION-MAKING

The decision on the management of severe neuropathic patients involves complex bioethical dilemmas. Decision-making must balance principles such as beneficence, non-maleficence, autonomy (9) and justice, with an approach that considers the particularities of each case.

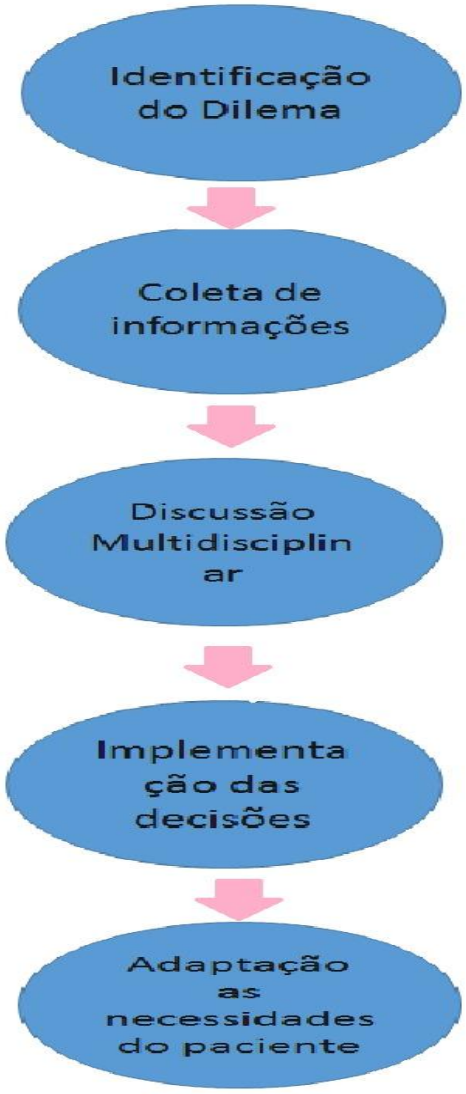
ETHICAL ALTERNATIVES

Ethical alternatives involve considering the clinical and familial implications of each treatment decision. Key options include:

1. Suspension of Invasive Interventions: Careful evaluation of life-prolonging treatments, such as mechanical ventilation, in order to avoid therapeutic obstinacy when treatments no longer have significant benefits for the patient's quality of life.

2. Transparent Discussion with Family: Engage the family in open discussions about the limits and goals of treatment, considering their beliefs, values, and expectations.
3. Transition to Palliative Care: Offer palliative care when the patient's condition deteriorates so that they can live comfortably until death, avoiding prolonging unnecessary suffering.
4. Multidisciplinary Follow-up: Implement multidisciplinary support that includes physicians, psychologists, social workers, and bioethicists to collectively discuss and decide on the most appropriate treatment for the patient and their family.

Graph 3: Multidisciplinary Decision Model



Description: This flowchart illustrates the decision-making process, starting with the identification of the dilemma, through information gathering and multidisciplinary discussion, to the implementation of decisions tailored to the patient's needs.[10,11,12]

FINAL CONCLUSION AND PROPOSALS FOR IMPROVEMENT

The care of severe neuropathic patients requires an approach that transcends the biomedical aspect, integrating emotional, social and spiritual dimensions. To improve this service, the following strategies are proposed:

- Professional Training: Ongoing training in palliative care and clinical ethics.
- Strengthening of Public Policies: Expansion of resources and infrastructure to serve patients with complex diseases.
- Promotion of Support Networks: Encouragement of the creation of communities that offer mutual support between families and caregivers.

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DOSE EVALUATION IN CHEST X-RAYS

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ABSTRACT

Objective: A study was carried out to determine whether the dose delivered to the patient during chest X-ray in two positions, posteroanterior and lateral, is in accordance with the value recommended by RDC 611/2022 (IN No. 90). Methodology: An exploratory and descriptive study was carried out based on data previously collected in an observational way in a hospital in the city of Salvador-BA. A total of 200 exposure parameters (voltage and current-time product) were collected from the 100 patients, 50 females and 50 males. These collected data were reproduced in the digital fixed X-ray equipment, belonging to the school clinic of the Federal Institute of Bahia. An X-ray measurement system with an ionization chamber and solid-state dose sensors specific for X-rays was used, which indicated the value of the skin entry dose (DEP) in software installed on a laptop. Results: It was found that the value of EPD delivered to patients is in accordance with the maximum reference value established by RDC 611/2022 (IN No. 90). The values for the current product-time (mAs) showed a great discrepancy between the positions, with an increase of 210%, while the voltage (kV) remained almost unchanged. Conclusion: It is noteworthy that although the value is below the recommended value, there is still the possibility of improvement with the implementation of a quality control and assurance program to contribute to the standardization of procedures and the use of a thickness meter for a better selection of the technical parameters used. Consolidating the application of protocols on an individual basis, taking into account the thickness of the structure to be studied to determine the technical parameters to be applied.

Keywords: Radiography. Thorax. Skin Entry Dose. Placements.

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INTRODUCTION

Since they were discovered, X-rays have played a significant role for diagnostic purposes, being increasingly used as new technologies are implemented to ensure greater safety and better image quality. According to a publication by the United Nations Scientific Committee on the Effects of Atomic Radiation, the total annual number of tests in the world is 4.2 billion. On average, a little more than 574 diagnostic medical examinations per 1,000 inhabitants are carried out per year (Unscear, 2020).

Among them, chest X-rays, as it is a useful, fast, non-invasive, and low-cost exam, continue to be one of the most requested in Brazil, corresponding to about 30% to 50% of X-rays (Guimieri, 2018). This view aims to serve as a record for the investigation of possible health changes in symptomatic or asymptomatic patients.

The quality of the image and the amount of radiation in a radiographic examination are closely linked to the specific technical characteristics, including the exposure parameters of the radiographic techniques such as voltage and current applied to the tube, effective collimation, focal point, patient positioning, focus-film and object-film distance, the operator's technical knowledge and the patient's physical and psychological state (Silva et al., 2013).

A good definition image must be produced with the lowest possible dose for the patient, compatible with an adequate diagnosis (Peixoto, 1999). Radiation will interact with matter through two mechanisms: direct, when radiation interacts directly with important molecules such as DNA, and can cause everything from genetic mutation to cell death; and indirect, when the radiation breaks down the water molecule, thus forming free radicals that can attack other important molecules. This mechanism is important, since our body is made up of more than 70% water (Okuno, 2013)

These interactions, however small, can cause damage to the cell, the biological effects caused by the interaction of ionizing radiation with matter can be of two types: deterministic and stochastic. Deterministic effects occur when irradiation in the body, general or localized, causes more cell death than can be compensated for by the body (threshold of clinical effects). Above this threshold, the severity of the damage increases with dose (Navarro et al., 2008), while stochastic effects are those whose probability of occurrence is a function of dose, with no threshold, as is the case with cancer. Thus, for any irradiated individual there is a chance that certain effects attributable to radiation will manifest themselves (CNEN, 2014). Thus, the higher the dose to which the patient is exposed, the greater the probability of occurrence. The need then arises to ascertain whether the dose delivered to the patient during the examination is in accordance with the

principle of optimization, presented by the International Commission on Radiation Protection (ICRP), which defines the dose as being "as low as reasonably practicable".

In view of the factors mentioned above, and with the increasing number of chest X-rays, the present study aims to assess the value of the Skin Entry Dose (PED) to which patients are exposed during chest X-rays performed in conventional X-ray equipment, in two positions, posteroanterior (PA) and lateral.

METHODOLOGY

This study consists of an exploratory and descriptive research. In which, mixed methods combine quantitative and qualitative techniques in the same research design (CRESWELL and CLARK, 2011). In this study, the exploratory method investigates a problem by providing information for a more accurate investigation, which combined with the descriptive method provides additional information on the researched topic, associating effectively (QUALYBEST, 2020).

DATA COLLECTION

The study was carried out based on data previously collected with authorization through a letter of consent from the Institution's Teaching and Research Board in an observational manner in a private hospital in the city of Salvador – BA.

Chest X-rays in two positions, posteroanterior and lateral (routine), were conducted by radiology technicians and technologists. In all, 200 exposure parameters were collected, namely voltage (kV) and current-time product (milliamperes per second, mAs), from 100 patients, 50 females and 50 males. These parameters were collected from the conventional fixed X-ray equipment of the SIEMENS® Multix B model with a constant of 40kV and PHILLIPS® Compact Plus 500 with a constant of 30kV.

As inclusion criteria, typical adult patients of both genders and aged 18 years or older were selected for sampling. RDC 611/2022 (IN No. 90), defines the typical individual as one in whom the biometric characteristics are: weight between 60 and 75 kg and height between 1.60 and 1.75 m.

As an exclusion criterion, patients who did not fit this established profile were discarded. An electronic spreadsheet was used to compile the data (Chart 1).

Chart 1 – data in spreadsheet

PCT	kV	mAs	Incidencia
1	92	7	PA
	92	23	PERFIL
2	95	3	PA
	97	13	PERFIL
3	92	5	PA
	92	16	PERFIL
4	90	10	PA
	90	25	PERFIL
5	95	5	PA
	95	18	PERFIL

Source: Survey data, 2020.

PARAMETER TESTING

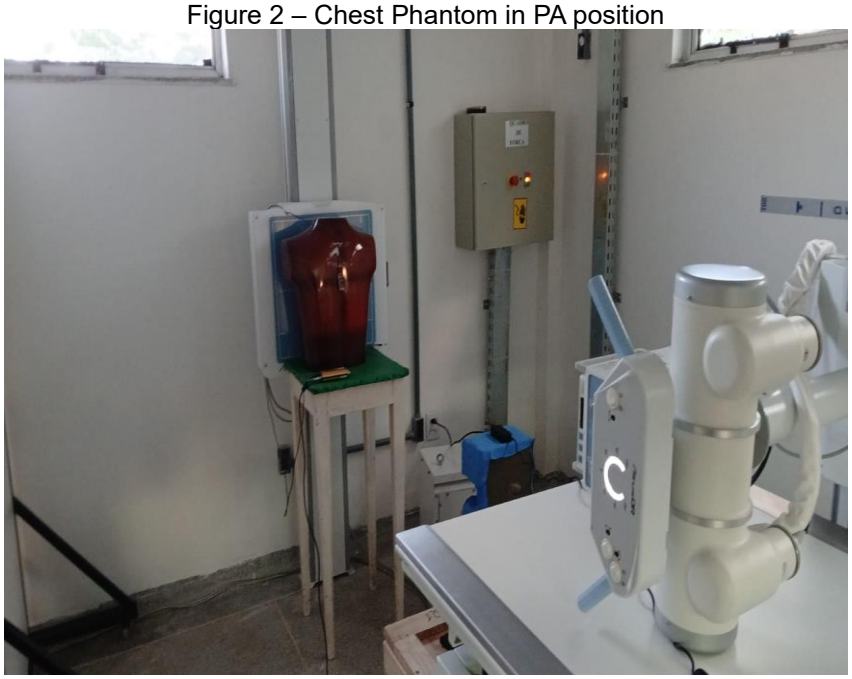
With the data on the technical factors (kV and mAs) collected from the equipment belonging to the private hospital, these were inserted into the digital fixed X-ray equipment, of the Konica Minolta® model XRD model (Figure 1), belonging to the LAFIR 2 laboratory of the teaching clinic of the Federal Institute of Bahia.

Figure 1 - Konica Minolta® conventional digital X-ray equipment model DRX

Source: Author, 2024.

To simulate the presence of the patient, a commercial Pixy Phantom model RSD 101 (Figure 2) and an X-ray measurement system with an ionization chamber, and specific solid-state dose sensors for X-rays, model RADCAL® Accu-Gold (Figure 3)

Figure 2 – Chest Phantom in PA position



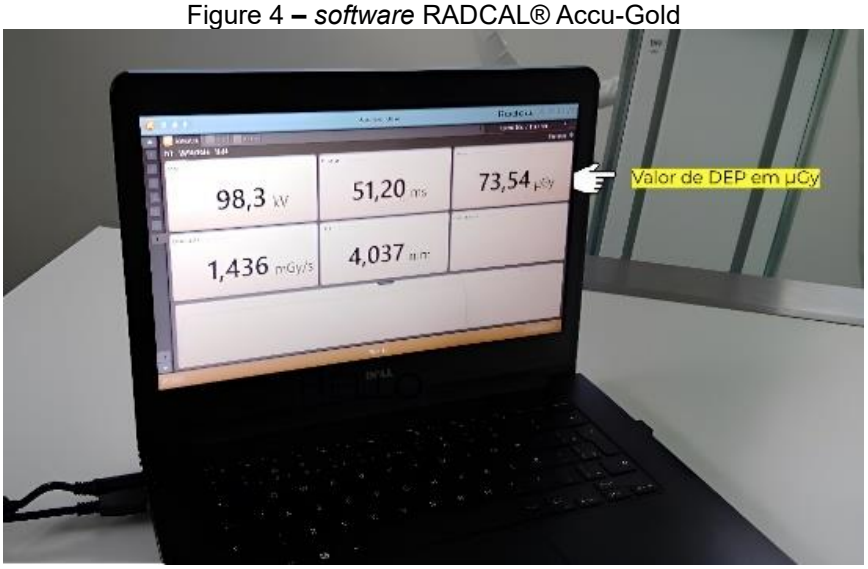
Source: Author, 2024.

Figure 3 – Radcal® AccuGold® Solid State Sensor and Ionization Chamber

Source: Author, 2024.

The DEP value was indicated in software installed on a laptop (Figure 4), with the value given in microgray (µGy) and later converted to milligray (mGy). For each of the views, 3 radiographs were taken and then the average was made to have a greater reliability in the result.

Figure 4 – *software* RADCAL® Accu-Gold



Source: Author, 2024.

The results were compiled and presented in absolute numbers and percentages, in the form of tables.

RESULTS

Of the 100 patients included in the study, 50 were women and 50 were men. In the comparison of the mean skin entry dose (EPD) by sex, it was found that in the views referring to the male gender (Table 1), there was an increase in the kilovoltage or voltage (kV) both in the posteroanterior and lateral positioning, probably due to the larger size of the male rib cage when compared to the female one, while the milliamperes or current time product (mAs), there was a greater increase in BP incidence than in lateral exposure, which presented a lower value than that found in female patients (Table 2), which led to a small increase in the dose, being clearer in BP.

Table 1 – Mean dose for the 50 male patients.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	93,82	6,2	0,10
PROFILE	94,76	17,69	0,26

Source: Author, 2024.

Table 2 – Mean dose for the 50 female patients.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	93,46	5,06	0,07
PROFILE	94,34	17,79	0,24

Source: Author, 2024.

The mean values of kV and mAs obtained from all the incidences (Table 3) showed a value below the maximum reference established by RDC 611/22 IN No. 90 (Table 4).

Table 3 - Total mean by incidences and their DEP values in reference.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	93,64	5,70	0,09
PROFILE	94,55	17,74	0,25

Source: Author, 2024.

Table 4 - Maximum reference value for chest X-ray - RDC 611/22 IN nº 90

Radiography	
INCIDENCE	DEP – mGy
PA	0,4
PROFILE	1,4

Source: Author, 2024.

The mean value of the absorbed dose per organ was evaluated separately using a computer program available free of charge on the internet CALDose_X version 5.0 (2010), more specifically the lung, and it was noted that the increase in the parameters from one incidence to the other led to an increase in the dose (Table 5).

Table 5 - Mean dose absorbed in the lung by incidence.

Average	
INCIDENCE	DEP – mGy
PA	0,02
PROFILE	0,04

Source: Author, 2024.

DISCUSSION

The emission of X-rays during radiographic examination requires special attention with regard to radioprotection for humans against possible undesirable effects caused by ionizing radiation. Radiological protection aims to minimize the risks of deterministic effects and decrease the likelihood of stochastic effects appearing (López, 2021).

Thus, an effective radiological protection program must be grounded in the Institution as a whole and its management staff must assume a commitment to safety, that is: the management structure must be efficient, the authorities, responsibilities and task descriptions must be clearly designated and documented, the resources for the safety area must be adequate and all employees must have a commitment to the principle of keeping radiation doses as as far as reasonably feasible (CNEN, 2014).

The results found show that the mean values of EPD to which patients are exposed during chest X-rays are below the maximum reference values established by RDC 611/22 IN No. 90, precisely individuals have a value 77.5% lower in their radiographs in the PA

view, while in lateral this value reaches 82.14%. On the other hand, for the selected technical parameters, it was found that in the change between the incidences, even with the variation in the size of the structure to be radiographed, from the PA to the Profile, the voltage (kV) was practically maintained, with a small increase of 0.91 kV, while the current product-time (mAs) had an increase of 12.04 (increase of approximately 211%), which led to an increase in the dose by 180% between the incidences.

In addition, the same evaluation was made separately for female patients, which showed an increase in voltage (kV) of 0.88 kV, while the current-time product (mAs) had an increase of 12.73 mAs (an increase of approximately 239%). For male patients, the voltage (kV) increased by 0.94 kV and the current-time product (mAs) by 11.49 mAs (an increase of approximately 180%), highlighting that the correction was only evidenced in only 13% of the patients.

These alterations demonstrated that with the increase in mAs there was a directly proportional increase in the dose. The amount of X-rays is directly proportional to the current-time product (mAs). Because, when this product is doubled, the number of electrons that reach the target of the tube also doubles and, therefore, twice the number of X-rays is emitted (Bushong, 2010)

Previously, in the same population, the value of the entry dose into the skin was calculated using a computer program CALDose_X version 5.0 (2010). The values presented by CALDose X indicated that the dose delivered to the patient was higher than that recommended by the current standard, for BP in male patients it had an average value of 0.41 kV and for females the value was also 0.41 mGy, in Profile the value reached 1.539 mGy for both. Thus, the value presented by the *software* (Table 6) was higher than that obtained by the ionization camera, which was properly calibrated (Table 7).

Table 6 - Mean by incidence and its reference EPD values (CALDose X)

Average							
		PA		-		PROFILE	
PATIENT	kV	mAs	DEP – mGy	-	kV	mAs	DEP – mGy
Man	94	6	0,41	-	95	17	1,539
Woman	93	5	0,41	-	94	17	1,539

Source: Santos (2020)

Table - 7 Means by incidence and their reference EPD values (ionization chamber)

Average							
		PA		-		PROFILE	
PATIENT	kV	mAs	DEP – mGy	-	kV	mAs	DEP – mGy
Man	93,82	6,2	0,10	-	94,76	17,69	0,26
Woman	93,46	5,06	0,07	-	94,34	17,19	0,24

Source: Author, 2024.

CONCLUSION

The conclusion of this study is that the values of the entry dose into the skin to which the patients are exposed during their chest X-rays are below the maximum reference value recommended by RDC 611/22 IN No. 90. However, the large discrepancy in the mean values of the current product-time suggests that there should be a better choice of technical parameters for each patient, seeking to further optimize the dose delivered.

This result shows the need to implement a quality control and assurance program to contribute to the standardization of procedures and the use of a thickness tester, an instrument used to measure the thickness of a patient's limb that will be X-rayed, for better selection of the technical parameters to be used, thus ensuring a reduction in the dose.

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DOSE ASSESSMENT ASSOCIATED WITH PATHOLOGY

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ABSTRACT

Objective: This study aimed to evaluate how changes in exposure parameters due to pathological suspicions can increase the dose on chest X-rays in two positions, posteroanterior and lateral, and whether the dose delivered to the patient is in accordance with the value recommended by RDC 611/2022 (IN No. 90). Methodology: An exploratory and descriptive study was carried out based on data previously collected in an observational way in a hospital in the city of Salvador-BA. A total of 200 exposure parameters (voltage and current-time product) were collected from the 100 patients, and which pathologies were associated with each of them. These collected data were reproduced in the digital fixed X-ray equipment, belonging to the school clinic of the Federal Institute of Bahia. An X-ray measurement system with an ionization chamber and solid-state dose sensors specific for X-rays was used, which indicated the value of the skin entry dose (DEP) in software installed on a laptop. Results: It was found that the value of EPD delivered to patients is in accordance with the maximum reference value established by RDC 611/2022 (IN No. 90). The values of the exposure parameters showed that even due to the physiological change caused by the pathogens, the voltage (kV) was little altered, while the value of the current product-time (mAs) had a large increase of 210% between the incidences. Conclusion: Although the value found for the entry dose into the skin was in accordance with the established limits, it was noted that for each pathology, little was done for a proportional change of the selected parameters, not only for the pathological suspicions, but also between the incidences, while the penetrability of the beam was little altered, the amount of X-rays produced was doubled, increasing the dose without actually having a diagnostic value for imaging.

Keywords: Tension. Pathologies. Incidences.

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INTRODUCTION

The image recorded by the exposure of any of the image receptors to X-rays is called radiography, remembering that at each step in the performance of a radiographic procedure, it must be completed accurately to ensure that the maximum amount of information is recorded in the image, as the information obtained through the radiographic examination can reveal the presence or absence of anomalies or traumas, this information in turn helps in the diagnosis and treatment of the patient (Frank et al, 2016). But despite its great importance in medical diagnosis, radiation has its risks, which operating professionals should always seek to minimize, so that the benefit of the exam is always greater than the risk.

Since there are risks arising from radiation, the biological effects of radiation can be divided into two, the deterministic: these effects are somatic and result from exposure to a high dose of radiation and usually manifest themselves above a certain dose, the threshold dose, which is determined according to the irradiated tissue. These effects are more severe the higher the radiation doses are (López, 2021). Stochastic effects, on the other hand, are those that do not have a threshold to occur, so any imaging procedure or therapy that involves the use of radiation involves some risk (Singh and Neutze, 2011).

Thus, with the growing increase in medical exposures to ionizing radiation, in 2020 it exceeded 4 million exams performed in a year worldwide (Unscear, 2020). Among them, chest X-rays, as it is a useful, fast, non-invasive, and low-cost exam, continue to be one of the most requested in Brazil, corresponding to about 30% to 50% of X-rays (Guimieri, 2018). Thus, the radiology technician or technologist should seek to minimize the radiation dose to the patient, to himself, and to others, according to the ALARA principle, which defines that the dose delivered to the patient should be as low as reasonably feasible (Fauber, 2017).

The quality of the image and the amount of radiation in a radiographic examination are closely linked to the specific technical characteristics, including the exposure parameters of the radiographic techniques such as voltage and current applied to the tube, effective collimation, focal point, patient positioning, focus-film and object-film distance, the operator's technical knowledge, and the patient's physical and psychological state (Silva et al., 2013). Another factor that can lead to changes in the parameters is the pathological suspicion, which can interfere in the choice of parameters already presented, because depending on the pathology, it may be necessary to have a greater or lesser penetrability of the X-ray beam, for better visualization of the affected structure or organ.

The penetrability of the beam is defined by means of the voltage (Kilovoltage, kV), the voltage is responsible for controlling the energy (penetrating power) of the X-ray beam, and the current-time product (Milliamperes per second, mAs), is responsible for controlling the amount or number of X-rays produced and the exposure time (Bontrager, 2015),

In view of the factors mentioned above, and with the increasing number of chest X-rays, the present study aims to assess the value of the Skin Entry Dose (PED) associated with the pathological suspicion of the patient, during chest X-ray examinations performed in conventional X-ray equipment, in two positions, posteroanterior (PA) and lateral.

METHODOLOGY

DATA COLLECTION

The study was carried out based on data previously collected with authorization through a letter of consent from the Institution's Teaching and Research Board in an observational manner in a private hospital in the city of Salvador – BA.

Chest X-rays in two positions, posteroanterior and lateral (routine), were conducted by radiology technicians and technologists. In all, exposure parameters were collected, namely voltage (kV) and current-time product (milliamperes per second, mAs), of 100 patients, with pathological suspicions (Pneumonia, Atelectasis, Tuberculosis, Chronic obstructive pulmonary disease, Pleural effusion, Respiratory tract infection) of each one. These parameters were collected from the conventional fixed X-ray equipment of the SIEMENS® Multix B model with a constant of 40kV and PHILLIPS® Compact Plus 500 with a constant of 30kV.

As inclusion criteria, typical adult patients of both genders and aged 18 years or older were selected for sampling. RDC 611/2022 (IN No. 90), defines the typical individual as one in whom the biometric characteristics are: weight between 60 and 75 kg and height between 1.60 and 1.75 m. As an exclusion criterion, patients who did not fit this established profile were discarded. A table was used to compile the exposure parameters (Chart 1), and to evaluate the pathologies, a table was used for the number of patients under suspicion (Table 1).

Chart 1 – data on technical parameters in a spreadsheet

PCT	Kv	mAs	Incidencia
1	92	7	PA
	92	23	PERFIL
2	95	3	PA
	97	13	PERFIL
3	92	5	PA
	92	16	PERFIL
4	90	10	PA
	90	25	PERFIL
5	95	5	PA
	95	18	PERFIL

Source: Survey data, 2020.

Table 1 – data from the study population, associated with each pathology

Average	
PATHOLOGICAL SUSPICION	Number of patients
PNEUMONIA	15
ATELECTASIA	16
TUBERCULOSIS	17
CHRONIC OBSTRUCTIVE PULMONARY DISEASE	19
DERRAME PLEURAL	15
RESPIRATORY TRACT INFECTION	18

Source: Survey data, 2024.

PARAMETER TESTING

With the data on the technical factors (kV and mAs) collected from the equipment belonging to the private hospital, these were inserted into the Konica Minolta® digital fixed X-ray equipment, model XRD model (Figure 1), belonging to the LAFIR 2 laboratory of the teaching clinic of the Federal Institute of Bahia. In addition, the pathological suspicion of each of the patients was recorded, 100 patients.

Figure 1 - Konica Minolta® conventional digital X-ray equipment model DRX

Source: Author, 2024.

To simulate the presence of the patient, a commercial Pixy Phantom model RSD 101 (Figure 2) and an X-ray measurement system with an ionization chamber and solid-state dose sensors specific for X-rays, model RADCAL® Accu-Gold (Figure 3), were used.

Figure 2 – Chest Phantom in PA position

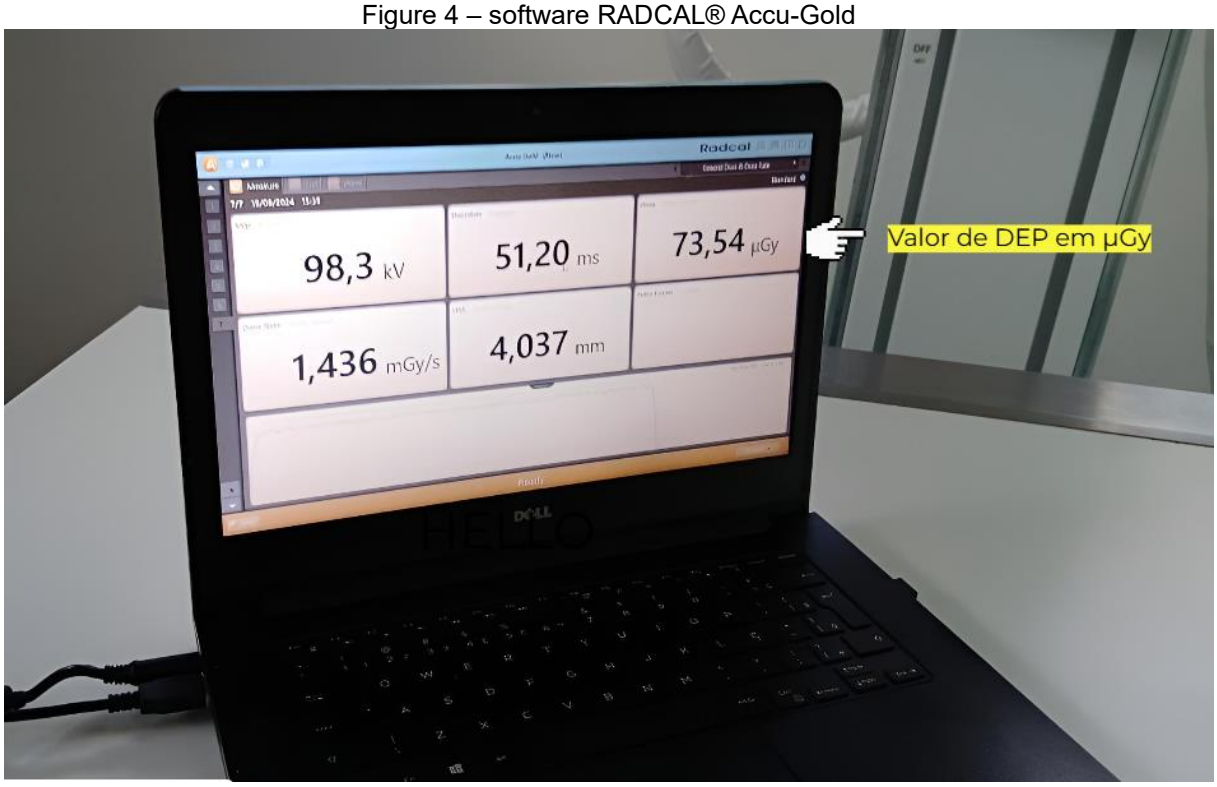
Source: Author, 2024.

Figure 3 – Radcal® AccuGold® Solid State Sensor and Ionization Chamber

Source: Author, 2024.

The DEP value was indicated in software installed on a laptop (Figure 4), with the value given in microgray (µGy) and later converted to milligray (mGy). For each of the views, 3 radiographs were taken and then the average was made to have a greater reliability in the result.

Figure 4 – software RADCAL® Accu-Gold



Source: Author, 2024.

The results were compiled and presented in absolute numbers and percentages, in the form of tables.

RESULTS

In view of each pathological suspicion, an average of the technical parameters (voltage and product, current-time) and an average for the skin entry dose (EPD) were performed from this division. Each pathology was separated by the total number of patients suspected of having the same pathologie. Taking as a reference the maximum reference value established by RDC 611/22 IN No. 90 (Table 2).

Table 2 - Maximum reference value for chest X-ray - RDC 611/22 IN nº 90

Chest X-ray	
INCIDENCE	DEP – mGy
PA	0,4
PROFILE	1,4

Source: Author, 2024

For the 15 patients with suspected pneumonia at the mean (Table 3), it was found that the difference in voltage (kV) between the incidences had a small increase, with an increase of 0.67 kV, while the mAs had an increase of 11.76 (an increase of approximately 177%), which led to a large increase in the dose.

Table 3 - Mean for patients with suspected pneumonia.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	93,73	4,11	0,07
PROFILE	94,4	15,87	0,22

Source: Author, 2024.

For the 16 patients with suspected atelectasis, for the mean (Table 4), the same logic was followed in the choice, while the voltage (kV) increased by 2 kV, while the mAs increased by 12.12 (an increase of approximately 253%).

Table 4 - Mean for patients with suspected atelectasis.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	95,06	4,79	0,07
PROFILE	97,06	16,91	0,24

Source: Author, 2024.

For the 17 patients with suspected tuberculosis, the mean (Table 5), among the incidences, for blood pressure, the value increased by 1.71 kV, whereas the mAs value increased by 11.12 (approximately 205%)

Table 5 - Mean for patients with suspected tuberculosis.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	94,35	5,41	0,08
PROFILE	96,06	16,53	0,24

Source: Author, 2024.

For the 19 patients with suspected chronic obstructive pulmonary disease (COPD), the mean found (Table 6) showed an increase in blood pressure of 0.10 kV, and the mAs increased by 13.21 (an increase of approximately 236%).

Table 6 - Mean for patients with suspected Chronic Obstructive Pulmonary Disease.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	92,11	5,58	0,08
PROFILE	92,21	18,79	0,26

Source: Author, 2024.

For the 15 patients with suspected pleural effusion, the mean (Table 7) showed that the voltage (kV) increased by 1.2 kV. The mAs, in turn, had an addition of 11.88 (an increase of approximately 226%).

Table 7 - Mean for patients with suspected pleural effusion.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	93,67	5,25	0,07
PROFILE	94,87	17,13	0,25

Source: Author, 2024.

Finally, for the 18 patients with suspected respiratory tract infection (RTI), the mean (Table 8) shows that the voltage (kV) was kept the same for both incidences, unlike the voltage, the mAs value increased by 11.64 (an increase of approximately 158%).

Table 8 - Mean for patients with suspected respiratory tract infection.

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	93,39	7,33	0,13
PROFILE	93,39	18,97	0,32

Source: Author, 2024.

In addition, to evaluate the total dose, the average of all incidences was made for the 100 patients (Table 9), showing an increase in voltage (kV) of 0.91 kV, while the mAs had an increase of 12.04 (increase of approximately 211%).

Table 9 - Total mean by incidences and their values of DEP in reference

Average			
INCIDENCE	kV	mAs	DEP – mGy
PA	93,64	5,70	0,09
PROFILE	94,55	17,74	0,25

Source: Author, 2024.

DISCUSSION

Every activity involving radiological protection in the diagnostic area is aimed at minimizing radiation exposure of patients and workers, one of the fundamental principles of radiological protection is to minimize time, since the dose received by an individual is directly related to the duration of exposure, since if the time during which an individual is exposed to radiation is doubled, the dose will be doubled (Bushong, 2010).

Currently, all over the world, it has been adopted that any dose, no matter how small, is associated with the probability of damage (stochastic effects), leading to the adoption of three basic principles, the justification that says that any activity involving radiation must bring a greater benefit than harm; optimization, which defines that the dose should be as low as reasonably feasible (ALARA - As Low As Reasonably Achievable); and the principle of individual dose limitation which determines that individual doses of workers and individuals in the public should not exceed annual dose limits (CNEN, 2014). Optimization is the basis for carrying out this project.

The results found show that the entry dose into the skin delivered to patients during their chest X-rays is in accordance with the maximum reference value established by RDC 611/22 IN No. 90, both when we talk about the different groups associated with different pathologies and the general average of all 100 patients. For further comparison, the PA value is 77.5% lower than the reference value, while the value of the dose for lateral is 82.14% lower.

However, although the dose is in compliance, it is important to pay attention to the changes made in the exposure parameters, in the case of the total mean of the patients, while the current-time product (mAs) had a percentage increase of approximately 211% between the incidences, which also led to an increase in the dose, since the amount of X-rays is directly proportional to the current-time product (Bushong, 2010), while the voltage

(kV) responsible for the penetrability of the X-ray beam, as previously explained, had a percentage increase between the incidences of approximately 1%.

This leads in turn to the loss of details in the radiographic image, due to the changes caused in the density of the tissues by the pathologies, so the changes in the parameters are only causing the increase in the dose, not contributing to the correct diagnosis.

The pathophysiology of each of the diseases has specific characteristics that may lead to the need for parameter adjustment.

Pneumonia originates in the airways and spreads to the alveoli, thus producing an immune response in the lungs that causes the alveolar sacs to fill with exudate (Fleming, 2008). Radiographically, the inflammation caused leads to an increase in the radiodensity of the tissue, thus requiring an increase in the penetrability of the beam and an adjustment in the current product-time (mAs) in order not to have the loss of contrast, but what was evidenced is that the change to the voltage (kV) was approximately 0.7% while the mAs had a percentage increase of approximately 286%.

Chronic obstructive pulmonary disease (COPD) is characterized by persistent airway obstruction that often causes difficulty emptying the lungs; it can be caused by emphysema or chronic bronchitis (smoking is the main cause of COPD) (Bontrager, 2015). Due to the destruction of elastin in the alveoli, the lung tends to lose its elasticity, which causes the air to become stagnant, leading to an increase in residual air volume. Radiographically, this hyperinflation leads to an increase in the presence of air in the structure and an excessive dilation of the lung, which makes a decrease in the penetration of the beam, for better visualization, the results found an increase in voltage (kV) from one incidence to another, of 0.1%, as well as the mAs should be maintained or even reduce its value, however, this population has undergone a percentage increase of approximately 196%.

Atelectasis refers to the collapse of a peripheral, segmental or lobar lung region, or to the collapse of one or both lungs, resulting in the inability to perform gas exchange, and in more severe cases the displacement of the trachea of the heart may occur (Hernández, 2008). This difficulty in air intake leads to an increase in lung density, so an increase in voltage (kV) would end up helping in a better visualization of the pathology, however the result shows that this increase reached only 2%, while the mAs had a significant increase of approximately 253%.

Pleural effusion can be inflammatory or non-inflammatory, it occurs due to the accumulation of serous fluid in the pleura, this accumulation leads to compression of the lungs, causing respiratory distress in the patient (Kumar et al, 2016). Both types of pleural effusion can be demonstrated through the presence of fluid levels on chest X-rays with

horizontal rays, small amounts are more visible in the lateral decubitus position with the affected side down or in an upright position (Bontrager, 2015). Just as atelectasis, due to the reduction in the ability of the lung to dilate, there is an increase in radiodensity, added to the presence of fluid in the pleural space, it is necessary to increase the voltage (kV) for better visualization, for this pathology the percentage increase in kV was approximately 1.2%, while the mAs had a percentage increase of approximately 226%.

Respiratory tract infections (RIs) can be simple, caused by bacterial or viral agents. Depending on its severity, it may not be necessary to change the parameters, perhaps only a discreet adjustment of the mAs. Thus, it was observed that among the incidences, the tension did not change at all, even with the increase in body structure, and the mAs had a percentage increase of 158%

Tuberculosis, in turn, is caused by the inhalation of mycobacteria, it is transmitted mainly by air droplets, but it can also be transmitted by the inhalation of these dry mycobacteria (Fleming, 2008). For this pathology Lordotic AP views are often requested, as they are better for visualization of calcifications and cavitations in the apices and upper lobes (Bontrager, 2015). Thus, depending on the extent of these calcifications or fibroses, an increase in tension is necessary due to its greater density. The results showed a percentage increase for voltage (kV) of approximately 1.8%, while mAs had a percentage increase of approximately 205%.

CONCLUSION

From the results presented, it is concluded that the entry dose into the skin is in accordance with the maximum reference values established by RDC 611/22 IN No. 90. However, it is notorious that the selection of parameters, taking into account the suspected pathologies that affected the patients, was not carried out in a way that the physiological changes caused by them were considered, thus resulting in a loss of details for a better diagnosis.

In addition, the increase of such a large percentage of the current product time (mAs) led to a significant increase between the incidences, which could be avoided with a control between the voltage (kV) and the mAs, because for each 15% increase in kV, it is possible to reduce the mAs by half without compromising the image quality. also reducing the dose delivered. Thus, the need to implement a permanent education program (PEP) for adequate training of professionals is shown.

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GUMMY SMILE: BOTULINUM TOXIN AS A TREATMENT OPTION

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ABSTRACT

Nowadays, aesthetics has become one of the goals to be achieved during dental treatment, the smile in turn is among one of the most important elements of the face, for it to be considered harmonious there must be a correlation between lips, shape and color of the dental elements and gums. When the smile is characterized by an exaggerated exposure of the gums, it is considered unsightly and is called "Gummy Smile". Among its etiologies, we find hyperactivity of the upper lip, which occurs when the muscles responsible for smiling exert a force greater than normal; Botulinum toxin is considered a treatment option in these cases. Therefore, through a literature review, this study aims to discuss the gummy smile and the use of botulinum toxin as a therapeutic treatment option when it has the etiology of the hyperactivity of the upper lip. Google Scholar, Scielo, Pubmed, physical and virtual libraries were used as databases. In view of the research, it was possible to conclude that botulinum toxin is effective for the treatment of gummy smile, as it is a procedure that has ease and safety in application, fast action and low risk, but the correct diagnosis is essential to outline the treatment plan with satisfactory results, as it is also concluded that this treatment option will be effective only when the etiology is the hyperactivity of the upper lip.

Keywords: Smile. Hyperactivity. Toxin.

INTRODUCTION

The smile can be considered as one of the most important components of the face. It is capable of expressing countless sensations and is also a form of communication in society. Since ancient times, aesthetics and beauty standards have been of paramount importance to human beings, the smile in turn is considered one of the most prominent features on the face, making this an extremely relevant element in the search for a harmonious face, it is interconnected with self-esteem, beauty and well-being, Its characteristics can be noticed not only by the dental surgeon, but also by people considered laymen in the area.

According to the literature, for the smile to be considered aesthetic, there must be a correlation between lips, gums, color and shape of the dental remains. The gummy smile is diagnosed when during the act of smiling the patient exposes an excessive amount of maxillary gums and several times it is perceived by the patient himself, taking him to the dental surgeon who must have the knowledge to diagnose its etiology, thus being able to offer the appropriate treatment.

Scientific evidence reports that the relationship between the color and shape of the dental elements, the gums and the lips are important characteristics for the smile to be considered aesthetic, the functioning of the lip muscles is also interconnected because in this region there are several muscles that provide the mobility of the upper lip. There are several etiologies for gummy smile, and with that the dentist must be prepared when choosing the treatment plan that has the best prognosis. Among the etiologies, we find muscle hyperactivity of the upper lip, caused by the excess force exerted by the muscles involved during the act of smiling. Given this, when diagnosed with a gummy smile, can botulinum toxin be used as an effective treatment option?

This study aims to know the performance of botulinum toxin as an ally in the treatment of patients with gummy smile, and specifically, to describe the gummy smile and its relationship with upper lip hyperactivity, in addition to pointing out the performance of botulinum toxin mitigating and/or correcting this condition.

DEVELOPMENT

METHODOLOGY

The type of research carried out was a Literature Review, where books, dissertations and scientific articles selected through a search in the following databases were searched: *Google* Scholar, *Scielo*, *Pubmed*, physical and virtual library.

The period of the articles researched was the works published in the last 15 years, in the period from 2008 to 2023; The inclusion criteria were national works published in Portuguese; The exclusion criterion was temporal, i.e., articles prior to 2008 were not used. The keywords used in the search were: "Gummy smile", "Botulinum Toxin", "Treatment".

RESULTS AND DISCUSSION

Gengival Smile

Smiling is a dynamic process, we can say that it is not only related to the correct dental and skeletal positioning, but also has a direct relationship with the anatomy and functioning of the labial muscles (SEIXAS; COSTA-PINTO AND ARAÚJO, 2011). Facial aesthetic harmony is directly related to the smile, which is formed through the union of three components: The lips, gums and teeth (PEDRON, 2015).

Most dental professionals agree that, during the act of smiling, the upper lip should be positioned at the level of the gingival margin of the maxillary central incisors (SEIXAS; COSTA-PINTO AND ARAÚJO, 2011). During smiling, a characteristic for it to be considered aesthetic is an exposure of the total length of the upper anterior teeth to the premolars, upper teeth touching slightly or leaving a small space with the lower lip and incisal curve of the teeth parallel to the internal curvature of the lower lip (MARSON *et al.*, 2014).

In order for the smile to be considered ideal, the position of the lower edge of the upper lip must be in accordance with the gingival margin of the upper central incisor, leaving it all exposed (MARSON *et al.*, 2014). Their height can be influenced through the age and gender of the patient. Several findings are found that women may have a higher smile than men (SEIXAS; COSTA-PINTO AND ARAÚJO, 2011).

What leads the smile to be considered harmonious is when its gingival exposure is not greater than 2 mm, since above this measure, it can be considered that there is an aesthetic loss in the patient, considering him with a gummy smile (PAULO, OLIVEIRA AND FREITAS, 2018). It can be caused by several reasons, including: Vertical maxillary excess, increased interlabial space at rest, greater muscular ability to raise the upper lip when smiling, overbite and increased overjets. The short upper lip and short clinical crown may also contribute to gingival exposure (DUTRA, 2011).

When it comes to the etiological factors of the gummy smile, some aspects must be considered in the clinical evaluation of patients: the interlabial distance at rest, the exposure of the maxillary incisors at rest and during speech, the arch of the smile, the width/length of the maxillary incisors and the morphofunctional characteristics of the upper lip. For patients who have a gummy smile and normal facial proportions, lip length within the middle limits,

marginal gingiva located close to the JCE and teeth with a normal width/length ratio, the etiology may be related to the hyperactivity of the muscles that move the upper lip during the act of smiling. When not hyperactive, the upper lip moves between 6 and 8 mm from the resting position to the wide smile, however, when hyperactive, this distance can be between 1.5 and 2 times greater (SEIXAS; COSTA-PINTO AND ARAÚJO, 2011).

Upper lip muscle hyperactivity

The lips play an important role in facial expression, especially in the act of smiling, where there are numerous variations in the lip morphofunctional characteristics such as: Thickness and insertion, length and the direction and contraction of the muscle fibers of the muscles related to it. In addition to the orbicularis oris muscle, which internally contours the lips, there are other muscles that influence the mobility of the upper lip, they are: zygomaticus major, zygomaticus minor, levator lip superior, levator lip superioris and wing of the nose, levator corner of the mouth and depressor septum nasal (SEIXAS; COSTA-PINTO AND ARAÚJO, 2011).

The smile during its formation can present two stages: The first, called voluntary smile, which will raise the upper lip in the direction of the nasolabial fold through the muscle contraction of the levator muscles that originate in this groove and are inserted into the lip. The medial muscle bundles have the function of elevating the upper lip in the region of the anterior teeth and the lateral ones in the region of the posterior teeth until it meets a resistance of the adipose tissue that the cheeks have. In the second stage, called spontaneous smile, it begins with a greater elevation of both the upper lip and the nasolabial fold, through the action of three muscle groups: The zygomaticus major muscle, the upper fibers of the buccinator muscle and the levator labii superior muscle, originating in the infraorbital region (SEIXAS; COSTA-PINTO AND ARAÚJO, 2011).

Hyperactivity of the upper lip is characterized by excess strength of the muscles: levator labrum superior and depressor septum nasal (SENISE *et al*., 2015). The fact that these muscles are hyperactive will cause an excessive elevation of the upper lip, leaving the gums more exposed, this mobility is a consequence of the muscle contraction of the muscles involved in the act of smiling. Thinner lips may be more tense and have a more intense response during the moment of contraction (SEIXAS; COSTA-PINTO AND ARAÚJO, 2011). Despite finding that some muscles have a greater influence to cause hyperactivity of the upper lip, all the muscles that are involved in the smile will influence the elevation of the upper lip (MAZZUCO *et al*., 2010 apud PINTO, 2016).

Botulinum toxin

Until recently, botulinum toxin was not allowed for dental use. However, due to the amendment of CFO resolution 112/2011, the dental surgeon was able to apply botulinum toxin for therapeutic purposes (SENISE *et al.*, 2015). It should be remembered that the dental surgeon is authorized to use botulinum toxin in the orofacial region in Resolution 198/2019 by the Federal Council of Dentistry (CFO) (CHEN *et al.,* 2019 apud GALDINO AND BRITO, 2021).

Botulinum toxin is synthesized by the anaerobic Gram-positive bacterium Clostridium botulinum, its action inhibits the release of acetylcholine at the neuromuscular junction, preventing muscle contraction from occurring. There are 7 different serotypes of the toxin (A, B, C1, D, E, F, and G). However, type A is the subtype most frequently used in the clinic and the most effective (PEDRON, 2014). It can be considered as the treatment of first choice when it comes to gummy smile whose main etiology is muscle hyperfunction, due to its ease and safety of applications, no need for the use of large doses, fast effect, less invasive method, high tolerability by the patient and low complication rate, when compared to surgical procedures (REGO; SANTOS AND PEDRON, 2015).

The application of Botulinum Toxin in the treatment of gummy smile will lead to a reduction in the contraction of the levator lip superior muscle (nasal portion), the muscle responsible for lifting the upper lip. When this muscle is hyperactive, it leads to an excessive elevation of the upper lip, leading to gum exposure (SILVA, 2012). The mechanism of action of botulinum toxin can be divided into 2 phases, where in the first phase neuromuscular communication will be blocked and in the second phase this communication is reestablished (SENISE *et al.,* 2015)

In the first phase, botulinum toxin will block the transmission of overactive nerve impulses from the target muscles, selectively preventing the release of acetylcholine at the neuromuscular junction, temporarily preventing contraction, with this, the nerve impulses responsible for controlling muscle contractions are blocked, reducing muscle activity. As botox has a temporary effect, in the second phase neuromuscular communication is restored. Its time of action will depend on each patient and the type of treatment (SENISE *et al.,* 2015).

In the case of puncture points, the markings can be made with the pointed demographic pencil. To perform the application, the muscles must be at rest. For people with 3 to 5 mm of gingival exposure, the recommended dose is 2U to 3U per point. The contents should be applied in an oblique direction by a 4 mm needle on the surface of the skin. According to the literature, injections should be made delicately, with light pressure on

the plunger (BARBOSA CMR and BARBOSA JRA, 2017 apud AQUINO *et al.,* 2019). However, the location of the point and the dosage are factors dependent on the size of the gummy smile exposure (GUPTA & KOHLI, 2019 apud GALDINO AND BRITO, 2021).

Botulinum toxin is a simple, practical and effective method in the aesthetic correction of the gummy smile, other factors that can consider the toxin as a first-line therapy are: Ease and safety during application; use of reduced amount; fast action; low risk; and reversible effect (MAZZUCO AND HEXSEL, 2010 apud SENISE *et al*., 2015). It stands out because it is a quick, less invasive and reversible procedure that is effective in solving the patient's muscle problem, without harming the tissues. This becomes a positive point, as patients who are afraid of the final result will be safe in receiving a minimally invasive procedure (DE PAULO; DE OLIVEIRA AND FREITAS, 2018).

Using botulinum toxin is an alternative form of treatment for gummy smile, but this form will guarantee only temporary benefits, since its effect over time is lost (SENISE *et al.,* 2015). Resistance to botulinum toxin is considered rare, the literature shows that the patient can produce antibodies that inhibit the effects of the toxin. This occurs through a high dose over a short period of time, increasing the risk of developing neutralizing antibodies against the applied product (BRITO *et al.,* 2016 apud GALDINO AND BRITO, 2021).

The injection of botulinum toxin is a simple and safe procedure, but it can be associated with some adverse events, such as pain at the injection site, bruising, infection, edema, ptosis or elongation of the upper lip and asymmetry of the smile. The dental surgeon must be aware of the dosage, the precision of the technique and the location of the puncture (PEDRON, 2015). The use of Botox is contraindicated during pregnancy or while breastfeeding; in cases of allergy to Botox toxin or human albumin; presence of inflammation/infection at the injection site; muscular neuropathy, muscle disorder such as amyotrophic lateral sclerosis (ALS), muscular dystrophy, Lambert Eaton syndrome, Multiple Sclerosis; and people who use calcium channel blockers and aminoglycosides (SENISE *et al*., 2015).

CONCLUSION

Through this literature review, it was possible to discuss how the smile is an extremely important item because it deals with one of the most noted facial features in the human being, being possible through it to transmit sensations that are directly linked to the feelings that occur during daily life. Although the gummy smile is often perceived by the patient himself, knowing the correct anatomy of a harmonic smile is essential when giving

your diagnosis, only after knowing the characteristics of both will it be possible to conclude the diagnosis.

Faced with the diagnosis of gummy smile, it is up to the dental surgeon to have the knowledge to identify its etiology, and through this choose the treatment plan that will be more effective and with more satisfactory results. The etiology known as hyperactivity of the upper lip occurs when the muscles responsible for smiling act in a hyperactive way, that is, an excess of force is exerted by them, causing a greater elevation of the upper lip.

Currently, when it comes to the above etiology, dentistry uses botulinum toxin type A as a treatment option for gummy smile, and it has been showing excellent results because it is a simple, conservative, practical and effective method in correcting the gummy smile, it is safe during application, fast action and low risk. Its effect is reversible, and this can trigger two reactions in the patient, it can be considered a positive point for patients who are not looking for a definitive solution, since a few months after its application neuromuscular transmission is reestablished; However, it can be considered a negative point, since to maintain the result it is necessary to apply it from time to time.

Through the results found in this research, it is possible to conclude that the objectives of knowing the link between gummy smile and upper lip hyperactivity were achieved, based on the literary findings it can also be noted that the correct diagnosis is crucial for the use of botulinum toxin type A to be effective, because in the case of another etiology besides upper lip hyperactivity, there are still no studies that prove its effectiveness. This study can serve as a range for future research, mainly because it is a new area where new relevant discoveries can still be made, when compared to other areas of dentistry.

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EPIDEMIOLOGICAL STUDY OF CASES OF MENTAL DISORDERS THAT OCCURRED WITH HEALTH PROFESSIONALS FROM 2007 TO 2023

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ABSTRACT

Introduction: The objective of this study was to analyze the SINAN notification forms in the identification of work-related illness classified as a mental disorder, analyzing the variables age, main types of mental disorders, occupation and evolution of cases. Methodology: This is a quantitative, ecological, epidemiological study describing the cases of mental disorders recorded in MT from 2007 to 2023. The study was based on secondary data from the 2000 and 2022 demographic censuses, and from the SINAN-Tabwin information system. Results and Discussion: The demographic and sociodemographic profile revealed that the most commonly affected age group is between 53 and 57 years of age with 0.52% of reported cases, with a predominance in women reaching 0.41% of cases of the disease in 2023. When we analyze the level of education, we can highlight the highest occurrence in complete high school with 0.69% in 2022, when we refer to occupation we can list teacher with 0.17%. Conclusion: In view of the analysis, we noticed the existence of a decrease in notifications of mental disorders over these years. The low rate of notifications can be attributed to several factors, including the stigma associated with mental disorders, the lack of awareness about the importance of notification, and possible failures in the registration and communication systems, we realized the need to develop strategies aimed at strengthening the completion of the notification of mental disorders, and the continuing education of professionals in the care network to know the disease and strengthen the notification process.

Keywords: Mental disorders. Health professionals.

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INTRODUCTION

Mental disorders are categorical descriptions of psychopathological patterns, characterized by nosological alterations that can trigger an imbalance in cognitive and affective processes, generating as a determined consequence, the multifactorial incidence of dysfunctional disorders for the individual in suffering (DALGALARRONDO, 2019).

The epidemiology of mental disorders is part of a quantitative list of analyses whose investigative scope is to understand the phenomena of mental illnesses, outlining the conditioning factors that impact specific groups of humanity (ALMEIDA, 2000).

Within this perspective, it is necessary to highlight that the investigative processes, of a quantitative nature, on the components related to mental disorders in Brazil, are understood, through epidemiology, as an analysis that takes into account the atypical conditions of thoughts, emotions, behaviors and interpersonal relationships (ALMEIDA, 2000).

According to the Ministry of Health (2018), work is one of the determinants of the health and well-being of workers and their families [...], but it can also cause discomfort, suffering, illness and death of workers, deepen inequities, the vulnerability of people and communities, and produce environmental degradation.

The global burden of non-psychotic mental disorder comes from neuropsychiatric disorders, associated with this estimate and its chronic and disabling nature, public health has been paying more attention and giving more importance to mental disorders (LUCCHESE et al., 2014).

The execution of work requires concentration, which, in addition to the technical skills acquired, requires commitment to human life. Today, however, the experience of the profession as an art is relative, taking into account the exhausting challenges that involve health institutions. (BENATI, et al., 2017).

According to SOARES, et al. (2019), factors such as high working hours, scarcity of Personal Protective Equipment (PPE), inadequate working conditions and low remuneration, contribute to the development of professional exhaustion, marked by mental and physical stress. In addition, daily care for patients with different diseases, facing pain, suffering, death, overwork, high responsibility and on-call activities can also correspond to the causes of these problems.

Discouragement, anger, anxiety, apathy, depersonalization, inertia and hypersensitivity can come from the physical, emotional and mental exhaustion generated by work, which can result in a drop in productivity, performance and satisfaction of the worker

both in the general context of their profession and in the company to which they provide services (RODRIGUES, et al., 2014).

The psychological pressures that workers are subjected to in the work environment can also originate from the amount of work to be performed, within an insufficient period, out of step with the worker's ability. In addition, those who have minor psychic disorders (symptoms of anxiety, depression, or somatization) are more likely to reduce their ability to work (FERNANDES, et al., 2018).

Work is an activity that proposes a direct relationship between the physical and the psychic, and can represent balance and satisfaction or cause tension and physical and mental illness of the worker, through organizational stress. Thus, when the psychosocial context becomes full of diversity, causing tensions that overload the individual's perception, a profusion of emotional exhaustion can set in, generating extreme consequences of a psychic order (FERNANDES, et al., 2018).

In view of this, the following research problem was elaborated: what is the epidemiological profile of cases of work-related mental disorders treated in MT?

Therefore, the study aims to understand the cases of mental disorders in health professionals in the years 2007 to 2023 in Mato Grosso.

METHODOLOGY

This is a quantitative epidemiological study of the ecological type on the cases of mental disorders registered in MT in the years 2007 to 2023.

A temporal analysis of the incidence rates of these cases in the general population was performed. The study was based on secondary data from the 2000 and 2022 demographic censuses, as well as on the SINAN-Tabwin information system of the Coordination of Occupational Health Surveillance of the Mato Grosso State Health Department (SES/MT).

The study sought to observe the populations with the highest number of cases of the work-related mental disorder. The analysis was developed with secondary data from the SINAN-Tabwin information system of the State Coordination of Occupational Health Surveillance and with IBGE data for the calculation basis of the working population.

The study population comprised the cases of workers in its general scope who were notified with mental disorders, registered in MT from January 1, 2007 to December 31, 2023. The study had to be adapted due to the low number of notifications of the disease in the territory of Mato Grosso. All reported active cases were analyzed, with a causal link at work, with clinical evidence diagnosed by the ICD 10 Mental and behavioral disorders (F00

to F99), Alcoholism (Y90 and Y91), Burnout syndrome (Z73.0), Symptoms and signs related to cognition, perception, emotional state and behavior (R40 to R46), People with potential health risks related to socioeconomic and psychosocial circumstances (Z55 to Z65), according to the notification form.

Inclusion criteria were established that included cases diagnosed or under investigation, as long as they presented clinical evidence for the disease. Cases with notifications with incomplete, erroneous or duplicate data were excluded.

The study variables included sociodemographic, clinical, and epidemiological aspects of active cases of mental disorders in workers. These variables were grouped into three distinct categories.

The first category involved "Patient Identification Data," which comprises information such as the patient's name (or anonymous identification, when applicable), date of birth, gender, full address, race/color, education, and health care facility where the patient received care.

The second category refers to "Disease Information," which includes disease-related data, such as the date of notification, the place of notification (including address, city, and state.

The third category involves occupation, diagnosis, number of cases of the disease and evolution of the disease. These variables were analyzed comprehensively in order to better understand the incidence of cases of mental disorders and the characteristics associated with these events in MBA workers during the study period.

Data were collected at the Occupational Health Surveillance Coordination of the Mato Grosso State Health Department, between January 1 and June 1, 2024, based on the SINAN-Tabwin notification form and IBGE data.

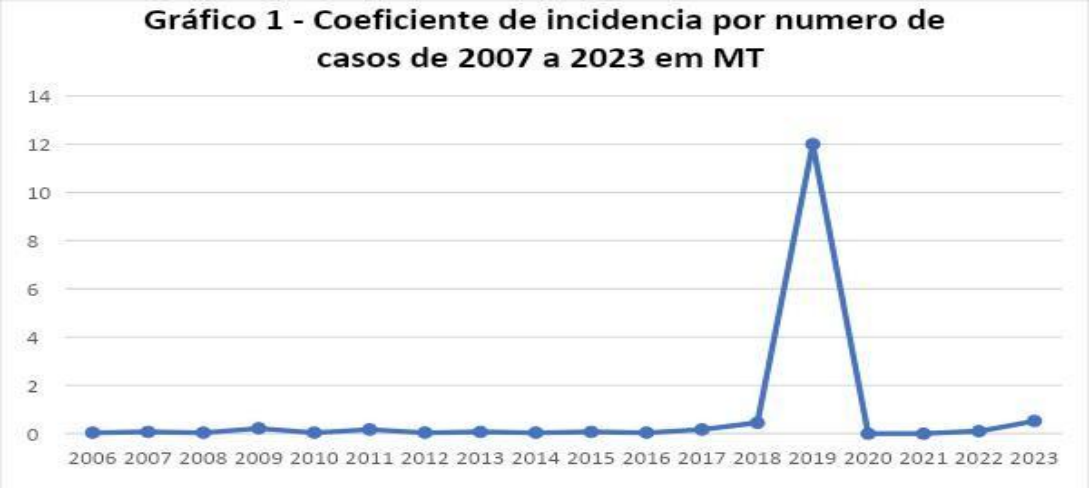
Data analysis was performed based on descriptive statistics, compiled in Excel spreadsheets, including the calculation of incidence rates and the analysis of the various variables.

It was not necessary to submit the project to the Research Ethics Committee, since it was a study that used secondary data, dispensing with the approval of the ethics committee.

RESULTS AND DISCUSSION

The data presented in Graph 1 highlights the number of cases and the incidence rates of the number of cases of mental disorders that occurred in the years 2006 to 2023 in

MT. Where we highlight the highest incidence in 2019, and in the other years there was a low incidence rate of the disease when analyzed.



SOURCE: SINAN/TABWIN, 2023

According to MORREIRA and NUNES (2021), the incidence of cases of mental disorders in Brazil has increased significantly in recent years, reflecting a greater awareness and diagnosis of these health problems.

According to a study by GONÇALVES and KAPCZINSKI (2008), they have shown high prevalence of mental disorders in the population, with estimates of 12.2% to 48.6% throughout life. Unfortunately, most of these patients do not have their diagnosis recognized and therefore are not treated. It is estimated that around 55% of patients with major depression treated at the primary level are not diagnosed, and this percentage is 77% when it comes to generalized anxiety disorder. Among the main reasons for the non-recognition of mental disorders is the greater probability of these patients reporting only somatic symptoms when in consultation, and the difficulty of the medical staff in recognizing these symptoms as indicative of mental disorder.

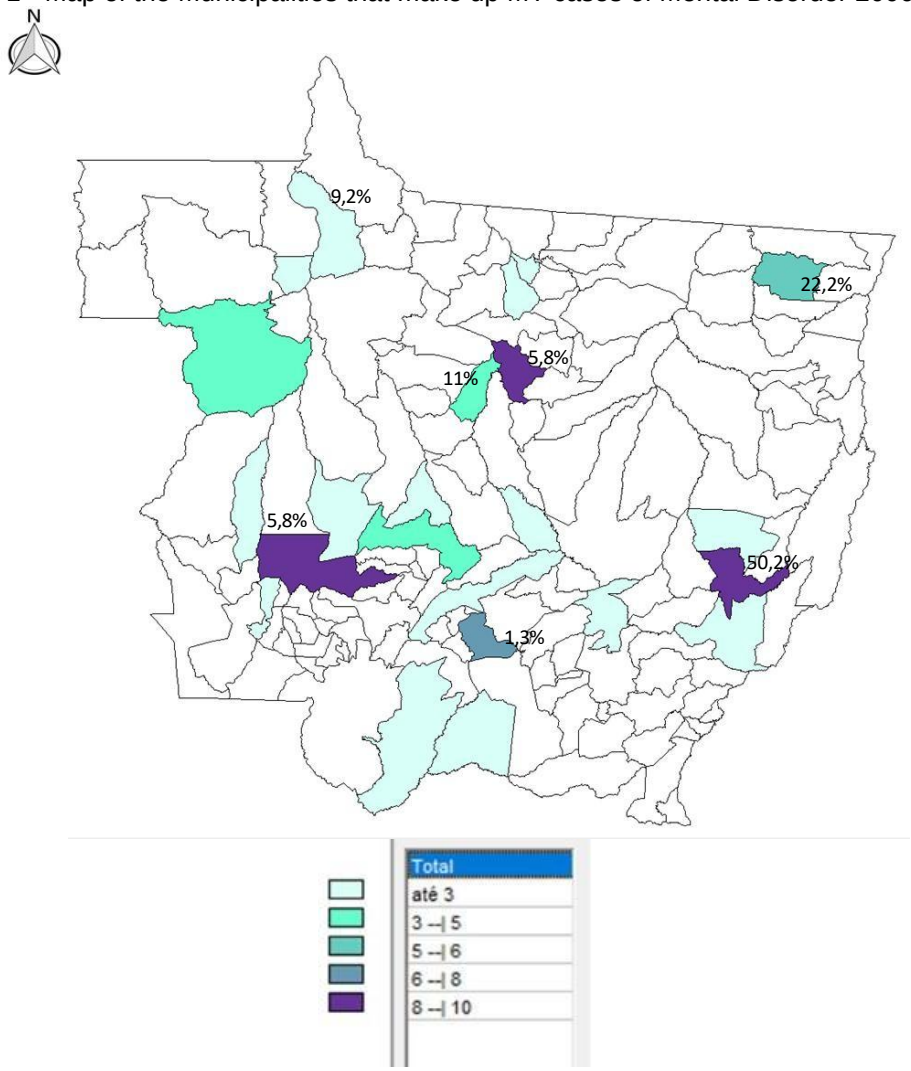
SOURCE: SINAN/TABWIN, 2024

When analyzing the data by age group, there was an increase in 2009 in the age group of 39 to 43 years with 0.069% of cases, 0.47% in the age group of 53 to 57 years, increasing significantly mainly in the years 2018, 2019 and 2023, where we noticed in 2018 the age group of 39 to 43 years with an incidence coefficient of 0.2%, age group from 49 to 53 years with a coefficient of 0.4% and in the age group from 53 to 57 years with a coefficient of 0.49%. In 2019, the incident coefficient increased in the age group from 44 to 48 years of age, with 0.49% of reported cases, and in 2023, the age group most affected by the disease was from 53 to 57 years of age, with 0.52% of reported cases.

The study conducted by Horta, et al. (2021) showed a statistically significant association between the presence of moderate to high stress in the age group equal to or greater than 37 years.

Observed in another study by OLIVEIRA, et al (2020), showed the highest rates of affected by professionals in the age group between 30 and 49 years, explained by the fact that most of the workforce in Brazil is approximately 35 years old.

FIGURE 1 - Map of the Municipalities that make up MT cases of Mental Disorder 2006 to 2023



SOURCE: SINAN/TABWIN, 2024

As shown in the map of the MT region, we noticed that of the 142 municipalities, 07 municipalities had cases of work-related Mental Disorder. When we calculate by PEAO (Economically Active Population) we notice 22.2% of confirmed cases in the municipality of Confresa, Cuiabá with 1.3% of cases, Ipiranga do norte with 67.1%, Juína with 11% of cases, Sinop with 5.8% of cases, Nova Bandeirantes with 9.2%, Tangará da Serra with 5.8% and Nova Xavantina with 50.2% of cases.

According to the Ministry of Health (2009), it was highlighted that among the Brazilian states, Mato Grosso (MT) was one of the few states that, between 2006 and 2009, reported work-related mental disorders in SINAN. The number of cases reported in this period was: two cases in 2006, four cases in 2007, one case in 2008 and seven cases in 2009.

According to a study The incidence of mental disorders in municipalities in Mato Grosso has been a focus of study due to its significant impact on public health. According to a study published in 2022, mental disorders accounted for a considerable portion of

absences from work in the region, being the third leading cause of absenteeism, with 5,042 days of absence recorded. This highlights the urgent need for specific mental health interventions and policies for the Mato Grosso population.

Additionally, in comparison with this study, according to data from COSIANI (2013), it reports that more than 30% of the population of São Paulo is diagnosed with mental disorders, the region with the highest number of hospitalizations was the Southeast. However, the highest incidence is observed in the South, followed by the Midwest and Southeast. This is consistent with previous reports indicating a high prevalence of mental disorders in patients and cities in Rio Grande do Sul, the largest state in the southern region.

When making comparisons with other studies, it is possible to see that there is a lack of research on mental disorders in the state, it was possible to observe that, according to the study by COLEDAM et al. (2022), it reveals a significant disparity in the distribution of scientific research in the Brazilian regions, with a predominance in the Southeast, South, and Northeast regions. The Central-West region, in particular, shows a worrying lack of studies, including for widely investigated professional categories, such as professors and nursing workers. This gap can be attributed to the smaller number of research centers and universities in the region, limiting the production of local research.

Through the above, we found that the inclusion of data from the Midwest region is essential to obtain a comprehensive view of the mental health of Brazilian workers and to develop effective public policies.

Table 1 - Analysis of cases of Mental Disorders by sex

Years	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Female	0.034	0	0.034	0.2	0.034	0.13	0.034	0.069	0	0.069	0.034	0.17	0.31	0.38	0	0	0.1	0.41
Male	0	0.069	0	0.069	0	0.034	0	0	0.034	0	0	0	0.13	0.034	0	0	0	0.1

SOURCE: SINAN/TABWIN, 2024.

When analyzing the cases of Mental Disorders by sex, we can observe that there is a greater number of females compared to males, with the highest number of cases recorded for women in 2023 with 0.41%, followed by 2019 with 0.38% and 2017 with 0.17%. For men, the highest values are in 2018 with 0.13% and then in 2023 with 0.1%.

The research by MARAGNO et al. (2006), based on a survey of 2,337 people, identified significantly greater mental disorders in women and the elderly and those with lower income and education.

According to SOUZA, et al (2020), these data suggest a greater vulnerability of women in relation to mental disorders in the workplace in Mato Grosso. The literature indicates that factors such as double working hours (professional work and domestic responsibilities), gender discrimination, harassment, and less access to mental health resources may contribute to this disparity.

SOURCE: SINAN/TABWIN, 2024

As shown in graph 3, incidence rates vary over time, with some notable peaks in certain years.

The "Not Informed" group peaked in 2009 with a coefficient of 0.069%, with another peak in 2018 of 0.069 and maintaining the level in 2019. In 2023, the coefficient increases again, approaching 0.1%.

The group of "Complete Elementary Education" remains stable over time, with very low coefficients, and with an increase of 0.069% in 2017 and 2018.

The group of "Incomplete Elementary School" maintained a stable and very low line throughout the period, with small variations, with an increase in 2018 and reaching a peak in 2019 with 0.069%.

The group of "Complete High School" remained in a stable line with low values, with small increases in 2022 and 2023 reaching a peak of 0.31%.

The "Incomplete High School" group is similar to the "Complete Elementary School" group, with a stable and low line, with small variations over time, without significant peaks, with an increase of 0.13% only in 2009.

The group of "Complete Higher Education" had a notable peak in 2018, with a coefficient of 0.24% remaining in 2019, with another peak in 2023 reaching 0.1%.

The group of "Incomplete Higher Education" remained at a null level in most years, with an increase of 0.034% only in 2009 and in 2011 with a higher level of 0.069%.

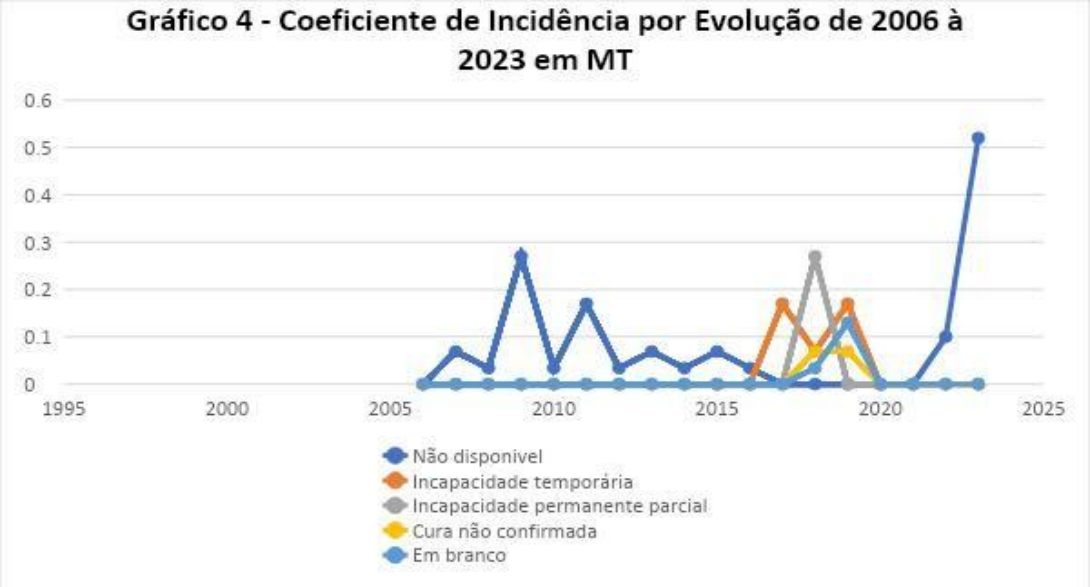
The study by LUDERMIR and MELO FILHO (2002) with 621 adults aged 15 years and older recorded a prevalence of mental disorders in 35% of the sample of 62,363 individuals, living in area II of the city of Olinda. In this study, low schooling and precarious housing conditions were associated with the development of disorders. Subjects with the worst per capita family income had a higher prevalence of mental disorders.

Specifically regarding the low level of education found in our study, it can be argued that this may be one of the determining factors for workers with less opportunity for education to be forced to enter the informal labor market (PATEL; KLEINMAN, 2003). The level of education is one of the variables that can influence better living conditions for individuals, one of them being the insertion in the labor market (LUDERMIR and MELO FILHO, 2002).

Lack of education and/or difficulties in accessing school, work and socioeconomic conditions according to CAMPOS et al, (2017), can be risk factors for mental health problems or even their aggravation, as they influence the individual's autonomy and their ability to reflect and participate in social exchanges.

According to SALVATO et al, (2010), a study on schooling and income inequality identified that the higher the percentage of schooling, the higher the income; It also highlighted, however, the existence of other factors, such as the life of the inhabitants,

ethnic factors, age structure of the population, quality of the existing infrastructure, presence/absence of stimuli to development and historical factors, which directly affect the income variable among individuals.



SOURCE: SINAN/TABWIN, 2024

In view of the analysis of Graph 4, it is evident that the incidence of cases in MT has significant fluctuations over the years, with peaks in 2009 of 0.27%, 2011 with 0.17% and 2023 of 0.52%, especially in the "Not available" category.

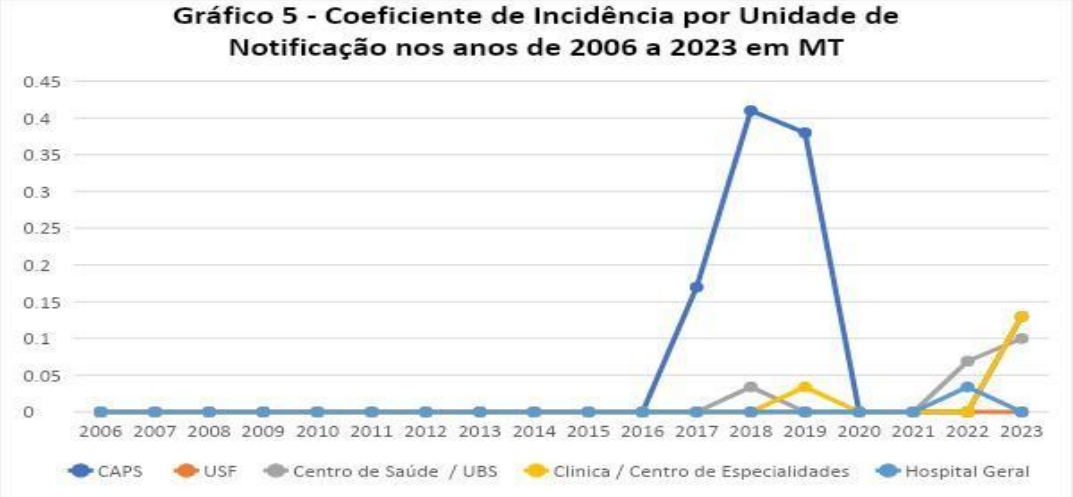
The "Partial Permanent Disability" line had notable peaks in 2018, with a lower presence in other years, as well as the "Blank" line that the incidence was null in all years, except in 2018 of 0.27%.

The "Temporary Disability" line had a peak incidence in 2017 of 0.17%, fell in 2018 with 0.069% and returned to the peak in 2019 again with 0.17%, with zero incidence in the other years.

The "Unconfirmed cure" line had a sporadic presence with peaks in 2018 and 2019 with only 0.069%.

Mortality and disability rates due to mental disorders vary in the population according to the diagnosis. Morbidity due to mental disorders is considered high, in addition to influencing comorbidities such as diabetes, cardiovascular diseases, and others (WHO, 2013).

To illustrate the current scenario, in 2023 288,041 disability benefits due to mental and behavioral disorders were granted in Brazil. The number includes both temporary disability benefits (former sickness benefit) and permanent disability benefits (former disability retirement) (BRASIL, 2009).



SOURCE: SINAN/TABWIN, 2023

According to the analysis, all units had a very low or almost non-existent incidence coefficient. There was a significant increase in cases reported by the CAPS, reaching a peak in 2018 of 0.41%, starting in 2017 with 0.17% and with a drop in 2019 of 0.38%.

The Health Center/UBS had a minimal presence over the years, with a small increase in 2018 with 0.034%, rising in 2022 with 0.069% and reaching a peak in 2023 with 0.1%.

The General Hospital has remained with zero presence over the years, with an increase only in 2022 with 0.034%.

The Clinic/Specialty Center also shows a small incidence over the years, but with small peaks in 2019 with 0.034% and in 2023 with 0.13%.

At the USF, the cases of notification are null.

For SANTOS and FURTADO (2020), the Psychosocial Care Center (CAPS) is the health unit in Brazil that most notifies cases of mental disorders, due to its fundamental role in the care and monitoring of patients with severe and persistent mental disorders.

According to SILVA and SANTOS (2021), Basic Health Units (BHU) in Brazil play a very relevant role in the notification of mental disorders, being fundamental for the early detection, follow-up, and appropriate referral of patients to specialized services.

Table 2 - Analysis of cases of Mental Disorders by area of residence

Years	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Urban	0.034	0,069	0,034	0,27	0,034	0,13	0,034	0,069	0,034	0,069	0	0,17	0,45	0,41	0	0	0,034	0,52
Peri	0	0	0	0	0	0	0	0	0	0	0	0	0,034	0	0	0	0	0
Rural	0	0	0	0	0	0,034	0	0	0	0	0,034	0	0	0	0	0	0,034	0

SOURCE: SINAN/TABWIN, 2024.

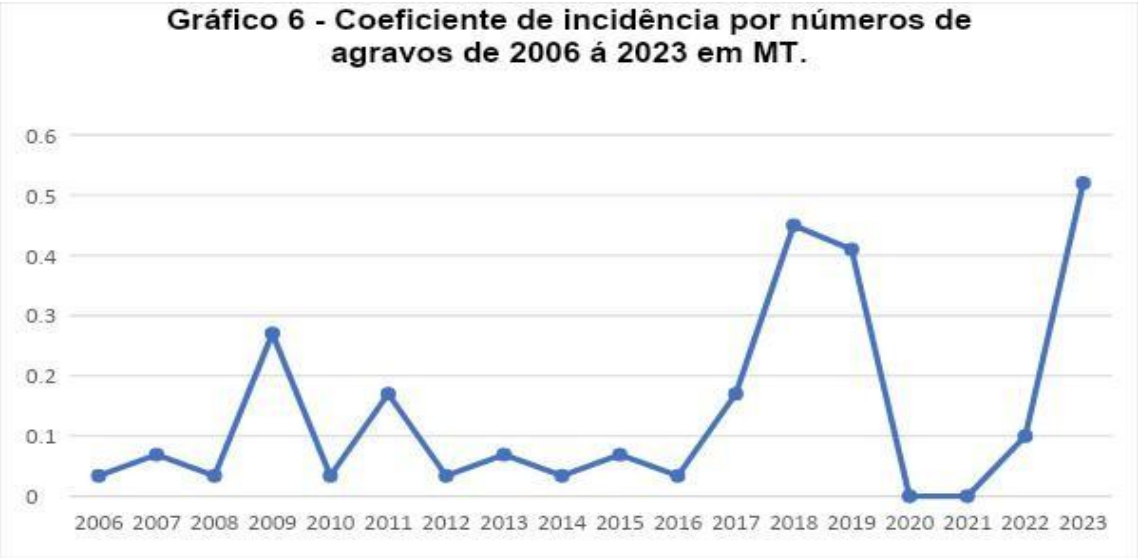
When analyzing the cases of Mental Disorders by area of residence, the "urban area" shows considerable fluctuations over the years, with a considerable increase in 2017

of 0.17%, reaching 0.45% in 2018 and remaining at 0.41% in 2019, and reaching its second notification peak in 2023 with 0.52%.

In the "peri-urban" zone there was notification only in 2018 with 0.034%, being null in other years. In the "rural area" there were only 3 years of notifications, 2011, 2016 and 2022, all with 0.034%.

Studies indicate that both urban and rural areas have high notifications of cases of mental disorders, although with different characteristics and associated risk factors. Urban areas often show a higher prevalence of stress-related mental disorders and the fast pace of life, while rural areas stand out for difficulties in accessing mental health services and social isolation (LIMA, 2018).

Gráfico 6 - Coeficiente de incidência por números de agravos de 2006 á 2023 em MT.



SOURCE: SINAN/TABWIN, 2024.

The data presented in Graph 6 highlights the number of cases and the incidence rates of cases of mental disorders that occurred in the years 2006 to 2023 in MT. Where we highlight the most incidence in the years 2018 and 2019 where we highlight the incidence of 0.45 in 2018 and 0.41 in 2019, rising again in 2023. In the other years, there was a low incidence rate of the disease when analyzed.

There were notifications of diseases in most years, reaching their peaks in 2009 with 0.27%, in 2018 with 0.45% and 2023 with 0.52%, being null only in 2020 and 2021.

The analysis of the results presented reveals some trends and differences between the years studied.

According to the study by CARDOSO, et al (2015), mental health problems are among one of the major causes of frequently disabling diseases identified in their research. These diseases most often cause losses of work capacity, including a drop in professional performance, absences and leaves in the workplace.

According to the study by SILVA (2015), in Brazil, mental disorders represent the third biggest reason why people receive government benefits when they can no longer work. The stress caused by psychosocial conditions at work can greatly affect the mental health of workers. It is the responsibility of the INSS medical experts to assess whether the disease that incapacitates this worker is related to working conditions.

These authors provide a comprehensive view of the importance of health problem notification, highlighting both the challenges faced and the need for improvement in the health surveillance system. As we can see in graph 6, the years 2020 and 2021 were the years in which notifications of diseases were null. These data lead us to reflect on the covid-19 pandemic period in Brazil and its possible negative effects on notifications of mental disorders.

SOURCE: SINAN/TABWIN, 2024.

In the analysis of Graph 7, most of the lines remain close to the horizontal axis over the years, indicating a relatively low and constant incidence for most breeds.

The "White" race/color group had a slight increase in 2009 of 0.1% and another significant peak in 2019 of 0.24%, followed by zero until 2021 and an increase again in 2023 of 0.13%.

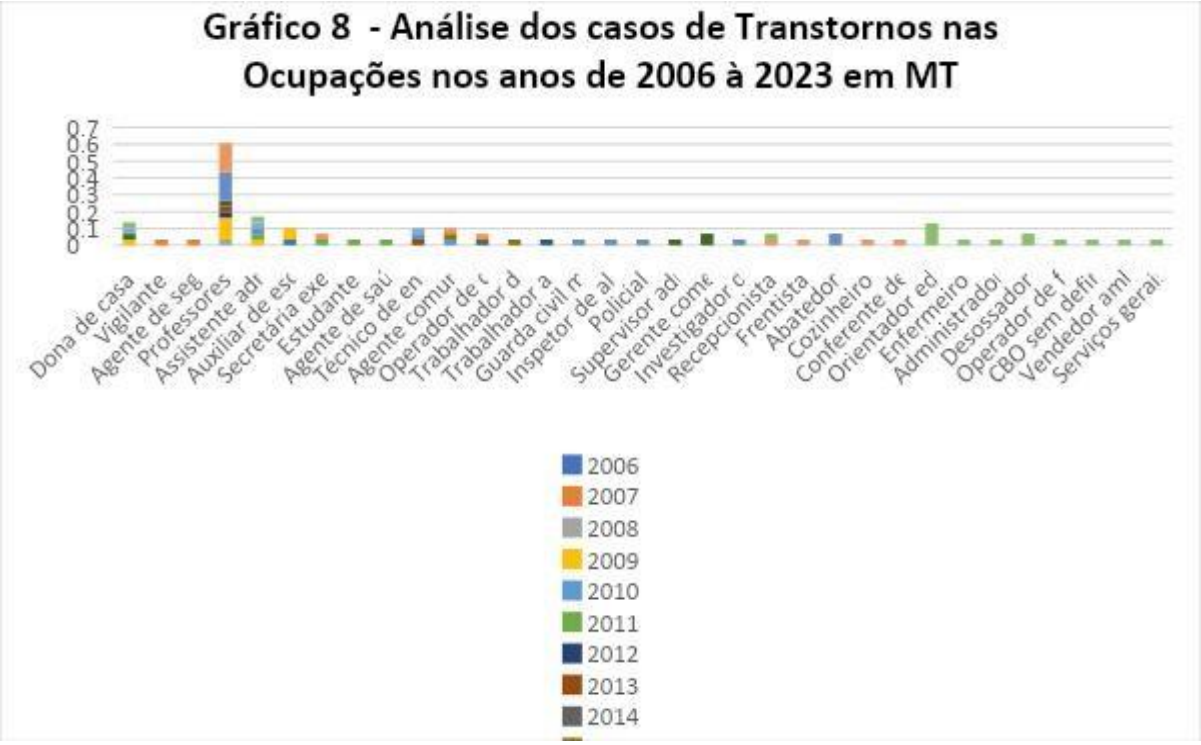
The "brown" race/color group shows an increase of 0.13% in 2009, 0.1% in 2011, and from 2017 to 2019 with the highest peak of 0.31%, in the "black" race/color remains relatively low over the years with small variations and an increase in 2023 of 0.069%.

In the "yellow" race/color, it presents notification in only 2 years in 2011 and 2018 with 0.034% in both with minimum values and without major variations, "indigenous" race/color presents notification in only 3 years in 2007, 2009 and 2023 with 0.034% in all

notifications with minimum values and without major variations, "not informed" race/color remains null until 2022 presenting notification only in 2023 of 0.13%.

When we compared the white and brown race/color in relation to the incidence patterns, we noticed significant differences. The white race generally has a low incidence over time, with some sporadic peaks in certain years. In contrast, the brown race shows a more constant pattern of increase, with periods in which the peaks of incidence are more pronounced. These variations suggest distinct health dynamics among these ethnic-racial groups, possibly influenced by factors such as access to health services, social and behavioral contexts related to health, among other aspects.

The study carried out by SMOLEN (2017) presents results similar to those found in this work, indicating that mental disorders have a higher prevalence among people who do not identify themselves as white. However, race-related results may vary depending on the population studied, especially if there is a higher proportion of respondents who consider themselves to be from such an ethno-racial group. Despite this, comparisons between studies reveal that both white and brown people have high rates of notification of mental disorders compared to other groups. This shows that mental disorders affect not only specific ethnic-racial groups, suggesting that even in supposedly more favored work environments, white and brown people are also affected by these disorders.



SOURCE: SINAN/TABWIN, 2024.

By analyzing Graph 8, we can observe that the most frequent occupations were Housewife, Teacher, Administrative Assistant, Nursing Technician and Community Health Agent, and the rest of the occupations had only 2 or fewer notifications in the years 2006 to 2023.

The occupation of Housewife in the years 2009, 2017, 2022 and 2023 with 0.34% in all the years mentioned, with the rest of the years null, occupation of Teacher with the highest number of notifications, being in 2008, 2009, 2012, 2013, 2017, 2018 and 2019 reaching the maximum peak of 0.17% in 2018 and 2019, in the analysis of the occupation of Administrative Assistant there was notification in 5 years of 2009, 2011, 2018, 2022 and 2023 with a percentage of 0.034% in all notified years.

The occupation of Nursing Technician was notified in 3 years, in 2013, 2018 and 2023, all with 0.034% of notification, being similar to the occupation of Community Health Agent with 3 years notified in 2010, 2015 and 2019 with a percentage of 0.034%. The other occupations had few notifications, with the majority with 0.034%, including nursing technicians and nurses.

Since psychic suffering is so expressive all over the world, work relationships are also faced with mental and behavioral disorders on a daily basis. In a WHO report (2021), work-related mental disorders occupy a rate of 30% of minor mental disorders, and 5 to 10% of severe mental disorders in the employed workforce.

Evidence indicates that work-related mental and behavioral disorders are prevalent worldwide. It is estimated that 10% of adults have such conditions and that 25% of the world's population manifests at least one mental disorder throughout their lives (FARO et al., 2020).

According to CARRERO (2010), issues related to the work relationship and mental health/illness have aroused, in recent years, great interest from researchers and scholars, which has resulted in the construction of several theoretical-methodological approaches on the subject. Work-related mental disorders and behavior are determined not only by work aspects, such as unhealthy environments, exposure to harmful agents, presence of noise, but it is also essential to associate the social context, where the individual is inserted, as well as to know the life history of each subject.

The occupation of teacher had a constant presence in the notifications over the years mentioned. The increase in notifications, especially in the years 2018 and 2019, suggests a higher incidence of factors that impact the health and well-being of teachers during these years.

According to TOSTES et al. (2018), it is necessary to expand the investigation to better understand the causes of teachers' mental suffering. He highlights the importance of offering subsidies that enable significant changes and improve the mental health of teachers, acting in the processes that determine illness instead of resorting only to medicalization.

This scenario highlights the importance of taking care of working conditions in various occupations, seeking ways to alleviate the challenges and risks they face daily in their work environment.

CONCLUSION

Through our research based on data from the Notifiable Diseases Information System (SINAN), we analyzed cases of mental disorders among professionals from different areas in the period from 2006 to 2023.

The data revealed a surprisingly low number of notifications of mental disorders over these years. This underreporting is especially pronounced among nursing professionals, who represent a significant part of the health workforce. The low rate of reporting can be attributed to several factors, including the stigma associated with mental disorders, a lack of awareness of the importance of reporting, and potential failures in registration and communication systems.

The data showed peaks in the incidence of mental disorders in 2018 and 2019, respectively, and a new increase in 2023. The analysis also revealed the presence of sparse notifications in other years, with no notifications in 2020 and 2021, possibly due to the COVID-19 pandemic.

The Psychosocial Care Center (CAPS) emerged as the main responsible for the notification of cases of mental disorders, evidencing its fundamental role in the mental health care of the population.

In sum, our research highlights the urgent need to address the underreporting of mental disorders among professionals, and the importance of an integrated and compassionate approach to mental health. Only through a joint effort between managers, health professionals and regulatory bodies will it be possible to address this issue effectively and provide better working and living conditions for these professionals. Strengthening mental health services, early detection, continuous follow-up and support for the most affected occupations are essential steps to improve the well-being of our population.

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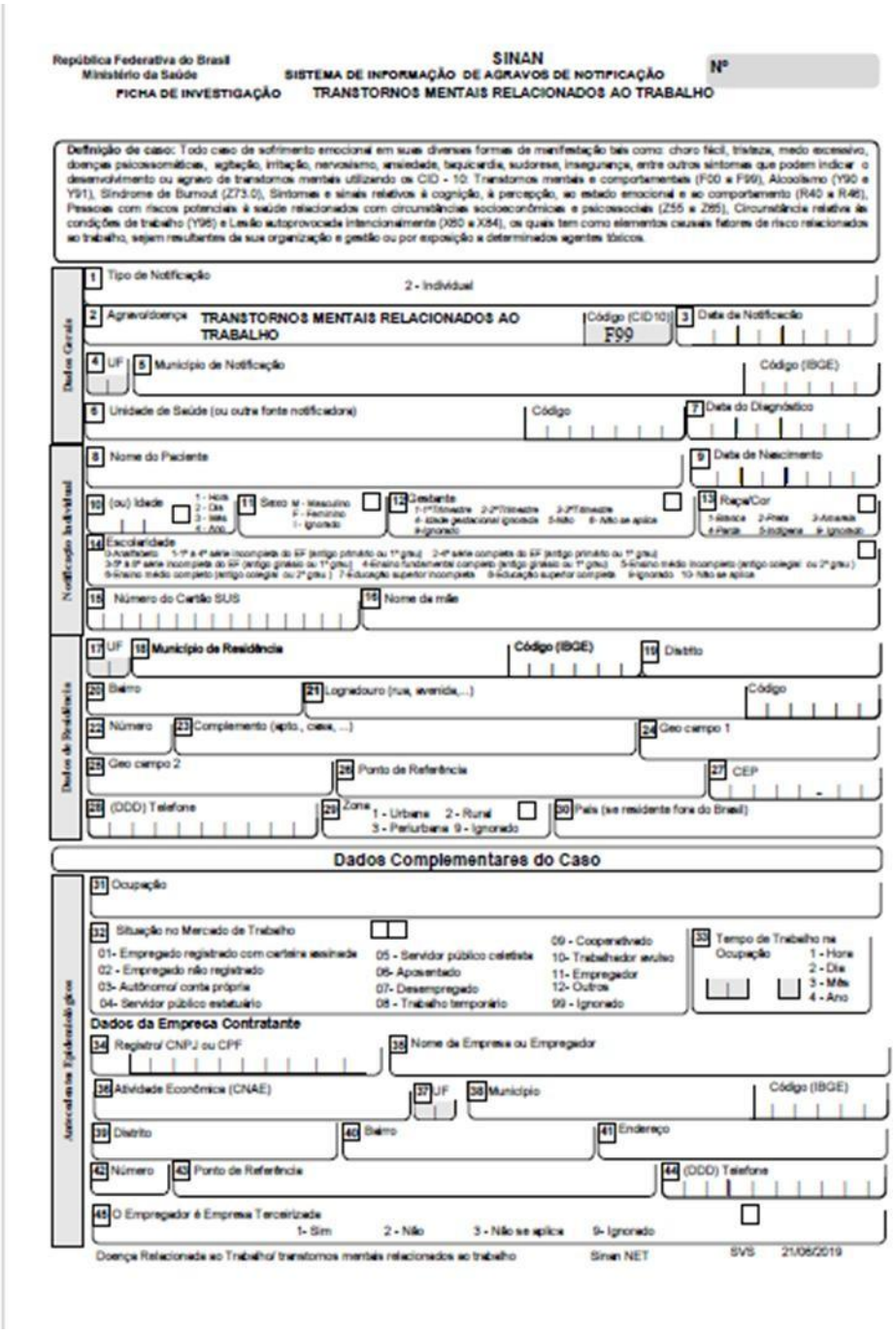
ATTACHMENTS



República Federativa do Brasil
Ministério da Saúde
FICHA DE INVESTIGAÇÃO

SINAN
SISTEMA DE INFORMAÇÃO DE AGRAVOS DE NOTIFICAÇÃO
TRANSTORNOS MENTAIS RELACIONADOS AO TRABALHO

Nº

Definição de caso: Todo caso de sofrimento emocional em suas diversas formas de manifestação tais como: choro fácil, tristeza, medo excessivo, doenças psicossomáticas, agitação, irritação, nervosismo, ansiedade, taquicardia, sudorese, insegurança, entre outros sintomas que podem indicar o desenvolvimento ou agravo de transtornos mentais utilizando os CID - 10: Transtornos mentais e comportamentais (F00 a F99), Alcoolismo (Y90 e Y91), Síndrome de Burnout (Z73.0), Sintomas e sinais relativos à cognição, à percepção, ao estado emocional e ao comportamento (R40 a R46), Pessoas com riscos potenciais à saúde relacionados com circunstâncias socioeconômicas e psicossociais (Z55 a Z65), Circunstância relativa às condições de trabalho (Y96) e Lesão autoprovocada intencionalmente (X60 a X84), os quais tem como elementos causais fatores de risco relacionados ao trabalho, sejam resultantes de sua organização e gestão ou por exposição a determinados agentes tóxicos.

Dados Gerais

1 Tipo de Notificação — 2 - Individual

2 Agravo/doença — TRANSTORNOS MENTAIS RELACIONADOS AO TRABALHO — Código (CID10) F99 — 3 Data da Notificação

4 UF — 5 Município de Notificação — Código (IBGE)

6 Unidade de Saúde (ou outra fonte notificadora) — Código — 7 Data do Diagnóstico

Notificação Individual

8 Nome do Paciente — 9 Data de Nascimento

10 (ou) Idade — 1 - Hora, 2 - Dia, 3 - Mês, 4 - Ano — 11 Sexo M - Masculino, F - Feminino, I - Ignorado — 12 Gestante — 1-1º Trimestre 2-2º Trimestre 3-3º Trimestre 4-Idade gestacional ignorada 5-Não 6-Não se aplica 9-Ignorado — 13 Raça/Cor — 1-Branca 2-Preta 3-Amarela 4-Parda 5-Indígena 9-Ignorado

14 Escolaridade — 0-Analfabeto 1-1ª a 4ª série incompleta do EF (antigo primário ou 1º grau) 2-4ª série completa do EF (antigo primário ou 1º grau) 3-5ª a 8ª série incompleta do EF (antigo ginásio ou 1º grau) 4-Ensino fundamental completo (antigo ginásio ou 1º grau) 5-Ensino médio incompleto (antigo colegial ou 2º grau) 6-Ensino médio completo (antigo colegial ou 2º grau) 7-Educação superior incompleta 8-Educação superior completa 9-Ignorado 10-Não se aplica

15 Número do Cartão SUS — 16 Nome da mãe

Dados de Residência

17 UF — 18 Município de Residência — Código (IBGE) — 19 Distrito

20 Bairro — 21 Logradouro (rua, avenida,...) — Código

22 Número — 23 Complemento (apto., casa, ...) — 24 Geo campo 1

25 Geo campo 2 — 26 Ponto de Referência — 27 CEP

28 (DDD) Telefone — 29 Zona 1 - Urbana 2 - Rural 3 - Periurbana 9 - Ignorado — 30 País (se residente fora do Brasil)

Dados Complementares do Caso

Informações Trabalhista

31 Ocupação

32 Situação no Mercado de Trabalho
01- Empregado registrado com carteira assinada
02 - Empregado não registrado
03- Autônomo/ conta própria
04- Servidor público estatutário
05 - Servidor público celetista
06- Aposentado
07- Desempregado
08 - Trabalho temporário
09 - Cooperativado
10- Trabalhador avulso
11- Empregador
12- Outros
99 - Ignorado

33 Tempo de Trabalho na Ocupação — 1 - Hora, 2 - Dia, 3 - Mês, 4 - Ano

Dados da Empresa Contratante

34 Registro/ CNPJ ou CPF — 35 Nome da Empresa ou Empregador

36 Atividade Econômica (CNAE) — 37 UF — 38 Município — Código (IBGE)

39 Distrito — 40 Bairro — 41 Endereço

42 Número — 43 Ponto de Referência — 44 (DDD) Telefone

45 O Empregador é Empresa Terceirizada — 1- Sim 2 - Não 3 - Não se aplica 9- Ignorado

Doença Relacionada ao Trabalho/ transtornos mentais relacionados ao trabalho — Sinan NET — SVS — 21/06/2019

OFF-SITE CONSTRUCTION IN HOSPITAL ARCHITECTURE: A CASE STUDY ON THE QUALITY OF MODULAR VOLUMETRIC CONSTRUCTION

https://doi.org/10.56238/sevened2024.039-021

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ABSTRACT

This article is part of the author's master's thesis and emphasizes the techniques of Modular Volumetric Construction applied in hospitals, through a case study. The relevance of the technique applied to hospitals occurred with the advent of the pandemic, in 2020, this quick assembly technique, already widespread and consolidated in the residential and service market (hotels and offices), has its attention and application focused on the hospital area in response to the immediate demand for inpatient beds. The general objective of this work is to understand the quality of the processes of the off-site modular construction system, applied in adult hospitalization units. Also as specific objectives, we can address: characterization of environments from the points of view of function, flexibility, adaptability, growth and performance; understand the current market scenario of this system in the hospital area in the country; and analyze the benefits and challenges of this technique. As methodological procedures, bibliographic research, case study recognized today, technical visit, data collection and analysis were adopted. The case study refers to an annex block for hospitalization in a hospital already built, in the city of São Paulo. The expected results of this research are: presentation and approach of the volumetric modular construction technique; understanding of some concepts of hospital architecture in adult inpatient wards;

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and in-depth analysis of the case study for knowledge and presentation of the technique, concepts and design.

Keywords: Modular volumetric construction. Hospital architecture. Inpatient unit. Metal structure. Off-site construction.

INTRODUCTION

The health area is dynamic and complex. In Brazil, the relationship between supply and demand for hospital beds is disproportionate to the safety standards recommended by the WHO (World Health Organization) and the Ministry of Health. A hospital bed is understood to be a bed intended for the hospitalization of a patient in the hospital. In this account, observation or auxiliary beds (for diagnosis, recovery or supervision purposes) are not considered. [1]

The WHO recommends 3.0 to 5.0 hospital beds per 1,000 inhabitants. The Ministry of Health, through Ordinance MS No. 1,011/2002, recommends 2.5 hospital beds per 1,000 inhabitants.

A survey carried out by the Brigh Cities platform in 2020 shows that about 10% of Brazilian cities meet the WHO recommendation.[2] However, observing the example of the study on Fortaleza, which is listed among these 10% of Brazilian cities that meet the WHO recommendation, in reality it has beds referred to other cities that still do not serve the entire population of the metropolitan region, which involves 19 municipalities.

Another aspect that can be addressed in relation to the types of emergency constructions is their relationship with the project. Some industrialized construction systems have a standard design technique that can dispense with the development of a project, as it has already been defined as a standard and can be applied in most contexts of implementation.

> In the face of the new coronavirus pandemic, the need arose to build field hospitals in record time to serve the most affected population and, among the alternatives, modular construction proved to be an effective solution, bringing to light the importance of modular projects and agile management. (Guimarães; Santos, 2022 – p. 04)

In the cut of the modular volumetric system, companies have to consider the relationships between cost-benefit, flexibility, durability, large-scale deployment, customization and functionalities. It is also a system that allows permanent construction and makes it possible to transport it to another location or its disassembly. Once the pandemic and the emergency nature are over, it is possible to systematically approach the modular system for more satisfactory results, considering other problem parameters: resources, quantity, costs, quality, and time (Rosso, 1980).

> ... The greatest obstacles in the way of the industrialization of construction are not of a technical nature, in the elaboration of projects, manufacture and assembly of architectural organisms, but of an economic, administrative and political nature. (Bruna; 2013, p. 144).

Modular volumetric construction has a history dating back to the 19th century, but it has established itself as a modern and efficient technique in the 21st century. This technique continues to gain popularity around the world. In Brazil, as a soft construction system, it spreads slowly, in view of the predominance in the market of other constructive solutions.

OBJECTIVES

The main objective of this work is to understand the quality of the processes of the modular *off-site* construction system applied in an adult hospitalization. Such processes of design, execution and management.

Figure 1 – Volumetric module factory

Source: Brasil ao Cubo[3]

The specific objectives are:

- ✓ Characterize the environments of an adult hospitalization unit, built with the modular volumetric system, analyzing function, flexibility, adaptability, growth and performance;
- ✓ To analyze what are the positive and negative specificities of the use of this constructive technique in hospital admission environments;
- ✓ To understand the current scenario of the volumetric construction market focused on the hospital area in the country.

Hospital environments have several characteristics and specific needs, which need to be met. Each environment has its own functions, operations and services are constantly growing and changing; the hospital building needs to be well inserted in the local and urban context; spaces need to be flexible for contingency cases and change of use; and finally,

[3] Available at <https://brasilaocubo.com/portfolio/hospital-vila-santa-catarina-21>. Accessed on: 01 Sep. 2024

comfort and safety performances need to be met. The tensioned and pneumatic construction systems meet the deadline requirements, but are very limiting to the requirements described in this paragraph, without having the character of permanent constructions.

> In order to enable predictive maintenance and safety, the hospital must be assured of various forms of flexibility and accessibility, such as: inter-floor spaces, technical floors, technical walls, structure with outdated modulation of architectural modulation, duct passages, horizontal and vertical technical spaces, as well as slabs and beams subject to present and future drilling, others. (KARMAN; 2011, p. 41).

METHODOLOGICAL PROCEDURES

The bibliographic research for this article considered works and publications mainly referring to the subject of off-site modular construction. Topics on industrialized construction, hospital architecture, prefabricated construction, among others emphatic to the theme, were also researched.

The work is also based on a very representative case study in the context of the community, as highlighted by Robert Yin (1999) about the importance of defining the case study from the point of view of three contexts: hospital, community and systemic. Yin (2009) defines that the research process of a case study is linear, from Planning to Sharing of results, however, in the middle of this linear process, the stages interact with each other in an order that is not necessarily linear, with the objective of constant review aiming at the quality of the results.

The case study was built in the midst of the first wave of the pandemic, on an emergency basis, increasing the installed capacity of Hospital 1 by another 100 inpatient beds. The data collection was based on a technical visit with the annex built and occupied, in addition to published bibliographic research and material provided for research by Hospital 1. Currently, the annex operates as adult surgical hospitalization beds. The construction was financed by a group of partner companies that donated the building to the Health Department of the Municipality of São Paulo. The construction was carried out by Brasil ao Cubo company.

Figure 2 – Case study 1 – Hospital Annex 1 (2020)

Source: Tecverde, 2020 – p.1.[4]

As a method, project analysis will be developed through redesigns and analyses using the concept of decomposition, of the main and secondary structures, the fences and the infrastructure necessary to implement a work in terms of adapting to the new technologies necessary in a state-of-the-art hospital.

The article was developed through the methods of historical, comparative and monographic procedures. Also as methodological procedure, a hypothetical-deductive approach method is used, in view of the available knowledge on a subject in recent development: the off-site modular construction applied in hospitals.

VOLUMETRIC MODULAR CONSTRUCTION

We will approach the topic of Volumetric Modular Construction in different but connected views. We will talk about: historical view, concepts, uses and a deepening of the Volumetric Modular Construction technique.

Housing is man's first need in terms of environmental comfort, leading him to carry out a construction to protect himself. Therefore, it is not surprising that the first examples of prefabricated construction were residences. Volumetric modular construction originated in the construction of residential buildings, but today it opens up a range of applications and uses, such as in hotels and hospitals (Smith, 2010). Today's modular constructions not only fulfill their basic functions, but can also be customized to meet the comfort needs of residents.

To understand the process of the emergence of volumetric modular construction, it is important to consider that this history is part of the evolution of prefabricated construction.

[4] Available at <https://www.tecverde.com.br/2020/04/27/entrega-hospital-mboi-mirim/>. Accessed on: 01 Sep. 2024

Therefore, we will distinguish in this work the emergence of prefabricated construction from the emergence of volumetric modular construction, as a branch of the previous one.

The process of industrialization in civil construction, with reference to the long history of construction itself as a human need, is something very recent. It is challenging to define a point of convergence between the research bases to demarcate a place or historical period of the emergence of prefabricated construction. Prefabricated houses in England were sent to the USA in 1624, for the construction of the fishing village of Cape Anne (Arieff in Oliveira e Vale, 2018).

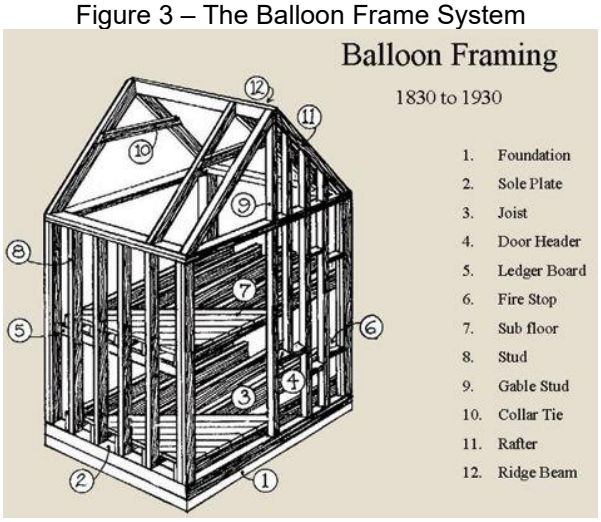
In the research developed for this work, it is worth highlighting two records of prefabricated hospitals built in wood. One of them is in the West Indies, in 1801. John Rollo (1750-1809), a Scottish military surgeon, pioneer in the treatment of diabetes, makes this record in his notebook entitled "A short account of the Royal Artillery Hospital at Woolwich", specifically on page 32 (Rollo, 1801). This record is interesting for this research that involves modular construction applied to hospital architecture.

> "There are also temporary hospitals and they are preferable to the hut and the tent. They are, however, suitable only for expeditions of an island nature, as they would require a land support, with a proportion of carts and horses that would be impracticable. Such a hospital was built by the West India Company and being approved, many were produced and shipped to the islands. During the tests, they were heavily criticized. The heat penetrated the sides and the roof, especially this one, which, being made of copper, diffused an intense heat, in fact so intense that they became uninhabitable, until the installation of another roof raised to twelve inches, with tiles". (Rollo, 1801 – p. 35).

In 1801, Rollo documented the thermal comfort problem of the modular hospitals he visited in the West Indies. Even today, this remains a challenge in volumetric modular construction. A recent English study, by Fifield, Lomas, Giridharan and Allinson, addresses summer overheating in hospital inpatient wards built using the volumetric modular technique. In this study, carried out in a hospital in England, there are conclusions about energy inefficiency and lack of natural ventilation.

The other record of prefabricated wooden hospitals was around 1790, built in England to be sent to Australia. There, hospitals, warehouses and houses were built. The construction system became known as Balloon Frame (Herbert in Oliveira and Vale, 2018).

Figure 3 – The Balloon Frame System



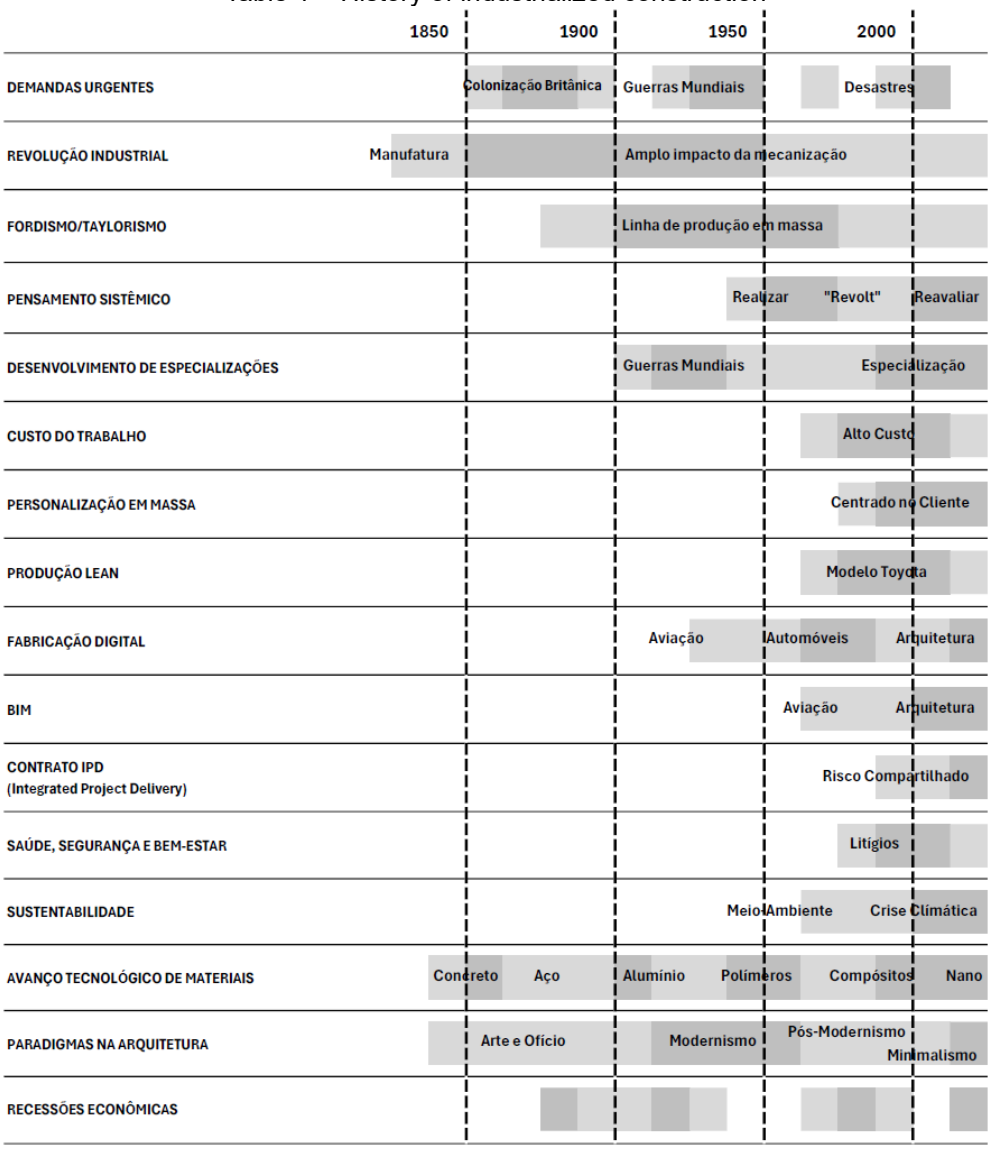
Source: Small Step Energy Solutions LLC, 2012 – p.1. [5]

The Balloon Frame construction system consisted of wooden structures with uprights at the total height of the building, usually up to two floors. The beams, also in whole uprights, were part of the slab structure.

The industrial revolution was very favorable for prefabrication, enabling the development of new connection systems, development of materials, technological processes and logistics for transporting prefabricated elements. In this period we have some events and demands that influenced the development of construction: industrial revolution, quality control, systems thinking, world wars, British colonization and the beginning of modernism in architecture. In the following table (adapted from Smith, 2010), this evolution is summarized in events, periods and concepts.

[5] Available at <https://smallstepenergy.wordpress.com/tag/balloon-framing/>. Accessed on: 23 Nov. 2024

Table 1 – History of industrialized construction



Source: Beltramini, from (Smith, 2010 – p. 4)

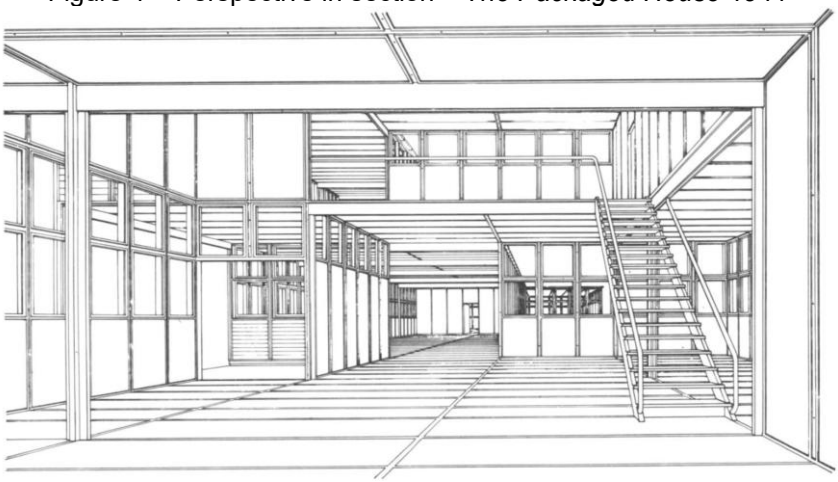
In this work, we will delimit a historical milestone of great value and importance for architecture, considering the historical components presented in the previous table. And we will develop the analysis and research from the Packaged House by Walter Gropius and Konrad Wachsmann, a proposal for a prefabricated house from 1941, with very close concepts to what we know today as volumetric modular construction.

Walter Gropius (1883-1969) was a German architect, founder of the Bauhaus, a school that marked the world history of art, design and architecture. Konrad Wachsmann (1901-1980) was also a German architect. In the United States they had great recognition, where they migrated due to Nazism during World War II.

Gropius and Wachsmann have developed a universal modular building system for houses with components, panels, structures and connections. Giving rise to three-

dimensional elements in prefabricated construction, which we know today as Three-Dimensional Modular Construction.

Figure 4 – Perspective in section – *The Packaged House* 1941



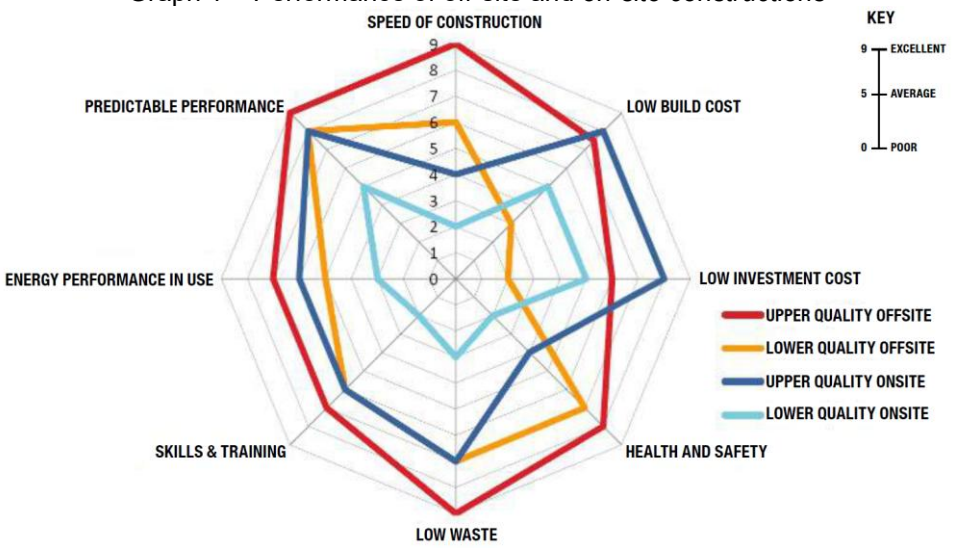
Source: Herbert, 1984 – p. 251

Gropius, still at the Bauhaus, argued that the architect should design the construction industry and not be shaped by it. There was a sincere desire in the architect and a great interest in industrialized construction (Rupnik *in* Valério, 2017). When Wachsmann arrived in the United States as a refugee and with few belongings, in September 1941, he met Gropius and presented him with some drawings on a steel construction system and some studies on modular construction (Herbert, 1984). A working and research partnership was born that evolved into Packaged House. Today a reference in the studies and history of prefabrication and volumetric modular construction.

> [...] it seems evident that the solution envisaged by W. Gropius of a "large-scale builder's game", composed of standardized pieces of industrial production, would not limit the variety of specific compositions and the resulting spaces, but rather, depending on the creative talent of the architect, would allow the creation of new rhythms and express the individual or national character of architecture. (Bruna, 2002 – p. 25 and 26).

For entrepreneurs and builders, there are a number of justifications for choosing the off-site modular volumetric construction system, including: deadline, cost, safety, waste reduction, quality control, and control of the construction schedule. All these justifications are related to the sustainability of the work, so it can be said that off-site construction is more sustainable than conventional on-site construction.

Graph 1 – Performance of off-site and *on-site constructions*



Source: Hairstans, 2014 – p. 15

> Off-site construction refers to the part of the construction process carried out off-site, in a facility suitable for production. This methodology's main characteristics are the high speed and reduction of on-site activities, avoiding the management of a large number of people on site, obtaining more assertive planning. (RCDI+S, 2023 – p. 21).

We show in Graph 1, by Hairstans (2014), a quality comparison between the two types of construction processes. To delve deeper into the topic of sustainability, Krug and Miles (2013) conduct research with eight case studies (three off-site and five conventional on-site) with the following conclusions:

Table 2 – Benefits of off-site construction for sustainability

ATTRIBUTE	POTENTIAL IMPROVEMENT	SOCIAL BENEFIT	FINANCIAL BENEFIT
Social development			
Health and Safety	>80%	High	Not applicable
Working Conditions	Considerable	Considerable	Not applicable
Environmental Development			
Transport Reduction	>60%	Considerable	Small
Energy Reduction (Construction)	>80%	Small	Small
Waste Reduction	>90%	Considerable	Considerable
Energy Reduction (Operation)	>25%	Considerable	Small
Economic Development			
Fast construction	>60%	Considerable	High
Improved cash flow	Considerable	Small	High
Reduction of failures	>80%	Small	Considerable

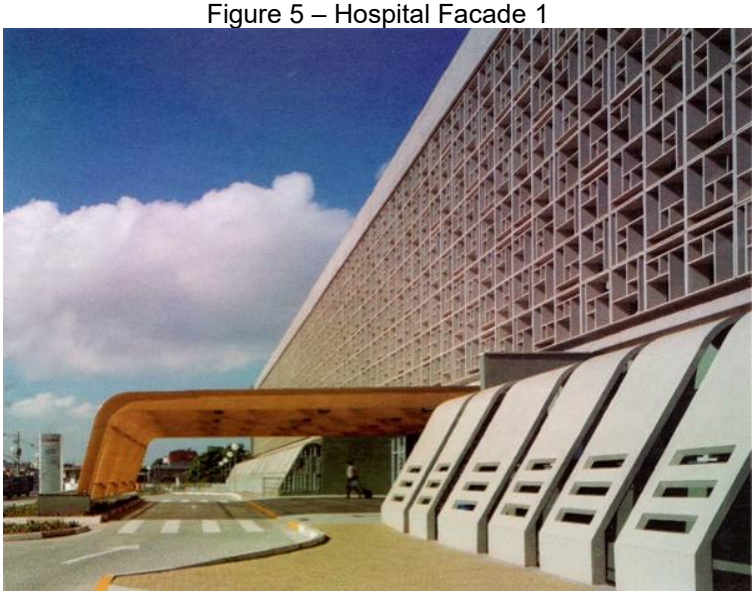
Source: Prepared by Beltramini from (Krug and Miles, 2013 – p. 4)

CASE STUDY

Hospital 1 is located in the South Zone of the city of São Paulo, was inaugurated in 2008 and is a municipal hospital with indirect private administration since its inauguration. Originally, The hospital was originally designed with 200 hospitalization beds and 40 ICU

beds. It has emergency services, ambulatory, hospitalization, birth center, obstetric center and surgical center. It had, before its expansion, approximately 27 thousand square meters.

Figure 5 – Hospital Facade 1



Source: Healtharq, 2013

It is a very important health care establishment in the region, which lacks health services. The hospital is referenced for a population of about 700 thousand inhabitants, corresponding to the neighborhoods of Jardim Ângela, Jardim São Luis and Capão Redondo. Before its inauguration, this population was assisted by another equivalent EAS (Itapecerica da Serra General Hospital), inaugurated in 1999, about 10 kilometers away from Hospital 1.

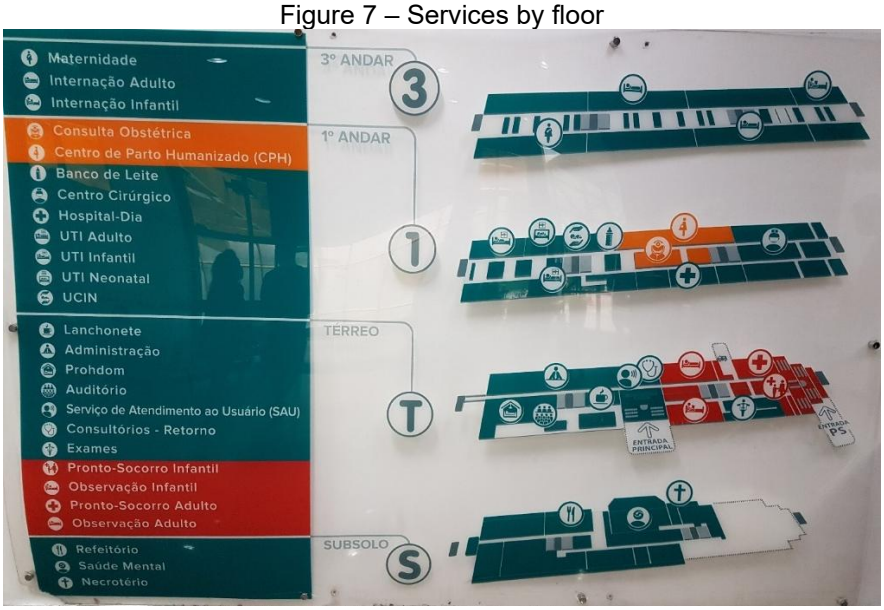
Designed in partnership by Borelli & Merigo (architects José Borelli Neto and Hercules Merigo) and Makhohl Arquitetura (architect Walter Makhohl), Hospital 1 was built and inaugurated in 2008. It is a medium-sized general hospital and has four floors that house the care services: psychiatric hospitalization (basement); emergency room, outpatient center and diagnostic center (ground floor); surgical center, obstetric center, birth center and intensive care units (1st floor); inpatient wards (3rd floor). The second floor is a technical floor dedicated to the positioning of machines and equipment that serve the critical areas located on the lower floor. Its total built area is approximately 27,000 m².

Figure 6 – Implementation of the Hospital 1

Source: Healtharq, 2013

The hospital has a horizontal and pavilion characteristic, with two elevator towers and four stairs towers. The sectors were very well implemented in the building both from a horizontal and vertical point of view. The result observed on site is the high availability of elevators that are required for short trips. Ten large internal garden atriums were also positioned that allow natural light and ventilation to enter from the third to the first floor.

Figure 7 – Services by floor



Source: Beltramini, panel photographed at the site on 12/09/2020

CONTEXTUALIZATION

In March 2020, the Covid-19 pandemic began. With the imminence of an increase in cases and the need for a quick and immediate response from agents of society, the

assembly of the field hospital attached to Hospital 1 was quickly organized, initially designed with 100 inpatient beds, divided into 16 wards.

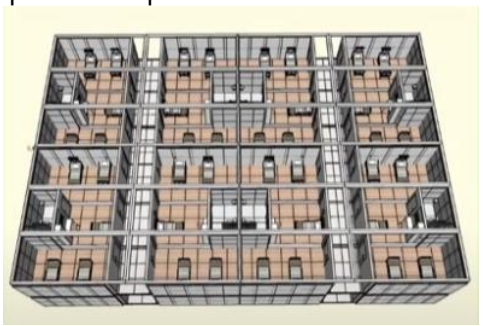
However, the path to the project to be executed in 34 days would start with a very different idea. Brasil ao Cubo, the construction company that designed and executed the Hospital 1 annex, originally conceived the idea of modules for residential hospital beds, which could be installed or attached close to people's homes, as presented in the video 100 beds in 33 days (Brasil ao Cubo, 2022a). That kind of module wasn't executed and replaced very quickly by a new idea: building modular hospitals.

Figure 8 – Original design for a residential hospital bed

Source: Brasil ao Cubo, 2022b

The new idea presented modules of hospitalization rooms clustered and organized in such a way that a characterization of a hospital hospitalization unit was initiated. The modules were arranged in two corridors. Figure 29 illustrates this arrangement in 22 connected modules for the formation of 08 inpatient wards, with 05 beds in each ward and totaling 40 beds. This was the initial conception for the project of the Annex of Hospital 1.

Figure 9 – First conception of hospitalization in modules for the implementation unit



Source: Brasil ao Cubo, 2022b

PROJECT

One of the challenges for the implementation of the annex was its connection with the existing hospital, considering that at the time the hospital had been referenced for the care of patients with Covid-19. However, other services such as the obstetric center and the birth center were maintained. It was essential to adapt the access of these patients and their internal referral within the hospital.

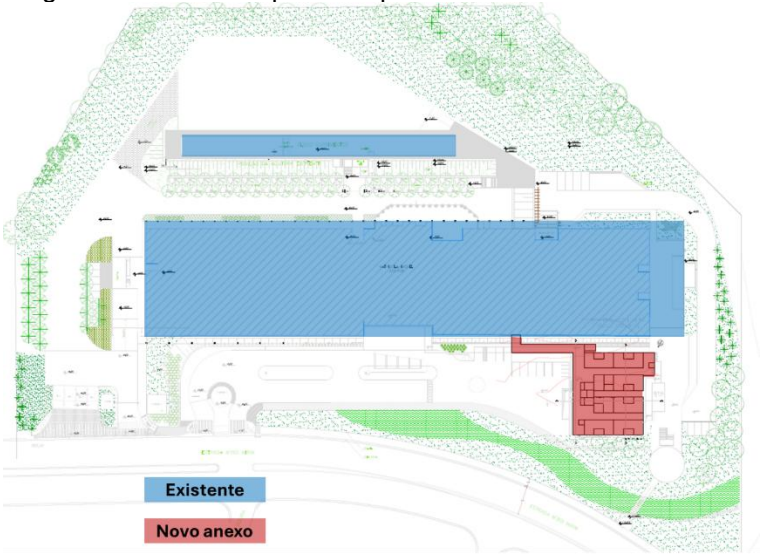
Figure 10 – Annex implementation patio

Source: Ateliê Urbano[6]

The annex was implemented in a parking area, close to the access to the Emergency Room. The layout of the building would need to facilitate the connection with the main block of the hospital, since all support services and other care services are positioned in the existing building. Services such as: clothing processing, kitchen, operating room, diagnostic center, laboratory, maintenance and intensive care unit.

This connection with the main block was solved with two walkways that connect the existing building and the annex, with a smaller walkway on the ground floor level and a larger walkway, with visual prominence, on the first floor level. In the following figure, the location of the annex is highlighted in red and the existing building in blue.

Figure 11 – Situation plan – implementation of the new annex



Source: Hospital 1, adapted by Beltramini

The new annex building has a built area of 1,640m² divided into two floors (ground floor and upper floor) and two walkways that connect with the hospital. In all, it consists of 70 volumetric modules produced in the State of Santa Catarina in three different factories of

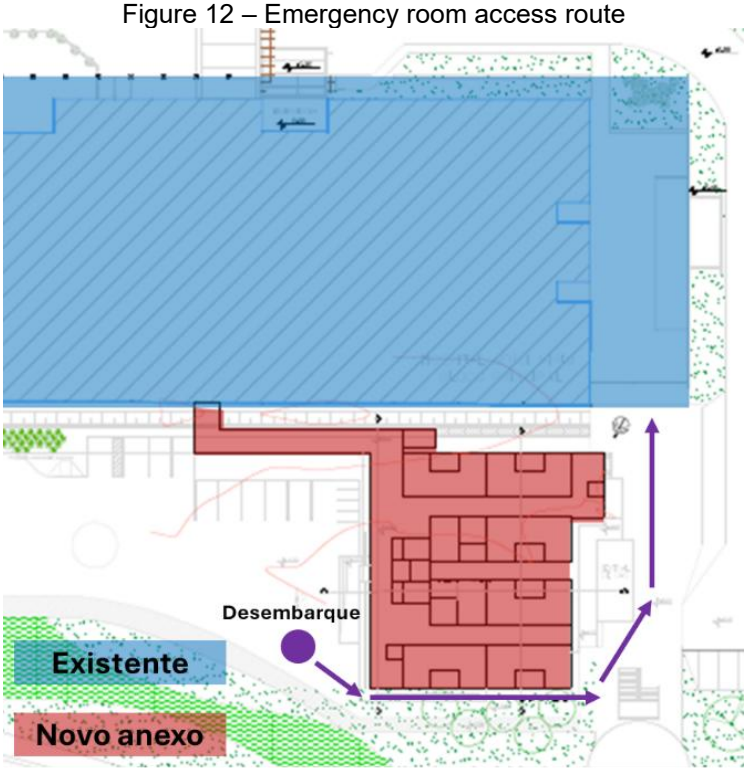
Gerdau and Tecverde. These ready volumes were transported by vehicles that traveled about 400 kilometers and each vehicle with the capacity to hold up to two modules, so at least 35 transport vehicles (trucks) were needed for the logistics of this off-site construction.

It is interesting to point out that the original project has significant differences from the executed project. This can be classified into two types of adjustments: one to meet demand without meeting a technical standard and another because of financial-operational feasibility.

Each floor consists of two inpatient wards with a shared support area. In each wing there are four rooms, originally, three wards of 04 beds and a room of 01 isolation bed. Therefore, in total, according to the plan presented below, the annex building would have an installed capacity for 52 inpatient beds. However, it was executed and inaugurated with 100 inpatient beds.

The first impact observed and experienced at the site because of the implementation of the annex block is in the access to the Hospital's Emergency Room. Previously, this access was facilitated, with the possibility of stopping for boarding/disembarking and minimally close to the entrance on rainy days. The attached block changed this dynamic, conditioning the patient in the emergency room to take a longer turn, on foot, in bad weather and without the possibility of vehicle approach. This has become a daily challenge in the emergency room routine.

Figure 12 – Emergency room access route

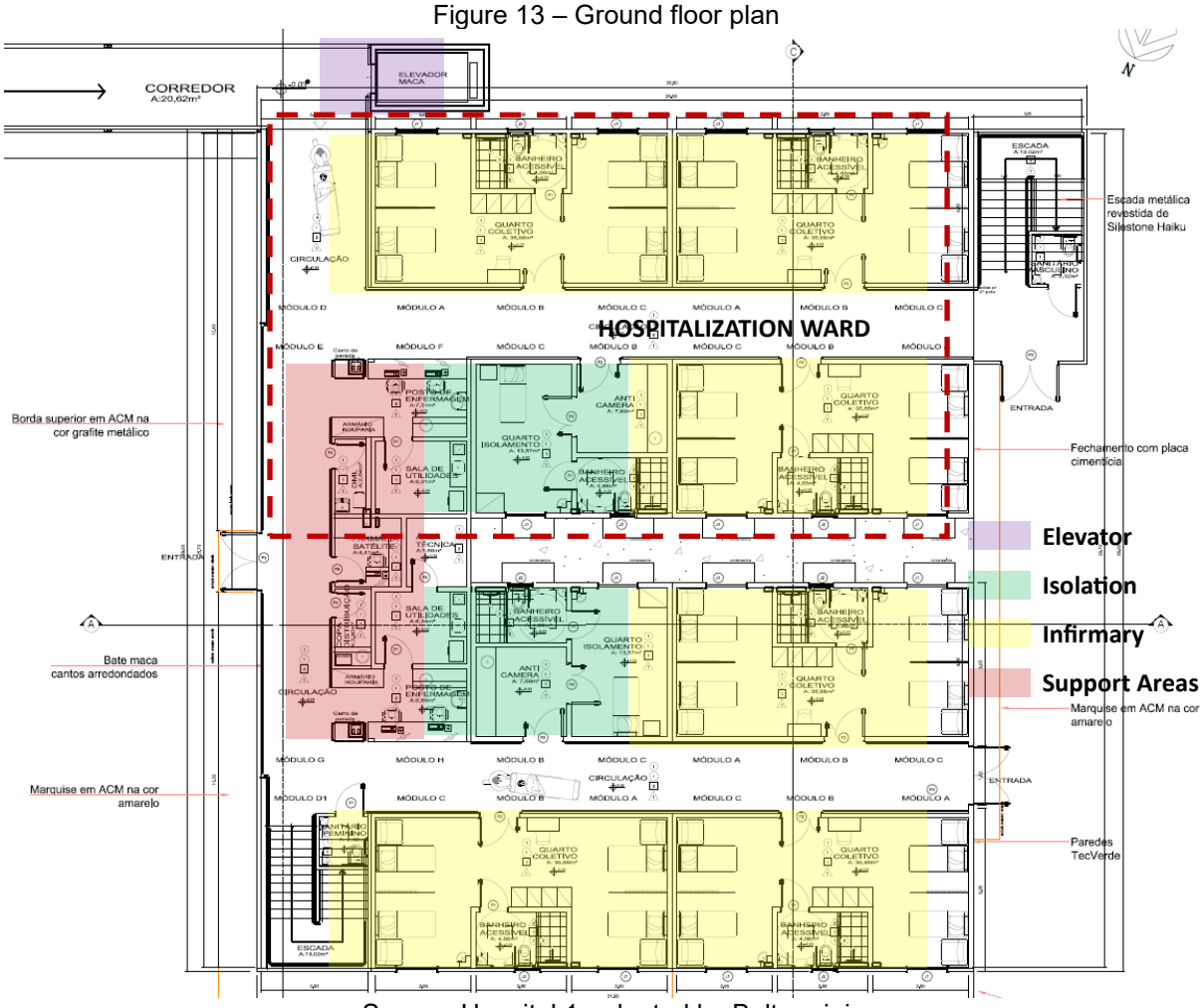


Source: Hospital 1, adapted by Beltramini

The flow of patients who use the annex block comes from inside the hospital with the entire access interface exclusively through the walkways that connect the two blocks. Doors that look like patient entrances are just escape routes in the event of a fire. In the previous figure, the flow drawn in purple represents the patient who will use the emergency room service, located in the existing block.

Another consequent problem of the implementation of the annex is the exit from the emergency room, also observed during a technical visit. The patient from the emergency room who has been discharged, leaves through the same entrance door, and sometimes some are unable to walk. The simple act of requesting a car by app and meeting the driver at the door is not possible, because vehicles can no longer reach the door of the emergency room. The patient should be taken to the boarding/disembarking area of the emergency room, represented by the purple ball in the previous image.

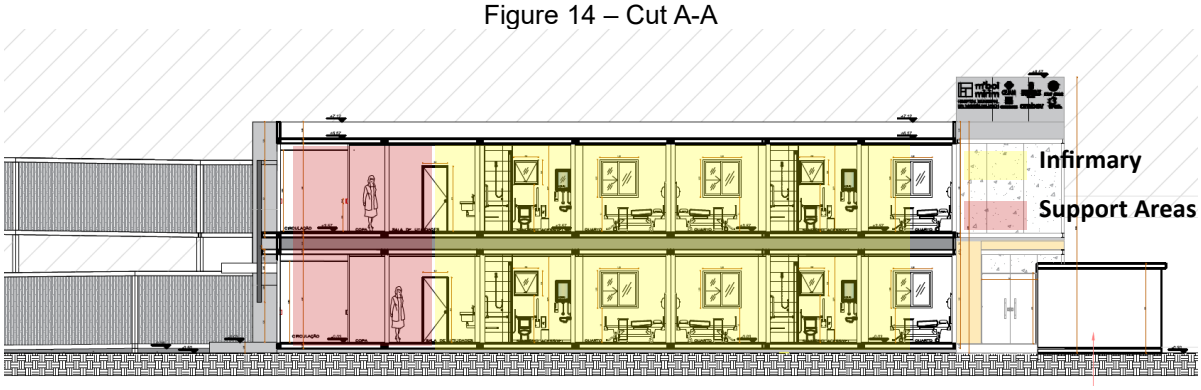
Figure 13 – Ground floor plan



Source: Hospital 1, adapted by Beltramini

The plan of the upper floor practically repeats the plan of the ground floor, only the toilets located near the stairs change position a little.

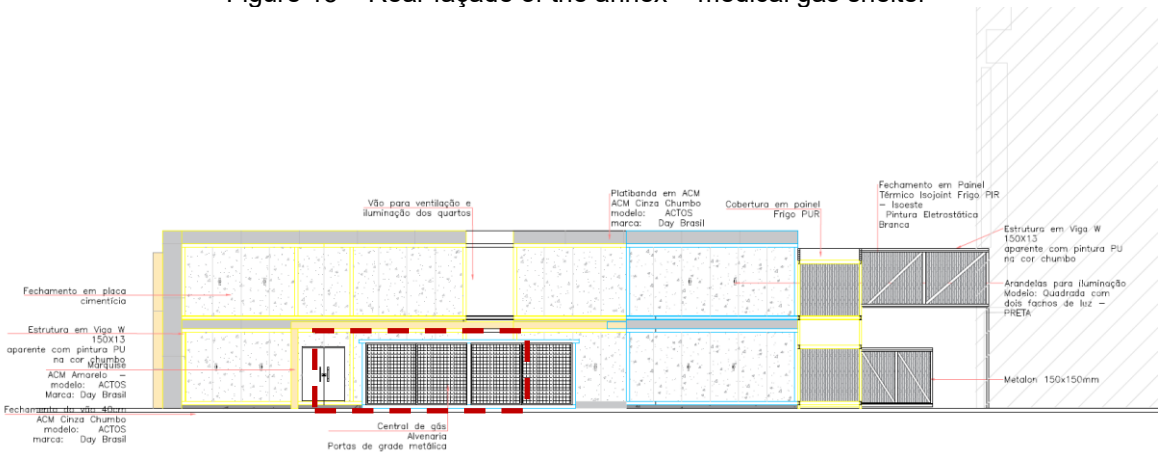
Figure 14 – Cut A-A



Source: Hospital 1, adapted by Beltramini

The references of the support services are the central offices of the existing block of the hospital. Services such as central pharmacy, warehouse, kitchen, laboratory, maintenance, clothing processing supply and collect daily in the hospitalization rooms of the annex block. It has an exclusive center for medical gases, which has a compressed air compressor and an oxygen cryogenic tank. The central is positioned at the back of the annex and has a lesson learned verified in a technical visit.

Figure 15 – Rear façade of the annex – medical gas shelter



Source: Hospital 1

During a technical visit to the site, it was found that the medical compressed air compressor, equipment that is located on the outside of the annex (demarcated in the previous drawing), emits a very loud periodic noise every 10 or 15 minutes. Inside the annex block, whether in the corridor or in the hospitalization rooms, this loud noise is perceived by patients and generates discomfort and discomfort, especially during the silence of the night.

In the following plan, represented in Figure 23, it is possible to see the volumetric modules drawn in pink. It can be seen that the dimensioning between the modules has a variation, there are larger and smaller modules, in addition to the specific ones

manufactured for the interconnection walkway to Hospital 1. The docking of these modules is done at the place where the annex is deployed. It is estimated that about 80% of the construction is carried out at the factory and the other 20% is done on site (Brasil ao Cubo, 2024a).

Figure 16 – Ground floor plan of the annex

Source: Hospital 1

It is interesting to observe through the photos of the internal environments, that each module has three beds, unlike the project drawing, which represents two beds. This interferes with compliance with the hospital infrastructure standard, RDC 50 of 2002, in relation to the parameters of lateral distance between bed and wall. This has not been met in practice.

Figure 17 – Nurse photo of 06 leitos (26/05/2023)

Source: Beltramini

Each floor has two inpatient wards, each consisting of three rooms of 06 beds and 01 room of 04 beds. The rooms of 06 beds are made up of three modules: two modules with 03 beds each and one module with the bathroom. Originally in the implementation, there was a seventh bed in the room, to care for Covid-19 cases at the beginning of the pandemic. However, it was quickly removed due to the risks of its positioning and exceeding the maximum number of beds per room recommended by the RDC 50/02 standard.

The finishes and coatings are simple. In general, vinyl blanket applied to the floor, white acrylic paint on the walls and removable lining. Wet areas also have vinyl blanket on the floor and acrylic paint on the walls, even if the recommended ceramic finish is recommended. The ceramic was installed only on the floors and walls of the bathroom stalls.

Figure 18 – Photo of the bedroom bathroom (05/26/2023)

Fonte: Beltramini

Figure 19 – Bedroom photo

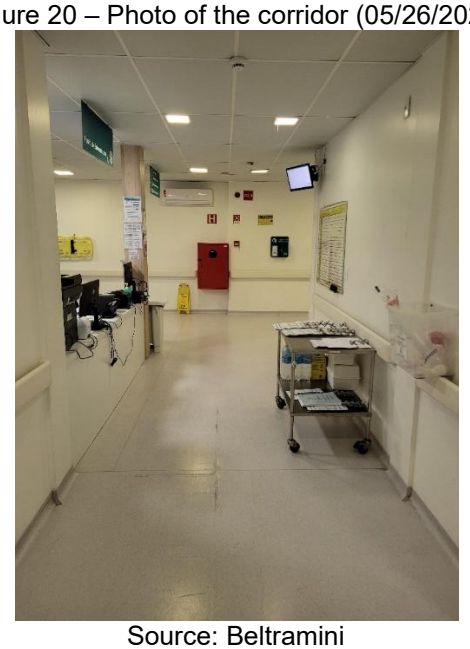
Source: Municipal Health Department[7]

In the technical visit made to the site, some differences between the project and the execution could be observed. The main one was in relation to the number of beds per room,

as already presented. Another important change was that in the project there was an isolation bed, mandatory as a rule for every 30 inpatient beds. None of the rooms in the annex were characterized or built as isolation beds.

Pathologies were also observed from the coupling of the modules in the center of the corridors. One of them had a large crack in the floor, signaled to avoid accidents. Another observation is that if we compare the photos of the inauguration of the building and the photos of the day of the technical visit, we will notice a reduction in illuminance in the environments. Not justified by digital image processing, as technical visits were made regularly between 2020 and 2024.

Figure 20 – Photo of the corridor (05/26/2023)



Source: Beltramini

CONSTRUCTION PROCESS

The volumetric modules were built in Santa Catarina and Paraná, the execution and assembly process was divided into three stages: assembly of the metal chassis used for floor and ceiling, assembly of the wall panels with completion of the modules and coupling on site.

Figure 21 – Base of the module at the factory – metal floor chassis

Source: Brasil ao Cubo, 2022b

The manufacture of the components and modules was carried out in three manufacturing parks located in Santa Catarina and Paraná, in the cities of Tubarão, Araucária and Curitiba. Two sites owned by Brasil ao Cubo and one site owned by Tecverde. The structure of the chassis and module is in steel and the composition of the wall panels is in the wood frame system in composition with isothermal panels.

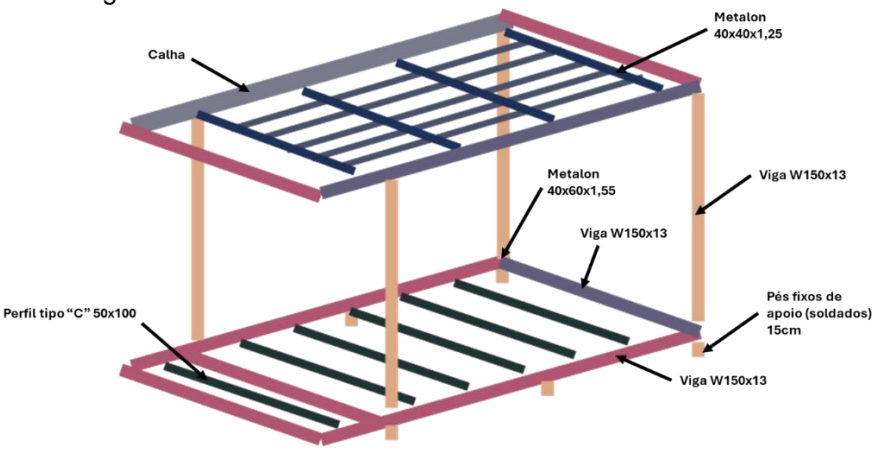
The first stage was carried out in Tubarão, with the assembly of chassis of 70 volumetric modules, that is, about 140 chassis mounted on a metal structure with a high quality and control production line.

Figure 22 – Fábrica da Brasil ao Cubo em Tubarão/SC – montagem dos chassis

Source: Brasil ao Cubo, 2022b

The composition of the floor chassis is different from the composition of the roof chassis, each with its own functional and structural requirements. The following perspective was reproduced by the author from a partial drawing of Brasil ao Cubo (2022b). The drawing is schematic for understanding, this assembly of the module was done in the stage of assembling the walls.

Figure 23 – Volumetric scheme of the module steel structure



Source: Beltramini – reproduction from Brasil ao Cubo, 2022b

The walls of the modules were manufactured in an automated yard in Curitiba, with a production line process for cutting frames (windows and doors). After the assembly of the panels, the modules were assembled in a third factory in Araucária, with the junction of the chassis and panels, which gives rise to the volumetric modules. This composition of the modules can be considered a separate stage, placed between stages 2 and 3, classified by Brasil ao Cubo (2022b).

Figure 24 – Tecverde factory in Curitiba/PR – assembly of the wall panels

Source: Brasil ao Cubo, 2022b

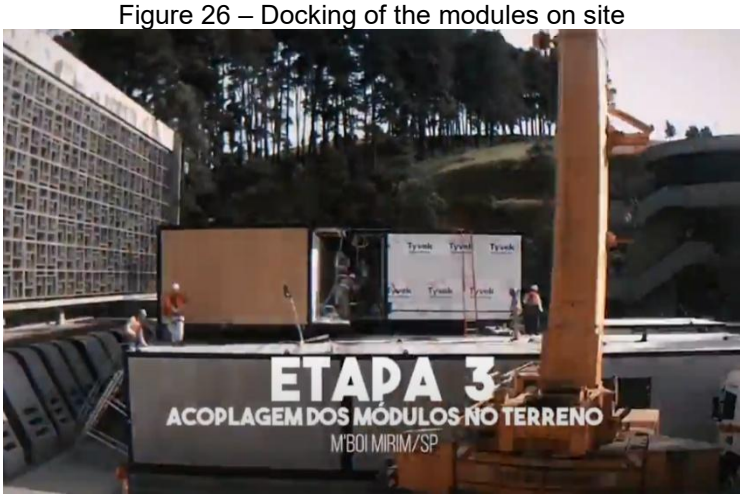
Before receiving and docking the modules (step 3), the site had to be prepared first. A shallow foundation, radier, was made to receive the manufactured modules. All transit logistics in the region were adapted for the stopping of trucks and unloading of modules. In all, 35 trucks were mobilized, asynchronously.

Figure 25 – Preparation of a shallow structure (radier) to receive the modules (04/02/2020)

Source: Beltramini, panel photographed at the site on 10/21/2020

The modules were transported by trucks (two modules per vehicle) to the site of implementation, a distance of just over 400 kilometers. Step 3 consists of coupling the modules at the construction site of the annex.

Figure 26 – Docking of the modules on site



Source: Brasil ao Cubo, 2022b

The coupling is done in a short period of time, compared to a conventional work. The entire manufacturing and docking process was done in 34 days. The modules began to arrive at the site 12 days after the start of production of the modules in the factory. On the 34th day, the annex was equipped and inaugurated, through the effort and commitment of the companies involved in the construction and operation.

Figure 27 – Modules Coupling (04/05/2020)

Source: Beltramini, panel photographed at the site on 10/21/2020

FINAL CONSIDERATIONS

It is pertinent to remember that this case study was a pioneer in uniting the technique of modular volumetric construction with hospital architecture. Much needs to be developed and studied.

These final considerations are conclusive in the scenario of this research, in the present time. Other academic research, work and market developments will follow that will certainly improve the construction technique, its relationship with the project and the hospital space built itself.

During the development of the research, some analyses and observations were made that we will summarize below, along with the conclusions regarding the theme of modular volumetric construction and its application in hospital architecture and engineering, based on the case study presented.

- We return to the results of Guimarães and Rosa (2022), who pointed out as lessons learned by the companies involved, citing the following points for improvement:
- Access to the roof;
- Positioning of the gas plant;
- Waits at the foundation;
- Docking details;
- Logistic order of delivery and coupling of modules according to degree of complexity.

In addition to the points mentioned, from the design point of view, we highlight and reinforce these themes of attention, considering the study of the materials and the technical visit carried out:

- Non-compliance with the RDC 50/02 standard in relation to lateral clearance between beds and walls;
- Use of MDF in the finishing of walls in the corridors to the floor. This material is not recommended on baseboards or heights that may be subject to washing;
- The project does not include a specific distribution pantry for the unit. It is shared with a pantry inside the Hospital;
- Acoustics allows patients to hear the noises generated in the medical gas shelter, especially those emitted by the medical compressed air compressor;
- Air conditioning equipment without adequate filtration for inpatient wards;
- Excessive prolongation of the flow of access to the Hospital's emergency room. The implementation of the annex made it difficult to access the emergency room, however this does not depend on the construction technique;
- The project provides for isolation rooms, but they were not built.

Still in relation to the design process, no positive points, or advantages, exclusive to the construction technique that can improve the design stages were identified. However, it is an advantage of this technique to have modular structuring in the design, especially because it is a hospital project. Perhaps an exclusive advantage may be the possibility of building a dedicated module for factory testing.

From the point of view of construction technique, we highlight other topics of attention verified in the analysis of materials and in the visit to the site. They are:

- The corridors presented pathologies in the coupling joints of the modules after one year of use and occupation of the annex;
- At the beginning of the operation, the hospital's maintenance team was highly dependent on the companies involved in the construction for correction and prevention of construction and installation failures;
- A weak point of this technique is the acoustic and thermal comfort, according to some materials studied. If they are not well observed and treated during design and execution, the building will have chronic pathologies in this sense. The case study presents this problem in acoustic comfort.

The main advantage of modular volumetric construction is the execution time, a record among engineering construction techniques. The market has some resistance to the adoption of this type of construction, as the cost is higher than conventional constructions. It is known that the published investment for the construction of the annex of the case study

was ten million reais and that its built area is 1,200 square meters. Therefore, we have an average cost of R$ 8,333.33/m².

For the market that intends to adopt the modular volumetric construction technique, it is not enough to compare construction prices per square meter. It is essential to carry out a feasibility study considering the construction deadlines, the costs per square meter and apply a billing forecast during the months of anticipation of the deadline of modular volumetric construction in relation to conventional construction.

The construction company Brasil ao Cubo designed and executed hospitals and hospital annexes in some states during and after the Covid-19 pandemic. For this research, the authors maintained technical contact with an engineer from the company, whose name we will not disclose in this research. In September 2024, he announced that the company had closed activities for projects and custom works, including hospital ones. The company would be investing and launching residential and hotel models.

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NEW APPROACHES TO ORGAN PRESERVATION SURGERY IN PATIENTS WITH LIVER CANCER: A CRITICAL REVIEW AND EVALUATION OF INNOVATIONS

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ABSTRACT

Liver cancer, especially hepatocellular carcinoma, is a leading cause of cancer death and is more common in patients with cirrhosis and chronic hepatitis. Innovative surgical techniques, such as anatomical resection and selective portal embolization, have been shown to be effective in preserving healthy liver tissue and reducing postoperative complications. Studies indicate improvements in survival and recovery rates, especially in cases of tumors located in areas that are difficult to resect. However, implementing these approaches requires expert centers and more research to validate long-term results.

Keywords: Liver cancer. Anatomical resection. Selective portal embolization. Organ-sparing surgery. Postoperative complications. Long-term survival.

INTRODUCTION

Liver cancer, particularly hepatocellular carcinoma (HCC), represents one of the leading causes of cancer death worldwide, with an increasing incidence, especially in patients with liver cirrhosis and chronic hepatitis. Traditionally, surgical treatment has been one of the most effective options for patients with localized liver cancer. However, liver resection surgery presents significant challenges, especially with regard to the need to balance tumor removal with the preservation of functional liver tissue. Extensive removal of healthy liver can result in liver failure, a serious complication that significantly affects postoperative morbidity and mortality.

Traditional surgical approaches, based on wide resections, are still widely used, but often result in substantial losses of liver tissue, increasing the risk of complications such as acute liver failure and infection. In response to these challenges, more innovative techniques have emerged in recent decades, with the aim of preserving a greater amount of viable liver tissue, reducing the risk of complications and improving postoperative outcomes. Among these new approaches, anatomical resection of the liver and selective portal embolization stand out, both of which have the potential to significantly improve clinical outcomes in patients with liver cancer.

OBJECTIVE

The aim of this study was to evaluate the impact of new surgical approaches, specifically anatomical resection and selective portal embolization, on the preservation of healthy liver tissue and the reduction of postoperative complications in patients with liver cancer. In addition, we sought to compare the outcomes of these approaches with the results of traditional surgical techniques.

METHODS

A systematic review of the literature was conducted in the PubMed, Scopus and VHL databases, using the descriptors "liver cancer", "anatomical resection" and "selective portal embolization". Studies published between 2015 and 2024 that addressed patients undergoing liver resections with a focus on the preservation of healthy liver tissue were included. The selection of articles was conducted according to the criteria of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The analysis of the results was based on comparisons between traditional liver resection techniques and new surgical approaches, taking into account postoperative complications such as liver failure, infection, bleeding and mortality.

RESULTS AND DISCUSSION

Of the 25 studies included in the review, 15 studies showed that patients undergoing anatomical resection had a significant reduction of approximately 40% in postoperative complications compared with traditional resection techniques. This decrease was particularly observed in complications related to liver failure and the need for blood transfusions. In addition, anatomical resection has been shown to preserve an average of 35% to 40% of functional liver tissue, which directly contributed to faster recovery and lower risk of postoperative liver failure.

Selective portal embolization, which aims to induce hypertrophy of the remaining hepatic lobe prior to resection, has also been shown to be effective in improving postoperative liver function. In patients who received this technique, a preservation of healthy liver volume was observed, which contributed to the maintenance of liver function in the long term. The combined use of selective portal embolization and anatomical resection resulted in a reduced rate of liver failure in 25% of the patients analyzed.

In addition, most studies (18 out of 25) reported significant improvements in long-term survival rates, especially in patients whose tumors were located in hard-to-reach areas or in complex anatomical regions of the liver, such as the left and right lobes. These patients, who would traditionally have high rates of tumor recurrence and associated complications, demonstrated significantly better survival with the use of these new approaches. The anatomical resection technique, by allowing a more precise and controlled removal of the tumor, associated with the preservation of functional liver tissue, has the potential to reduce the rate of tumor recurrence.

LIMITATIONS AND FINAL CONSIDERATIONS

Despite the promising results, new surgical techniques, such as anatomical resection and selective portal embolization, still face significant challenges in terms of their large-scale implementation. The technical complexity of these approaches requires specialized training for the surgical team, as well as the availability of state-of-the-art equipment and advanced hospital infrastructure. Currently, these techniques are mainly available in specialized centers, limiting their access to a restricted number of patients.

In addition, although the reviewed studies have shown favorable results in terms of reducing complications and increasing survival, there is still a need for more multicenter, long-term studies to validate these findings. Combining innovative techniques with a personalized approach to liver cancer treatment may represent the future of liver surgery, but clinical implementation requires greater scientific evidence and specialized training.

CONCLUSION

New surgical techniques, such as anatomical resection and selective portal embolization, have been shown to be effective in reducing postoperative complications and preserving healthy liver tissue in patients with liver cancer. These approaches have been shown to improve survival and postoperative recovery rates, offering a promising alternative to traditional techniques, especially in patients with tumors located in areas that are difficult to resect. However, its implementation is restricted to specialized centers, and it is essential that surgical training be expanded, as well as hospital infrastructure, so that more patients benefit from these innovative techniques. Continued research and improvement of surgical technologies and approaches could expand treatment options for liver cancer, with a significant positive impact on patients' quality of life.

OVERVIEW OF CATARACT SURGERY OCCURRENCE IN BRAZIL: ANALYSIS BY SEX, AGE, AND ETHNICITY IN THE LAST DECADE

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ABSTRACT

Cataracts remain one of the leading causes of preventable blindness worldwide, especially among the elderly population. In Brazil, the number of cataract surgeries has grown considerably in the last ten years, driven by advances in medicine, such as the improvement of surgical techniques, and by the demographic aging of the population. The prevalence of the disease is estimated to increase as the population ages, since cataracts are more common in people over the age of 60. This study performs an integrative review on the occurrence of cataract surgeries in Brazil between 2010 and 2020, with emphasis on the analysis by sex, age, and ethnicity. The results reveal that women, especially the elderly over 65 years of age, are the most affected by the disease and consequently, the ones who most undergo surgery. Although the increase in the number of procedures is significant, there was a lack of consistent data on the distribution of the disease by ethnicity, which limits the understanding of regional and racial disparities in access to treatment. This highlights the need for more in-depth studies that address these issues in more detail, with the aim of improving public eye health policies and promoting more equitable access to ophthalmic health services in Brazil.

Keywords: Cataract. Cataract Surgery. Public health. Epidemiology. Brazil.

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INTRODUCTION

Cataracts are one of the main causes of reversible blindness in the world, characterized by progressive opacification of the lens, which impairs the quality of vision by making it difficult for light to pass through to the retina. When left untreated, this condition can lead to total vision loss, significantly impacting patients' quality of life, especially with regard to autonomy, productivity, and mental health. Although it is widely recognized as an aging-related condition, its prevalence is also associated with socioeconomic, environmental, and genetic factors (IBGE, 2020). Exposure to ultraviolet radiation, ocular trauma, smoking, diabetes mellitus, and long-term corticosteroid use are additional risk factors that may influence its development.

Population aging is a global reality and, in Brazil, it is no different. Data from the Brazilian Institute of Geography and Statistics (IBGE, 2020) show that the elderly population has grown rapidly in recent decades, driving the demand for specialized health services, including the treatment of aging-related diseases such as cataracts. At the same time, inequality in access to health care is a constant challenge in the country, especially with regard to vulnerable populations. This inequality can directly influence cataract diagnosis and treatment rates, making it essential to analyze factors such as gender, age, and ethnicity in detail to understand regional and sociodemographic disparities.

In Brazil, the Unified Health System (SUS) plays a central role in combating blindness caused by cataracts, being responsible for more than 80% of surgical procedures performed in the country, according to data from the Ministry of Health (2021). Cataract surgeries are among the most commonly performed elective procedures by the SUS, which reflects the significant impact of this condition on public health. However, despite advances in the number of surgeries performed, important gaps still exist, especially with regard to coverage of the most vulnerable populations and the planning of public policies that prioritize equity in access to eye health services.

The justification for this study lies in the relevance of cataracts as a public health problem that demands priority attention. The analysis of the occurrence of cataract surgeries in Brazil can provide important subsidies for the improvement of strategies for the prevention, diagnosis, and treatment of this condition. In addition, understanding how factors such as gender, age, and ethnicity influence access to treatment is essential for the

formulation of public policies that reduce inequalities, promote equity in the health system, and improve patients' quality of life.

The objective of this study was to review data on the occurrence of cataract surgeries in Brazil over the last ten years, analyzing their distribution by sex, age, and ethnicity. Through this analysis, we seek to identify epidemiological patterns and possible disparities in access to treatment, contributing to the development of more effective actions to combat cataracts and promote the eye health of the Brazilian population.

THEORETICAL FRAMEWORK

Cataracts are one of the most common eye diseases in the world, with increasing prevalence as the population ages. The scientific literature indicates that cataracts are directly associated with the natural aging process of the lens, which gradually loses its transparency due to protein aggregation and changes in cellular metabolism. Data from the Brazilian Institute of Geography and Statistics (IBGE, 2020) show that the prevalence of the disease in people over 60 years of age is over 30%, with a significant increase in the age group of 65 to 74 years (33.9%) and a peak in individuals over 75 years of age, where the prevalence reaches 55.5%. This data reinforces the need for special attention to eye health in elderly populations, given the impact of visual loss on patients' quality of life and autonomy.

In addition to age, sex is another relevant factor in the epidemiology of cataracts. Studies suggest that women have a higher prevalence of the disease compared to men. This difference can be explained, in part, by hormonal factors, such as the reduction in estrogen levels after menopause, which can accelerate the aging process of the lens and increase susceptibility to oxidative stress (Fiocruz, 2020). Other sociocultural factors can also influence, such as women's greater access to health services in certain regions, which favors the diagnosis of the disease. However, in scenarios of social inequality, women may also face barriers to accessing treatment, especially in areas of low health system coverage.

As for ethnicity, there is a diversity of findings in the international literature, but there are still significant gaps in national studies. Data from the World Health Organization (WHO, 2018) indicate that Afro-descendant populations may have a higher prevalence of nuclear cataracts, while indigenous and Asian populations have a higher risk of developing specific forms of the disease, such as cortical or posterior subcapsular cataracts. These patterns may be related to genetic, environmental, and socioeconomic differences, such as

increased exposure to ultraviolet radiation in certain regions and limited access to eye care. In the Brazilian context, however, there is a lack of robust studies that analyze the relationship between ethnicity and types of cataracts, despite the country's ethnic diversity.

Another important aspect to be considered is the impact of socioeconomic inequalities on access to cataract diagnosis and treatment. Studies show that low-income populations or those living in rural areas have less access to eye health services, which can delay diagnosis and aggravate cases of the disease. This situation reflects the need for public policies that expand the coverage of ophthalmological services, especially through the Unified Health System (SUS), which already plays a crucial role in the treatment of cataracts in Brazil.

Therefore, when addressing the prevalence of cataracts, it is essential to consider not only biological factors, such as age, sex, and genetic predisposition, but also the social determinants of health, which directly influence access to diagnosis and treatment. These factors need to be investigated more broadly in the Brazilian context to support public policies that ensure greater equity in eye health.

METHODOLOGY

This integrative review was conducted with the objective of gathering, analyzing, and synthesizing the available evidence on the occurrence of cataract surgeries in Brazil, considering their distribution by sex, age, and ethnicity. The methodology followed a protocol structured in five stages: formulation of the problem, search in the literature, evaluation of the data, analysis of the results and presentation of the synthesis, ensuring the integrity and reliability of the process.

In the problem formulation stage, the guiding question of the review was defined: "What are the demographic and epidemiological patterns of cataract surgeries performed in Brazil in the last ten years, considering gender, age and ethnicity?". This question guided the search for data and allowed the delineation of clear inclusion and exclusion criteria.

For the literature search, the SciELO and PubMed databases and repositories of the Ministry of Health (2023) were used, in addition to official data made available by DataSUS. The search strategies included terms such as "cataract surgery in Brazil", "cataract prevalence", "eye health in the SUS" and "demographic data on cataracts", with combinations in Portuguese and English to expand the reach. The survey covered publications between 2013 and 2023, allowing for an up-to-date and comprehensive analysis.

The inclusion criteria established were: studies that addressed cataract surgeries performed in Brazil, with data stratified by sex, age, or ethnicity; articles published in Portuguese, English or Spanish; and government reports or official data that presented relevant information. International studies that did not provide specific information about Brazil, articles that did not present clear demographic or epidemiological data, and publications prior to 2013 were excluded.

In the data evaluation stage, the selected studies were analyzed for methodological quality, relevance, and reliability of the information. For this, a critical evaluation tool was used based on criteria such as clarity of the objective, robustness of the methodology used and consistency of the results presented. The extracted data included the number of surgeries performed, demographic distribution, and trends over the years.

The analysis of the results was carried out in a descriptive and comparative way, with the identification of patterns and gaps in the available data. The information was organized into tables and graphs to facilitate the visualization of the findings. Differences between demographic groups, such as gender, age, and ethnicity, were analyzed to identify potential disparities in access to treatment.

Finally, in the synthesis presentation stage, the results were consolidated in a critical discussion, highlighting the advances and challenges in the Brazilian context. The process was carried out in a transparent and rigorous manner, ensuring that the conclusions faithfully reflected the data analyzed and contributed to the formulation of more inclusive and effective public policies.

This methodology allowed for a systematic and comprehensive review, providing a solid basis for understanding the trends in cataract surgeries in Brazil and the inequalities associated with access to these procedures.

RESULTS AND DISCUSSIONS

The data collected indicate a significant increase in the number of cataract surgeries performed in Brazil over the last decade, reflecting both the expansion of access to health services and the growth of the elderly population. In 2010, the Unified Health System (SUS) performed about 302 thousand cataract surgeries, while in 2020 this number exceeded 600 thousand procedures, representing an increase of more than 98% in the period (Ministry of Health, 2021). This growth, according to Santos et al. (2019), is directly associated with government initiatives, such as the National Program for Elective Surgeries, which prioritizes ophthalmological care for the most vulnerable population, in addition to

awareness-raising actions and expansion of Primary Health Care (PHC) coverage, which facilitates early access to diagnosis and treatment.

DISTRIBUTION BY SEX

The prevalence of cataracts is higher in women (38.6%) compared to men (29.4%), which is in line with global data that point to greater female susceptibility to the disease (Fiocruz, 2020). This pattern can be explained by greater female longevity, which exposes them for longer to the aging process of the lens, and by hormonal factors, such as the reduction of estrogen after menopause, which contribute to metabolic changes and greater susceptibility to oxidative stress (NICE, 2018). In addition, women generally seek health services more, which favors early diagnosis and access to treatment (WHO, 2021). However, in contexts of greater social inequality, women in rural areas or less assisted regions face additional barriers to accessing cataract surgeries, such as low income, difficulty in getting to specialized centers, and lack of information about available services (Silva et al., 2021). This highlights the need for affirmative actions to ensure equity in eye care, with a focus on reducing social gender inequalities.

DISTRIBUTION BY AGE

Cataracts are widely recognized as an aging-related disease, and the data analyzed confirm that most surgeries are performed on individuals aged 60 and over. According to the IBGE (2020), the prevalence of cataracts increases significantly with age: while about 33.9% of people between 65 and 74 years old have the condition, this number jumps to 55.5% in people over 75 years old. These data corroborate the findings of international studies, such as that of the World Health Organization (WHO, 2018), which indicate the increasing prevalence of cataract in the elderly population. The efforts of the SUS to meet the demand of the elderly population have been notorious, especially with campaigns of joint efforts for ophthalmological surgeries, which aim to reduce waiting lines and improve access to treatment. However, the accelerated aging of the Brazilian population, combined with the growing demand for ophthalmological services, brings new challenges, demanding greater investment in public policies aimed at the eye health of the elderly. According to Nascimento et al. (2020), such policies should include not only increasing the supply of surgeries, but also promoting preventive actions and expanding access to treatment in less favored areas.

DISTRIBUTION BY ETHNICITY

Although international data suggest differences in the prevalence and types of cataract between ethnic groups—with Afro-descendants having a higher prevalence of nuclear cataract and indigenous and Asian people having a higher incidence of cortical cataract (WHO, 2018)—there is a lack of detailed information on the distribution of cataract surgeries among different ethnic groups in Brazil. This gap in national data compromises the formulation of public policies that consider the cultural, environmental, and epidemiological specificities of each group. For example, international studies show that Afro-descendant populations may face additional barriers to accessing treatment due to socioeconomic inequalities, such as less access to quality health services and lack of financial resources (Choudhury et al., 2019). In Brazil, a similar scenario may occur, but the lack of data makes it difficult to accurately identify the needs of these populations, particularly in contexts of racial discrimination and regional inequality. Therefore, for Figueiredo et al. (2021) it is crucial that new studies address the issue of ethnicity in the context of Brazilian eye health, not only to fill this gap, but also to subsidize the creation of inclusive public policies that serve all segments of the population in an equitable manner.

A study carried out at the Clementino Fraga Filho University Hospital, in Rio de Janeiro, analyzed 148 patients who underwent cataract surgery. The mean age of the patients was 69 years, with 91.8% being over 50 years old. There was a predominance of females (60.1%) and whites (48%), followed by browns (37.2%). In addition, most patients had a low level of education, with 50.7% having incomplete elementary school. These data reinforce the association between cataracts and aging, in addition to highlighting the higher prevalence in women and the influence of socioeconomic factors on the occurrence of the disease, such as little formal education, which impacts access to information and health (Freitas et al., 2019).

According to the document "Eye Health Conditions in Brazil", published by the Brazilian Council of Ophthalmology, the prevalence of senile cataracts increases significantly with age. Among individuals under 65 years of age, the prevalence is 17.6%; in the 65 to 74 age group, it rises to 47.1%; and in people over 75 years of age, it reaches 73.3% (CBO, 2020). These data show the strong correlation between population aging and the increase in the incidence of cataracts, highlighting the importance of public policies aimed at the eye health of the elderly population, especially in a scenario of accelerated demographic aging in Brazil.

A study conducted at the Ophthalmology Reference Center of the Federal University of Goiás evaluated the prevalence of cataract in patients treated by the institution. The

results indicated that 60.9% of the patients did not have significant visual impairment, while 21.8% had moderate low vision, 3.9% had severe low vision and 11.3% were blind. According to Lima et al. (2020), the distribution by age group showed a higher prevalence in individuals over 60 years of age, corroborating the association between cataract and aging.

The Brazilian studies analyzed corroborate the previous findings, indicating a higher prevalence of cataract in women and elderly individuals. The association with socioeconomic factors, such as low level of education, is also evident. However, there is still a lack of specific data on the distribution of cataracts among different ethnic groups in Brazil, which limits the complete understanding of the risk factors and epidemiology of the disease in the country. This gap highlights the need for future research that addresses the influence of ethnicity on the prevalence of and access to cataract treatment, aiming to subsidize more inclusive and equitable public policies, with a focus on reducing inequalities in access to eye health.

CONCLUSION

The review showed a significant increase in the number of cataract surgeries in Brazil over the last decade, with a substantial growth in access to ophthalmological services, especially among the elderly population. The highest prevalence of the disease was observed in women and in older individuals, corroborating global data that associate aging with the development of cataracts. Public policies, such as the National Program for Elective Surgeries, have been fundamental to expand access to treatment, reflecting an effort by the Unified Health System (SUS) to serve a growing population of elderly people.

However, the absence of robust data on the distribution of the disease by ethnicity represents an important gap that hinders the creation of more equitable and effective eye health policies. The scarcity of specific information on ethnic differences in the prevalence of and access to cataract surgery in Brazil compromises the formulation of public health strategies that can more accurately and inclusively meet the needs of diverse population groups, such as Afro-descendant, indigenous, and Asian populations. This gap highlights the importance of investing in studies that consider the ethnic and cultural characteristics of Brazil, promoting ophthalmological care that takes into account the specificities of each group.

Among the limitations of this study, the scarcity of detailed ethnographic and epidemiological data on Brazilian populations stands out, particularly with regard to the stratification of cataract prevalence by ethnicity. Although there are national studies that

address the prevalence of cataract, few present information disaggregated by ethnic groups, which hinders a more in-depth analysis of the social, cultural, and genetic determinants that influence the development of the disease. In addition, the review did not include studies that may have been published in sources not indexed in the accessed databases, which may have led to the exclusion of relevant studies.

Another limitation refers to the focus on surgeries performed in the Unified Health System (SUS), which, although comprehensive, does not fully represent the reality of the entire Brazilian population, especially in contexts of unequal access to private health services.

Considering the limitations and gaps identified, it is suggested that future studies address the issue of ethnicity in the context of cataract more broadly, with an emphasis on the collection of more specific data and the inclusion of populations that are often not adequately represented in existing research. Future research could explore the social and economic barriers that hinder access to treatment for certain ethnic groups, as well as examine the impact of public policies aimed at reducing these inequalities.

In addition, it would be valuable to conduct longitudinal studies that follow the evolution of cataracts in different age groups and ethnicities, in order to identify patterns of prevalence, risk factors, and long-term treatment outcomes. The creation of national databases that stratify eye health information by demographic and socioeconomic characteristics may be a crucial step towards improving equity in eye care in Brazil.

Finally, the analysis of public policies aimed at eye health should be expanded, incorporating more inclusive approaches that consider the disparities between the various regions of Brazil, in addition to focusing on cataract education and prevention, especially in at-risk populations.

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PHARMACOLOGICAL APPROACHES IN THE TREATMENT OF PARKINSON'S DISEASE: AN INTEGRATIVE REVIEW

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ABSTRACT

Parkinson's disease (PD) is a progressive neurodegenerative condition that affects movement, and its treatment involves medications, complementary therapies and, in specific cases, interventions such as deep brain stimulation, aiming to improve the patient's quality of life. From this perspective, the present study aimed to analyze pharmacological approaches in the treatment of PD, with emphasis on efficacy, safety, and impact on motor and non-motor symptoms. This was an integrative literature review, whose data searches were carried out in the PUBMED, SCIELO and LILACS databases. Initially, a total of 442 articles were located, and after screening and careful selection, about 08 articles were chosen to compose this review. A total of 4,764 individuals were evaluated, most of whom were male, aged between 50 and 70 years. Among the medications used, levodopa was most prominent, both in monotherapy and in combination with another drug. Studies show that levodopa, alone or in combination, is effective in motor symptoms, but does not impact the progression of the disease. Intrajejunal therapy and combination with selegiline offer additional benefits, while flavonoids may complement treatment. Isradipine, on the other

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hand, has not shown efficacy in the progression of the disease. It is concluded that the pharmacological approach to PD continues to be fundamental for the management of motor and non-motor symptoms, with levodopa being the pillar of treatment, complemented by combination therapies and new agents that offer additional benefits in certain contexts.

Keywords: Parkinson's disease. Pharmacological therapy. Combination treatment. Effectiveness.

INTRODUCTION

Parkinson's disease (PD) is a complex neurodegenerative condition, which is manifested by debilitating motor and non-motor symptoms, resulting from the progressive loss of dopaminergic neurons (LEVADA *et al.,* 2024). From a pathological point of view, PD is characterized by the degeneration of dopaminergic neurons in the substantia nigra pars compacta (SN), located in the midbrain, and by the presence of Lewy bodies, which are cytoplasmic inclusions that contain insoluble aggregates of alpha-synuclein. In addition, PD has a more widespread pathology, affecting other regions of the brain and also involving non-dopaminergic neurons, which contributes to the complexity and diversity of symptoms associated with the disease (SIMON; TANNER; BRUNDIN, 2020).

Most cases of PD probably have a multifactorial etiology, resulting from the interaction between environmental and genetic factors. Exposure to toxic chemicals and head trauma can increase the risk of developing PD, while certain lifestyle habits can contribute to reducing this risk (GOLDMAN *et al.,* 2019). In addition, genetic susceptibility factors may influence how environmental exposures affect disease. Age is considered the most relevant risk factor for the onset of the disease, and men are more susceptible than women, with an approximate prevalence rate of 3:2 (BLAUWENDRAAT; NALLS; SINGLETON, 2020).

The clinical diagnosis of PD is predominantly based on motor signs, including asymmetric and progressively slow resting tremor, cogwheel rigidity, and bradykinesia (TOLOSA *et al.,* 2021). However, it is also important to consider non-motor symptoms, which can appear years before motor deficits appear. These non-motor symptoms can include anosmia, constipation, depression, and sleep behavior disorders. In the advanced stages of the disease, other non-motor features may manifest, such as autonomic dysfunction, pain, and cognitive impairment (CHIA; TAN; CHAO, 2020).

Currently, the treatments available for PD focus on relieving symptoms, but cannot prevent the progression of the disease. Emerging therapies, such as stem cell-derived dopaminergic cell transplantation, show potential but face ethical challenges and limitations regarding cell availability. The reprogramming of astrocytes to replace lost neurons presents itself as a promising alternative, as well as approaches aimed at repairing mitochondrial dysfunctions and controlling inflammation. While cellular reprogramming brings hope, it is essential to carefully evaluate the potential long-term consequences before its widespread clinical implementation (WANG *et al.,* 2023).

Pharmacological approaches to the treatment of PD primarily include the use of levodopa and dopamine agonists, which help relieve motor symptoms by replacing or

stimulating dopamine (CATTANEO; JOST, 2023). Emerging therapies, such as GLP-1 receptor agonists (e.g., liraglutide and exenatide), have been investigated due to their neuroprotective potential, including reducing inflammation and toxic protein accumulation (NOWELL *et al.,* 2023; CATTANEO; JOST, 2023). Other antidiabetic agents, such as metformin and PPARγ agonists, are also being studied, aiming to combat both the motor and cognitive symptoms of PD, exploring mechanisms such as reducing oxidative stress and improving mitochondrial function (NOWELL *et al.,* 2023).

Given the complexity of PD and its growing impact on public health, investigating effective treatments that can modify its progression is crucial. PD significantly affects the quality of life of patients, also bringing challenges to health systems. Exploring new approaches, such as cell therapies and the use of antidiabetic drugs, is promising, although it still requires rigorous studies to prove safety and efficacy. This research is justified by the need for therapeutic strategies that not only relieve symptoms, but also influence the course of PD, bringing lasting benefits to patients.

From this perspective, the present study aimed to analyze pharmacological approaches in the treatment of PD, with emphasis on efficacy, safety, and impact on motor and non-motor symptoms, in order to provide a comprehensive and up-to-date view of the advances and limitations of the main drugs used.

METHODOLOGY

It is an integrative literature review, which consists of a research method that allows for a comprehensive and systematic analysis of scientific studies, promoting the characterization and dissemination of knowledge (DANTAS *et al*., 2022).

The search strategy of this research was based on the PICO strategy, defined as follows: **P (Patients):** Patients diagnosed with Parkinson's Disease; **I (Intervention):** Pharmacological treatments; **C (Comparison):** Other treatments (e.g., surgical, non-pharmacological); **O (Results):** Efficacy in controlling symptoms, safety and adverse effects.

Based on the PICO strategy, the following guiding question was defined: "What are the most effective and safe pharmacological approaches for the control of motor and non-motor symptoms in Parkinson's Disease, according to recent scientific literature?"

The selection of studies was carried out in the *Medical Literature Analysis and Retrieval System Online* (MEDLINE/PUBMED), SCIELO and Latin American and Caribbean Literature on Health Sciences (LILACS) databases. The search for articles was carried out using the following descriptors, in Portuguese: "Parkinson's Disease", "Pharmacological

Treatment", and in English: "Parkinson Disease"; "Drug Therapy". Based on the Descriptors in Sciences and Health (DeCS) and Medical Subject Headings (MESH) and with the help of the Boolean operators "AND" and "OR". During the searches, the following combination of descriptors was used: "Parkinson Disease and Drug Therapy".

Complete articles, accessible online and free of charge, in Portuguese and English, that deal with pharmacological approaches in the treatment of Parkinson's Disease, with a focus on the efficacy and safety of drugs, published in the last 5 years, were included. Editorials, letters to the reader, reflective studies, abstracts, duplicate articles, theses, dissertations, manuals, and studies that did not correspond to the theme or objective of the review were excluded.

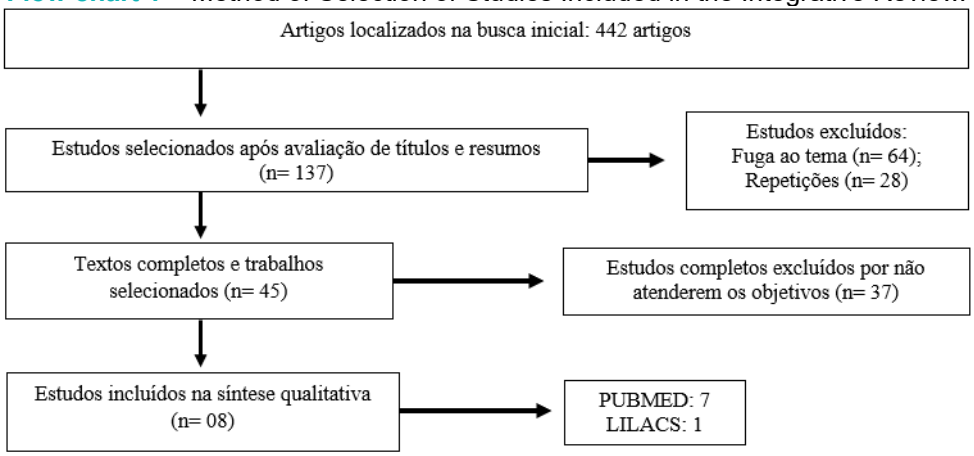
After collecting data in the databases, the titles and abstracts were read, and among the studies selected after this process, the full articles were read, and from these, the studies eligible for analysis were chosen. The study was carried out respecting the researched literature, with no changes in the results found to the benefit of this research.

After collecting data in the research databases, the titles and abstracts were read. Among the studies selected at this stage, the articles were read in full, from which those eligible for analysis were chosen. This data was organized into tables, and the search strategy represented in the flowchart.

Based on the search strategy, a total of 442 complete articles were initially found, which were screened and evaluated. After reviewing the titles and abstracts, 305 articles were discarded because they did not meet the eligibility criteria and 137 articles were selected for content analysis. In the end, only 08 studies met all the criteria and were incorporated into this review, as shown in flowchart 1.

Subsequently, after the critical analysis of the selected articles, carried out by an independent researcher, the works were classified by author, year of publication, objective, type of study and sample size.

Flow chart 1 – Method of Selection of Studies Included in the Integrative Review.



Source: Authors, 2025.

RESULTS

Based on the search strategy and after selection and analysis of the eligibility criteria, about 08 studies met all the criteria and were incorporated into this review. Table 1 presents the methodological characteristics of the included studies. It is important to note that most of the searches were obtained from the Pubmed database (83.3%) and consisted of Randomized Clinical Trial studies (50.0%).

Table 1. Methodological characteristics of the studies included in the integrative review.

Author/ Year	Study Type	Periodic	Database
Verschuur et al., 2019	Randomized Clinical Trial	N Engl J Med	PUBMED
Popa et al., 2020	Study Retrospective	Medicine	PUBMED
Simuni et al., 2020	Randomized Clinical Trial	Annals of Internal Medicine	LILACS
Jiang et al., 2020	Systematic Review and Meta-analysis	Aging Clin Exp Res	PUBMED
Mehta et al., 2021	Randomized Clinical Trial	Neurol Ther	PUBMED
Wang et al., 2022	Retrospective Cohort Study	Eur J Neurol	PUBMED
Santos-García et al., 2023	Randomized Clinical Trial	Parkinsonism Relat Disord	PUBMED
González-May et al., 2024	Systematic Review	Nutr Res	PUBMED

Source: Authors, 2025.

Chart 1 shows the characteristics of the treatments performed in the included studies. It is verified that 4,764 individuals were evaluated, most of whom were male, aged between 50 and 70 years. Among the medications used, levodopa was most prominent, both in monotherapy and in combination with another drug.

Table 1. Characteristics of Parkinson's treatments used in the studies.

Author/ Year	Sample	Treatment Used	Dosage and Treatment Time
Verschuur et al., 2019	No: 445 Gender: 69.8% men Age: 65 years old	Levodopa Carbidopa Placebo	Levodopa Dose: 100mg – 3 times/day Carbidopa Dose: 25 mg – 3 times/day Duration: 40 weeks

Popa et al., 2020	No: 61 Gender: 68.9% men Age: 70.4 years	Levodopa-Carbidopa (Intestinal Gel) Levodopa-Carbidopa (oral)	NR
Simuni et al., 2020	No: 336 Gender: 68.0% men Age: 62 years	Isradipine Placebo	Dose: 5 mg - 2 times/day Duration: 36 months
Jiang et al., 2020	No.: 2.008 Gender: NR Age: 50 to 66 years old	Levodopa Selegiline + Levodopa	Selegiline Dose: 1 to 10 mg Levodopa dose: 300 to 750 mg Duration: 2 to 60 months
Mehta et al., 2021	No: 196 Gender: 54.0% Age: 64.2 years	Amantadine (Gocovri ®) Placebo	Dose: 274 mg – 1 time/day Duration: 12 weeks
Wang et al., 2022	N: 1.526 Gender: 53.0% men Age: 69.0 years	Amantadine (Gocovri ®) Levodopa	NR
Santos-García et al., 2023	N: 63 Gender: 68.3% men Age: 63.9 years	Levodopa	NR
González-May et al., 2024	No: 129 Gender: NR Age: 69 years old	Flavonoids	Dose: 2.6 to 10.7 mg of flavonoids

Legend: NR: not reported. Source: Authors, 2025.

The reviewed studies show that levodopa, alone or in combination with other medications, is effective in controlling motor symptoms, but does not alter the progression of Parkinson's disease. Intrajejunal therapy improves motor fluctuations in advanced stages, whereas combination with selegiline is more effective than monotherapy. The response to levodopa remains consistent in the long term, and flavonoids, present in foods such as cocoa, can complement treatment, reducing motor symptoms and the risk of progression. Isradipine, however, has not shown benefits in the progression of the disease. Amantadine has been shown to be effective in improving dyskinesia, depressed mood, and daytime sleepiness.

Chart 2 shows the main observations found after analyzing the treatments performed in the studies included in this review.

Table 2. Effects of treatments used in the studies included in the integrative review.

Author/ Year	Treatment Effects
Verschuur et al., 2019	Treatment with levodopa at a dose of 100 mg three times daily in combination with carbidopa at a dose of 25 mg three times a day had no disease-modifying effect, either beneficial or harmful.
Popa et al., 2020	Continuous intrajejunal infusion of levodopa-carbidopa intestinal gel ensures a clinically significant reduction in motor fluctuations compared to oral therapy in advanced Parkinson's disease.
Simuni et al., 2020	Long-term treatment with immediate-release isradipine did not slow the clinical progression of early-stage Parkinson's disease.
Jiang et al., 2020	Selegiline + Levodopa combination therapy is superior to Levodopa monotherapy for the improvement of clinical symptoms in patients with Parkinson's disease. In addition, the safety profile of Selegiline + Levodopa combination therapy is comparable to that of Levodopa monotherapy.

Mehta et al., 2021	In addition to significant improvements in dyskinesia and OFF time with Gocovri, study participants also experienced improvement in depressed mood and daytime sleepiness.
Wang et al., 2022	Early treatment with amantadine may delay the onset of levodopa-induced dyskinesia.
Santos-García et al., 2023	There was a median response to levodopa, stable, and in fact, more than 70% of patients showed a good response after a 4-year follow-up.
González-May et al., 2024	Higher consumption of total flavonoids and their subclasses, anthocyanins, or foods rich in them (apples, red wine, blueberries, and strawberries) reduce the risk of developing Parkinson's disease and its mortality.

Source: Authors, 2025.

DISCUSSION

The reviewed studies present complementary and, in some cases, divergent perspectives on the management of Parkinson's disease (PD), addressing aspects related to the efficacy of different interventions, safety, and impact on disease progression.

Verschuur *et al.* (2019) and Simuni *et al.* (2020) investigated treatments with a potential PD progression-modifying effect, but both studies found no evidence to do so. Verschuur *et al.* (2019) evaluated levodopa, combined with carbidopa, in patients with early PD, showing significant improvement in motor symptoms in the initial phase of treatment, but with no impact on disease progression after 80 weeks. Similarly, Simuni *et al.* (2020) did not identify neuroprotective benefits with long-term use of isradipine, suggesting that the doses employed may have been insufficient. These findings reinforce that, although effective in symptomatic management, these interventions do not significantly alter the course of PD.

On the other hand, Santos-García *et al.* (2023) demonstrated that the efficacy of levodopa in relieving motor symptoms remains consistent in the long term, even in patients with motor fluctuations. This study highlighted the stability of the clinical response to levodopa, corroborating its importance as a therapeutic basis and reinforcing the need to consider its efficacy before the indication of invasive treatments, such as deep brain stimulation.

Jiang *et al.* Wang et al. (2020) broadened this discussion by showing that the combination of levodopa with selegiline offers additional advantages over levodopa monotherapy, with a more significant reduction in motor and non-motor symptoms, and overall Parkinson's Disease Rating Scale scores. These findings suggest that combined strategies can enhance therapeutic benefits without compromising treatment safety.

In contrast to traditional pharmacological approaches, González-May *et al.* Wang et al. (2024) explored the role of polyphenols in PD management, noting modest improvements in motor symptoms and potential benefits in disease progression due to the

antioxidant and neuroprotective properties of these compounds. However, the impact on non-motor symptoms, quality of life, and mood was limited, and adverse events such as nausea and dizziness were more frequent with curcumin and licorice interventions.

Finally, Popa *et al.* (2020) highlighted the clinical superiority of intrajejunal gel (LCIG) administration of levodopa-carbidopa compared to the oral route in patients with advanced PD. The group treated with LCIG showed a significant reduction in motor fluctuations, dyskinesia, and wearing-off episodes, demonstrating greater stability in motor symptoms and improvement in functionality. However, anxiety disorders were more prevalent in this group, signaling the need for careful monitoring.

Mehta *et al.* (2021) and Wang *et al.* (2022) explored the effects of amantadine in different PD contexts, highlighting its potential impact on motor and non-motor symptoms. Mehta *et al.* (2021) evaluated the effects of extended-release amantadine (Gocovri) on non-motor PD symptoms, using Part I of the MDS-UPDRS. Patients randomized to receive Gocovri or placebo had, at baseline, symptoms such as sleep problems, daytime sleepiness, pain, and fatigue, significantly affecting quality of life. The analysis revealed that in addition to improving dyskinesia and reducing OFF time, Gocovri also improved specific non-motor symptoms, such as depressed mood and daytime sleepiness. These results suggest a relationship between the reduction of motor complications and the improvement of non-motor symptoms, indicating comprehensive benefits of the drug in the management of PD.

On the other hand, Wang *et al.* (2022) investigated the association between early amantadine use and late onset of levodopa-induced dyskinesia in patients with early-stage PD. Comparing amantadine with other agents such as anticholinergics and MAO-B inhibitors, the results indicated that the use of amantadine significantly delayed the onset of dyskinesia in analyses performed at 6 and 12 months, with adjusted hazard ratios of 0.65 and 0.64, respectively. These data suggest that early treatment with amantadine may be more effective than other symptomatic drugs in preventing motor complications related to levodopa use.

Both studies highlight the therapeutic potential of amantadine, both in reducing motor symptoms and improving non-motor aspects of PD. In addition, they reinforce the need for additional studies to deepen the understanding of the mechanisms by which amantadine influences these symptoms and to validate its applications in the clinical management of PD.

Overall, studies indicate that while levodopa remains the therapeutic mainstay for PD, combination approaches, such as with selegiline or LCIG, and complementary

interventions, such as polyphenols, may offer additional benefits. However, the absence of disease-progression-modifying impact in investigated interventions underscores the need for further studies, especially those exploring different doses, duration of treatment, and therapeutic combinations.

CONCLUSION

The reviewed studies highlight important advances in the management of Parkinson's disease (PD), while also highlighting limitations in the current ability to modify disease progression. Levodopa remains the most effective therapeutic mainstay, with sustained efficacy over time, both alone and in combination with other agents such as selegiline or in advanced formulations such as intrajejunal gel. Amantadine has also shown significant benefits, including improvement of motor and non-motor symptoms and the potential to delay levodopa-induced dyskinesia.

However, alternative strategies, such as the use of polyphenols, showed more modest results and limiting adverse effects. In addition, investigated interventions with neuroprotective potential, such as isradipine and levodopa in early stages, have not demonstrated an impact on modifying PD progression.

These findings reinforce the need for further research on combined approaches, innovative therapies, and adjustments in doses and durations of treatments. Although symptomatic management of PD has progressed, achieving interventions that effectively modify the course of the disease remains a central challenge.

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PRESSURE INJURY IN HOSPITALIZED ELDERLY

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ABSTRACT

The study aims to analyze cases of pressure injury in elderly patients admitted to a reference hospital in Recife from 2021 to 2023, describe the number of cases of pressure injury in hospitalized elderly people, and analyze which regions of the body have the highest prevalence of pressure injury. This is a descriptive and retrospective cross-sectional

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research, with a quantitative approach, where data analysis of elderly people in hospitalization from January 2021 to September 2023 was carried out. Age, gender, region of the body with pressure injury, hospitalization sector, and degree of pressure injury were observed. The study had a sample of 175 participants, of which women constituted the majority, of which 204 pressure lesions were analyzed, which was predominantly located in the sacral region in all sectors analyzed. It is concluded that the sacral region was the place most exposed to continuous and intense pressure, demonstrating failures in patient management recurrently by professionals or a limitation of the team in performing effective decompression due to lack of appropriate strategies for the patient.

Keywords: Pressure Ulcer. Assistance to the Elderly. Hospitalization.

INTRODUCTION

The increase in the life expectancy rate and decrease in the mortality rate that occurs in the country causes a significant increase in the number of elderly people (Oliveira, 2019). Population aging should be carefully observed by the health sectors, as the aging process provides morphological and physiological changes in the epidermis and dermis, causing skin fragility, increasing the chances of developing chronic and degenerative diseases, and restricting movement. These characteristics common to aging are considered factors that weaken skin functions and favor the appearance of lesions (Levine, 2020; Martins *et al.*, 2021; Souza *et al.,* 2017).

Among the injuries common to the public are pressure injuries (LP), which are iatrogenic and likely to occur. LP are caused by intense and prolonged pressure on the skin, which usually appear over a bony prominence or related to the use of a medical device (NPUAP, 2016). It is noteworthy that, when analyzing the development of LP during hospitalization, it is observed that the elderly are more likely to develop this iatrogenic disease (Jesus *et al.*, 2020).

It should be emphasized that PF has multifactorial causes, and is also associated with preexisting diseases, medication use, smoking, alcoholism, diaper use, movement restriction, surgical procedures, impaired tissue integrity, obesity, decreased level of consciousness, patient hygiene status, length of hospital stay, among other factors, which are commonly associated with the elderly (Frazão, Moraes, Reis, Silva, 2019; Souza *et al.*, 2017).

Therefore, in response to the need for actions to reduce the incidences of LP and other iatrogenesis, the Ministry of Health in 2013 instituted, through Ordinance No. 529/2013, the National Patient Safety Program, which advocates risk management through the promotion of quality and safety for the patient in all health spaces (Brasil, 2013).

In addition, based on Resolution No. 36, of July 25, 2013, of the Collegiate Board of the National Health Surveillance Agency (ANVISA), the six goals of the World Health Organization (WHO) are adopted as the scope of action for events associated with health care, which aim to ensure the dissemination of the patient safety culture. Prevention of LP is one of these actions, being one of the concerns of the national patient safety program (PNSP) (ANVISA, 2013; Brazil, 2014).

Given the different risks associated with health care, each health service must have its own patient safety plan, which must contain the characteristics of the service and the possible risks that the patient may be exposed to (Brasil, 2013).

Therefore, in order to prevent the emergence of pressure injuries in a health institution, it is necessary to know the risk factors that patients are subjected to within the service. The study was carried out in a hospital that offers care in the specialties of neurology, neurosurgery and cardiology, has 180 beds, of which 30 are in the intensive care unit (ICU).

Therefore, the study aimed to analyze the cases of pressure injuries in hospitalized elderly, describing the frequency of pressure injuries in this population in different sectors of the hospital and analyzing the characteristics of these injuries (regions of the body with the highest prevalence of PF and staging).

METHODOLOGY

This is a cross-sectional, descriptive and retrospective study, with a quantitative approach. The research was carried out through the analysis of the database of the skin care sector of a reference hospital in neurology, neurosurgery and cardiology located in Recife, Pernambuco. The hospital has 180 beds, of which 30 are in Intensive Care Units (ICU).

Data from older adults who were hospitalized at some point between January 2021 and September 2023 were analyzed. To enter the study, individuals needed to be 60 years ≥ age during hospitalization and be hospitalized at some point in the period from 2021 to 2023. Patients who already had pressure injuries before admission were excluded. At the end of the analysis, the study sample consisted of 175 patients.

Of these 175 patients, age, gender, region of the body with pressure injury, hospitalization sector, and degree of pressure injury were observed.

The age variable was categorized every ten years, i.e., individuals aged 60 to 69 years were classified in the same category, as well as those aged 70 to 79 and 80 to 89. Patients aged ≥ 90 years were the only exception, as there is a smaller number of individuals who fit into the age group of 90 to 100 and this number decreases when observed in individuals over 100 years old.

Regarding gender, the participants were categorized as male or female. Pressure injury regions were classified into 12 regions: sacral, gluteal, intragluteal, calcaneal, trochanteric, malleolus, scapula, pinna, thigh, knee, olecranon, palm.

Regarding the hospitalization sector, they were separated into: cardiology, neurology, neurosurgery, neurological intensive care unit (ICU), cardiology ICU, red, yellow 1 and yellow 2 rooms, that is, in total the participants were allocated to 8 sectors.

The cardiology, neurology, and neurosurgery sectors are wards, while the red, yellow 1, and yellow 2 sectors are subdivisions of the emergency room.

Finally, the staging of pressure lesions was observed, for staging, categorization was performed as grade 1, grade 2, grade 3, grade 4, unclassifiable, deep tissue and not informed.

Data analysis was performed using the *google spreadsheets* tool, where the data was placed in the spreadsheet to describe the data and organize it in tables and charts.

The study was approved by the Research Ethics Committee of the Academic Center of Vitória - Federal University of Pernambuco (CAAE: 76991323.8.0000.9430 and opinion number: 6.775.679).

RESULTS

Among the 175 elderly people evaluated, 88 (50.3%) were female and 87 (49.7%) were male, regarding age, most participants were in the age group of 70 to 79 years (71) and the age group of 90 years or older had the lowest number of participants (8). When analyzing the gender and age of the patients, the number of female patients predominated as they advanced (Table 1).

Table 1. Population characteristics, Recife/Pernambuco, 2024

Age	Middle Ages	Men (N= 87)		Women (N= 88)		Total
		n	n (%)	n	n (%)	
60-69	64,8	32	52,5	28	47,5	61
70-79	74,9	36	50,7	35	49,3	71
80-89	83,8	17	47,2	19	52,8	36
≥ 90	95,4	2	25	6	75	8

Source: Authors, 2024.

In all, 204 pressure injuries were analyzed in 12 regions, of which the sacral (51.9%) and gluteal (16.7%) regions represent the sites most frequently committed by pressure injuries, and the classification of injuries as grade 2 (63.7%) is the most prevalent (Chart 1).

It is noteworthy that 3 pressure injuries do not have the identification of the site, and the staging of 8 lesions has not yet been reported.

Table 1. Number of pressure injuries in relation to body region and their respective degree, Recife, Pernambuco, 2024.

Regions of the body with LP (n)	Degree of injury	Quantity (N= 204)
Sacral Region (106)	Grade 1	6
	Grade 2	63
	Grade 3	16
	Grade 4	5

	Unsortable	12
	Deep Tissue	1
	Not informed*	3
Gluteal Region (34)	Grade 1	3
	Grade 2	24
	Grade 3	3
	Grade 4	2
	Not informed*	2
Intragluteal (19)	Grade 2	16
	Grade 3	1
	Grade 4	1
	Unsortable	1
Calcaneus (13)	Grade 1	3
	Grade 2	5
	Unsortable	4
	Deep Tissue	1
Thigh (1)	Grade 2	1
Scapula (4)	Grade 1	2
	Grade 2	2
Knee (1)	Grade 2	1
Malleolus (9)	Grade 2	7
	Not informed*	2
Olecrano (1)	Not informed*	1
Palm (1)	Grade 1	1
Pinna (2)	Grade 2	2
Trochanteric (10)	Grade 1	1
	Grade 2	8
	Unsortable	1
Location not specified (3)	Grade 2	1
	Grade 4	1
	Unsortable	1

*There was no information on the degree of the lesion in the database.
Source: Authors, 2024.

When analyzing the sector and the number of elderly patients hospitalized with pressure ulcers, as shown in Table 2, it can be seen that the cardiology sector (83.5) has the most advanced patients, followed by yellow 2 (77.9) and yellow 1 (76.2).

Neurology has the highest number of patients with pressure injuries (60) and is the largest sector with PL (69), but it is yellow 2 that has the highest average number of pressure injuries per individual (1.5), followed by red room (1.3), yellow 1 (1.2) and neurology (1.2). The sacral region and grade 2 classification were the most prominent across all sectors.

Table 2. Sector and number of patients hospitalized with pressure injuries, Recife, Pernambuco, 2024.

Sector	Middle Ages	Patients (N= 178)		Pressure injuries (N=204)			
		M	H	Number of injuries per sector[1]	Most common region (n)	Most common grade (n)	Number of average lesions per patient*
Yellow 1[2]	76,2	3	3	7	Sacred (4)	Grade 2 (5)	1,2
Yellow 2[2]	77,9	9	4	19	Sacred (8)	Grade 2 (13)	1,5
Neurosurgery[3]	72,9	12	10	22	Sacred (11)	Grade 2 (12)	1
Cardiology[3]	83,5	1	1	2	Glutes and sacral (1)	Grade 2 (2)	1
Neurology[3]	75,4	33	27	69	Sacred (33)	Grade 2 (44)	1,2
Red room[2]	74,4	14	24	49	Sacred (29)	Grade 2 (32)	1,3
Neurological ICU	71,1	12	9	23	Sacred (14)	Grade 2 (14)	1,1
Cardiology ICU	69,9	4	9	13	Sacred (6)	Grade 2 (7)	1

[1]Refers only to the number of pressure injuries. [2] Subdivision of the emergency sector. [3] Wards.
Source: Authors, 2024

DISCUSSION

Pressure ulcers affect individuals regardless of age, however, with advancing age there are a series of morphophysiological changes that lead to frailty and incidence of injuries, and it is still common for the elderly to have chronic diseases that cause greater health fragility in this age group (Alves *et al.*, 2022; Levine, 2020).

In the present study, it was observed that most of the population was made up of women. The predominance of females in advancing age in the study is also observed in similar studies that observe the incidence of pressure injuries in the elderly, the behavior may be associated with a greater demand by women for health services when compared to males (Barbosa and Faustino, 2022; Palmeira *et al.*, 2022; Thumé, Roland, Poll, 2021).

Furthermore, the occurrence of the predominance of women in the study may be related to the fact that the female gender is reported as a risk factor, as found in another study (Barbosa and Faustino, 2022).

In addition, the male public is associated with a lifestyle with health risk behaviors (Bibiano *et al.,* 2019). On the other hand, studies on the incidence of PL in adults and the elderly have shown that males are the majority (Alves *et al.*, 2022; Frederico, Mendonça, Carvalho, 2024).

It is analyzed that the highest rate of hospitalization of males occurred in the age group of 50 to 59 years and men aged 20 to 59 years have higher morbidity and mortality when compared to females, which may explain the higher incidence of PL in the male public in studies that analyze adults and the elderly (Brasil, 2018).

Regarding the site of appearance of pressure lesions, it was noted that it varies depending on the study analyzed, considering that PF is caused by continuous and intense pressure on a certain point of the skin (NPUAP, 2016).

Regarding the profile of the hospital analyzed, it was possible to verify that PF in the sacral region is predominant. Corroborating other studies that also present the sacral region as the most prevalent site, it is noteworthy that the gluteal and occipital regions are also reported with great frequency (Alves *et al.,* 2019; Jesus *et al.*,2020; Lima, Araújo, Simonetti, 2023).

Still on PL, the most commonly found staging was grade 2, the finding is also reported by other studies, which analyzed the incidence of PF (Alves *et al.,* 2019; Frederico, Mendonça, Carvalho, 2024; Lima, Araújo, Simonetti, 2023). Furthermore, the appearance of multiple pressure lesions in an individual is also described in another study, which noted that most patients developed only 1 or 2 PF (37.5%) while 12.5% had 4 or 7 lesions in the postoperative period of cardiac surgeries.

It should be noted that, in the present study, the sectors associated with cardiology had an average of 1 PL per individual and only the sectors linked to emergency (yellow 1, yellow 2 and red room), neurology and the neurological ICU had an average of more than 1 PL per individual (Lima, Araújo, Simonetti, 2023).

With regard to cardiology, having the number of older patients hospitalized when compared to the other sectors may be related to the fact that cardiac morbidities are one of the most common causes of hospitalization among the elderly public (Barbosa and Faustino, 2022). As for cardiology having the lowest prevalence of elderly hospitalized patients with PF, it may be associated with something observed in a study that analyzed that the incidence of PF in cardiac surgeries corresponds to less than 10% of the cases, with a greater association between the appearance of PF and plasma infusion than with the surgical procedure (Lima, Araújo, Simonetti, 2023).

It should be noted that patients who developed pressure injuries have a higher risk of dying (Lima, Araújo, Simonetti, 2023; Song *et al.,* 2019). It is also observed that pressure injuries after cardiac surgical procedures have statistically significant associations with operative complications such as: arrhythmias, cardiorespiratory arrest, Sepsis, Delirium, assistance-related infection, hypotension, and anemia (Brazil, 2018).

In relation to the neurology sector, it is possible to note the high number of patients hospitalized in the sector affected by PL, the data corroborates what was described by Souza, who described cognitive deficit and neurological impairment as factors that influence the development of pressure injuries (Souza *et al.*, 2017). It is also observed that patients undergoing neurological surgeries had a higher prevalence in the development of PL (Alves *et al.,* 2019).

The emergency sector, which was analyzed in a subdivided manner into yellow 1, yellow 2 and red room, is configured in the place with most users at high risk for the development of pressure ulcers. Sensory perception, skin moisture, activity, mobility, nutrition, friction and shear were factors of greater limitation in the emergency sector when compared to the inpatient sectors. Silva *et al.,* (2020) noted that the sectors related to the emergency room have the highest number of average LPs per patient, which may be related to the fact that the risk of developing pressure injuries within the emergency room was linear with increasing age.

CONCLUSION

In this study, it was possible to analyze that women constituted the majority of the participants, that in three years 175 hospitalized elderly developed 204 pressure injuries during hospitalization, most of which were located in the sacral region and classified as grade 2. In addition, it was observed that, regardless of the hospitalization sector, the sacral region and grade 2 classification was predominant.

Thus, it can be concluded that the sacral region was the site most exposed to continuous and intense pressure, thus leading to the development of pressure ulcers. Therefore, it is interesting to reevaluate strategies used to decompress the region and think of new ways to prevent the presence of LP.

The present study has limitations, considering that it was based on data from a database, some incomplete information was found in relation to the site of the pressure injury, staging of the lesion and no information was found about the patient's length of hospital stay.

Finally, it is hoped that the study can contribute to the improvement of the hospital's patient safety plan and to the development of new strategies for the prevention and treatment of PL.

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USE OF OSIMERTINIB 160mg FOR TREATMENT OF NSCLC: CASE REPORT

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ABSTRACT

Introduction: Lung cancer is the most prevalent cancer in the world, and it is also the cancer with the highest mortality. Non-small cell lung cancer (NSCLC) accounts for 85% of cases, and is related to bone metastases in the central nervous system (CNS), and liver. It is known that a large part of the mutations involved in the development of NSCLC is the mutation in the epidermal growth factor receptor (EGFR) gene, leading to the production of EGFR with permanent activation, and thus, generating a lack of control over cell growth pathways. Thus, drugs capable of blocking the mutated EGFR receptor and reversing the constitutive activation of the receptor have been developed. Currently, the drugs available with this capacity are tyrosine kinase inhibitors (TKIs), including osimertinib (third-generation TKI), which has the ability to act on EGFR T790M mutations, and penetrate the blood-brain barrier, allowing the treatment of leptomeningeal and brain metastases. Currently, osimertinib is used in doses of 80 mg for the treatment of NSCLC with CNS metastasis resistant to first- and second-generation TKIs, and there are few studies on therapeutic and side effects at higher doses. Thus, the present case report seeks to elucidate the effects caused by osimertinib 160mg on NSCLC associated with meningeal metastasis and to understand the side effects observed with the increase in the dose of the drug. Case report: A 53-year-old female patient diagnosed in 2018 with NSCLC with EGFR mutation and meningeal metastasis. She used osimertinib 80 mg, with tumor growth in the lung and meninges. In 2020, the dose was increased to 160 mg after developing meningeal syndrome and observing the presence of tumor cells in cerebrospinal fluid. The patient developed adverse reactions to the medication and dose increases. She presented clinical worsening at the end of 2021, evolving to death in 2022. Conclusion: Osimertinib 160mg has high efficacy for the control of neoplasms and metastases with EGFR mutations, and more intense side effects than the usual dose, and further studies are needed to understand the efficacy of the drug in meningeal metastases in the long term.

Keywords: Antineoplastic drugs. Non-small cell lung carcinoma. Meningeal neoplasms.

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INTRODUCTION

Lung cancer is the most prevalent malignant disease in the world, accounting for 13% of cancer diagnoses. In Brazil, it is the second most common type of cancer in men, and the fourth in women. Lung cancer is also the leading cause of mortality among types of cancer, responsible for 1.8 million deaths per year worldwide. In Brazil, the 5-year survival rate is 18%, close to global averages (10% to 20%) (ARAUJO *et al*., 2018). Non-small cell lung cancer (NSCLC) accounts for 80-85% of lung cancer cases, 30% to 40% of people with NSCLC develop bone metastasis over the course of the disease (RAJAPPA; KRISHNA; NARAYANAN, 2019) and, 20% to 40% develop metastasis in the central nervous system (CNS) (LEE *et al*., 2019).

Epidermal growth factor receptor (EGFR) mutation is present in 11% to 43% of NSCLC cases (OH *et al*., 2019), in bone metastases (HIGUCHI *et al*., 2020), and in leptomeningeal and brain metastases (RAJAPPA; KRISHNA; NARAYANAN, 2019). EGFR is a tyrosine kinase receptor of the ErbB family that is activated by epithelial growth factors (EGF) and induces cell division. Mutations in EGFR genes lead to constitutive activation of the receptor and uncontrolled activation of cell division pathways, which can lead to cancer development and progression (RAJAPPA; KRISHNA; NARAYANAN, 2019). Deletion mutations in exon 19 and point mutations in exon 21 are the most common mutations in the EGFR gene. In these cases, treatment with first- and second-generation EGFR-tyrosine kinase inhibitors show satisfactory responses (OH *et al*., 2019). In some cases, resistance mechanisms are acquired, reducing the action of first and second generation EGFR-tyrosine kinase inhibitors. The EGFR Thr790Met mutation (T790M) is the most common mechanism of resistance, present in 48 to 62% of cases (PROVENCIO *et al*., 2021). Other mechanisms such as amplification of the proto-oncogene MET, human epidermal growth factor 2 (HER2), and hepatocyte growth factor (HGF) are present in 20 to 30% of mutations. With the development of mutations and the failure of the therapeutic regimen of first- and second-generation drugs, third-generation EGFR-tyrosine kinase inhibitors selective for mutations in T790M have been developed, with osimertinib being the only drug currently approved by the Food and Drug Administration (FDA) (OH *et al*., 2019). Osimertinib is an irreversible EGFR-tyrosine kinase inhibitor selective for EGFR and T790M (PROVENCIO *et al*., 2021), being able to penetrate the blood-brain barrier (BBB) (SAKURAI; TUCHIDA; NISHIDA, 2021). The passage of the drug through the BBB demonstrated activity on leptomeningeal and brain metastases with mutations in EGFR T790M. The AURA 3 study demonstrated that the objective response rate for brain metastases is 70% with osimertinib,

versus 31% with the dual regimen of platinum-based chemotherapy (RAJAPPA; KRISHNA; NARAYANAN, 2019).

The AURA 3 study demonstrated a significant increase in progression-free survival in patients using osimertinib (10.1 months) when compared to using platinum-based chemotherapy (4.4 months), and increased progression-free survival in patients with central nervous system metastases. AURA 3 revealed that the time for the onset of the main symptoms of deterioration was longer in patients who used osimertinib, increasing the quality of life and overall quality of the individual (RAJAPPA; KRISHNA; NARAYANAN, 2019). OH *et al*., 2019 observed that the mean progression-free survival time in patients who used osimertinib 80 mg/day orally was 7.4 months, and after 12 months, 24.1% of the patients remained without disease progression. After disease progression, it was observed that the T790M mutation became undetectable in 70% of patients (OH *et al*., 2019).

NSCLC metastases often involve mutations in EGFR genes. Vascular endothelial growth factor (VEGF) is overexpressed in NSCLC tumors, and contributes to tumor growth. VEGF inhibition is an attempt to reduce tumor growth and decrease tissue action. The study by HIGUCHI *et al*., 2020 compared the treatment efficiency of osimertinib in contrast to bevacizumab, an anti-VEGF monoclonal antibody, in rodents with bone metastases by NSCLC. The study observed that there is a significant difference in tumor evolution between treatments, with a reduction in the presence of tumor cells in rodents treated with osimertinib, and an increase in survival time compared to those treated with bevacizumab (HIGUCHI *et al*., 2020).

In patients with leptomeningeal metastasis, osimertinib is administered at a dose of 160 mg in an attempt to increase the concentration of the drug in the cerebrospinal fluid. The study by PARK *et al*. (2020), demonstrated that 75% of patients who developed leptomeningeal metastasis during treatment with osimertinib 80 mg had the disease controlled with the use of 160 mg of the drug. During treatment, it was observed that patients have greater progression of extracranial lesions than intracranial lesions, but there are disagreements between the site with the best response (PARK *et al*., 2020).

The most common adverse effects reported by the use of 80 mg osimertinib include diarrhea, pruritus, paresthesia, erythematous plaques, rashes, stomatitis, and nausea (FANG *et al*., 2019), effects such as skin rash, loss of appetite, thrombocytopenia, and leukopenia may also be observed during treatment (WANG; CANG; LIU, 2016).

Based on the studies presented, this study proposes the comparison of efficacy, side effects and modifications of the organism with the use of 160 mg of the drug osimertinib, since the use of 160 mg of osimertinib for the treatment of NSCLC with metastasis in the

leptomeninges is still little reported in recent studies, with a lack of information on the efficacy of the treatment. side effects and effects not yet well clarified with the use of the dose. A better understanding of the body's response to NSCLC treatment with osimertinib 160 mg will allow the evaluation of effectiveness, anticipation of probable side effects, and the best therapeutic choice for the patient. The information obtained from the proposed work will allow the comparison of the use of 80 mg, usually described in studies, with the use of 160 mg of osimertinib, in order to understand the differences in therapeutic effect and side effects related to the different doses.

METHODOLOGY

A description of the history of the patient diagnosed with NSCLC was performed, with metastasis in the leptomeninges and submission to treatment with osimertinib 160 mg per day. Clinical data were collected from the patient's follow-up records, laboratory and radiological tests performed during the period, upon acceptance of the informed consent form by the patient, and with authorization from the place where the data were collected. As there are few conclusive studies on the efficacy of Osimertinib 160mg for the treatment of EGFR-mutated NSCLC (del19), and side effects of the drug, the evolution of the disease, efficacy of the treatment and side effects reported by the patient have been described in detail. The case report project was approved by the CEP. CAAE: 59936022.6.0000.5539. Opinion number: 5.529.386.

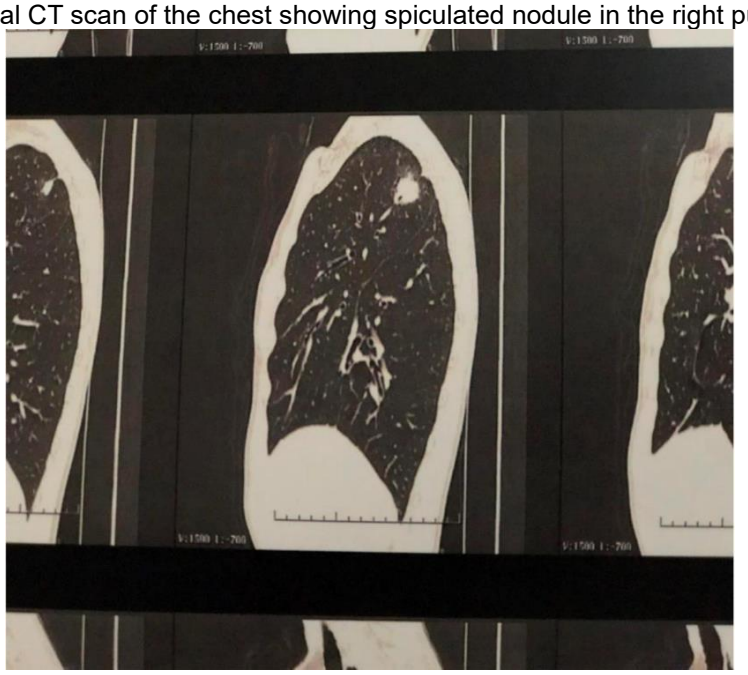
DEVELOPMENT

A 53-year-old female patient was diagnosed with non-small cell lung cancer, mutated EGFR adenocarcinoma (exon 19 deletion) associated with meningeal metastasis. The patient sought medical care on 07/18/2018, in which she reported diffuse low back pain, vertigo and unilateral hypoacusis. Previously performed NB (degenerative discopathy), and bone scintigraphy was requested. Computed tomography previously performed showed findings of pulmonary masses and CNS involvement.

On 07/24/2018, a chest CT scan was performed, showing a nodular lesion in the right lung apex, in a posterior situation, there is a nodular, spiculated and imprecise lesion, measuring approximately 24.3 x 22.1 x 21.2 mm (Figure 1). A lesion with a similar appearance is found in the anterior segment of the upper lobe of the left lung, measuring 11 x 10 x 9 mm (Figure 2). Other portions of the lung parenchyma showed normal attenuation, with no evidence of consolidative lesions, nodules, or interstitiopathies. Leading to the diagnostic impression of spiculated and imprecise nodules located in the upper lobes of

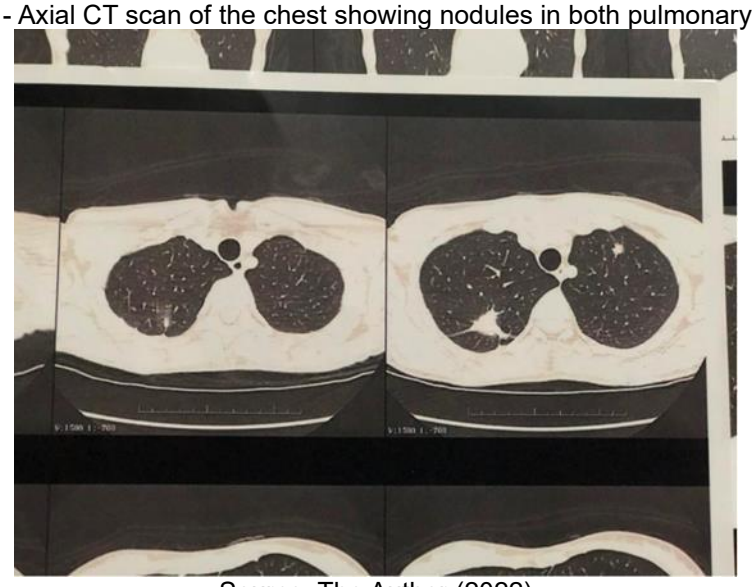
both lungs, and with the other characteristics described above. A better diagnostic investigation is indicated.

Figure 1 - Sagittal CT scan of the chest showing spiculated nodule in the right pulmonary apex.



Source: The Author (2022)

Figure 2 - Axial CT scan of the chest showing nodules in both pulmonary apexes.

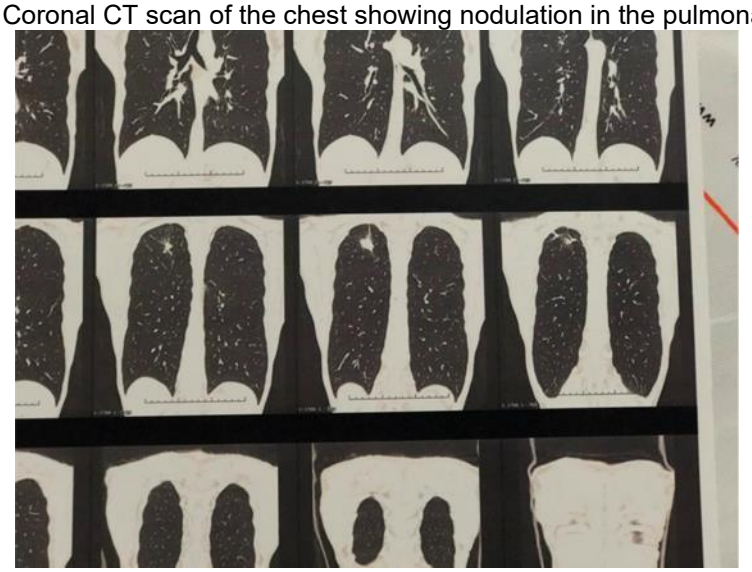


Source: The Author (2022)

On 07/27/2018, a positron emission tomography/computed tomography (PET/CT) scan, and a percutaneous computed tomography-guided biopsy/drainage were performed, due to a history of pulmonary nodule evaluation. Report, two solid pulmonary nodules with spiculated contours located at the right apex measuring 2.8 x 2.4 cm and at the left apex (Figure 3) measuring 1.2 x 0.9 cm, with increased metabolism (maximum SUV 6.8 and 2.1 cm, respectively). Additional TC findings without metabolic alterations: Smooth thickening of

the interlobular septa at the apices. Calcified pulmonary granuloma in LSE (sequelae). Some rare sparse, punctiform, non-calcified solid pulmonary nodules measuring less than 4 mm. Diagnostic impression: 1. two pulmonary nodules, with increased metabolism, suspicious for neoplasia. The one on the right was biopsied on the day.

Figure 3 - Coronal CT scan of the chest showing nodulation in the pulmonary apices



Source: The Author (2022)

Osimertinib was started on 08/04/2018 with a conventional dose of 80mg/day, after confirmation of metastasis in the central nervous system (CNS) - meningeal carcinomatosis - through oncotic cerebrospinal fluid cytology, in which the presence of EGFR mutation with exon 19 deletion in metastatic cells in the meninges was found. With the initiation of the medication, the clinical picture and the evolution of the disease were stabilized, with no other symptoms associated with NSCLC or metastasis in the meninges.

26 months after the start of treatment with Osimertinib 80mg/day, the patient underwent a new oncotic cytopathology of the cerebrospinal fluid in September 2020, after developing symptoms of meningeal syndrome, characterizing disease progression. The examination identified isolated cells, with the presence of atypia and cells in cell division, which is a positive characteristic for malignancy. On the date of collection, the patient had a stage of pulmonary adenocarcinoma (CAC) IV. Due to the condition developed by the patient, and the clinical evolution of disease progression, treatment with an increase in the dose of Osimertinib to 160mg/day was instituted on 10/03/2020, associated with the use of corticosteroids.

After 9 months of using Osimertinib 160mg, the patient reported paresthesia on the face, with predominance on the right side, visual acuity in the right eye, and pressure in the head region. In addition, a skin rash was observed in the dorsal region of the forearm and

bilateral periorbital edema. With the increase in the dose from 80mg to 160mg, it was possible to observe the same side effects as the initial dose, but more exacerbated. On physical examination, the patient had GTR and LOT, bilateral periorbital edema was observed, weight 43 kg, BMI 16.6 kg/m². EC IV (T2N0M1).

After 10 months of using the drug, the patient reported worsening of paresthesia in the face, and the appearance of paresthesia in the feet and hands. He reported worsening of visual acuity and worsening of hearing in the left ear. Improvement of the skin rash was observed. Serum samples were collected to evaluate the carcinoembryonic antigen (CEA), obtaining a result: < 1.73 ng/ml. Chest CT scan showed stable disease compared with previous CT, and abdominal CT showed no commemorative signs.

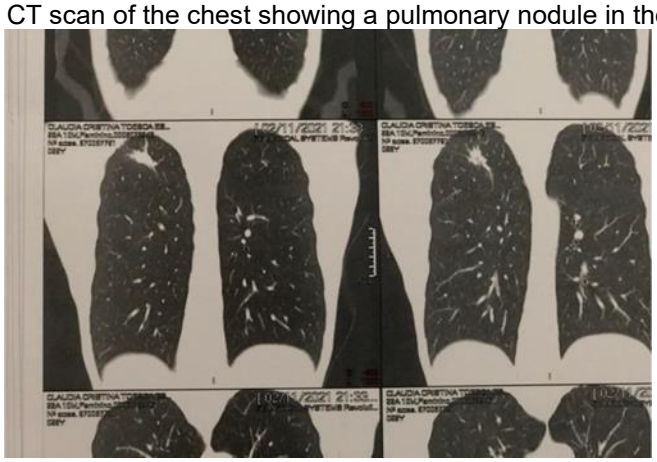
The patient was evolving well with the treatment, and the tumor had been encapsulated and had no significant changes in size. In 2021, the patient's condition was destabilized, it was thought to be related to side effects of the 3rd dose of the COVID-19 vaccine, being a condition of intense headaches, dizziness, vision alteration and partial hearing loss. Corticosteroids were then prescribed for symptomatic control. After a few months without improvement of the condition, a worsening of the meningeal metastasis was found after investigation: the patient returned to the doctor on 10/07/2021, reported having received the 3rd dose of the vaccine for COVID-19. In addition, she reported worsening of diplopia and balance, and increased syncope, in addition to severe headache. Due to the proximity of the vaccine, it was understood that the worsening of the condition would be related to this, but due to the lack of improvement and evolution, it was confirmed that these effects were due to an exacerbation of the meningeal metastasis. Recommended start of dexamethasone 4mg per day (09/22/2021). Laboratory tests showed pancytopenia and CEA < 1.73 ng/ml.

On 10/21/2021, the patient was consulted again, and improvement in the headache reported by the patient was observed, and the sensation of pressure in the head and paresthesia in the face persisted, in addition to diplopia and decreased visual acuity in the right eye. The laboratory test for CEA collection showed 2.58 ng/ml, indicating an increase in CEA compared to the previous consultation. On this occasion, he was instructed to wean off dexamethasone and perform tests to control the disease.

On 11/02/2021, a chest CT scan was performed, and the presence of non-calcified pulmonary nodules with irregular morphology associated with linear opacities in the posterior segment of the right upper lobe, measuring 23 x 20 mm in the axial plane, and in the anterior segment of the left upper lobe, measuring 8 mm in mean diameter (Figure 4). Millimetric calcified granuloma in the upper lobe of the left lung (Figure 5). Therefore, it was

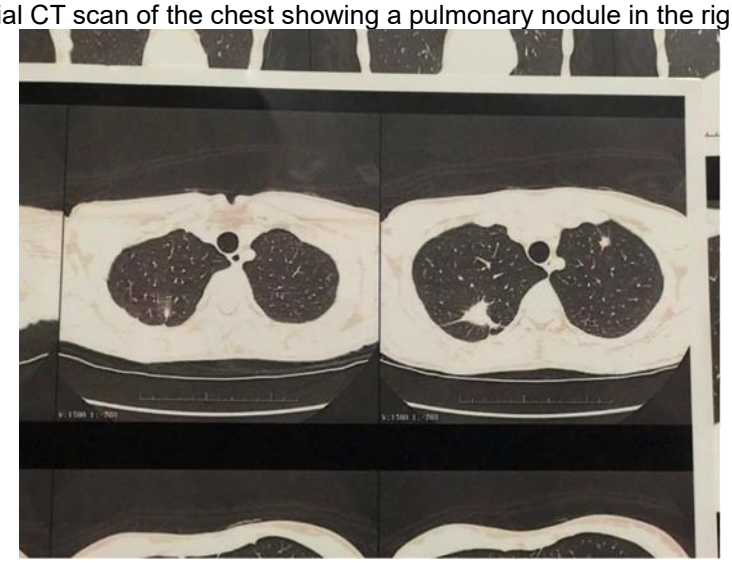
characterized that the examination does not present significant changes from other imaging studies performed previously, taking into account the findings described.

Figure 4 - Coronal CT scan of the chest showing a pulmonary nodule in the right upper lobe.



Source: The Author (2022)

Figure 5 - Axial CT scan of the chest showing a pulmonary nodule in the right upper lobe.



Source: The Author (2022)

The drug was not as effective in these final stages of treatment, the patient evolved with blindness, almost complete hearing loss, osteopenia, and an increase in pain intensity. A patient in November 2021 had to be bedridden, combining physiotherapy service and intravenous medications to control symptoms (corticosteroids and morphine), and it was no longer possible to use osimertinib due to the patient's impossibility of swallowing. In March, the patient began to have respiratory distress crises and reached a cachectic condition, requiring parenteral feeding when possible and oxygen therapy.

On 05/31/2022, the patient died due to complications from metastatic NSCLC to the meninges.

DISCUSSION

New scientific research on malignant neoplasms and the search for more modern treatments make it possible to increase overall survival and better prognosis of patients with this pathology. Cancer is responsible for the second leading cause of death in the world, with an annual incidence of 625 thousand new cases in Brazil (SOBRAL *et al*., 2022). Studies have shown an increase in the prevalence of neoplasms in the population, according to the increase in cardiovascular disease prevention policies. From this perspective, it is important that new antineoplastic drugs be developed and studied, supporting the clinical use in patients for the treatment of the disease. (BRAZIL, 2019).

Osimertinib, an oral drug, a third-generation EGFR tyrosine kinase inhibitor, was developed to combat neoplastic cells that have epidermal growth factor receptor (EGFR) mutation. The inhibitory action on EGFR tyrosine kinase prevents cell growth by suppressing the mutated protein, and thus inhibits the progression of the neoplasm. (ZHAO; CHEN, 2022). The relationship between non-small cell lung cancer (NSCLC) and EGFR receptor mutation is well-defined (OH *et al*., 2019), being present in 43% of lung adenocarcinomas and in meningeal metastases originating from NSCLC (RAJAPPA; KRISHNA; NARAYANAN, 2019). In the reported clinical history, the patient was diagnosed with adenocarcinoma NSCLC with EGFR mutation (del19) evaluated by immunohistochemical examination.

NSCLC is well described in association with the presence of brain metastases, meningeal (RAJAPPA; KRISHNA; NARAYANAN, 2019) and bone (HIGUICHI *et al*., 2020).

The metastases found usually have mutations in EGFR genes, and EGFR-tyrosine kinase inhibitors are used for the treatment and control of the disease. In cases of metastases in the meninges or brain, osimertinib is the drug of choice, as it is a third-generation EGFR-tyrosine kinase inhibitor, with a greater capacity to penetrate the blood-brain barrier and with better efficacy in treatment (SAKURAI; TUCHIDA; NISHIDA, 2021). Due to the presence of metastasis of NSCLC in the meninges, evidenced in an oncotic cytology examination of the cerebrospinal fluid, the medical team started treatment with Osimertinib 80mg, to stabilize the disease. In the following months, imaging tests revealed control of lung tumor size, with a mass of 24x22x21mm reported at the apex of the right lung lobe, on CT scans performed ten days before starting treatment (07/24/2018) with Osimertinib 80mg, in contrast to scans performed on 11/02/2021, using Osimertinib 160 mg, in which stabilization of the mass size (23x20mm) in the right lung lobe was observed.

In studies conducted using Osimertinib 80 mg, side effects experienced by patients included disseminated pruritus, stomatitis (FANG *et al*., 2019), inappetence, and skin rash

(PARK *et al*., 2020). In the case report described, after starting the use of Osimertinib 80mg, the patient reported xerostomia, paresthesia, and skin rash associated with the appearance of hyperemic plaques in the face, trunks, upper and lower limbs. Subsequently, with the need to increase the dose of osimertinib to 160 mg daily, the patient reported the maintenance of the side effects of the drug, highlighting the increase in the intensity of the sensation of paresthesia with progression to the hands and feet.

Carcinoembryonic antigen (CEA) is a glycoprotein that has a high serum concentration in the occurrence of production by the growing tumor. High CEA levels are related to tumor progression and a poorer prognosis. As a result, serum antigen evaluation aims to monitor tumor progression and the effectiveness of ongoing treatment (LAPORTE, 2019). Studies have shown that serum CEA levels > 10 ng/ml are related to poor prognosis, and a greater relationship with metastases (NUMATA *et al*., 2020). The patient had undetectable CEA levels (< 1.73 ng/ml) during the use of osimertinib 160 mg during treatment. A slight increase in CEA concentration was observed compared to the previous values (2.58 ng/ml) at the end of treatment with osimertinib 160mg, along with worsening of the symptoms of diplopia and headache reported by osimertinib 160mg.

CONCLUSION

The use of osimertinib at a dose of 160mg is not yet used widely and therefore there is still no satisfactory research material for direct conclusions, but visualizing the case presented, the drug has high efficacy for tumor control, avoiding evolutions, increasing the survival of patients who only have NSCLC, but in patients who progress to metastasis, more studies are needed to determine how effective the drug would be for control of other tumors, seeking to correlate their mutations and etiologies in order to cover the use of osimertinib for other similar types of cancer. It is likely that the continuous use of this medication can lead to an alteration in the tumor, making it resistant, due to the selectivity that tumor clones can develop. More studies are still needed for this confirmation, so it is only a hypothesis. Thus, we conclude that the 80mg dose of osimertinib was effective in controlling NSCLC. Increasing the dose to 160 mg was necessary after the progression of metastasis in the meninges. The patient responded well to treatment with 160mg in the first months, however, with possible clonal selectivity and reduced efficacy of the drug even at a higher dose after a certain period. With the increase in dose to 160mg, it was possible to notice a relative increase in the intensity of side effects, without the appearance of new adverse signs and symptoms compared to the 80mg/day dose of Osimertinib.

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Agradeço a minha mãe por tudo, ela foi minha inspiração para ser o melhor que eu poderia ser, ela lutou por muito contra essa doença tão difícil, quando fizeram o diagnóstico deram para ela 3 semanas, mas ela não se abalou nem por um segundo e lutou, muito, por quase 5 anos, a história dela é uma inspiração, para todos, porém além da incrível guerreira que ela foi, ela foi principalmente minha mãe, a mulher que me ensinou tudo, e que me amou mais do que tudo no mundo. Espero que aonde quer que ela esteja ela possa ver esse trabalho e sinta todo amor que quis transmitir para ela através dele, e que possa ajudar muitos a lutar contra essa doença terrível. Te amo mãe.

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EFFICACY AND SAFETY OF TRANSCRANIAL MAGNETIC STIMULATION IN THE TREATMENT OF COCAINE USE DISORDER: AN INTEGRATIVE REVIEW

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ABSTRACT

Introduction: Cocaine Use Disorder (OCD) is one of the greatest public health challenges, with high relapse rates and absence of approved pharmacological treatments. Conventional methods, such as cognitive behavioral therapy (CBT), show limited effectiveness, making it necessary to search for alternative approaches. Transcranial Magnetic Stimulation (TMS) has emerged as a promising tool, acting on the modulation of brain circuits involved in inhibitory control and craving, essential factors for the success of the treatment of TEC. **Objective:** This integrative review aimed to evaluate the efficacy and safety of TMS in the treatment of TUC, identifying its impacts on the reduction of craving, cocaine consumption, and neurophysiological modulation. **Methodology:** The search was carried out in scientific databases (PubMed, Scopus, Web of Science, PsycINFO, and Cochrane Library), including studies published between 2013 and 2023. Randomized clinical trials, systematic reviews, and observational studies that investigated the application of TMS in individuals with OCD were analyzed. The inclusion criteria included surveys with human samples and quantitative evaluation of the effects of TMS on the consumption of the substance. **Results:** The findings indicate that high-frequency TMS (≥10 Hz) applied to the left dorsolateral prefrontal cortex (DLPFC) promotes a significant reduction in craving and cocaine consumption, as well as improvements in inhibitory control and impulsivity. The safety of the treatment was widely confirmed, with mild and transient adverse effects, such as headache and discomfort at the application site, with no serious events recorded. However, methodological heterogeneity, variation in stimulation protocols, and lack of standardization of outcomes make it difficult to make direct comparisons between studies. **Conclusion:** TMS presents itself as an innovative and safe therapeutic alternative for the treatment of TUC, especially for patients resistant to conventional approaches. However, for it to be consolidated as a clinical treatment, greater methodological rigor is needed, with more robust randomized clinical trials, standardization of stimulation protocols, and inclusion of neurophysiological biomarkers. In addition, future studies should explore the integration of TMS with conventional approaches, such as CBT, to enhance its therapeutic effects and expand its clinical applicability.

Keywords: Transcranial Magnetic Stimulation. Cocaine Use Disorder. Craving. Neurostimulation. Nonpharmacological treatment.

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INTRODUCTION

Cocaine use disorder (OCD) represents one of the greatest global public health challenges, impacting not only affected individuals but also their families, communities, and health systems. Cocaine is a highly addictive psychostimulant substance, whose repeated administration can lead to profound neurobiological changes, compromising brain circuits related to inhibitory control, decision-making, and reward (Bolloni et al., 2018). In addition, the high relapse rates and the absence of effective pharmacological interventions further aggravate the clinical management of this condition. Currently, there are no drugs approved by the Food and Drug Administration (FDA) for the treatment of TUC, limiting the therapeutic options available (Moretti, Poh, & Rodger, 2020). Thus, conventional treatment relies mostly on psychosocial approaches, such as cognitive behavioral therapy (CBT) and rehabilitation programs. However, although effective in some cases, these strategies have limitations in the lasting control of craving, a preponderant factor for the relapse of cocaine users (Steele & Maxwell, 2021).

The urgent need for new therapeutic approaches has driven the development of interventions that utilize non-invasive brain stimulation techniques, such as Transcranial Magnetic Stimulation (TMS) (Harmelech, Hanlon & Tendler, 2023). This method has emerged as a promising alternative by acting directly on brain circuits involved in the regulation of inhibitory control and modulation of the reward system, both of which are profoundly altered in individuals with cocaine dependence (Rasgado-Toledo et al., 2024).

TMS enables the stimulation of specific areas of the brain, such as the dorsolateral prefrontal cortex (DLPFC), a crucial structure for impulse control and decision-making. Recent evidence suggests that TMS can significantly reduce craving and cocaine use, presenting itself as an innovative therapeutic alternative for a disorder that historically exhibits high relapse rates and low response to conventional treatments (Tarraneo et al., 2015).

However, research on TMS in the treatment of TUC is still limited and fragmented, with significant variability in stimulation protocols, the number of sessions applied, and target brain areas, making it difficult to consolidate well-established clinical guidelines (Steele & Maxwell, 2021). In addition, few studies explore the long-term safety of TMS for this specific audience, making a broader and more systematized analysis necessary (Moretti, Poh, & Rodger, 2020).

Given this scenario, this integrative review aims to evaluate and synthesize the available scientific evidence on the efficacy and safety of TMS in the treatment of TUC. Through the analysis of recent and robust studies, we seek to understand the potential of

this technique as a viable therapeutic tool, focusing on both behavioral outcomes and underlying neurophysiological mechanisms (Torres-Castaño et al., 2021). In addition, it is intended to identify gaps in the literature and direct future investigations that can improve the clinical application of this technology in the management of cocaine dependence.

METHODOLOGY

This integrative review was conducted with the aim of synthesizing the scientific evidence on the efficacy and safety of Transcranial Magnetic Stimulation (TMS) in the treatment of Cocaine Use Disorder (OCD). To ensure the scope and quality of the bibliographic survey, the search followed strict methodological guidelines, using well-defined strategies for research, selection and analysis of studies.

SEARCH STRATEGY

The search was carried out in the main scientific databases recognized for integrative and systematic reviews, ensuring a robust and up-to-date survey of the literature. The databases consulted were:

- PubMed/MEDLINE
- Scopus
- Web of Science
- PsycINFO
- Cochrane Library

The search strategy used controlled descriptors extracted from Medical Subject Headings (MeSH) and DeCS (Health Sciences Descriptors), combined with Boolean operators (AND, OR, NOT) to broaden and refine the results. The search terms were defined based on previous studies and on the recommendations of the PubMed Thesaurus, ensuring the inclusion of terminological variations and synonyms pertinent to the theme.

INCLUSION AND EXCLUSION CRITERIA

To ensure the relevance of the studies analyzed, the following inclusion criteria were adopted:

- Studies published between 2013 and 2023.
- Articles in English and Portuguese.
- Clinical trials, systematic reviews, and meta-analyses that investigated the efficacy and safety of TMS in the treatment of TUC.

- Studies that addressed specific stimulation protocols, analyzing parameters such as frequency, intensity, and target brain area.
- Research that evaluated clinical outcomes, such as reduced craving, decreased cocaine use, and TMS-related adverse effects.
- The following were excluded from the analysis:
- In vitro experimental studies and research with animal models.
- Isolated case studies, editorials, letters to the editor, and conference abstracts.
- Publications that did not directly address TMS as a treatment for TUC.
- Articles that were not available in full in the databases consulted.

STUDY SELECTION PROCESS

The selection of articles was carried out in three independent stages:

1. Reading of titles and abstracts to verify compatibility with the inclusion criteria.
2. Full reading of the selected texts, evaluating the methodology, sample and results.
3. Final inclusion of articles that fully met the established criteria.

To minimize selection bias, two independent reviewers screened the studies, and any disagreements were resolved by consensus or by consulting a third reviewer.

DATA EXTRACTION AND ANALYSIS

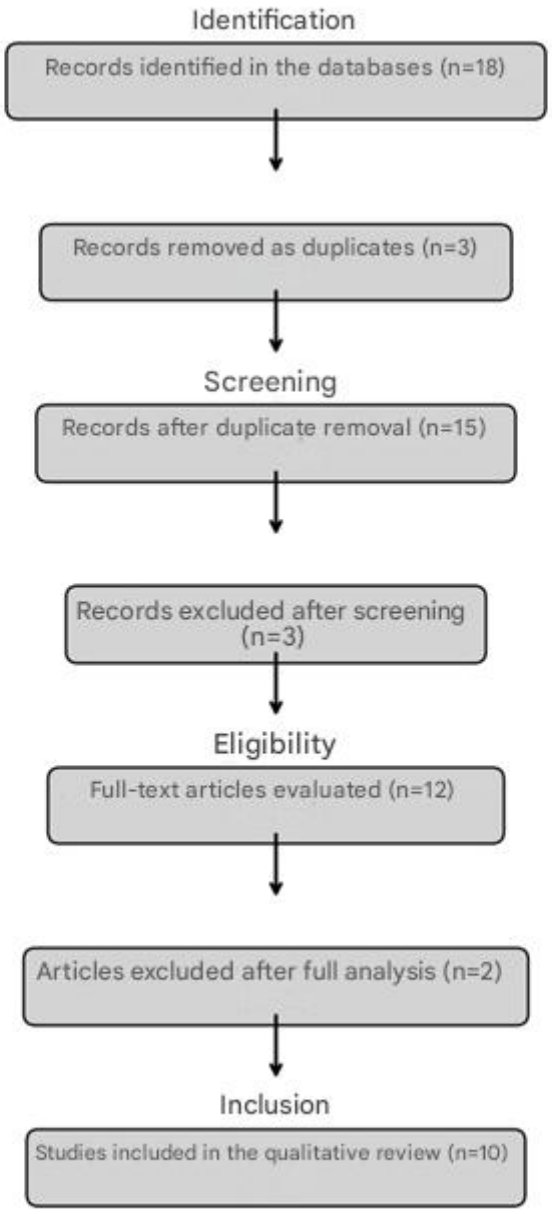
The data were extracted and organized in a standardized spreadsheet, containing the following information:

- Authors and year of publication
- Objective of the study
- Type of study and methodological design
- Sample and inclusion/exclusion criteria
- TMS protocol used (frequency, intensity, number of sessions, target area)
- Main outcomes assessed (craving, cocaine use, safety)
- Results and conclusions

Data analysis was conducted in a descriptive and synthetic manner, considering the methodological heterogeneity of the studies and highlighting patterns and inconsistencies in the findings. The results were presented through comparative tables and qualitative analysis, seeking to identify trends and gaps in the existing literature.

The study selection process followed a rigorous methodological criterion to ensure the quality and relevance of the evidence analyzed. Initially, 18 registries were identified from the PubMed/MEDLINE, Scopus, Web of Science, PsycINFO, and Cochrane Library databases, using controlled descriptors from MeSH and DeCS and Boolean operators to refine the results. After removing 3 duplicate records, 15 studies remained for screening.

In the screening phase, titles and abstracts were evaluated according to the established inclusion and exclusion criteria, resulting in the elimination of 3 studies that did not meet the requirements. The remaining 12 articles were read in full for detailed analysis of their methodology, sample, and results, of which 2 were excluded because they did not directly address Transcranial Magnetic Stimulation (TMS) as a treatment for Cocaine Use Disorder (OCD). At the end of the process, 10 studies were included in the qualitative review, as shown in the following PRISMA flowchart.



(Adapted by the author, 2025)

RESULTS

The present review analysed a total of 10 studies published between 2013 and 2023, covering different Transcranial Magnetic Stimulation (TMS) protocols applied to the treatment of Cocaine Use Disorder (OCD). The included studies present a wide methodological and geographic diversity, reflecting different approaches to the use of TMS for this disorder. Table 1 summarizes the main characteristics of the reviewed studies, highlighting the authors, year of publication, place of conduction, methodological design, sample size, stimulation parameters used, and most relevant conclusions. This synthesis

facilitates the understanding of advances and gaps in the application of TMS as a therapeutic tool.

GENERAL CHARACTERISTICS OF THE STUDIES

The studies analyzed used different methodological approaches, including randomized controlled trials, open-label studies, and systematic reviews. Regarding the TMS protocols, variations were observed in the following aspects:

- Stimulated area: Predominantly the left dorsolateral prefrontal cortex (DLPFC), a region associated with inhibitory control and regulation of craving.
- Stimulation protocol: Most studies used rTMS (repetitive Transcranial Magnetic Stimulation), while a smaller portion integrated Theta Burst Stimulation (TBS).
- Stimulation frequency: It ranged from 10 to 50 Hz, with a predominance of high-frequency protocols (≥5 Hz), suggesting excitatory effects on neural circuits involved in the control of addictive behavior.
- Intensity: Usually expressed as a percentage of the motor threshold (between 80% and 120%), reflecting different levels of cortical activation.
- Duration and number of sessions: The number of sessions ranged from 10 to 36, distributed over periods of two weeks to three months, showing a promising pattern of clinical application for the modulation of cortico-striatal circuits and the reduction of cocaine consumption.

In general, the heterogeneity in the protocols applied highlights the need for standardization of stimulation parameters to optimize the therapeutic effects of TMS.

Autores e Ano	Desenho do Estudo	Tamanho da Amostra	Frequência e Pulsos	Área Estimulada e frequência	Protocolo (rTMS/TBS)	Sessões Realizadas	Ansiedade Pré/Pós (HAM-A)	Depressão Pré/Pós (HAM-D)	Qualidade de Vida (WHOQOL-BREF) Pré/Pós	Redução do Craving (%)	Conclusões Principais
Torres-Castaño et al. (2021)[7]	Revisão Sistemática	12 estudos incluídos	10Hz (F3) / 2000 Pulsos	F3(**CPFDLE**)	Alta (10 Hz, 120% **L.M**)	10 sessões	Não reportado	Não reportado	Não reportado	25%	EMT demonstrou eficácia moderada na redução de craving e consumo de cocaína; efeitos adversos mínimos.
Bolloni et al. (2018)[1]	Revisão Sistemática	6 estudos incluídos	10Hz (F3) / 2000 Pulsos	F3 (**CPFDLE**)	Alta (10 Hz, 120% **L.M**)	15 sessões	Redução	Redução	Melhoria	30%	Protocolos de alta frequência mostram maior eficácia; necessidade de padronização de protocolos.
Amerio et al. (2023)[10]	Revisão Sistemática de Ensaios Clínicos Randomizados	8 estudos incluídos	10Hz (F3) / 2000 Pulsos	F3 (**CPFDLE**)	Alta (10 Hz, 120% **L.M**)	20 sessões	Não reportado	Redução	Não reportado	35%	Alta frequência no DLPFC reduz craving e impulsividade; evidências ainda heterogêneas.
Terraneo et al. (2016)[6]	Estudo Piloto Randomizado	32 participantes	10Hz (F3) / 2000 Pulsos	F3 (**CPFDLE**)	Alta (10 Hz, 120% **L.M**)	29 sessões	Redução	Redução	Não reportado	40%	Redução significativa no uso de cocaína e craving após EMT de alta frequência no DLPFC esquerdo.
Madeo et al. (2020)[8]	Estudo Observacional Longitudinal	284 participantes	10Hz (F3) / 2000 Pulsos	F3(**CPFDLE**)	Alta (10 Hz, 120% **L.M**)	36 sessões	Não reportado	Não reportado	Melhoria	45%	Redução significativa no uso de cocaína e craving após EMT de alta frequência no DLPFC esquerdo.
Steele & Maxwell (2021)[3]	Revisão Narrativa	Não aplicável	1Hz (F4) / 1000 Pulsos	F4 (**CPFDLE**)	Baixa (1 Hz, 100% **L.M**)	Variável	Não reportado	Não reportado	Não reportado	Não reportado	Sugere EMT como ferramenta promissora para transtornos de uso de substâncias; foco no controle inibitório.
Rasgado-Toledo et al. (2024)[5]	Estudo Randomizado	48 participantes	10Hz (F3) / 2000 Pulsos	F3 (**CPFDLE**)	Alta (10 Hz, 120% **L.M**)	30 sessões	Redução	Melhoria	Melhoria	50%	Redução do consumo de cocaína.

EFFECTIVENESS OF TMS IN REDUCING CRAVING AND COCAINE USE

TMS has demonstrated significant efficacy in reducing craving and cocaine use, especially when applied at a high frequency (≥10 Hz) over the left DLPFC. Studies such as those by Bolloni et al. (2018) and Madeo et al. (2020) have indicated that high-frequency protocols promote a measurable reduction in consumption desire and relapse rates, with improvements observed in the first weeks of treatment.

In randomized controlled trials, such as that of Amerio et al. (2023), a significant impact on impulsive control and decreased reactivity to stimuli associated with the use of the substance was identified, reinforcing the ability of TMS to modulate cortical networks involved in addictive behavior. The main beneficial effects included:

- Reduction in craving reported by subjective scales and physiological tests of response to stimuli associated with cocaine.
- Decrease in cocaine consumption, verified through urine analysis and hair tests.
- Improvement in inhibitory control, evidenced by neuropsychological tests after the intervention.

However, the variability in the stimulation protocols still represents a challenge for the reproducibility of the results. The need for controlled clinical trials with larger samples and more rigorous methodologies is evident to consolidate TMS as a definitive therapeutic alternative for TUC.

SAFETY AND ADVERSE EFFECTS

The studies analyzed confirmed that TMS is largely safe and well tolerated, with minimal and transient adverse effects. Among the most reported adverse events, the following stand out:

- Mild to moderate headache, seen in a fraction of patients, usually resolves without the need for intervention.
- Discomfort at the application site, reported in protocols of higher intensity, but without significant impact on treatment adherence.
- Transient fatigue and dizziness, in isolated cases, with no reports of serious adverse events.

Studies such as those by Madeo et al. (2020) and Lolli et al. (2021) indicated that participants demonstrated high adherence to treatment, with low dropout rates. Trials with sham control groups did not identify statistically significant differences between adverse events in the active and placebo groups, reinforcing the safety of TMS for this audience.

SUMMARY OF RESULTS AND CLINICAL IMPLICATIONS

The findings of this review suggest that TMS, especially at high frequency and applied to the left DLPFC, is a promising intervention for the management of cocaine use disorder, contributing to:

- Sustained reduction of craving and substance consumption.
- Improvement in inhibitory control and emotional self-regulation of users.
- Low incidence of adverse effects, making it a safe and viable option.

However, heterogeneity in stimulation protocols, sample characteristics, and evaluation methods still represents an obstacle to the standardization of this approach. Future studies should prioritize:

- Greater methodological control, with more representative and randomized samples.
- Integration of advanced technologies, such as neuronavigation, to improve the accuracy of stimulation.
- Longitudinal evaluation of the effects of EMT, ensuring the measurement of long-term impacts.

TMS demonstrates great potential as a complementary and non-pharmacological therapy for the treatment of TUC, but additional research is still needed to establish more robust clinical guidelines and expand its applicability in medical practice.

DISCUSSION

The findings of this review reinforce Transcranial Magnetic Stimulation (TMS) as a promising therapeutic approach for Cocaine Use Disorder (OCD). Clinical trials have shown that TMS, especially when applied at high frequency (≥10 Hz) on the left dorsolateral prefrontal cortex (DLPFC), can modulate neural circuits involved in addictive behavior, promoting a statistically significant reduction in craving and cocaine consumption (Bolloni et al., 2018; Amerio et al., 2023).

However, the review revealed significant methodological heterogeneity among the studies analyzed. Differences in stimulation parameters, such as frequency, intensity, and number of sessions, make direct comparisons difficult and limit the generalizability of findings. In addition, the reduced number of clinical trials with robust samples and longitudinal follow-up prevents definitive conclusions about the long-term efficacy and safety of TMS (Lolli et al., 2021).

Another important limitation is the absence of standardized protocols for measuring outcomes, such as craving and relapse rates. Most studies have used subjective scales to assess craving, but there is a lack of objective biomarkers that can consolidate TMS as a validated clinical treatment (Madeo et al., 2020). In addition, few studies have evaluated the duration of therapeutic effects, and it is essential that future research incorporate longer follow-ups to verify the sustainability of the benefits.

ADVANCES IN EMT PROTOCOLS

The analysis of the protocols used in the reviewed studies demonstrates important advances in the use of TMS for the TUC. The predominant stimulation of the left DLPFC is consistent with its role in inhibitory control and regulation of craving. Clinical trials indicate that high-frequency protocols (≥10 Hz) exert excitatory effects on cortico-striatal networks, while approaches such as Theta Burst Stimulation (TBS) have emerged as alternatives to optimize neural plasticity with shorter application time (Tarraneo et al, 2015).

In addition, the personalization of interventions is evident in the intensity levels adopted (80%-120% of the motor threshold), allowing adjustments according to the needs of the patients. The duration of the protocols ranged from 10 to 36 sessions over periods of

two weeks to three months, reflecting different experimental approaches but also highlighting the need for greater standardization (Steele & Maxwell, 2021).

Despite these variations, data suggest that TMS has a favorable safety profile, with minimal adverse events and high adherence by participants. However, comparative studies between different stimulation parameters are still needed to consolidate accurate clinical guidelines (Harmelech, Hanlon, & Tendler, 2023; Torres-Castaño et al., 2021).

COMPARISON WITH OTHER TREATMENTS

When comparing TMS with traditional approaches to TUC, such as Cognitive Behavioral Therapy (CBT) and pharmacological interventions, it is observed that TMS has significant advantages. Although CBT is widely used, its effectiveness depends on active patient engagement, which can be challenging for individuals with a history of multiple relapses. In contrast, TMS demonstrates benefits even in patients with poor adherence to conventional therapies, which expands its application possibilities (Tarraneo et al, 2015).

In addition, the lack of medications approved specifically for TUC reinforces the need for effective therapeutic alternatives, and TMS emerges as a viable option, with minimal adverse effects compared to traditionally used medications such as antidepressants and antipsychotics (Amerio et al., 2023).

Another promising prospect is the integration of TMS with traditional treatments such as CBT and motivational interventions. Preliminary studies suggest that the combination of these approaches can enhance the results, promoting synergistic effects and increasing the chances of therapeutic success. However, this strategy still needs to be explored in long-term randomized controlled trials to determine its efficacy and practical feasibility (Bolloni et al., 2018; Rasgado-Toledo et al., 2024).

IMPLICATIONS AND FUTURE DIRECTIONS

Despite the methodological limitations identified, advances in the application of TMS to the TUC are significant. The reviewed literature points to strong therapeutic potential, but there is a need for more rigorous clinical trials that can:

- Standardize stimulation protocols, including frequency, intensity, and duration of treatment (Moretti, Poh, & Rodger, 2020).
- Expand population samples, ensuring greater representativeness and external validity of findings (Madeo et al., 2020).
- Investigate neurophysiological biomarkers, allowing objective assessments of the effects of TMS (Torres-Castaño et al., 2021).

- Follow patients for longer periods, to understand the sustainability of benefits over time (Lolli et al., 2021).

TMS has been shown to be a robust and safe approach, with the ability to remodel neural circuits involved in cocaine addiction. However, future research should focus on optimizing stimulation protocols and integrating TMS with traditional therapies, aiming to improve its clinical effectiveness and applicability in the treatment of TUC (Amerio et al., 2023).

CONCLUSION

The present integrative review highlights Transcranial Magnetic Stimulation (TMS) as a promising therapeutic strategy for Cocaine Use Disorder (OCD). The studies analyzed demonstrated that TMS, especially when applied at high frequency to the left dorsolateral prefrontal cortex (DLPFC), can significantly reduce craving and consumption of the substance, in addition to improving inhibitory control and decreasing impulsivity. These effects are consistent with the modulation of cortico-striatal circuits, highlighting TMS as a potentially effective tool to reverse neural dysfunctions associated with addiction.

In addition to the clinical benefits, the safety and tolerability of TMS have been widely confirmed, with minimal and transient adverse effects, such as mild headache and localized discomfort at the stimulation site. These findings reinforce the viability of TMS as a noninvasive treatment, especially for patients with a history of multiple relapses or resistant to conventional approaches, such as cognitive behavioral therapy and pharmacological interventions. However, despite the promising results, the heterogeneity in the stimulation protocols, the limited number of studies with robust samples and longitudinal follow-up, as well as the lack of standardization in the criteria for evaluating the outcomes, represent challenges for the clinical implementation of TMS in the treatment of TUC.

Given these limitations, it is recommended that future research focus on standardizing TMS protocols, establishing optimal parameters for frequency, intensity, and number of sessions to maximize treatment efficacy. In addition, there is a need to expand randomized clinical trials, ensuring more representative samples and methodological rigor to strengthen the validity of the findings, as well as to investigate the integration of TMS with conventional therapies, such as CBT, to evaluate possible synergistic effects. The incorporation of neurophysiological biomarkers and neuroimaging may allow a more objective assessment of the effects of TMS on the brains of patients with OCD, and the

extension of the follow-up time of patients may determine the long-term sustainability of the therapeutic effects.

Thus, TMS stands out as an innovative and safe approach, with the potential to redefine the management strategies of Cocaine Use Disorder. However, future studies are essential to consolidate clinical guidelines, ensure the optimization of protocols, and expand their applicability in medical and psychiatric practice.

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BENEFITS AND CHALLENGES ASSOCIATED WITH THE IMPLEMENTATION OF NAVIGATION PROGRAMS IN CANCER CENTERS: AN INTEGRATIVE REVIEW[1]

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ABSTRACT

The increasing complexity of cancer treatments, combined with the fragmentation of the health system, exposes patients to a series of challenges that can compromise quality of life and treatment outcomes. In this context, patient navigation emerges as a promising strategy to optimize care, ensuring continuity of care and the best possible experience for patients throughout the oncological pathway. This integrative review aims to analyze the scientific evidence on the effectiveness of patient navigation in the oncology context, identifying the main benefits and challenges of implementation in oncology centers. To this end, an integrative literature review was carried out, with the selection of descriptors and keywords based on the PICO strategy. The search and selection process of primary studies was carried out in the Virtual Health Library (VHL), including the following databases: Medical Literature Analysis and Retrieval System Online (MEDLINE), Latin American and Caribbean Literature on Health Sciences (LILACS) and Nursing Database (BDENF). The search returned 2,019 publications, of which 5 were eligible for analysis. Despite the challenges in implementing navigation in cancer centers, the promising results justify the effort. By optimizing the patient journey, navigation provides a more humanized experience, improves the quality of life of patients and their families, and contributes to the efficiency of the health system, enabling the identification and correction of failures and the optimization of the use of resources.

Keywords: Patient Navigation. Oncology and Nursing Care.

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INTRODUCTION

Cancer is widely recognized as one of the major public health problems in the world, being among the leading causes of death and, consequently, acting as a significant barrier to increased life expectancy. In several countries, it ranks first or second among the causes of premature death, before the age of 70 (SUNG et al., 2021).

Estimates from the International Agency for Research on Cancer (IARC), supported by the best available data for 2022, reveal the increasing burden of cancer in the world, with a particularly intense impact on vulnerable populations and the urgent need to reduce cancer-related inequalities globally. In this sense, the World Health Organization (WHO) reinforces this urgency by presenting the results of a survey carried out in 115 countries, which showed that, in most of these countries, inadequate resources are allocated to priority oncology and palliative care services within universal health coverage (PAHO, 2024).

Recent studies by IARC indicate that, in 2022, about two-thirds of new cases and deaths from cancer were due to only 10 types of the disease, considering data from 185 countries and 36 types of cancer (PAHO, 2024). In this scenario, lung cancer is the most common type in the world, with 2.5 million new cases, representing 12.4% of the total, female breast cancer ranks second, followed by colorectal, prostate and stomach cancer.

In terms of mortality, lung cancer is also the most lethal, with 1.8 million deaths, corresponding to 18.7% of all cancer deaths. This increase in the number of cases may be associated with the persistence of tobacco use, especially in Asia (PAHO, 2024).

A warning for 2050 is that cancer cases are expected to rise by 77%, reaching more than 35 million new cases, a frightening increase compared to the 20 million cases estimated in 2022 (FIOCRUZ, 2024). This panorama requires understanding of health systems and actions concerning oncological conditions, new cases, patients already affected, but, above all, prevention mechanisms and access to health services in order to contain this advance.

In addition, inequality manifests itself with the increase in cases of cancer, especially breast cancer. In countries with a high human development index (HDI), one in 12 women will be diagnosed, while in countries with a low HDI, this rate is one in 27. In addition, women in countries with lower HDI are 50% less likely to receive an early diagnosis due to inadequate access to quality treatment (PAHO, 2024).

Regarding the comprehensiveness and universality of health care, oncology is a highly complex specialty, requiring patients to undergo various treatments that often require multiple hospital visits and regular imaging and laboratory tests (ROQUE et al., 2023). The

main therapeutic modalities, such as surgery, chemotherapy and radiotherapy, involve the transmission of a significant volume of information to patients and their families at the beginning of treatment, which often makes it difficult to fully assimilate this content. (PAUTASSO et al., 2020)

In international contexts, the health system has been poorly prepared to deal with the growing demand of patients, mainly due to the shortage of a committed workforce and the fragmentation of health systems, factors that compromise efficiency and quality (ROCQUE et al., 2016). According to data from the Ministry of Health and Welfare of Taiwan, cancer has been the leading cause of death in the country for more than four decades, with breast cancer being the second leading cause of cancer deaths among women (WEI-ZHEN et al., 2024).

In Brazil, the weaknesses that the health system presents include the fragmentation of care and the difficulty in navigating a system that requires the integration of multiple specialties. This reality results in barriers that make it difficult for patients to access timely diagnosis and treatment. In the specific case of breast cancer, the high mortality rate, estimated at 12.78 deaths per 100,000 women per year, is largely attributed to the delay in diagnosis and treatment initiation (LIMA et al., 2021).

Although there are guidelines, such as Ordinance No. 3,535, of September 1998, which establishes a hierarchical network of High Complexity Oncology Centers (CACON), and Law No. 12,732, which guarantees the start of treatment within 60 days after diagnosis, these initiatives are still not enough to solve the structural problems of the health system. The barriers to access to care are even more pronounced for socially vulnerable patients, who face financial, communicational, and systemic difficulties that complicate their treatment journey. (LIMA et al., 2021).

THEORETICAL FRAMEWORK - PATIENT NAVIGATION

In the context of oncological health care, the Patient Navigation Program (NP) emerges as an innovative proposal to address these weaknesses. Inspired by the work of Dr. Harold Freeman, in the 1990s, the first patient navigation program was created in the State of New York, United States. This pioneering program aimed to eliminate several barriers that can hinder access to and continuity of care for patients, such as those of a socioeconomic, sociocultural, psychological, communication, and bureaucratic nature (ROQUE et al., 2023).

The approach of the PN program contemplates the process of the *health continuum*, ranging from prevention and early detection to diagnosis, treatment and palliative care at

the end of life. Thus, PN emerged as an innovative strategy to ensure that individuals receive more integrated and humane care, making it easier to navigate the complex healthcare system and improving clinical outcomes and patient experience (PAUTASSO et al., 2020).

Harold Freeman, in his 20 years of study on Patient Navigation, outlined nine fundamental principles that guide this practice. Such principles aim to optimize the patient's journey in the health system, ensuring comprehensive and effective care. In summary, patient navigation, as advocated by Freeman, seeks: a patient-centered model of care to ensure that the patient's trajectory in the health system is fluid and coordinated; integration between the levels of care to facilitate communication and collaboration between the various sectors of the health system; a solid therapeutic relationship to establish a bond of trust between the patient and the navigator; clear roles and responsibilities to delimit the tasks of each member of the health team; financial efficiency and sustainability to optimize available resources and ensure adequate cost-benefit; task assignment to distribute tasks according to each browser's background and experience; delimitation of the process to understand when the navigation starts and when it is completed; connection between the points of care to act as a link between the various health services and the qualified coordination to supervise and coordinate the work of navigators. In short, Freeman's nine principles represent a valuable guide for implementing effective patient navigation programs (ROQUE et al., 2023).

Freeman's work achieved a significant increase in five-year survival rates, from 39% to 70%, in addition to reducing the incidence of cancer in advanced stages from 40% to 21%, which contributed to the creation of the *Patient Navigator Outreach and Chronic,* Disease Prevention Act, in 2005 (FREEMAN; RODRIGUEZ; 2011).

The studies also identified the health system as the main barrier to effective treatment. Thus, observing the successful approaches in countries such as the United States and Canada, PN aims to facilitate access to timely diagnosis and treatment, ensuring that patients receive the necessary attention at all stages of their journey. This practice involves the assessment of individual needs, the planning and implementation of actions that promote care coordination. In addition, it seeks to empower patients, providing information and support, so that they can interact more effectively with health professionals (PAUTASSO et al., 2018).

PN has been shown to be effective in several areas, with evidence demonstrating its ability to increase treatment adherence, reduce delays in the initiation of cancer treatments, and improve clinical outcomes (PAUTASSO et al, 2018).

In a cancer center of a regional teaching hospital in northern Taiwan, a randomized controlled trial evaluated the impact of nurse navigators on the mental health of cancer patients, the inclusion of these in cancer care teams was effective in reducing gaps between patients and health providers, promoting more agile referrals and access to adequate services. This approach also contributes to significant psychosocial benefits, positively impacting various dimensions of mental health and reinforcing its role in improving the quality of life of cancer patients (WEI-ZHEN et al., 2018)

Regarding the average length of hospital stay, a study indicates that patients who do not receive follow-up by nurse navigators tend to stay in the hospital for an average period of 9 to 11 days longer than those who have this support. In addition, PN results in a reduction in visits to the urgent and emergency sector of hospitals, reduces the length of hospital stay, and promotes a better use of available resources. The guidance and continuous support offered to patients by the nurse navigator are fundamental factors that contribute to these positive results (RODRIGUES et al., 2021).

At the *Madonna del Soccorso* Hospital, in Italy, a comparative study with 100 cancer patients followed by nurse navigators and a control group of an equal number of patients treated three years earlier, without this follow-up, showed significant improvements in clinical outcomes. The results showed advances in activities of daily living (20% vs. 8%), reduction of nutritional problems (40% vs. 21%), pain (18% vs. 2%), surgical wounds (45% vs. 1%), and improvement in mobilization (8% vs. 0%) between the group with and without a nurse navigator, respectively (MERLINI et al., 2024).

Another relevant aspect of PN refers to the patients' experience and their well-being, explicitly placed at the center of the process, promoting a more humanized and integrated approach. This strategy not only aims to improve clinical outcomes, but also seeks to minimize the emotional and social impacts that the disease can bring. In addition, the incorporation of this program into the health network is urgent, to increase the reach and effectiveness of the treatment offered by health professionals (RODRIGUES et al., 2020).

In the United States, significant efforts have been made to develop and standardize metrics related to the impact of PN on the health of the oncology population. In March 2010, the *American Cancer Society* hosted the National Patient Navigation Leadership Summit with the goal of establishing consensus on common outcome metrics in order to strengthen scientific evidence on the effectiveness of patient navigation. More recently, the Academy of Oncology Nurses and Patient Navigators has also led initiatives to create standardized metrics for program certification and to assess the reliability and validity of 10 key metrics.

These efforts aim to improve consistency in assessments, although there is still some documented heterogeneity in the outcome measures used (BATTAGLIA et al., 2022).

In Brazil, the development of NP programs is still incipient, with the first relevant publications occurring from 2018 onwards. In 2020, a PN program aimed at patients with head and neck cancer, structured for the Brazilian reality, was evidenced, along with the Navigation Need Assessment Scale (PAUTASSO et al, 2023). The Brazilian panorama regarding the legislation and regulation of the patient navigation program (PN) has advanced, although it still faces significant challenges. The first national event on the topic took place on January 30, 2020, at the headquarters of the Regional Nursing Council - COREN-SP, marking an important step in the dissemination of knowledge about patient navigation in Brazil (COREN-SP, 2020)

Within the scope of the supplementary health system, the search for more efficient and patient-centered care models has been constant. In this sense, in 2016, the National Health Agency - ANS launched the OncoRede Project in the supplementary health sector, aiming to restructure cancer care. Through the OncoRede Project, the ANS encouraged the adoption of patient navigation as a strategy to improve the quality of cancer care in the supplementary health sector (ANS, 2016).

Law No. 14,450, enacted on September 21, 2022, created the National Patient Navigation Program for People with Malignant Breast Neoplasm. This program aims to provide support and guidance to patients from diagnosis to treatment within the Unified Health System (SUS). Subsequently, Law No. 14,758, approved on December 19, 2023, institutes the National Policy for Cancer Prevention and Control, encompassing the National Program for the Navigation of People with a Diagnosis of Cancer, with the objective of integrating PN actions with cancer-related health policies.

Additionally, COFEN Resolution No. 735, of January 17, 2024, regulates the performance of nurse navigators and clinical specialists, establishing parameters for the training and practice of these professionals, which are fundamental for the effectiveness of the navigation program (LIMA, 2024). In addition to federal legislation, initiatives at the municipal level are also being developed. An example is Bill No. 32/2023, which proposes the creation of a PN program with malignant breast neoplasm in the municipality of Guaxupé, in Minas Gerais, reflecting a local action that complements national guidelines (GUAXUPÉ, 2023).

While these legislations represent significant advances, there is still a need for more comprehensive regulation and a consolidated legal framework that directs the practice of navigation in Brazil, ensuring that patients receive the necessary support in an effective and

coordinated manner. Continuity of professional regulation is essential for PN programs to be able to fully operate and provide comprehensive care to cancer patients. Laws and guidelines, both federal and municipal, are crucial for strengthening the navigation program, allowing the practice to integrate into the health system and meet the needs of patients effectively.

One of the pioneering PN programs was implemented in an oncology hospital in Porto Alegre, Rio Grande do Sul (PAUTASSO et al., 2020). This hospital belongs to a philanthropic hospital complex and serves patients from the Unified Health System, the supplementary health system and private individuals. Classified as a High Complexity Oncology Care Center (CACON), it is one of the three CACON existing in the state, offering extensive care to cancer patients in various specialties. The PN program focused on patients with breast cancer was developed between October 15, 2019 and August 15, 2022, and remains active to this day, highlighting the importance of continuity in care and support for these patients (PAUTASSO et al., 2023).

However, the absence of standardized metrics to document the impact of NP and identify best practices prevents a consistent evaluation of results and compromises the development of sustainable guidelines in our country. This knowledge is essential to support public policies and strengthen the sustainability of the program (BATTAGLIA et al., 2022).

In view of the scarcity of studies that deal with the benefits of PN in the Brazilian context, the present study proposed to carry out an integrative review with the objective of analyzing scientific evidence on the benefits and challenges associated with the implementation of patient navigation programs in cancer centers. Through this analysis, it is expected to contribute to the discussion on the effectiveness of navigation approaches in the fight against cancer and in the promotion of more efficient and humanized care, which respects the particularities of each patient and always seeks to improve the quality of life and health of the population.

This review is essential to deepen the theoretical and practical understanding of PN in the Brazilian oncological context. In addition, the review seeks to fill gaps about the real benefits of PN, expanding the scientific knowledge base and enabling the creation of new explanatory models that guide future research.

With the perception that each program should make use of its reality of epidemiological profile, access tools, among others, this study can contribute to the construction and evaluation of PN programs adapted to different contexts, with the same purpose of improving access and experience of cancer patients.

METHOD

Integrative review of the scientific literature, carried out through the following steps: 1) definition of the question of the review question; 2) search and selection of primary studies; 3) Extraction of data from primary studies; 4) Critical evaluation of primary studies; 5) Summary of the results of the review and 6) Presentation of the Review. (MENDES; SCOTT; GALVÃO; 2019).

For the construction of the question and the search for primary studies, the PICO strategy was used, considering P = population; I = intervention; C = comparison; and O = result. For element P, "cancer patients" were considered, for I "implementation of the navigation program", for C "absence of a navigation program, and O "reduction in the time to start treatment and better clinical outcomes". Thus, resulting in the guiding question: What are the benefits and challenges associated with the implementation of navigation nursing programs in cancer centers? Deriving from this question, *insights* emerge on how these factors impact the treatment and clinical outcome of patients.

The search and selection process of primary studies was carried out in the Virtual Health Library (VHL), including the following databases: *Medical Literature Analysis and Retrieval System Online* (MEDLINE), Latin American and Caribbean Literature on Health Sciences (LILACS) and Nursing Database (BDENF).

The following inclusion criteria were considered: studies that contained the search terms listed anywhere in the document, articles published in full with free online access, in Portuguese, English or Spanish, with a 5-year period of publication and that answered the research question. The exclusion criteria were: editorials, letters, expert comments, abstracts of proceedings, theses, dissertations, course completion papers, official documents of national and international programs, books, literature reviews and duplicate studies.

The search strategy used the descriptors in Health Sciences (DeCS): 'patient navigation', 'oncology' and 'nursing care', in three languages, being Portuguese, English and Spanish for the research to include Latin America. They were combined with each other by the Boolean operators "AND" and "OR" (Chart 1).

Chart 1 – Search strategies in the databases

MEDLINE	("Navegação de Pacientes" OR "Patient Navigation" OR "Navegación de Pacientes") AND (oncologia OR "Medical Oncology" OR "Oncología Médica") OR ("Assistência de Enfermagem" OR "Nursing Care" OR "Atención de Enfermería") AND db:("MEDLINE") AND instance:"regional"
BDENF	("Navegação de Pacientes" OR "Patient Navigation" OR "Navegación de Pacientes") AND (oncologia OR "Medical Oncology" OR "Oncología Médica") OR ("Assistência de Enfermagem" OR "Nursing Care" OR "Atención de Enfermería") AND db:("BDENF") AND instance:"regional"

LILACS	("Navegação de Pacientes" OR "Patient Navigation" OR "Navegación de Pacientes") AND (oncologia OR "Medical Oncology" OR "Oncología Médica") OR ("Assistência de Enfermagem" OR "Nursing Care" OR "Atención de Enfermería") AND db:("LILACS") AND instance:"regional"

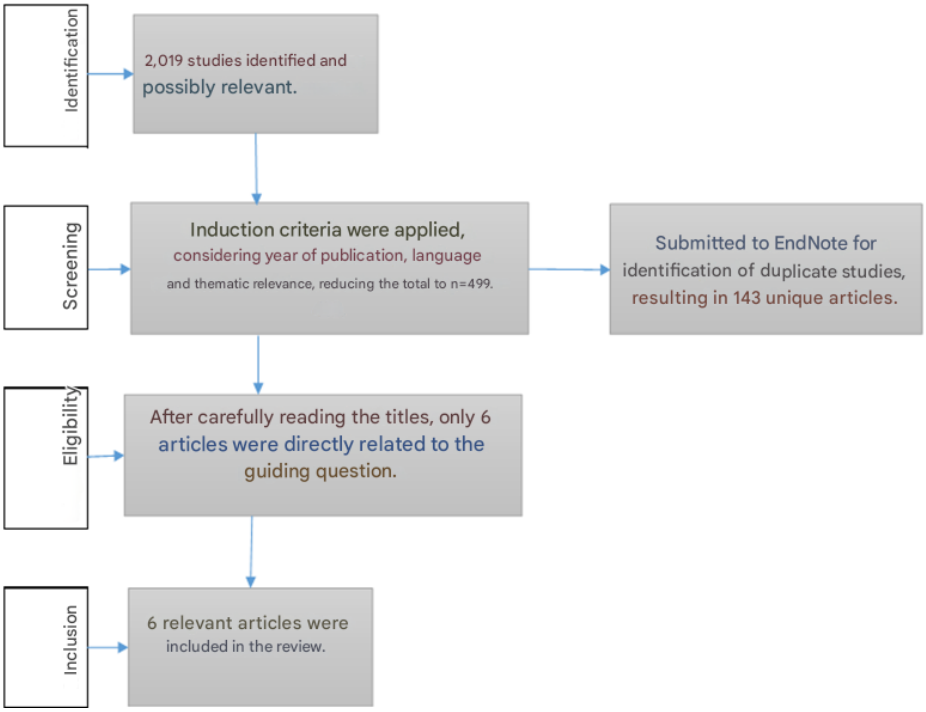
Source: authorial. 2025

Subsequently, the selection of studies occurred in two stages, starting with the reading of the titles and abstracts to identify the relationship with the research question, as well as with the inclusion and exclusion criteria adopted. Next, we proceeded with the critical evaluation and complete reading of the pre-selected studies, excluding those that did not meet the inclusion criteria.

The searches were carried out using the combined descriptors, obtaining a total of 2,019 articles. Then, the inclusion criteria were applied, considering the year of publication, language, and thematic relevance, resulting in 499 articles. These articles were then submitted to the EndNote tool for the identification of duplicate studies, resulting in 143 unique articles. After careful reading of the titles, only 5 articles presented a direct relationship with the guiding question, and were included in the review.

The selection of studies occurred in two main stages: In the first phase, the titles of the studies were read. This approach allowed us to exclude records that clearly did not meet the inclusion criteria defined earlier. After an initial screening, a full reading was carried out, following the same rigor as in the previous phase, resulting in the final selection of the studies that made up the review sample (Figure 1).

Figure 1 - Selection of studies on the benefits and challenges associated with the implementation of patient navigation programs in cancer centers.



Source: author, 2025.

After selecting the studies, the main information was extracted with the aid of a script. The following information was selected: title, author, year, objective, methodological design, results and conclusions. This step was performed by one reviewer and then reviewed by a second reviewer. In addition, data related to the location of the primary study, the profile of patients in the study sample, and the main results of each study were analyzed in an instrument adapted from Ursi et al., (2006).

After identifying the primary studies in the given databases, the records were exported to an Excel spreadsheet. This organization allowed the systematization of the essential information of each article, categorizing them by author/year of publication, title, objective, summary of the main findings, and whether or not the study was accepted for inclusion in the review.

To assess the methodological quality of the primary studies included in the review, the theoretical framework of Melnik and Fineout Overholt (2022) was used for an assessment of the hierarchy of evidence, in which the quality of evidence is classified into six levels, namely: level 1, evidence from a systematic review or meta-analysis of all relevant RCTs; level 2, evidence from the opinion of authorities and/or reports from expert committees; level 3, Evidence obtained from well-designed controlled trials without randomization; level 4, Evidence from well-designed case-control and cohort studies; level 5, evidence from systematic reviews of descriptive and qualitative studies; level 6, evidence from single descriptive or qualitative studies; level 7, evidence from the opinion of authorities and/or reports from expert committees. (MELNIK; FINEOUT-OVERHOLT, 2022).

A narrative analysis and the integration of data extracted from the studies were elaborated in order to generate a new perspective on the benefits and challenges of patient navigation programs and navigation nursing in cancer centers, summarized in a descriptive table. In addition, similarities and distinctions between the studies were analyzed in order to promote a broad understanding of the health system.

The results of the present review were organized in relation to data related to the year, place and origin of the publications. Next, a table was elaborated that presents the selected studies in a summarized way, being analyzed in the light of the theoretical framework on patient navigation programs.

RESULTS

The present review aims to analyze scientific evidence on the benefits and challenges associated with the implementation of patient navigation programs in cancer centers. For this, it has a sample of 5 studies that deal with the proposed theme.

02 (two) articles from the year 2019, 01 (one) article from the year 2020 and 02 (two) articles from the year 2023 were selected. Regarding the place of publication, there are 02 from Brazil, 01 (one) from Germany, 01 (one) Australia, 01 (one) United States

Most of the articles have low strength of evidence, as can be seen in Chart 2.

Chart 2 – Selected studies (n=5) on the benefits and challenges associated with the implementation of patient navigation programs in cancer centers.

Autor/Ano	Título/Local	Objetivo/ Delineamento / NE	Amostra	Benefícios/Desafios
A1 / Pautasso, et al., 2020	Nurse Navigator: desenvolvimento de um programa para o Brasil* / Porto Alegre, RS, Brasil	Desenvolver um Programa de NP oncológicos, fundamentado no modelo proposto pelo *The George Washington University*. Estudo descritivo: NE: 6	Pacientes com câncer de cabeça e pescoço em tratamento em um CACON	A estruturação de um modelo de programa adequado às necessidades dos pacientes e ao funcionamento de um serviço de referência em oncologia brasileiro acarretará importantes mudanças no seu contexto assistencial. / Desafio: A principal limitação do estudo foi que, devido ao tempo necessário para o desenvolvimento e adaptação do Programa de NP à realidade do CACON, não foi possível realizar a avaliação da sua efetividade.
A2 Pautasso, et al, 2023.	Trajetória para implementação de programa de navegação de pacientes na oncologia: relato de experiência / Porto Alegre, RS, Brasil	Descrever a trajetória para a implementação de um Programa de Navegação para pacientes oncológicos. Relato de experiência / NE: 7.	Pacientes com câncer de cabeça e pescoço e de mama	Houve uma redução de 70% na mediana de tempo entre indicação e primeira consulta com a oncologia clínica (de 105 para 31,5 dias); redução de 28,6% do tempo entre sintoma ou a primeira consulta e o diagnóstico (de 21 para 15 dias); 26% de redução do tempo entre diagnóstico e início de neoadjuvância (de 77 para 57 dias); e o tempo entre indicação do tratamento e início de neoadjuvância (de cerca de 30 para 8 dias). / Desafio: O tempo insuficiente (2horas por dia) impediu o seguimento adequado do processo de NP e o acúmulo de trabalho das enfermeiras assistenciais e da gestora, que dividiam suas funções específicas com a NP, impossibilitou a implementação efetiva do programa
A3 Enomoto; Shen, 2019	Reflexão do autor da ASO: Demonstrando os benefícios da navegação da oncologia / Winston Salem, NC	Investigar a diferença no tempo entre a primeira consulta oncológica e a data do primeiro tratamento em pacientes com qualquer neoplasia maligna pancreática antes e depois da inclusão de um navegador oncológico. Estudo descritivo: NE: 6	Pacientes com neoplasia maligna pancreática.	Houve uma redução de tempo de espera em quase 16 dias, o que foi estatisticamente significativo e clinicamente relevante. / Desafio: A neoplasia pancreática carece de evidências científicas robustas.
A4 Schindel et al., 2023	Associações entre suporte à navegação e utilização de cuidados de saúde e custos em pacientes com câncer avançado: uma análise baseada em dados administrativos de planos de saúde / Alemanha	Avaliar associações entre suporte de navegação e utilização de cuidados de saúde, e os custos associados a esses cuidados. Estudo randomizado: NE:3	Foram incluídos 717 pacientes (GI: 149, GC: 568).	Os pacientes do GI apresentaram menor tempo médio de internação hospitalar. No GI, foram prescritos 21% menos medicamentos e houve em média 15% menos contatos médicos ambulatoriais por mês. Os custos médios faturados no GI foram 23% menores do que no GC($p<0,001$). / Desafio: As economias esperadas não foram atingidas devido a desafios na navegação entre setores, especialmente no atendimento ambulatorial. Estudos futuros devem investigar como os benefícios da presença de um navegador no hospital podem ser estendidos ao setor ambulatorial, considerando as preferências do paciente.
A5 Holdsworth et al., 2019	Negociando Questões Leigas e Clínicas: Implementando um Programa de Navegação Leiga no Tratamento do Câncer / Austrália	Descrever esses desafios de implementação em 1 centro acadêmico de câncer para informar esforços futuros. Método misto com abordagem qualitativa: NE:6.	676 pessoas entrevistadas	Benefícios: Ponto positivo da navegação leiga é a redução de carga de trabalho da equipe de atendimento clínico. / Desafio: implicações na vida real: A implementação de programas de navegação leiga fora da equipe de atendimento clínico pode não ser eficaz para superar falhas do sistema que afetam negativamente a coordenação do atendimento. Os navegadores leigos provavelmente precisam ser integrados ou trabalhar sob a direção de equipes clínicas para alcançar uma implementação bem-sucedida e produzir os resultados positivos para os pacientes que muitos programas demonstraram.

Source: authorial. 2025. NE: Level of Evidence (MELNIK; FINEOUT-OVERHOLT, 2022).

DISCUSSION

The analysis of the studies in the present review reveals a growing interest in the implementation of oncology navigation programs as a strategy to optimize the journey of cancer patients. The studies demonstrate the diversity of contexts, approaches and results obtained, evidencing the complexity and importance of this theme.

The studies identified challenges common to the implementation of navigation programs, such as the lack of resources, the need for professional qualification, and the complexity of care coordination at different levels of care. On the other hand, most studies have shown positive results in terms of reducing waiting times, improving quality of life, and increasing patient satisfaction, these being the different indicators to evaluate the impact of navigation. In addition, all studies aimed to improve the experience of cancer patients, reducing barriers to access, optimizing care coordination, and ensuring continuity of treatment.

IMPACTS TO THE PATIENT AND THE SYSTEM

In a pilot project for the implementation of PN in a CACON, located in Rio Grande do Sul, it was found that this model of care emerges as a light in oncological care in Brazil and, when developed with a focus on patient-centered care, can illuminate the lives of many people who still live in the shadow of the barriers to access to care in the current health system. so fragmented and disjointed (PAUTASSO, et al., 2020)

Similarly, in a navigation program implemented at a large-scale community cancer center in the southeastern United States, significant advantages were shown after one year of operation. A survey comparing patients who included navigation services with those undergoing usual treatment revealed statistically significant differences in aspects such as access, timely time, financial resources, assistance, qualification, and satisfaction. As no group was excluded based on diagnosis, treatment, socioeconomic status, or ethnicity, the results suggest that navigation can benefit all patients using the current health service who suffer from fragmentation, reinforcing that these services should not be restricted to specific minorities, but widely available to all patients (CAMPBELL et al., 2010).

In both studies, carried out in Brazil and the United States, oncological navigation proved to be effective in overcoming the barriers of the health system, providing a more humanized and patient-centered care, showing that despite different sociocultural contexts and health systems, it results in similar benefits for patients (CAMPBELL et al., 2010; PAUTASSO, et al., 2020).

The study by Enomoto et al. (2019), carried out at the Department of Surgery of the Wake Forest Baptist Medical Center, in the United States, also incisively evidenced the impact of oncological navigation in reducing the waiting time for the start of treatment in patients with pancreatic neoplasms. By including an oncology navigator, the researchers were able to reduce the interval between the first contact with the patient and the performance of any intervention by almost 16 days, demonstrating the effectiveness of this strategy in optimizing care for this specific population.

Another benefit demonstrated by Schindel et al. (2023), in a study with a private health plan, shows that the implementation of a navigation program for patients with advanced cancer resulted in a significant reduction in both the average length of hospital stay and the number of medications prescribed, culminating in a 23% saving in total costs. These results highlight the potential of navigation not only to improve the quality of life of patients, but also to optimize the management of resources in a private health system.

The studies were carried out in different contexts (public, private, rural, urban), with distinct population and organizational characteristics. All studies demonstrated a significant

reduction in the time between diagnosis and initiation of treatment, evidencing the effectiveness of navigation in speeding up the care process. Navigation contributes to a better quality of life for patients, providing emotional support, clear information and facilitating access to health services, it has also demonstrated a positive economic impact of navigation, with a reduction in hospital and medication costs.

ROLE OF THE NAVIGATOR

Navigation programs present different models of action, with variations in the profile of the professional navigator, in the intensity of the intervention and in the scope of activities (Pautasso et al. 2020). Nurses, for example, have specific attributions in addition to the basic ones. The patient navigator plays a fundamental role in the journey of individuals with cancer. Its main function is to guide and assist the patient in all stages of treatment, from diagnosis to post-treatment follow-up, acting as a true "beacon" in an often complex and challenging process. The navigator acts in the coordination of care as a link between the patient and the different health professionals involved in the treatment, ensuring communication and continuity of care.

It offers clear and accurate information about the diagnosis, treatment options, side effects, and available resources, helping the patient to make decisions, as it identifies and seeks solutions to the barriers that the patient may encounter during treatment, such as financial, logistical, or bureaucratic difficulties. In addition, it offers emotional support to the patient and their family, helping them to cope with the emotions and challenges of the disease. The navigator ensures that the patient's rights are respected and that they receive the appropriate treatment, acting as an *advocacy*.

The study by Holdsworth et al. (2019) is an example of a program with a different model of action, it evidenced the complexity of implementing lay navigation programs, which is different from the approach of the studies already mentioned, especially with regard to integration with clinical teams. The authors highlight that the lack of clarity in the attributions and the distrust on the part of health professionals can compromise the success of these initiatives. In addition, both the need for browsers to master a wide range of information about the services offered, as well as the difficulties in performing complex administrative tasks, are additional challenges.

This reality highlights the need for a paradigm shift in the health system, encouraging professionals to adhere to the practice of navigation. Lay navigation not only benefits the treatment, but also generates savings for the institutions.

CHALLENGES IN THE IMPLEMENTATION OF NP

Although PN contributes significantly to treatment adherence and continuity of care, its implementation faces challenges that permeate the scarcity of resources, the need for professional training, and the complexity of coordinating care at different levels of care. The proper qualification of the professionals involved is essential to overcome these barriers and ensure the success of these programs.

The present literature review demonstrates that the exclusive dedication of a professional to patient navigation is essential to ensure the quality of care. Pautasso et al. (2023) evidenced this need, by demonstrating that the allocation of only two hours a day for the activity significantly limited the performance of the process. This finding reinforces the importance of investing in qualified human resources dedicated exclusively to the implementation of effective navigation programs.

Another challenge frequently encountered in the implementation of navigation programs is the lack of patient preparation, proven in the same pilot project, in which most patients required complementary tests and did not have previous biopsies, significantly delaying the start of treatment. This situation demonstrates the importance of health education actions and better articulation between the levels of care to ensure that patients arrive at the reference services properly prepared (PAUTASSO et al, 2023).

The studies identify challenges common to the implementation of navigation programs, such as the lack of resources, the need for professional qualification, and the complexity of care coordination at different levels of care.

The patients' experience, mediated by navigation, shows that failures in the system, such as delays in starting treatment, directly impact their results and quality of life. This reality requires a restructuring of work processes, with the aim of ensuring more effective and humanized care.

CONCLUSION

The present review analyzed scientific evidence on the benefits and challenges associated with the implementation of patient navigation programs in cancer centers. The analysis revealed a growing interest in the implementation of oncological PN programs in various contexts, approaches and results obtained, highlighting the complexity of the topic as relevant as the disease itself.

Evidence shows favorable results in reducing waiting times, improving quality of life, and increasing patient satisfaction. On the other hand, common challenges to the

implementation of PN highlight lack of resources, lack of professional qualification, and the complexity of care coordination at different levels of care.

Despite the challenges in implementing navigation in cancer centers, the promising results justify the effort. By optimizing the patient journey, navigation provides a more humanized experience, improves the quality of life of patients and their families, and contributes to the efficiency of the health system, enabling the identification and correction of failures and the optimization of the use of resources.

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NEUROLOGICAL MANIFESTATIONS OF HIV: UPDATE

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ABSTRACT

HIV-associated neurological manifestations compromise the central nervous system (CNS) and peripheral nervous system (PNS), resulting in complications such as encephalitis, progressive multifocal leukoencephalopathy (PML), HIV-associated dementia, and peripheral neuropathies. These conditions stem from inflammation and neurotoxicity induced by the virus, affecting immune and supportive cells such as microglia and astrocytes. This study conducted a systematic review using the Research Portal of the Virtual Health Library, with a search limited to Brazilian articles that addressed neurological alterations in HIV. Ten articles were selected based on strict inclusion criteria. The results pointed to representative data on the prevalence, pathophysiology, and available therapies for neurological complications of HIV, highlighting the persistence of neurocognitive disorders even in patients on antiretroviral therapy (ART). While PML was evidenced as a significant complication, with a low survival rate among those affected. The discussion reinforces that, despite the advances in ART, factors such as advanced age, prolonged immunosuppression, and barriers to drug penetration in the CNS contribute to the persistence of neurocognitive changes. Personalized therapeutic strategies, combined with multidisciplinary integration, are essential for the management of these patients. It is concluded that the neurological complications of HIV remain a relevant clinical challenge. Continuous research and the development of more effective therapies are indispensable to improve the quality of life of patients and reduce the impacts of these manifestations.

Keywords: HIV. Neurological complications. Diagnosis. Therapy. Revision.

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INTRODUCTION

The main characteristic of HIV (Human Immunodeficiency Virus) is its ability to compromise the immune system, but its manifestations in the central nervous system (CNS) and in the peripheral nervous system (PNS) are also of great clinical relevance (Aráujo et al. 1996).

HIV-associated infections can lead to a number of neurological complications, which can occur at different stages of infection. CNS HIV can cause encephalitis, progressive multifocal leukoencephalopathy, and HIV-associated dementia, resulting in cognitive, motor, and behavioral changes. These conditions are often related to inflammation and neurotoxicity induced by the virus and activated immune cells, which although it does not directly affect neurons, according to Gáscón (2022) HIV is associated with infections in CNS support cells, such as microglia and astrocytes. This group of cells constitutes a fundamental cell group to preserve the conditions of the interstitial environment in the nervous tissue. In addition, they play an essential role in coordinating immune responses, in addition to synthesizing and releasing amino acids that are used by neurons. In addition, these cells also regulate the balance of ions that are crucial for the action potential in neuronal membranes. However, the infection of these cells is considered a factor that can trigger inflammation in the nervous tissue resulting in pathogens mentioned above.

In the PNS, HIV can cause peripheral neuropathies, which is a secondary involvement due to infection by the virus and also the result of occasional pathogenesis such as those mentioned in the paragraph above. In this way, the symptoms manifest as pain, weakness and loss of sensation in the extremities. As already mentioned, these neuropathies may be a consequence of the virus itself or the use of antiretroviral drugs (Santana et al. 2023; Gáscón, 2022).

Also from this perspective, progressive multifocal leukoencephalopathy (PML) is a disease that causes the loss of myelin in the brain and is caused by the John Cunningham virus (JCV). PML was a rare and fatal complication associated with hematologic cancers or inflammatory disorders prior to the HIV epidemic. According to studies (Santana et al. 2023) between 1958 and 1982, only 230 cases were recorded. With the advent of combination antiretroviral therapy (CART), HIV has become the leading cause of PML-related immunosuppression. Also in this study, the indices show that 3 to 5% of people living with HIV/AIDS develop PML, with a survival rate of only 10% after one year.

METHODS

The systematic review was carried out in January 2025 using the Research Portal of the Virtual Health Library in order to identify relevant studies in Brazil on the complications and neurological manifestations caused by HIV in this group. To this end, the search process used the following keywords: (neurological complications) and (HIV), limited to the title, abstract and subject fields. This database was accessed through the Virtual Health Library (http://pesquisa.bvsalud.org). The research was carried out in stages and in the state of the art the sources were presented in LILACS (28), MEDLINE (10), CUMED (5), BINACIS (2), BDENF (1) and Index Psicologia (1).

Articles were selected that met the following criteria: articles developed in Brazil and containing information on neurological changes in HIV. A total of 10 articles were selected meeting these criteria. In this sense, this study aims to identify studies published in the literature that evaluate the neurological alterations caused by HIV.

RESULTS

The analysis carried out allowed us to obtain reliable and representative data of the clinical reality, thanks to the rigorous criteria adopted for this study. This article addresses the neurological manifestations associated with the Human Immunodeficiency Virus (HIV), exploring from the most prevalent alterations to those less frequent, but clinically relevant. The study gathers up-to-date data on the pathophysiology of these manifestations, as well as available and emerging therapies that aim to mitigate the neurological impacts of HIV, contributing to better clinical management of patients.

DISCUSSION

Human immunodeficiency virus (HIV) infection transcends immune impairment, also affecting the central nervous system (CNS) and resulting in several neurological complications. Since the beginning of the epidemic, it has been observed that HIV can cause cognitive deficits, behavioral changes, and motor dysfunctions, significantly impacting the quality of life of patients (Christo, 2010).

With the advent of antiretroviral therapy (ART), there has been a reduction in HIV-associated mortality. However, even with treatment, many patients continue to have HIV-associated neurocognitive disorders (HAND). These disorders range from asymptomatic impairments to more severe forms, such as HIV-associated dementia. Studies indicate that the prevalence of HAND remains significant in the era of ART, affecting higher cognitive functions such as memory, attention, and executive functions (Pansera, 2017).

The impact of HIV on the CNS occurs due to the invasion of the virus into resident immune cells, such as macrophages and microglia, which release neurotoxic inflammatory cytokines. This inflammatory process can lead to neuronal degeneration and synaptic dysfunction, impairing higher cognitive functions (Cordeiro, 2019).

Recent studies indicate that the prevalence of neurocognitive alterations in patients with HIV remains significant, even in patients under regular treatment. Research has identified high rates of cognitive impairment in cohorts of newly diagnosed patients (Silvany, 2018).

In the context of vertical transmission, the damage can be even more pronounced. Children infected with HIV during the perinatal period are at increased risk of cognitive impairment, as the infection occurs during a critical period of CNS development. These patients often have deficits in motor skills and school performance (Souza, 2014).

The diagnosis of HIV-associated neurocognitive alterations requires a multidimensional approach. It is essential to perform a detailed clinical evaluation, complemented by neuropsychological examinations, neuroimaging, and analysis of the cerebrospinal fluid. The use of biomarkers to detect CNS inflammation, such as the presence of specific proteins in the cerebrospinal fluid, has shown promise in the early identification of these alterations (Midya; Chakraborty, 2015).

Risk factors such as older age, detectable viral load, and low CD4+ T lymphocyte count for prolonged periods are associated with the development of these complications. Patients with a lower CD4+ T nadir have a higher susceptibility to HIV-associated dementia, indicating that severe immunosuppression is directly linked to the severity of neurological damage (Christo, 2010).

While ART has brought significant advances, challenges remain. Not all antiretroviral drugs have good CNS penetration, allowing HIV to persist in viral reservoirs. These reservoirs may be responsible for ongoing neurological damage, even in patients with an undetectable viral load in peripheral blood (Cordeiro, 2019).

Therapeutic combination strategies with drugs with high CNS penetration can minimize the impacts of neurological changes. However, the side effects and long-term toxicity of these drugs still pose a challenge in clinical practice (Pansera, 2017).

The therapeutic approach should be personalized and multidisciplinary. Proper management of neurocognitive alterations requires the integration of neurologists, infectious disease specialists, and mental health specialists, in addition to including psychosocial support (Silvany, 2018).

CONCLUSION

HIV-associated neurological changes continue to be a relevant concern, especially due to the longevity achieved by patients with the advent of ART. Continuous research and development of new therapies are key to better understanding the underlying mechanisms of these changes and promoting effective interventions that improve patients' quality of life. Thus, it is possible to see that since the introduction of TARC, there has been a significant reduction in the incidence of PML among patients with HIV, although this decrease has been smaller than in other opportunistic infections.

Therefore, understanding the neurological manifestations of HIV is crucial for effective management of the disease and for improving patients' quality of life. HIV-associated neurological changes represent a significant concern, especially with regard to the increase in patients' life expectancy due to advances in antiretroviral therapies (ART). Despite improvements in treatment, many patients continue to face neurocognitive disorders that affect their quality of life. Thus, the scientific review highlights the need for a multidisciplinary approach to the management of these complications, involving neurologists, infectious disease specialists, and mental health professionals.

The identification of risk factors, such as low CD4+ T lymphocyte count and advanced age, is essential to understand the severity of neurological manifestations. Continued research and the development of new therapies are essential to improve the understanding of the neurological changes caused by HIV and to implement interventions that can improve the quality of life of affected patients.

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ETHICAL ASPECTS IN CONTEMPORARY HEALTH RESEARCH

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ABSTRACT

In contemporary times, research that deals with health issues, in general, tends to reproduce some guiding criteria in the construction and execution of the subjects involved. The current system of academic data production, as support for decision-making in society happens in a dynamic and intense way. Considering the logic of high productivity in academic publications, this article aims to discuss ethical aspects related to health research in contemporary times, keeping a close eye on the use of elements that help in the elaboration of authentic and ethical scientific research. The methodology included a selection of articles related to the theme to support a discussion, through a literature review and bibliographic survey. It is concluded that the dynamic flow for productivity in publications tends to weaken the rigor in ensuring the ethical aspects related to research, which also demonstrates that it is not depending on the construction of norms/rules, but rather on a particular commitment of the researcher. This is a challenge to be faced in the academic universe and given that the final product is a document (scientific article) publicly offered to nourish decision makers, there is a great responsibility in the final part that lies with the editorial boards of the journals that hold the manuscripts.

Keywords: Ethics. Contemporaneity. Health. Research.

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INTRODUCTION

First, for a more solid understanding of the themes that will be debated and analyzed, it is necessary to base it on the definitions of the subject investigated. When we started the debates, we realized that there is a need to guide health research professionals with regard to the criteria and guiding principles of all stages of scientific research.

According to Castilho and Kalil (2005, p. 346), we observe that the document prepared by the National Health Council (CNS) on ethics in medical research "mixes ethical aspects of research with issues and aspects of biosafety and health surveillance". This, for a good part of the scholars on the subject, may explain the non-implementation of the resolution in a comprehensive way. In order to universalize demands and guide the empirical sieves and contents, the National Research Ethics Committee (CONEP) was created with the purpose of substantiating the Consent Form, understood from the perspective, according to Castilho and Kalil (2005, p. 346), that one cannot have "any type of limitation to influence the will and decision of the research subject", bearing in mind that the subject of the research is not only information, but the search for clarification. CONEP has in its nature to be a collegiate, consultative, deliberative, educational, independent, normative instance formed in accordance with the National Health Council (CNS) (Castilho and Kalil, 2005).

Likewise, we note that after resolution 196/96, which created the so-called Research Ethics Committees (CEPs), the purpose of examining ethical issues in research with human beings throughout the territory was fostered according to the evaluation of three principles: consent of the subject; maintenance of the privacy of the subject's information; approval by peers and by the community (Castilho and Kalil, 2005).

Starting from this premise, with the application of the meaning of morality, or its understanding as a theory about the understanding of what would be right and wrong, we deal with its approaches from some perspectives: normative, when they manifest standardized bad or good actions, or descriptive, when people report their beliefs and actions, in addition to the analysis of concepts and their methods (Beauchamp and Childress, 2002). The constitution of ethics in research is in any case fundamental since, according to Castro e Silva, Mandes and Nakamura (2012, p),

> if we think that the choice of a theme or object of study is related to a singular life trajectory, in which at all times the researcher must ask himself how to reconcile the constitution of the ethical posture in relation to the researched with their desires, dreams, curiosities and expectations.

Seeking the values and importance of ethical aspects in contemporary health, which should encompass research that carries singularities, subjectivities, in order to constitute new knowledge and perspectives, ratifies the importance in the debate on ethics in its general sense, or as Castro e Silva et al (2012) says,

> In advance, we can affirm that the notion of ethics linked to research means much more than compliance with formal research protocols, such as the signing and collection of free and informed consents. Reduced to the formality of the contract signed between researcher and researched, research ceases to fulfill its main function, which is to enable the former to reflect on his ethical posture in scientific production.

Finally, from these dimensions, we will be able to debate fundamental themes so that the process of building trust and respect, both of the researcher and the researched, is gradually improved and specialized, so that research faithfully fulfills its duty as a builder of knowledge.

OBJECTIVE

The objective of this article is to discuss the ethical aspects that are linked to research, based on the notion of the concept of ethics and the development of scientific research, in view of its contribution to the understanding of the inseparable relationship between ethical aspects and research, also to the researcher himself, especially those that are focused on collective health.

JUSTIFICATION

The importance of discussing the theme involves several factors that range from the appropriate behavior of the researcher, as a receiver and constructor of the analysis, taking into account that steps, information, contents, authorizations, in addition to the uniqueness and privacy of the research subject, that is, the one who has the reports and shares them, must be respected, in order to "obtain the expected integrality in the research, which requires much more ethical behavior than a formula (Castilho and Kalil, 2005). Thus, when we focus on the research and the demands of the current dynamism of the public sphere, we can neglect important factors to develop a serious and impactful research for the environment. From this, we ask: does the rush to publish neglect ethics in research?

For the purposes of understanding, as stated by Castro e Silva et al, (2012) the "qualitative methods in health research require an initial clarification. When talking about method, it is necessary to differentiate it from techniques, so as not to reduce it to a merely instrumental aspect". The epistemological developments in the production of knowledge,

which can often opt for theoretical references to the detriment of collecting references opposed to those that are considered classical, must be consonant with the identification of a bibliography capable of leading the researcher to his limits and possibilities, so that there are no risks to the integrality of the research.

Another factor that justifies the need to keep the discussion always open to the ethical and guiding principles of health research is based on the researcher/research sponsor relationship. As much as the researcher must seek the proper information about the funder, so that his right to choose and autonomy in the elaboration of the research is preserved, he may still have conflicts of interest. This is confirmed by Castilho and Kalil (2005), when they discuss that there are "several cases reported in the medical literature of these conflicts of interest implying important ethical problems". Most of these problems arise from the lack of clarification and the lack of notes of the discomforts, risks and possible benefits that the research process generated.

The literature confirms the difficulties in finding clear and objective norms that can guide public health research projects and submissions, which mostly involve ethical issues. In this way, we expose the statement of Souto, Lucena, Cavalcanti and França (2011, p. 56):

> There are several ethical aspects related to research with secondary data, however, confidentiality, privacy, and individual consent were mentioned in most studies and it can be inferred that these are the most prevalent ethical dilemmas in this type of research.

Thus, the importance of retaining attention to the use of informed consent of those who will participate in the research, the use of secondary data, the use of images and their alterations in accordance with the rules of law in force under them, as well as full compliance with the methodological instruments of the research ethics committees and the commitment of the researcher to ensure that the ethical aspects related to research are complied with, justify the need to debate the topic directly, in order for "*ethical intentions to be transformed into ethical actions*" (Amorim, 2019, p. 1039), respecting the dignity of the human being.

METHODOLOGY

The methodology followed the literature review instrument, consulting productions that debated the central subject of the production, in order to raise contents that can help in the construction of an adequate literature. From the perspective of Lévy *apud* Brizola and Fantin (2016), the production of knowledge is built collectively, and therefore "some care

must be taken by those who propose to carry out research", since "a new research intends to address some bias that complements or contests what other researchers have already stated" (Brizola and Fantin, 2016, p. 23). Thus, literature review is "the gathering, the joining of ideas from different authors on a given topic, achieved through readings, research carried out by the researcher" (Brizola and Fantin, 2016, p. 27).

Also resorting to bibliographic research makes it possible to survey theoretical approaches that have already been published, such as books, scientific articles, considering that any scientific research is based on bibliographic research, which permeates the subject and ensures the researcher a solid basis to approach its content, deepening his knowledge about the object of research (Fonseca, 2012).

DEVELOPMENT

INFORMED CONSENT FORM

In order to understand what it is about, it is necessary to define and expose the object. The Informed Consent Form (ICF), according to Souza et al (2013, p.201) , is an "explanatory document, where all issues related to the clinical study that may be related to the research subject's decision are agreed upon, and thus ensure voluntary participation". Its application in an appropriate way generates a more ethical treatment in the relationship between researcher and researched, encouraging respect for human rights, and for this reason its growing increase in recent years has been observed. However, poor compliance with the informed consent form means that the number of suspensions of clinical studies by ethics councils, as in the United States, is high and the greatest cause among others.

The complexity of the information and its reading can impair the understanding of the research subjects, exposing, as stated by Souza et al (2013, p.204), "the absence or inadequacy of informed consent". This may be rooted in the very choice of the group to be analyzed, taking into account its particularities and subjectivities, such as cultural, school, social, economic, political, etc. In the words of Souza et al (2013, p.204), "according to the readability indices found, the texts proved to be difficult to understand, requiring greater education from the research subjects".

Thus, there is a need to create consent forms with appropriate language, according to the specificities of each group to be analyzed, so that conflicts in participation are increasingly smaller and there is acceptance and understanding of what is requested.

> Despite the high acceptance rates of the ICF, it is necessary to analyze the new methods of application of the informed consent, so that the research subjects with less education can fully understand the study proposals. (Souza et al, 2013, p. 205)

Through this perspective, we observe that future projects should include these reflections (Messer, 2004), with the possibility of adhering to other means that help the research subject to understand the study, such as visual resources or explanatory videos.

USE OF SECONDARY DATA

Secondary data are contents already collected or recorded by various sources, available for consultation and use in future research and studies. Its importance lies in the permission to carry out new studies, with more details, facilitating the development of new strategies and actions in public health. As a result, the reduction in time in the construction of research material contributes to greater dynamism, without the need for the help of field research.

With the democratization of scientific knowledge, through the internet, a greater scope of scientific production and the use of this data was made possible, as explained by Drummond et al (2009, p.9):

> However, the importance of these publications for the dissemination of scientific knowledge is recognized, as they are characterized by quality control by peers. The possibility of access to such publications has been expanded thanks to the democratization of the use of microcomputers, their growing dissemination in electronic media and the greater ease of use of the Internet. Through the internet, it is possible to have immediate access, in part or in full, to scientific articles published in indexed journals and made available by bibliographic databases.

As much as the encouragement to research professionals is greater compared to those who did not access such platforms, resulting in the expansion of discussions and theoretical contributions in the product of their work, there is still the danger of unbridled use and without due care in the production of research. The risks lie in the injury to data privacy and confidentiality, as well as individual consent, inferring ethical dilemmas that are "more prevalent in this type of research" (Souto et al, 2011, p.52)

The little discussion on the subject is also a risk factor when choosing to use this data, since in health this can even hurt the safety of medical records and patient data. In addition, the information may not be consistent with the central objective of the study, conflicting with the other parts of the text. With this, added to the time factor, the careless use of secondary data can affect the originality of the text itself, also added to the fact that the subject who produces an academic text is facing a challenge, that of writing, in addition to socializing people and building solid scientific knowledge (Pereira, 2023).

We also note that the lack of research on the aforementioned subject both in Brazil and in the world results, among other things, in the lack of guidance of researchers during the production of research with this methodology (Souto et al, 2011).

RESEARCHER'S COMMITMENT TO THE ETHICAL ASPECTS RELATED TO RESEARCH

To begin this debate, we emphasize, as in the words of Amorim (2011, p. 1035), that the "choice of the researcher should be guided by the needs and priorities of society", especially when they are being financed with public funds by the State, "however, this is not what is observed most of the time". The pressure for research, and the need to streamline time and follow a continuous flow of productions without the determined time required for their best construction, ends up facilitating the understanding that we must publish all the time, without carrying out in-depth research and with adequate ethical parameters. Amorim (2011, p.1036) assertively points out that it is observable that "many studies do not have a scientific and social justification to support them", or "do not follow scientific rigor, among other factors", and even so they choose to carry them out.

A logic of production for production's sake is guided, with an end in itself, it generates massive scientific production without the minimum ethical preparation for publications and dissemination of scientific content, but it sets its objective at obtaining an "excellent" curriculum (Amorim, 2011), that is, a utilitarian mechanism of production. More than imposing on researchers a burden of rapid academic production, it is necessary to stimulate their moral competence, which will help in carrying out actions and judgments in accordance with ethical principles (Rego, 2007).

In the same way, Amorim (2011, p. 1039) challenges us:

> (...) So, that an ethical culture in the area of research be stimulated and promoted, where those involved can recognize the challenges related to this process and have the sensitivity to act with equity, justice and respect, with responsibility towards current and future generations as a guide.

We agree that the Research Ethics Committees should approach these demands, with a view to an educational and responsible practice of scientific production, less utilitarian and more ethical, and thus it is necessary to have an intense work of basic training for new researchers, without excluding a recycling involving other researchers who work in this scientific area.

RESEARCH ETHICS COMMITTEES

The creation of research ethics committees in the national territory began in the 1988 resolution of the National Health Council (CNS), but was later consolidated in Resolution 196/96. The REC's have a multidisciplinary team, evaluating all stages of research with human beings, from the elaboration of the project to its final report and publication (Batista

et al, 2012). Regarding its definition itself, Batista et al (2012, p.151) describe its attributions and its objective as an interdisciplinary organization.

> In the formation of the committee, there must be a maximum of 50% of its members from the same professional category, and the participation of people who are not focused on research must also be guaranteed. In other words, it is not a committee of researchers, but a representative group of society. The objective of the REC's is to analyze the protocols of biomedical investigation, in aspects related to the research subjects, the importance and relevance of the research.

In view of the various scenarios of data manipulation and collection, as well as the risks of lack of adequate schedule or included budget, passing through methodological flaws in the preparation of projects, we observed problems that, first of all, were not guided by ethics in their genesis. The CEP's main initiative was to be a promoter of ethical principles involving human rights, not being able to support particular rights to the detriment of the universal rights of the community. The holding of events, the training of its members, are mechanisms that can be used to leverage the quality of the committees, in addition to being in line with the main idea of when they are thought and formed.

> The constitution of a REC must avoid the mistake of attributing to its members the character of representatives of interest groups, as well as adherence to certain religious beliefs or certain corporatist institutions. The CEP is not a place for negotiation of corporate interests; The interest should be to evaluate the impact of research on the well-being of people's lives. (Batista et al, 2012, p.155)

The committees' evaluations must value responsibility and attention, taking into account that the content obtained will have a considerable impact on the scientific community and society. For a rich approach with regard to a certain theme, which has the need to gather strong elements for the production of a quantitative study, for example, the committees have an essential role in the field of publications, as they will evaluate which ones were coherent with the research project and the time needed to formulate the content.

Thus, the role of the REC in the dissemination of ethical norms in research with human beings is indispensable, including its role also in the education of the researcher and in the correct way to form an authentic research project (Muñoz, 2005).

FINAL CONSIDERATIONS

Taking into account what has been exposed, we are faced with the phenomenon of dynamic flow in academic productivity, especially those related to health, which without the proper care and apparatus of the proper organisms that safeguard the primary elements for the constitution of good scientific research, the rigor in guaranteeing the ethical aspects related to research will become fragile. In any case, the subjective commitment of the

researcher proves to be more effective than depending on the construction of norms/guiding rules, This is a challenge to be faced in the academic universe and in scientific productions in a broad way, and that given the final product is a document (scientific article) publicly available with the objective of forming decision makers, There is a great responsibility in the final part, which lies with the editorial boards and research ethics committees, in general.

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EPIDEMIOLOGICAL ANALYSIS OF LEISHMANIASIS IN BRAZIL FROM 2018 TO 2023

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ABSTRACT

Introduction: Leishmaniasis is an infectious disease caused by protozoa of the genus *Leishmania*, transmitted by the bite of infected sandflies, popularly known as sandflies. Thus, the relevance of understanding the epidemiological profile of leishmaniasis is evident. **Objective:** To define the epidemiological profile of leishmaniasis in Brazil. **Methods:** This is a retrospective horizontal epidemiological profile that uses data from datasus for the years

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2018 to 2023. **Result:** 1,615,589 total cases were recorded in the 2018-2023 period. As a result, more cases were observed in the age group from 0 to 24 years old, in which 628,658 total cases were reported. **Discussion:** The year 2020 had 270,952 cases, which represents a drop in the number of notifications compared to 2019 with 267,454 total cases. When comparing the pandemic period with the post-pandemic period, an increase in the number of notifications was observed. There was possibly underreporting due to the overcrowding of hospitals during the pandemic period. **Conclusion:** In this sense, it is evident that the overcrowding of hospitals during the pandemic period was a determining factor for the decrease in reported cases as well as hospitalizations for leishmaniasis. The present study aims to inspire future public policies in the fight against leishmaniasis.

Keywords: Notifications. Overcrowding. Pandemic.

INTRODUCTION

Leishmaniasis is an important public health problem in Brazil and in the world, being a zoonosis considered a global public health problem, being one of the seven

priority endemic diseases for the World Health Organization (WHO) (Negreiros, 2024).

In Brazil, about 96% of the cases in South America are concentrated; distributed throughout the country, VL is present in 21 of the 27 Federative Units, demonstrating a large concentration of the number of cases of the disease in Brazil, largely due to factors associated with the climate in addition to socioeconomic factors, as well as the performance of the health system, given that Leishmaniasis is observed mainly in the poorest population (Silva, 2021).

In this context, the population's access to health care emerges as a crucial factor in this performance, since Leishmaniasis is a disease of the poor, occurring mainly in remote rural villages with precarious housing and little or no access to modern health care facilities. In endemic areas, the diagnosis of any form of leishmaniasis places enormous financial pressure on an already scarce financial resource, both at the individual and community levels. Most of the time, families need to sell their assets (land and livestock) or borrow from informal financial institutions with high interest rates to pay for the diagnosis and treatment of leishmaniasis (Alvar, 2012).

Leishmania infection in the macrophage occurs due to a series of events that will precede the entry of the infecting metacyclic promastigote form into the host cell, which will play a major role in the success or failure of the infection. In relation to the clinical spectrum of the disease, Leishmaniasis can remain asymptomatic in naturally resistant individuals, with an innate immune response capable of controlling the progression of the infection or, as in individuals with immunological susceptibility, result in a spectrum of clinical manifestations in the skin and/or nasopharyngeal mucous membranes, these events demonstrate the risks associated with the disease that is endemic, especially in South America, especially in Brazil. (SILVEIRA, 2008)

In Brazil, several factors have contributed to the appearance of new foci and new endemic areas of VL, among them, environmental transformations, growing urbanization and rural emptying. Despite this, over the years, the largest number of cases was maintained in the Northeast, in males and children, so it is evident how the profile of the disease is closely related to the socioeconomic conditions of Brazil, making it necessary to implement broad public policies in this context. (COUTO, 2018)

For all the above, the article aims to explore the particularities that involve inequality in the effects of preventive care for Leishmaniasis in Brazil, evaluating socioeconomic factors and temporality in relation to the pandemic.

METHODOLOGY

The present study is a retrospective, observational, and descriptive epidemiological analysis, evaluating the cases of leishmaniasis in the geographic coverage of Brazil, in the period described between 2018 and 2023.

Annual data were conducted to obtain annual data from the Information System of the Outpatient Information System of the SUS (Sia/Sus) of the Department of Information and Informatics of the SUS (DataSus). In aid of the theoretical foundation, scientific articles in Portuguese were used, extracted from the Scielo, PubMed and Scopus platforms.

To better direct the research, the following variables, clinical and diagnostic, were considered for analysis: , age group (0 to 80 years), total cases in the years 2018 to 2022, temporal situation in relation to the Covid-19 pandemic (pre-pandemic period from 2018 to 2019, pandemic from 2020 to 2021, post-pandemic year 2022).

RESULTS

Leishmaniasis is an inflammatory parasitic infectious disease that affects from the most superficial tissues (integumentary and mucosa) to the bloodstream and visceral organs (da Silva, 2024, p. 3), leishmaniasis in terms of its geographical distribution, constitutes "a health problem in tropical and subtropical countries, distributed on four continents (Americas, Europe, Africa and Asia), with an annual record of 0.7 to 1.3 million new cases, however, it is more frequent in South American countries, especially in Brazil (da Silva, 2024, p. 4) . Thus, particularities related to the quality of health services, application of control programs, low knowledge of the population about their prophylaxis associated with the low socioeconomic status of the region contribute significantly to these disparities.

In addition, regarding Leishmaniasis, an average of 1,615,589 cases were registered on the DataSus platform in the 2018-2023 period. The highest occurrence of cases was observed in the age group of 0-24 years, which had 628 thousand cases in the analyzed period, representing 39% of the total cases. Compared to the other age groups studied, 25-60 years (36%) and 60-80 years (25%).

It is important to highlight the variation in relation to the number of cases reported in the periods: pre-Covid 19 pandemic (2018-2019), during the pandemic (2020-2021) and

post-pandemic (2022, 2023). In this context, 365 thousand total cases were registered in 2018, but there was a significant reduction in the number of cases in 2020 compared to the previous two years, with 270 thousand cases, which represents a drop in the number of notifications of 27%. When comparing the pandemic period with the post-pandemic period, a growth in the number of notifications of morbidity of the disease was observed, in 2022 278 thousand cases were registered, indicating an increase of 3%.

DISCUSSION

However, an integrative review by (Alvar, 2012) was able to demonstrate that sociodemographic and economic factors are the most preponderant for the population to have knowledge about Leishmaniasis, with a direct relationship between unfavorable sociodemographic conditions and lack of knowledge about the disease. The literature also proposes a relationship that allows inferring for the North region and the state of Tocantins, since the incidence of poverty has a strong regional component, which is more evident in the North and Northeast, as analyzed by (COUTO, 2018).

In general, difficulties in relation to the prevention, diagnosis and treatment of Leishmaniasis markedly include aspects related to public management and professional practice, which coexist with economic and demographic disparities that condition early screening, in order to have repercussions on screening coverage. This was demonstrated by (Barcelos, 2024) , in an investigation that allowed us to conclude that the greatest deficits in procedures were found in the North, Midwest and Northeast regions, which share the highest incidence and mortality rates from Leishmaniasis, as well as the worst socioeconomic conditions and the greatest barriers to care. It should be considered that these conditions have greatly hindered the control of leishmaniasis in Brazil.

However, it is important to emphasize that there are multiple limiting factors in the practical application of Leishmaniasis care in Brazil in a broad and comprehensive way. In the study by (da Silva, 2024), obstacles related to the failure to implement the guidelines for early detection of Leishmaniasis among the regions of Brazil were listed. For the North of the country, the following were specified, respectively: low adherence of professionals, little organizational tradition in the use of guidelines, conflict with medical societies, disorganization of services, scarce financial resources and inappropriate demand from the population. From this, the complexity of the demand for improvements in health care in this region is evident, especially Leishmaniasis, due to its epidemiological relevance and accentuated morbidity and mortality.

(Von Zuben, 2016) It also demonstrated limiting factors of access to health services of a subjective-cultural dimension in the prevention of Leishmaniasis, highlighting fear, financial condition, lack of time due to work and care for the family.

Among the variables considered, it should be noted that the temporality common to a global phenomenon such as the COVID-19 pandemic suggests clear interferences in recent years, resulting in substantial delays in Leishmaniasis screening between 2020 and 2021. The reduction in the number of tests, added to the drop in subsequent records, may express underreporting, and the lack of clarity in these numbers brings the need to reinforce attention to the care of advanced cases. It is noteworthy that health agencies, during the period of the Sars-Cov-2 pandemic, would have advised citizens, in view of the urgency to control the public health scenario triggered by this infectious virus, that consultations, exams and surgeries that were not of an urgent nature should be postponed, adding the screening of Leishmaniasis being postponed, suggesting an underreporting resulting from this phenomenon.

A positive point is that the numbers of tests in the post-pandemic period demonstrated in this study exceeded those that were performed before the pandemic, which may demonstrate a population's search for screening in awareness of assessing health in a preventive way.

Thus, it can be inferred that important regional aspects of the incidence of Leishmaniasis in Brazil are projected, which urgently needs an individualized and efficient administration.

CONCLUSION

The records of diagnosed cases of Leishmaniasis in Brazil demonstrate a need for greater coverage by the government. As a consequence, there was a decrease in the number of diagnosed cases of Leishmaniasis, reflecting a reality of screening that is still insufficient, despite the slight increase in tests carried out in the post-Pandemic period in Brazil.

In addition, it was not possible to establish a relationship between education and the number of screening tests performed, due to the lack of numerical data on the level of education of citizens in Brazil.

It is concluded that the possible failures in the early screening of Leishmaniasis are linked to local organizational and sociocultural issues. Therefore, it is essential to review public policies to combat Leishmaniasis to address the obstacles that prevent more effective screening in the country, in addition to increasing the dissemination of information

on the definition, causes, and prevention of Leishmaniasis as this can significantly impact the number of early diagnoses and the success of treatment.

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VACCINE: ITS RELATIONSHIP BETWEEN HEALTH AND BASIC EDUCATION

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ABSTRACT

The research aimed to promote awareness and understanding actions to high school students of a State School in the Municipality of Nazaré da Mata - PE about the importance of vaccines in the prevention of diseases, through the combination of a didactic lecture and a playful activity, with the main purpose of consolidating the knowledge acquired and encouraging health practices based on scientific evidence. For the methodological procedure, the action research was divided into five stages and these stages were arranged in 3 different moments. The overall percentage of correct answers in the playful activity was 66%. From the analysis of the results obtained before and after the lecture, it was found that time and competition are antagonists in the students' performance, even if the later results, in general, were significant. The methodology used allowed that, despite the challenges proposed by the quiz, the students interacted positively with the approach. This contributed significantly to the understanding of the contents covered and was effective in building the relationship between teaching and learning.

Keywords: Education. School. Kahoot. Active methodologies. Vaccine. Public health.

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INTRODUCTION

The immune system performs the function of protecting the body against infectious and inflammatory agents, this system is divided into the innate immune system and the adaptive immune system. The innate immune system is formed by neutrophils, NK (Natural Killer cell) lymphocytes, macrophages and other cells, such a system is the body's first line of defense against invading microorganisms, becoming essential in the balance to keep the organism healthy (Sordi *et al.*, 2020).

In the case of the adaptive or acquired immune system, the defense is acquired throughout the individual's life according to the contact of the individual's body with a certain pathogen (bacteria, viruses, parasites, and fungi), this adaptive system is composed mainly of B and T lymphocyte cells (Veloso, 2022). According to Lima (2022), vaccines stimulate this adaptive immunity by sensitizing the body to a certain pathogen, creating an immunological memory, so when there is a new contact of the body with a certain pathogen, the body will activate the antibodies again, triggering the immunization process.

The term "vaccine" emerged in 1796 from the studies of the English scientist Edward Jenner from his studies on cowpox (Pereira and Souza, 2023). Vaccines are immunizing substances prepared with the main purpose of stimulating the body generating an immune response that aims to prevent diseases in a population (Ministry of Health, 2007). In general, this substance provides immunological subsidies to stimulate the production of specific antibodies against infections caused by viruses or bacteria (Pfizer, 2023).

The composition of the vaccine contains one or more than one antigen, and these are specific targets in the immune response it seeks to induce (Vilanova, 2020). Antigens are referred to in the literature consulted as foreign agents, which are characterized by viruses, bacteria, parasites, or fungi, which in contact with the body obtain the ability to bind in a specific way to generate an immune response (Rodrigues, 2022).

According to Cardoso *et.al* (2021), vaccines are considered the best resource for preventing infectious diseases. The authors point to vaccines as the best method of controlling these diseases, as they enhance the creation of antibodies by conferring immunological memory to the individual's body. In this way, immunization is an important tool for public health (Franco and Pereira, 2021).

Despite the importance of the vaccine in public health, Ramos *et al.* (2023) states that anti-vaccine movements are increasingly becoming persuasive and frequent. According to the authors, misinformation about vaccines is the pivot of this problem.

Thus, there is an urgent need to disseminate information based on scientific evidence on the subject. Menezes and Gomes (2024) state that it is essential to establish

practices for the population through a multidisciplinary approach to health promotion. The authors point out that the school environment becomes an important agent with regard to health education.

The guidelines on "Vaccine" and "public health" are provided for in skill 10 (EM13CNT310) of the National Common Curriculum Base (BNCC) for high school, in the discipline of Biology, thus, the guiding documents of the BNCC establish a relationship between the teaching of science in basic education and health.

Ferrari (2020) clarifies that it is essential to disseminate and teach various types of science, offering scientific activities especially in school spaces. Nevertheless, Silva et al. (2020) point out that the main objectives of the school space and education is to transform more reflective and critical subjects in society.

According to Augustinho and Vieira (2021), active methodologies are effective allies for students' meaningful learning in science teaching. The research used the lecture and the kahoot game as the main tools to promote learning of the content covered. The use of educational games by teachers has become a recurrent practice (Callegari, 2020). Didactic games are fundamental and viable tools in the construction of students' knowledge, allowing them to achieve meaningful learning (Andrade; Silva, 2020).

The research described in this article was triggered through the result of observations and reflections on themes studied in basic education according to the curriculum of Pernambuco in view of the experiences that occur during the supervised internship in the internship field, aligning the reflections diagnosed on the school floor with the theories and practices that make up the contents of the curricular components of the teaching degree course, with the student as the protagonist. Scalabrin and Molinari (2013) see the internship as "... An instrument that can make a difference for those who are entering the field of work related to education and who have the ability to transform the unfortunate reality of education in our country, which is far from satisfactory." Pimenta (1997) states that the internship is indispensable in the process of teacher training.

In view of the above, the research aimed to promote awareness and understanding actions among high school students from a State School in the Municipality of Nazaré da Mata-PE about the importance of vaccines in the prevention of diseases, through the combination of a didactic lecture and a playful activity, with the main purpose of consolidating the knowledge acquired and encouraging health education based on scientific evidence.

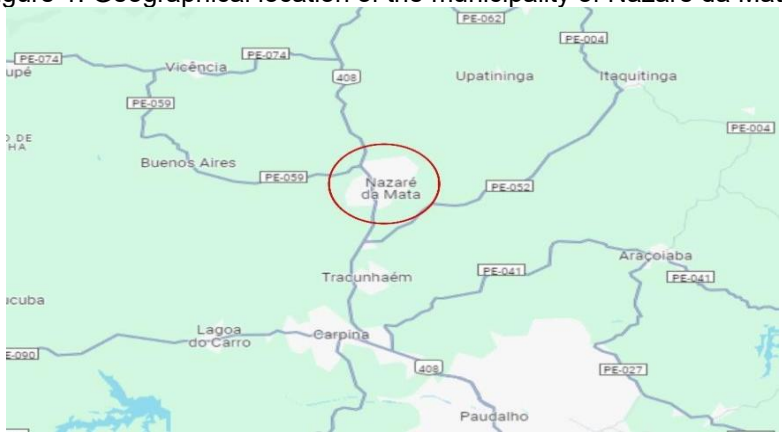
METHODOLOGY

TYPE OF RESEARCH

For the development of this research, action research was adopted. According to Silva *et al.* (2021) action research aims to extinguish paradigms between the researcher and the research participant. Thus, it ensures more integration between the research subjects, providing greater exchanges of knowledge about the thematic area to be studied, in addition to being favorable in the construction of paths for learning.

The research was applied in a State School in the Municipality of Nazaré da Mata – PE, located in the northern forest zone of the State of Pernambuco. This municipality has a territorial area of 130,572 km2 and a resident population of 30,648 inhabitants according to the last census of the Brazilian Institute of Geography and Statistics (IBGE, 2022). Figure 1 below shows the geographical location of the Municipality of Nazaré da Mata.

Figure 1. Geographical location of the municipality of Nazaré da Mata.

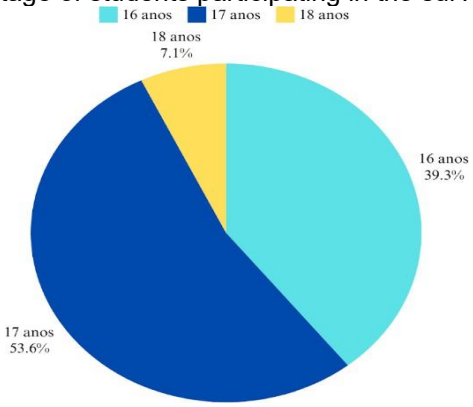


Source: Google Maps, 2024.

TARGET AUDIENCE OF THE RESEARCH

The target audience of the research was students from the 3rd year of high school. The first contact with this class was through Supervised Internship IV started in April 2024 and ended in June of the same year. In all, 28 students aged 16 to 18 years participated in the research (Graph 1).

Graph 1. Percentage of students participating in the survey by age group.



Source: Authorship, 2024.

STAGES OF THE RESEARCH

The research that was applied at the school was divided according to the steps below.

Stage 1: During the period from 2023 to 2024, a bibliographic survey was carried out on the proposed theme, in order to carry out a preliminary analysis on the theme of education and health. Articles from the last five years (2020 to 2024) involving the following descriptors were considered: "vaccine", "school", "adolescent vaccination", "prevention of diseases at school" and "vaccination campaign", in addition to the Ministry of Health website and the Pfizer Brazil website.

Stage 2: In April 2024, the organization of the intervention that would be carried out at the school began. The digital material was assembled in the Canva software in Slides (Figure 2), which was later presented to compose the lecture entitled "Vaccine: its importance in the immunization of the body in the prevention of diseases" to students with the help of a notebook and television.

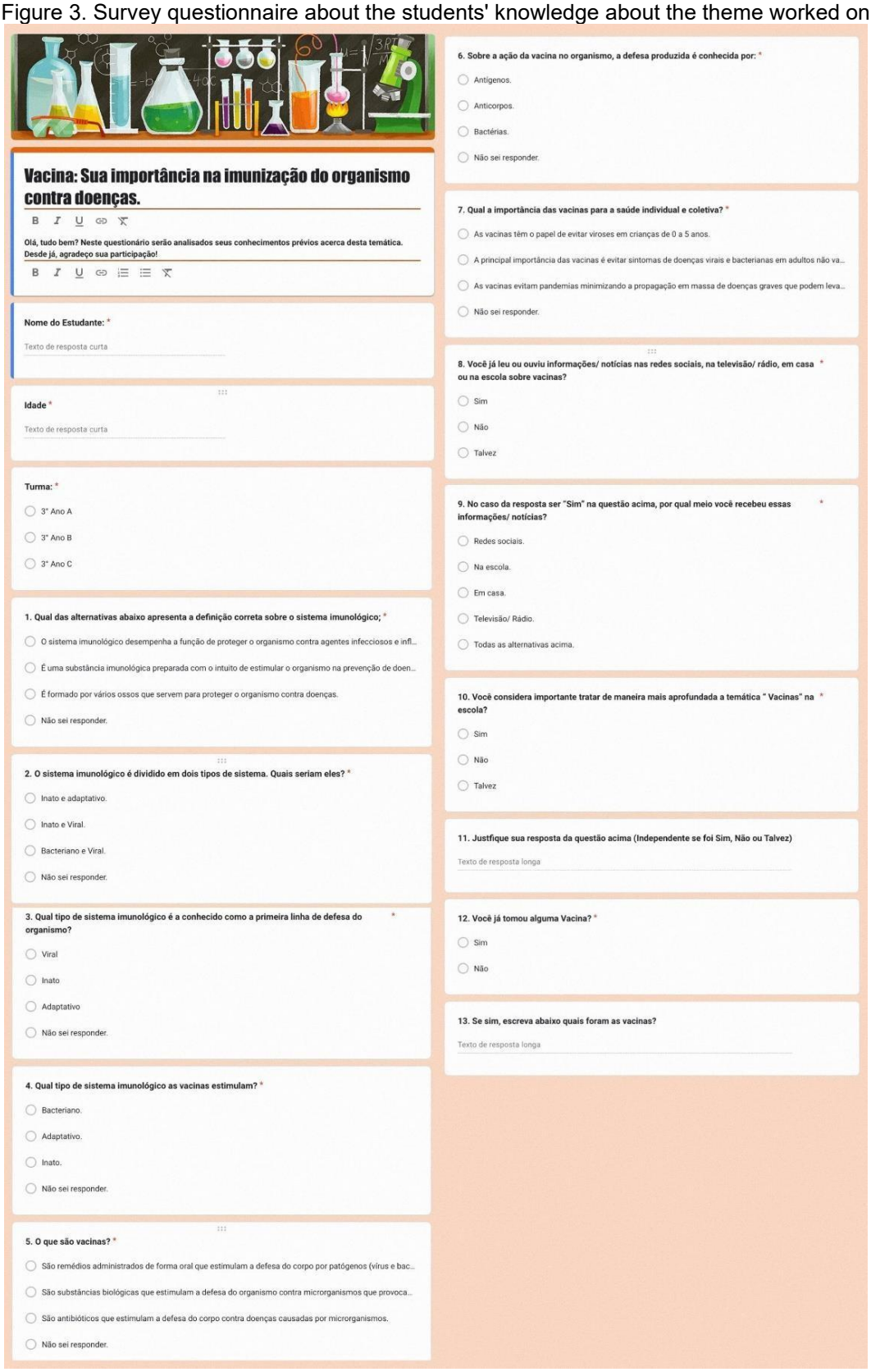
Figure 2. Slides used to compose the lecture.

Source: Authorship (2024).

In the lecture slides as seen above in figure 2, concepts about the vaccine, historical context, fake news involving vaccines, definition of the immune system, difference between the innate and acquired immune system, the importance of the vaccine, how the vaccine acts on the immune system and a brief timeline on vaccination in Brazil were addressed.

Stage 3: The stage was carried out in the same period as the previous one, in which the survey questionnaire was prepared in the Google Forms software (Google Forms), the questionnaire contained 13 questions on the theme, however it had 11 multi-school objectives and 2 discursive questions (Figure 3).

Figure 3. Survey questionnaire about the students' knowledge about the theme worked on



Vacina: Sua importância na imunização do organismo contra doenças.

Olá, tudo bem? Neste questionário serão analisados seus conhecimentos prévios acerca desta temática. Desde já, agradeço sua participação!

Nome do Estudante: *
Texto de resposta curta

Idade *
Texto de resposta curta

Turma: *
- 3° Ano A
- 3° Ano B
- 3° Ano C

1. Qual das alternativas abaixo apresenta a definição correta sobre o sistema imunológico; *
- O sistema imunológico desempenha a função de proteger o organismo contra agentes infecciosos e infl...
- É uma substância imunológica preparada com o intuito de estimular o organismo na prevenção de doen...
- É formado por vários ossos que servem para proteger o organismo contra doenças.
- Não sei responder.

2. O sistema imunológico é dividido em dois tipos de sistema. Quais seriam eles? *
- Inato e adaptativo.
- Inato e Viral.
- Bacteriano e Viral.
- Não sei responder.

3. Qual tipo de sistema imunológico é a conhecido como a primeira linha de defesa do organismo? *
- Viral
- Inato
- Adaptativo
- Não sei responder.

4. Qual tipo de sistema imunológico as vacinas estimulam? *
- Bacteriano.
- Adaptativo.
- Inato.
- Não sei responder.

5. O que são vacinas? *
- São remédios administrados de forma oral que estimulam a defesa do corpo por patógenos (vírus e bac...
- São substâncias biológicas que estimulam a defesa do organismo contra microrganismos que provoca...
- São antibióticos que estimulam a defesa do corpo contra doenças causadas por microrganismos.
- Não sei responder.

6. Sobre a ação da vacina no organismo, a defesa produzida é conhecida por: *
- Antígenos.
- Anticorpos.
- Bactérias.
- Não sei responder.

7. Qual a importância das vacinas para a saúde individual e coletiva? *
- As vacinas têm o papel de evitar viroses em crianças de 0 a 5 anos.
- A principal importância das vacinas é evitar sintomas de doenças virais e bacterianas em adultos não va...
- As vacinas evitam pandemias minimizando a propagação em massa de doenças graves que podem leva...
- Não sei responder.

8. Você já leu ou ouviu informações/ notícias nas redes sociais, na televisão/ rádio, em casa ou na escola sobre vacinas? *
- Sim
- Não
- Talvez

9. No caso da resposta ser "Sim" na questão acima, por qual meio você recebeu essas informações/ notícias? *
- Redes sociais.
- Na escola.
- Em casa.
- Televisão/ Rádio.
- Todas as alternativas acima.

10. Você considera importante tratar de maneira mais aprofundada a temática " Vacinas" na escola? *
- Sim
- Não
- Talvez

11. Justfique sua resposta da questão acima (Independente se foi Sim, Não ou Talvez)
Texto de resposta longa

12. Você já tomou alguma Vacina? *
- Sim
- Não

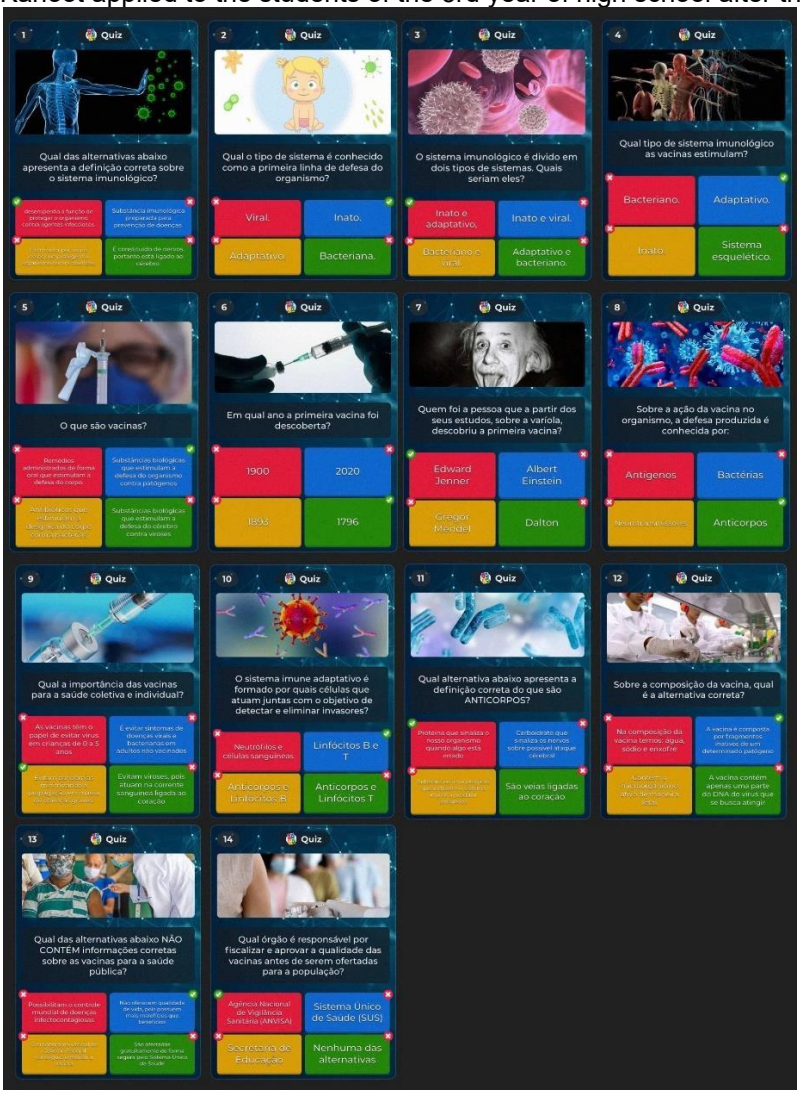
13. Se sim, escreva abaixo quais foram as vacinas?
Texto de resposta longa

Source: Authorship (2024).

Stage 4: A quiz was made in the Kahoot software in order to evaluate the knowledge acquired by the students after the lecture. The quiz contained 14 objective questions with 4 alternatives each, 7 of which were repeated from the probing questionnaire and 7 added

exclusively to the game on other topics in the thematic area addressed during the lecture. Each question had 20 seconds to be answered. Such information can be seen below in Figure 4.

Figure 4. Kahoot applied to the students of the 3rd year of high school after the lecture.



Source: Authorship (2024).

Stage 5: In May, the pedagogical intervention was applied in the classroom to the students. The intervention took place during the biology class, which lasted 50 minutes, and was divided into 3 moments listed below.

Moment 1: The link to the Google Forms polling questionnaire was released via whatsapp in the class group by the biology teacher. The class had approximately 10 minutes to answer the survey questionnaire.

Moment 2: After the students finished the survey questionnaire, the lecture entitled "Vaccine: its importance in the immunization of the body in the prevention of diseases" took

place, the class had an average of 30 minutes of lecture. This moment in the classroom can be seen in Figures 5.

Figure 5. Lecture to students in the 3rd year of high school.

Source: Authorship (2024).

Moment 3: After the end of the lecture, the participants were evaluated through the playful activity in the kahoot application. During this moment, the students had an average of 10 minutes to play the quiz.

After the completion of the 3 moments described above carried out at school with the students, an analysis of the results obtained in the survey questionnaire and the results acquired in Kahoot after the lecture was made. The answers obtained were counted and transcribed in the form of graphs. In the case of the discursive questions of the probing questionnaire, the students were enumerated by E1, E2 and so on to create a discussion based on their answers.

RESULTS AND DISCUSSIONS

The 7 questions applied in the survey questionnaire (QS) and in the Kahoot (QK) were analyzed (Chart 1). In the first question, I asked the students the correct definition of the immune system. After analyzing the results obtained, 85% of correct answers were observed in the probing questionnaire (QS) and 85% of correct answers in the Kahoot (QK). In the second question, it was explained that the immune system was divided into two types, and soon after the students were asked what these two types were. The total number of correct answers in the QS was 39.3% and in the QK it was 75%, visibly showing a considerable evolution. In the third question, the students were asked which of the immune systems was known as the body's first line of defense, in this question the correct answers were 53.6% in the Questionnaire and 80% in the Kahoot.

Regarding the topic "vaccine", the fourth question asked what type of immune system the vaccines stimulate, the previous answers observed were 60.7% and subsequent was 75%. In the case of the fifth question, students were asked "what are vaccines?", 85.7% of correct answers were identified in the questionnaire and 80% in Kahoot. In the sixth question, I asked about the defense that is produced by the vaccine, in this question the correct answers observed were 92.9% in the QS and 75% in the QK.

In the last question, students were asked if they were aware of the importance of vaccines for individual and collective health, in the survey questionnaire the correct answers were 96.4% and in the Kahoot they were 75%.

Table 1. Simultaneous analysis of the correct answers of the 7 questions of the survey questionnaire and the Kahoot of the students of class C of the 3rd year of high school.

QUESTIONS	Correct answers in the survey questionnaire	Correct answers in the kahoot quiz
1. Which of the following presents the correct definition of the immune system	85%	85%
2. The immune system is divided into two systems. What would they be?	39,3%	75%
3. Which type of immune system is known as the body's first line of defense?	53,6%	80%
4. What type of immune system do vaccines stimulate?	60,7%	75%
5. What vaccines?	85,7%	80%
6. Regarding the action of the vaccine in the body, the defense produced is known by:	92,9%	75%
7. What is the importance of vaccines for individual and collective health?	96,4%	75%

Source: Authorship, 2024.

In the Science curriculum of the early years of Pernambuco (2018), the skill EF04CI08APE focuses on understanding the organizational structures of living beings, including body systems. The high rate of correct answers in the first question of the questionnaire and in Kahoot shows that most students in the 3rd year of high school already had a good understanding of this content because they had already had contact with the subject in the initial grades, which facilitated the understanding of the theme proposed in the lecture.

On the other hand, the percentage of correct answers in the survey questionnaire in the second and third questions, within the same content, were the lowest. However, after the lecture, there was a significant increase in the correct answers to these two questions in the kahoot, as shown in Chart 1.

Nascimento and Feitosa (2020) state that the use of active methodologies in teaching offers important subsidies for critical and reflective training, promoting meaningful

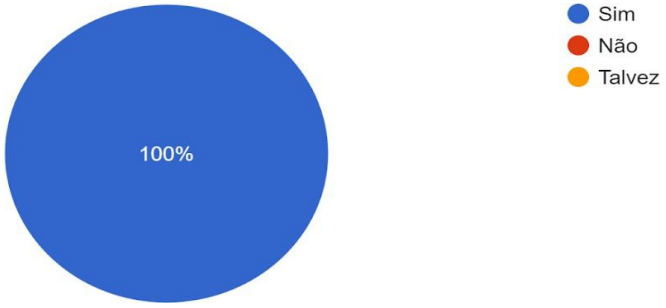
learning, especially when the student interacts with the content covered. Corroborating Azevedo *et al.* (2021) highlight that the use of differentiated methodologies, such as gamification, favors student participation in classes, enriching the teaching and learning process.

In the fourth question, the correct answers in the survey questionnaire were expressive. However, after the lecture, the evolution of correct answers in the kahoot was 14.3%, reaffirming the effectiveness of active methodologies in the construction of learning (Piffero *et al.,* 2020). The number of correct answers of class C of the 3rd year in the fifth, sixth and seventh question in the survey questionnaire was significant, as the content about vaccine, public health and biotechnology are provided for in the EM13CNT310 skill of the National Common Curriculum Base (BNCC, 2018) in the specific skill EM13CNT310BIO23PE of the Pernambuco curriculum for the 2nd year of high school, that is, the students had contact with the content in the previous school year, and are therefore familiar with the subject studied.

In kahoot, the correct answers in the fifth, sixth and seventh questions were expressive, although they were lower than in the survey questionnaire. Asked why the errors increased after the lecture, some students mentioned the lack of attention caused by the competition between them to quickly answer the questions in the game, leading to incorrect markings. On Kahoot, in addition to the correct answer, the score is also determined by the time it takes users to answer the questions. Oliveira and Andrade (2023) highlight that Kahoot, in addition to being attractive and playful, brings challenge and competition, increasing students' enthusiasm and motivation to learn.

In the eighth question of the survey questionnaire, students were asked if they had ever read or heard information on social media, at home, or at school about vaccines. In the analysis of the results obtained, it was identified that 100% of the students participating in the research had already read or heard information about vaccines (Graph 2).

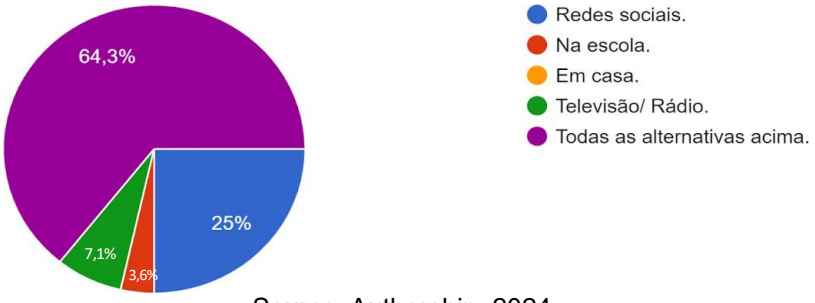
Graph 2. Percentage of 3rd year students who have already read or heard information/news about the vaccine.



Source: Authorship, 2024.

In the ninth question, the students were asked how they had access to this information/news. It was observed that 64.3% of the participants had access through various means, such as social networks, at school, at home and on television or radio, and 25% of the students had access through social networks, 7.1% had access through television or radio and 3.6% had access only through school. Such information can be seen in graph 3.

Graph 3. Means by which students in class C of the 3rd year obtained access to information/news about the vaccine.



Source: Authorship, 2024.

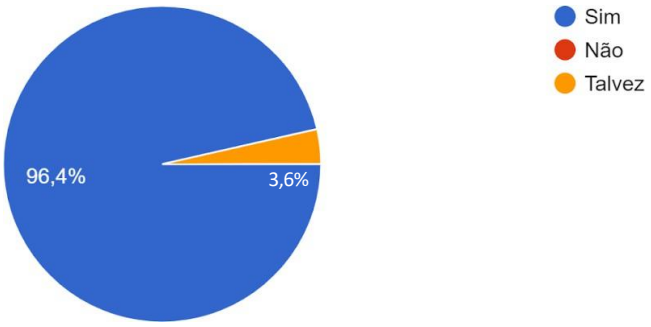
The analysis of graph 2 revealed that the adolescents participating in the research were aware of the topic addressed. Souza (2022) points out that in recent generations innovations and scientific discoveries have increased, significantly impacting the lives of individuals.

Graph 3 shows that most students read or heard information/news about vaccines from various media. However, during classroom discussions, many of them admitted to having had greater access to this information through social networks. In addition, 25% of the students revealed in the questionnaire that they obtained information exclusively through social networks through the internet. According to Neves and Borges (2020), the internet is considered one of the main means of communication. However, the authors highlight the importance of discussing the dissemination and dissemination of news and information on social networks, especially due to the ease and speed that fake news spread.

According to the analysis of Graph 3, only 3.6% of the students obtained information/news about vaccines through school, revealing a low percentage of dissemination of scientific information on the subject in the school environment. This contrasts with the guidelines of the National Common Curricular Base (BNCC, 2017) for high school, which, as highlighted on the website of the Ministry of Education (MEC), aims to develop competencies and skills in various areas of knowledge for the social and professional life of students.

In the tenth question of the questionnaire, the students were asked if they considered it important to deal with the theme in depth at school, and 96.4% of them said "yes" and 3.6% said "maybe" (Graph 4).

Graph 4. Percentage of students who answered about the importance of the vaccine topic being addressed in the school environment.



Source: Authorship, 2024.

In the eleventh question, he asked the students to justify their answer to the previous question with their words. Among the 28 answers, 7 answers from the students were selected, being enumerated by E1, E2, E3 and so on. This information can be seen in Chart 2.

Table 2. Justification of the answers to the tenth question of the 7 students of class C of the 3rd year about the importance of the vaccine theme being addressed at school.

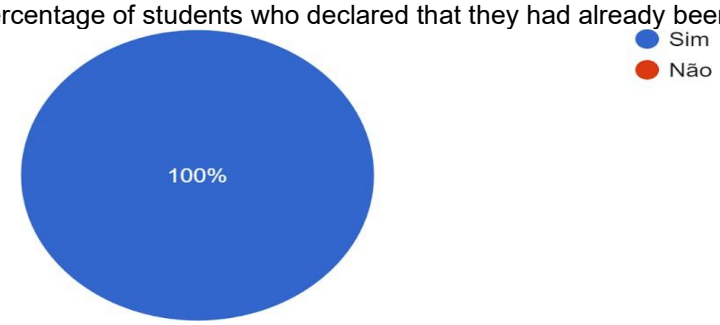
STUDENTS	ANSWERS
E1	Yes, because health is a right for everyone and access to reliable information contributes to a healthier collective (especially in relation to vaccines).
E2	It is important to avoid thoughts that vaccine is something negative.
E3	It is important for the collective health of the population and the well-being of citizens.
E4	It is important to address this issue in schools, so that children and young people understand from an early age the importance of vaccines in preventing diseases.
E5	Because vaccines play a very important role in preventing and combating pathologies.
E6	There are many people uninformed about the effectiveness of the vaccine, which makes them create unnecessary and unfounded suspicions.
E7	It is a very necessary subject, since some people think that vaccination is ineffective.

Source: Authorship, 2024.

After analyzing the students' responses, it was observed that in general they believe it is important to bring the topic of vaccines in depth at school. According to Pereira and Souza (2023), the vaccine theme has a public proportion, and its approach in Science Teaching is fundamental, as it highlights several other subjects from different perspectives that are inserted in the daily lives of students, in addition, the authors point out that addressing such a theme develops the students' ability to argue in the face of problematizations in a critical way regarding this theme.

In the twelfth question, the students were asked if they had already been vaccinated, and 100% of them answered that they had already taken the vaccine (Graph 5).

Graph 5. Percentage of students who declared that they had already been vaccinated.



Source: Authorship, 2024.

In the thirteenth question, the students who answered "yes" in the previous question should inform which vaccines they had taken. The students were numbered as E1, E2 and so on. After analyzing the results, it was found that 2 students did not provide information about the vaccines taken, resulting in a total of 26 valid answers. These answers are detailed in Chart 3.

Table 3. Distribution of students' responses regarding the type of vaccine received.

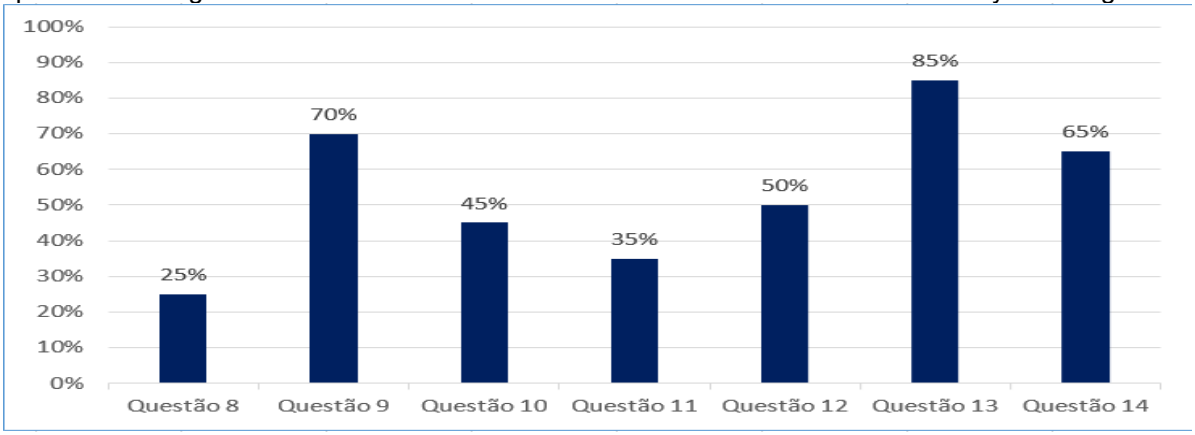
E1: those who have to take basic ones such as hepatitis, flu, yellow fever etc and covid.	**E2: Basically all of the vaccination schedule until the age of 15 (from 16 I don't know).**	**E3: All of them until 16 years old.**	**E4: All so far.**
E5: All that are allowed.	**E6: Beta hcg, viral riplice, measles.**	**E7: Pfizer, Bcg, hepatite B.**	**E8: Measles, flu, dengue, tetravalent, covid, tetanus and etc.**
E9: Flu.	**E10: I only remember Covid-19**	**E11: All (Bcg, MMR, HPV...)**	**E12: Various**
E13: All of the Little card	**E14: Flu, bitter fever, Pfizer...**	**E15: Pfizer, the influenza**	**E16: Pfizer, flu, yellow fever**
E17: influenza, HPV, Tetanus, BCG	**E18: Covid 19, CG, Trípice viral, HPV, Meningitis, tetravalent, poliomyelitis and others**	**E19: Sarampo, HIV, gripe, etc.**	**E20: there were several**
E21: Flu.	**E22: Covid, yellow fever, BCG, etc.**	**E23: All up to 16 years old.**	**E24: From the flu.**
E25: Pfizer, flu vaccine, anti-tetanus.	**E26: Covid-19, tetravalent and gripe.**	**E27: did not answer**	**E28:He did not answer.**

Source: Authorship, 2024.

When analyzing the results of chart 3, it was observed that most of the students participating in the research took more than one type of vaccine. According to Taschner and Almeida (2023), vaccines represent one of the most effective intervention measures in public health for the prevention of infectious diseases. The authors emphasize that vaccination is a right guaranteed by law for children and adolescents, evidencing the importance of this practice in the promotion of individual and collective health.

With regard to the kahoot-exclusive questions, the results obtained can be seen in graph 6.

Graph 6. Percentage of correct answers in the kahoot of students in class C of the 3rd year of high school.



Source: Authorship, 2024

The eighth question asked " In which year was the first vaccine discovered? " He brought four alternatives: "1900", "2020", "1893" and "1796". After analyzing the result, it was found that only 25% of the participants marked the correct alternative (Graph 6). According to the Butantan institute website (2021), the first vaccine was discovered in 1796.

The ninth question asked students who had been the scholar who discovered the first vaccine. In the alternatives there were "Edward Jenner", "Albert Einstein", "Gregor Mendel" and "Dalton", in this question, 70% of the students got it right (Graph 6). The world's first vaccine was discovered by the English physician Edward Jenner in 1796 during his studies on smallpox (Ayres; Travassos; Sampaio, 2023).

The tenth question asked "The adaptive immune system is formed by which cells that act together in order to detect and eliminate invaders?" The four alternatives contained "Neutrophils and blood cells", "B and T lymphocytes", "Antibodies and B lymphocytes" and "Antibodies and T lymphocytes". The percentage of correct answers was 45% (Graph 6). The immune system protects the body against diseases through biological structures and processes, and uses specific molecular mechanisms coordinated by cells, such as

lymphocytes. Acquired immunity has the function of conferring immunological memory to T and B lymphocytes (Costa *et al.,* 2020).

The eleventh question asked, "Which alternative below presents the correct definition of what antibodies are?" He brought the four alternatives "Protein that signals our body when something is wrong", "Carbohydrate that signals the nerves about possible brain attack", "Immunological substances that induce the immune system to produce antigens" and "They are veins linked to the heart". In this question, 35% of correct answers were correct (Graph 6). According to the website of the Oswaldo Cruz Foundation (Bio-Manguinhos/Fiocruz), antibodies are proteins that help the body fight pathogens such as; viruses, bacteria, fungi and parasites, from recognition through antigens. Almeida, Lameke and Figuerôa (2023) state that vaccines are effective and safe to protect the body against diseases, as vaccines stimulate the body's defense, based on specific antibodies.

The twelfth question asked "About the composition of the vaccine, what is the correct alternative?" And the alternatives were: "In the composition of the vaccine we have: water, sodium and sulfur", "The vaccine is composed of inactive fragments of a certain pathogen", "It contains the microorganism activated in a lethal way" and "The vaccine contains part of the DNA of the virus that is sought to be targeted". It was found that in this question the correct answers were 50% (Graph 6). To compose the vaccine, it is necessary to have a fragment of the infectious agent, live attenuated, dead or inactivated microorganisms, toxoids or subunits. In addition, stabilizers, preservatives, antibiotics, and residual proteins are added to the composition of the vaccine (Pinheiro, 2020).

The thirteenth question asked the students "Which of the alternatives below DOES NOT contain correct information about vaccines for public health" the alternatives were: "They enable the global control of infectious diseases", "They do not offer quality of life, as they have more harm than benefits", "The Federal Government's vaccination schedule managed to eradicate smallpox" and "They are offered free of charge and safely by the Unified Health System". In total, there were 85% of correct answers on this question (Graph 6). According to Araújo *et al.* (2022) vaccination is important for public health, as it is an effective means of promoting health while minimizing infectious diseases. Gugel *et al*. (2021) highlight that the Brazilian National Immunization Program (PNI) in 1973 was of great importance in public health, because through it, it was possible to eradicate several diseases in the country such as polio and smallpox.

The Unified Health System (SUS), created in 1988, is composed of the Ministry of Health. The implementation of the SUS in Brazil aimed at health promotion and prevention as a right for all in a safe way (Barros *et al.,* 2021).

Belchior *et al. (*2023) highlight that the vaccine is an essential resource for quality of life, as it prevents against several diseases. In line with Souza *et al*. (2022) state that vaccination has many benefits for the lives of individuals. Thus, it can be stated that the alternatives "They do not offer quality of life, because they have more harm than good" of the thirteenth question was the incorrect one.

The fourteenth question, the question was "Which body is responsible for inspecting and approving the quality of vaccines before they are offered to the population" the alternatives were: "National Health Surveillance Agency (ANVISA)", "Unified Health System (SUS)", "Department of Education" and "None of the alternatives". The number of correct answers was 65% in this question. The National Health Surveillance Agency (ANVISA) is a regulatory agency responsible for evaluating and proving the quality, efficacy, and safety of vaccines (Brasil, 2023).

At the end of the general analysis of the results obtained in Kahoot, it was found that the total percentage of correct answers of 3rd year students in the game was 66%.

FINAL CONSIDERATIONS

The pedagogical approach was satisfactory, as it allowed the participating students to interact with the theme while learning in a playful way about a complex and important subject for public health.

The use of the survey questionnaire as a methodological procedure allowed us to investigate the previous knowledge of the students who participated in the research. The quiz on the Kahoot app on the theme "Vaccine" in the biology discipline allowed us to work in a playful way with 3rd year students, reinforcing the subjects covered in the lecture.

From the analysis of the results obtained after the intervention carried out at the school, it was found that time and competition are antagonists in the students' performance, even though the subsequent results, in general, were significant.

The methodology used allowed that, despite the challenges proposed by the quiz, the students interacted positively with the approach. This contributed significantly to the understanding of the contents covered and was effective in building the relationship between teaching and learning.

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EFFICACY OF THE ERAS (ENHANCED RECOVERY AFTER SURGERY) PROTOCOL IN THE POSTOPERATIVE RECOVERY OF ABDOMINAL SURGERIES: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: Postoperative recovery is a significant challenge in abdominal surgeries due to the complications associated with surgical trauma. The Enhanced Recovery After

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Surgery (ERAS) protocol was developed as a multimodal approach to optimize perioperative management, reduce complications, and accelerate hospital discharge. However, the variability of results between different types of surgery and patient populations suggests the need for a systematic review to consolidate the available evidence. **Methodology:** This systematic review followed the PRISMA guidelines for article selection, using the acronym PICO to formulate the research question: "Is the ERAS protocol effective in postoperative recovery of patients undergoing abdominal surgery compared to conventional care?". The search was carried out in databases such as PubMed, Cochrane and SciELO, including randomized controlled trials and cohort studies published in the last ten years. The methodological quality of the articles was analyzed based on established criteria, and the agreement between reviewers was evaluated by the Kappa index. **Results:** The studies analyzed demonstrated that the application of the ERAS protocol is associated with a significant reduction in the length of hospital stay, ranging from 2.5 to 3.5 days compared to the control group. In gastrointestinal surgeries, the complication rate was 15% in the ERAS group versus 30% in the control group. In procedures such as hepatectomy, the adoption of the protocol resulted in a decrease in postoperative complications and a reduced length of hospital stay ($p < 0.001$). However, some surgeries, such as hysterectomies and pancreaticoduodenectomy, did not show significant differences between the groups. The rate of hospital readmission presented conflicting findings, being reduced in some studies, but without statistical difference in others. **Discussion:** The findings confirm that the ERAS protocol has a positive impact on reducing postoperative complications, length of hospital stay, and improving functional recovery. The observed benefits are attributed to strategies such as early mobilization, optimized analgesia management, and reduction in opioid use. However, the variability of results between different types of surgery suggests that the effectiveness of ERAS depends on the complexity of the procedure and the clinical status of the patient. In addition, the hospital readmission rate still does not present a clear consensus, which reinforces the need for studies with prolonged follow-up to assess the safety of the protocol. **Conclusion:** The systematic review demonstrates that the ERAS protocol is effective in postoperative recovery from abdominal surgeries, especially in gastrointestinal and hepatic procedures. However, its applicability should be adjusted according to the surgical complexity and the individual conditions of the patient. The heterogeneity of the studies analyzed highlights the importance of robust randomized controlled trials and long-term studies to refine the implementation of ERAS and consolidate its clinical advantages.

Keywords: Abdominal Surgeries. ERAS Protocol. Postoperative.

INTRODUCTION

Postoperative recovery has been one of the main challenges of abdominal surgery, due to the impact of surgical trauma on patient homeostasis. In this context, Enhanced Recovery After Surgery (ERAS) protocols have emerged as an evidence-based, multimodal approach to optimize perioperative management and reduce postoperative complications. Since its introduction in the 1990s by Henrik Kehlet, ERAS has been widely studied and applied, especially in colorectal surgeries, with documented benefits in reducing the length of hospital stay and complications associated with the surgical procedure [1,2].

The ERAS protocol combines several perioperative interventions, including preoperative preparation with nutritional counseling, tight analgesia control to minimize opioid use, multimodal anesthesia strategies, and accelerated rehabilitation with early mobilization [3]. Studies have shown that the implementation of this protocol can significantly reduce the length of hospital stay without increasing complication or readmission rates, being a safe and effective method for postoperative recovery [4,5].

Although the effectiveness of ERAS is widely recognized in colorectal surgeries, its impact on other abdominal surgeries is still the subject of investigations. A recent meta-analysis involving 39 studies and more than 6,500 patients demonstrated that the adoption of the ERAS protocol reduced the average length of hospital stay by 2.5 days and complication rates by 30%, without increasing hospital readmission rates [6]. These findings reinforce the importance of expanding ERAS to procedures beyond colorectal surgery, such as liver and pancreatic resections [7].

In hepatobiliopancreatic surgery, the adoption of ERAS has shown benefits, but its implementation is still limited due to the complexity of these procedures. Studies indicate that accelerated recovery after liver resections can reduce hospital stay by up to three days, without negatively impacting morbidity and mortality rates [8]. Similarly, in pancreatic surgery, ERAS has been associated with shorter hospital stay and reduced incidence of postoperative ileus [9].

In addition to the clinical benefits, the adoption of ERAS has a positive impact on hospital costs. Reduced hospital stays, lower opioid requirements, and faster patient recovery result in significant savings for healthcare systems. A recent study pointed out that the implementation of ERAS can reduce hospital costs by up to 5,000 dollars per patient [10]. However, challenges in adhering to the protocol, including institutional resistance and the need for staff training, still limit its broad implementation [11].

The applicability of ERAS in emergency surgery settings has also been explored. Although the protocol was initially developed for elective surgeries, studies suggest that its

strategies can be adapted to patients undergoing emergency procedures, resulting in shorter hospital stay and better functional recovery [12]. However, there are still controversies about the safety of its implementation in situations of hemodynamic instability or severe peritoneal infection [13].

In view of the growing evidence of the benefits of ERAS, several international guidelines have recommended its implementation in multiple types of abdominal surgery. The ERAS® Society has published specific guidelines for different surgical specialties, reinforcing the need for protocols adapted to each type of procedure [14]. However, the heterogeneity in the inclusion criteria of the studies and the variability in the adherence to the protocols make it difficult to standardize the findings and extrapolate the results to different clinical contexts [15].

Thus, this systematic review aims to critically evaluate the efficacy of the ERAS protocol in postoperative recovery from abdominal surgeries, comparing its effects with conventional care. The analysis of the available data will allow a better understanding of the benefits and limitations of this protocol, helping in decision-making for its broad implementation in clinical practice.

METHODOLOGY

The present study is a Systematic Review whose steps for its construction are described in the protocol PRISMA16 The guiding question was established based on the acronym PICO: "Is the ERAS protocol effective in improving the clinical complications of postoperative recovery in patients undergoing abdominal surgeries, when compared to conventional postoperative care?". The selection of articles was carried out in a double-blind manner and the search for articles in the databases was carried out during the second half of 2024 through the electronic platforms of *PubMed* (*National Library of Medicine and National Institute of Health*), *Cochrane Collaboration* and *SciELO.*

To prospect the articles, the descriptors in English were searched in the DeCS (Health Sciences Descriptors) and MeSH (*Medical Subject Headings) databases*. In addition, they were separated through the Boolean operators *AND and OR*, which provided a more refined search. In all databases, the following combination was applied: "("Enhanced Recovery After Surgery" OR ERAS OR "fast track surgery") AND ("abdominal surgery" OR "gastrointestinal surgery" OR "colorectal surgery" OR "hepatectomy" OR "pancreatectomy" OR "gastrectomy" OR "general surgery") AND ("postoperative recovery" OR "length of stay" OR "hospital stay" OR "postoperative complications" OR "pain

management" OR "readmission rates") AND (randomized controlled trial OR "cohort study")".

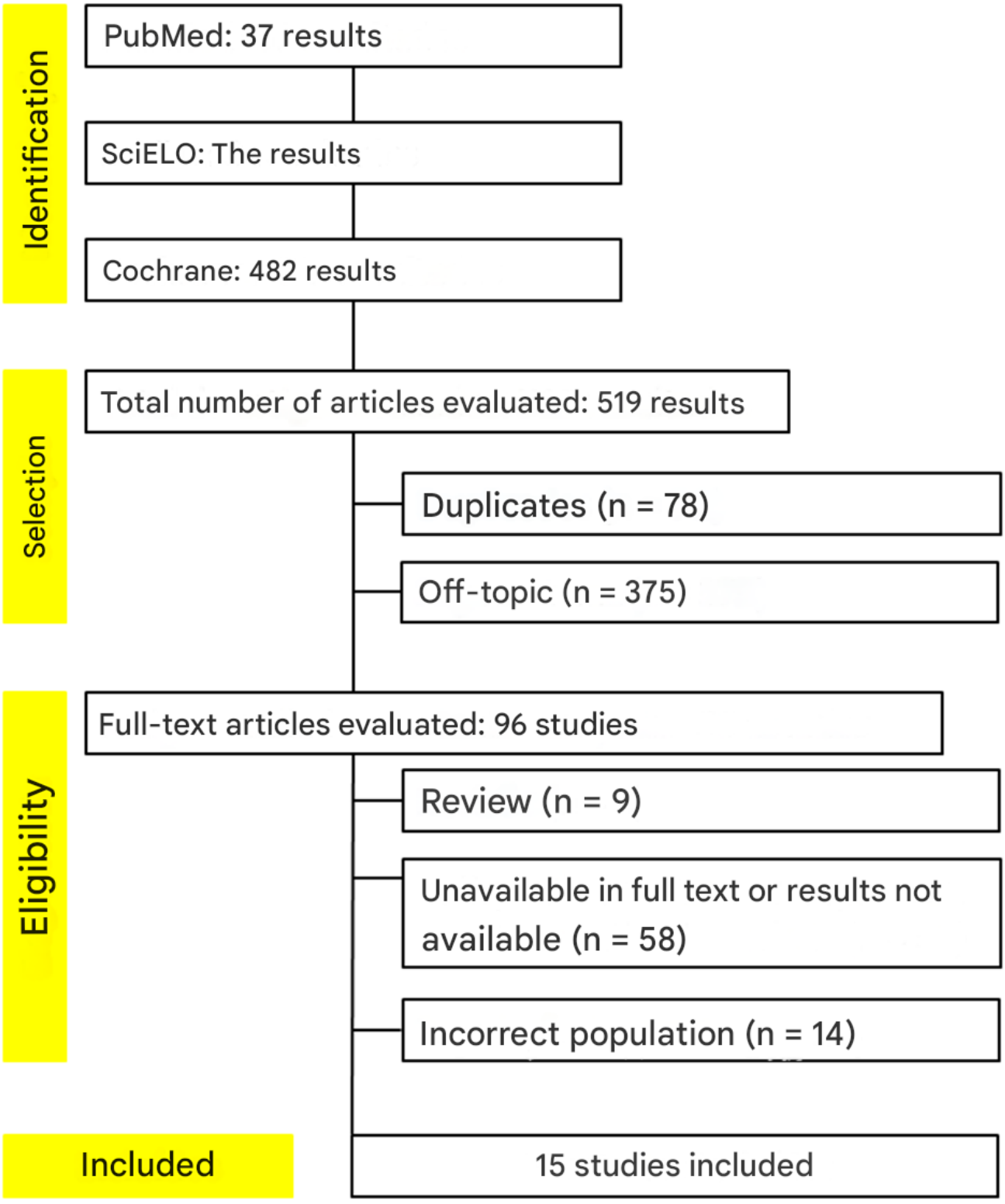
The inclusion criteria and filters used for this study were: (1) Randomized clinical trials and cohort studies evaluating the application of the ERAS protocol in patients undergoing abdominal surgery; (2) Works available in full text and free of charge; (3) Studies in humans over the age of 18 years and (4) English, Portuguese, and Spanish language studies published within the last 10 years; (5) Studies evaluating outcomes such as length of hospital stay, readmissions, and postoperative complications. The exclusion parameters were: (1) Duplication; (2) Escape from the theme; (3) Studies not available in full text and free of charge; (4) Works that did not fit the inclusion criteria and (5) Review articles. Thus, of the identified texts, those that met all the inclusion criteria were chosen considering their titles and abstracts.

Finally, the search was performed by two independent reviewers, and the analysis of interobserver agreement was performed using the *Kappa test* in the BioStatistics V.1.1.0 application and calculated according to the classical categorical method[17]. The value found was K = 0.713 (substantial agreement). The selected articles were critically evaluated by two double-blind observers and one reviewer, in order to assess their individual quality18,19. The 12 items of evaluation of the quality of the articles are expressed by scores and the calculation of the percentage corresponds to the result of the sum of the points achieved in each criterion divided by the maximum expected in each item, which also confers the result of the evaluation for the selected articles (Table 1).

RESULTS

Below is the flowchart with the summary of the selection process of articles in the databases according to the criteria Main Items for Reporting Systematic Reviews and Meta-analyses (PRISMA).

Figure 1: Flowchart based on the PRISMA protocol of the studies selected for this review.



Source: Prepared by the author, 2025.

Below is the analysis of the quality of the trials selected to compose the review. The analysis demonstrates a high level of methodological rigor in most of the included studies. It is observed that most studies obtained a score higher than 90%, indicating a high level of

compliance with the established methodological guidelines. Only two studies had lower scores, Han L et al. (92%) and Koek et al. (87.5%), suggesting small gaps in the methodological approach or in the presentation of data. The main weakness identified in almost all studies was in criterion 4 (Appropriate scope of psychometric properties), where all received a score of 1 (incomplete), which may indicate a limitation in the description or application of psychometric assessment methods. In general, the selected studies have good methodological quality, which strengthens the reliability of the review results.

Table 1: Analysis of the quality of the articles selected to compose the qualitative and quantitative analysis of this review. Legend: 1 - Review and detailing of studies in the literature to define the research question; 2 - Specific inclusion and exclusion criteria; 3 - Specific objectives; 4 - Appropriate scope of psychometric properties; 5 - Justification and presentation of sample size; 6 - Patient follow-up; 7 - Specific procedures for administration, execution and interpretation of results; 8 - Appropriate medication/evaluation techniques; 9 - Detailed data for each hypothesis; 10 - Appropriate statistics; 11 - Estimates of statistical errors; 12 - Valid conclusions and clinical recommendations. Score - 0 = absent; 1 = incomplete; 2 = complete.

	Evaluation Criteria												
Studies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total (%)**
Lqbal A et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Raymond B et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Lu DH et al.,	2	2	2	1	2	2	2	2	2	2	2	2	965
Piovano E et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Pagano E et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Fornmo HM et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Knab K et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Han L et al.,	1	2	2	1	2	2	2	2	2	2	2	2	92%
Pedziwiatr M et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Koek et al.,	1	1	2	1	2	2	2	2	2	2	2	2	87,5%
Jun S et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Qi S et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Parakonthun et al.	2	2	2	1	2	2	2	2	2	2	2	2	96%
Akbar A et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%
Tian Y et al.,	2	2	2	1	2	2	2	2	2	2	2	2	96%

Source: Author

Table 2: Table of the main data of the articles selected to compose the qualitative and quantitative analysis of this review. Legend: TE - Type of Study; IG - Intervention Group; CG - Control Group; CT - Complication Rate between groups; IT - Hospitalization Time; TR - Readmission Rate; TS - Follow-up Time; NE - Not Specified; RCT - Randomized Clinical Trial; WERE-. Enhanced Recovery After Surgery; OR - Odds Ratio; CCR - Colorectal Cancer.

Autor	TE	Amostra	GI	GC	Cirurgia	TC	TI	TR	TS
Lqbal A et al.,	Coorte	120	60 submetidos ao ERAS	60 em cuidados convencionais	Cirurgia GI	15% GI vs. 30% GC	3,5 dias GI vs. 5,8 dias GC	5% GI vs 13,3% GC	NI
Raymond B et al.,	ECR	1544	772 submetidos ao ERAS (ketamina perioperatória)	772 pacientes com placebo perioperatório	Cirurgia abdominal maior (CR, Hérnia)	NE	NR	NE	48h pós operatório
Lu DH et al.,	ECR	57	Bloqueio do gânglio estrelado pré-op	Sem bloqueio de gânglio estrelado pré-op	Cirurgia colorretal laparoscópica	NE	6,61 dias GI vs. 8,72 GC	NE	3 anos
Piovano E et al.,	ECR	2086	Pacientes submetidos ao ERAS	Pacientes submetidos a cuidados convencionais	Histerectomia	Sem diferença significativa entre os grupos	3,2 dias GI vs. 3,5 dias GC	NE	30 dias
Pagano E et al.,	ECR	2397	1337 submetidos ao ERAS	1060 em cuidados convencionais	Cirurgia colorretal	Sem diferença significativa entre os grupos (OR 1.22)	7,5 dias GI vs. 8,5 dias GC	Sem diferença significativa entre os grupos	30 dias
Formmo HM et al.,	Coorte	122	61 submetidos ao ERAS e educação sobre estoma	61 em cuidados convencionais sobre estoma	Ressecção colorretal em estoma	Sem diferença significativa entre os grupos	6 dias GI vs. 9 dias GC	Sem diferenças significativas entre os grupos	30 dias
Knab K et al.,	Coorte	153	100 submetidos ao ERAS	53 em cuidados convencionais	Cirurgia colorretal eletiva	Menor incidência de PONV e uso de opioides no grupo ERAS	NE	NE	NE
Han L et al.,	Coorte	116	33 pacientes com alimentação oral precoce em pós-op	40 pacientes com SNG e 40 com SNE	Gastrectomia laparoscópica	Menor taxa de distensão abdominal no grupo de alimentação oral precoce	Sem diferença entre os grupos	NE	7 dias
Pedziwiatr M et al.,	Coorte	188	Pacientes com CCR estágio IV submetido ao ERAS	Pacientes com CCR estágio I-III submetido ao ERAS	Ressecção colorretal laparoscópica	26,8% GI vs. 20% GC	5.7 dias GI vs. 4,7 dias	10% GI vs. 6% GC	30 dias
Koek et al.,	Coorte	169	126 submetidos a fluidoterapia dentro do ERAS	29 em cuidados convencionais	Pancreaticodu odenectomia	Sem diferença significativa entre os grupos na morbidade	Menor tempo no grupo ERAS (sem diferença significativa)	Sem diferença significativa	Até a alta hospitalar
Jun S et al.,	ECR	104	51 recebendo mosapride dentro do ERAS	53 em cuidados convencionais	Gastrectomia laparoscópica	Sem diferença significativa entre os grupos	Sem diferença significativa entre os grupos	NE	Até 5 dias pós-operatório
Qi S et al.,	ECR	160	80 submetidos ao ERAS	80 em cuidados convencionais	Hepatectomia	Menor taxa de complicações no grupo ERAS ($p = 0.009$)	Menor no grupo ERAS ($p < 0.001$)	Sem diferença significativa entre os grupos	30 dias
Parakonthun et al.	Coorte	158	67 submetidos ao ERAS	58 em cuidados convencionais	Cirurgia esofagogástrica e gástrica	Menor taxa de complicações no GI	Menor TI no GI ($p < 0.001$)	Sem diferença significativa entre os grupos	6 meses
Akbar A et al.,	Coorte	650	325 submetidos ao ERAS	325 em cuidados convencionais	Cirurgia abdominal eletiva	Menor taxa de complicações no GI	Menor tempo no GI	Menor taxa no GI	30 dias
Tian Y et al.,	ECR	80	40 submetidos ao ERAS	40 em cuidados convencionais	Gastrectomia radical	Menor taxa de complicações no GI	Menor tempo no GI	NE	30 dias

Source: Prepared by the author, 2025.

Table 2 highlights the main clinical outcomes of the included studies, demonstrating that, in general, the application of the ERAS protocol leads to lower complication rates, reduced length of hospital stay, and, in some cases, lower hospital readmission rates. Studies with randomized controlled trials (RCTs) were predominant in Table 2, and those

with larger samples, such as Pagano et al. (2397 patients) and Raymond et al. (1544 patients), have greater statistical power to demonstrate the benefits of the ERAS protocol. In these studies, the length of hospital stay was significantly reduced in the ERAS group compared to the control group. In addition, Qi et al. (160 patients, hepatectomy) reported a statistically significant reduction in the complication rate and length of hospital stay ($p < 0.001$), reinforcing the superiority of the protocol in certain types of surgery.

Reduced complication rates were one of the most consistent findings among the included studies. For example, Lqbal et al. (gastrointestinal surgery) showed that the complication rate in the ERAS group was 15% versus 30% in the control group. Other studies, such as Akbar et al. (elective abdominal surgery) and Tian et al. (radical gastrectomy), also reported a significant reduction in complications among patients who followed the ERAS protocol. However, some studies, such as Pagano et al. (colorectal surgery) and Piovano et al. (hysterectomy), found no significant differences between the groups, suggesting that the efficacy of ERAS may vary according to the type of surgical procedure.

The length of hospital stay was reduced in most studies that implemented the ERAS protocol. In particular, Lqbal et al. (3.5 vs. 5.8 days), Lu DH et al. (6.61 vs. 8.72 days), and Fornmo et al. (6 vs. 9 days) demonstrated a significant decrease in length of hospital stay. This finding is one of the main clinical benefits of ERAS, as it is directly related to lower hospital costs, reduced risk of nosocomial infections, and greater comfort for patients. Despite this, some studies, such as Koek et al. (pancreaticoduodenectomy), did not find a statistically significant difference in the length of hospital stay, which may be related to the complexity of the surgical procedure.

The rate of hospital readmission showed more varied results among the studies. While Akbar et al. and Lqbal et al. indicated a reduction in the readmission rate in patients in the ERAS group, other studies, such as Pagano et al. and Fornmo et al., did not find significant differences. This suggests that the impact of the ERAS protocol on readmission may be influenced by additional factors, such as the quality of postoperative follow-up and the patients' preconditions. In addition, some studies have not reported data on this variable, making it difficult to draw a definitive conclusion about this outcome.

Another relevant factor in the analysis of the studies was the follow-up time of the patients. While some studies, such as Lu DH et al. (3 years) and Parakonthun et al. (6 months), had a prolonged follow-up, allowing a better assessment of long-term outcomes, others were limited to the period of hospital stay or up to 30 days after surgery. The short

follow-up time may underestimate possible late complications, compromising the evaluation of the long-term efficacy of the ERAS protocol.

Comparing the clinical outcomes with the methodological quality of the studies, it is clear that studies with greater methodological rigor (with high scores in Table 1) tend to present more reliable results. For example, Lqbal et al. and Pagano et al., who obtained 96% methodological quality, demonstrated a significant reduction in the length of hospital stay and in the complication rate. On the other hand, studies with lower scores, such as Koek et al. (87.5%), presented less consistent findings.

In conclusion, the integrated analysis of the two tables confirms that the ERAS protocol is effective in most of the clinical scenarios evaluated, especially in reducing complications and length of stay. However, the variation in results between different types of surgery suggests that the applicability of ERAS should be adjusted according to the complexity of the procedure and the individual characteristics of the patients. In addition, further studies with long follow-up periods and robust samples are needed to consolidate the benefits of the ERAS protocol on long-term outcomes.

DISCUSSION

The reduction in the length of hospital stay was one of the main benefits observed, corroborating data from previous studies that demonstrate a positive impact of ERAS on this outcome20,21. Recent meta-analyses indicate that the adoption of this protocol can reduce the length of hospital stay by up to 2.37 days compared to conventional care, without a significant increase in complication or mortality rates21. However, the heterogeneity of the included studies should be considered when interpreting these findings.

The rate of postoperative complications was also reduced in most of the studies analyzed, which is one of the most consistent findings in the literature. According to Changsheng et al. [23] The application of the ERAS protocol in radical gastrectomy significantly reduced the incidence of pulmonary infection ($p = 0.02$), in addition to reducing the time to the first evacuation and the hospital cost. Similar results were found in the meta-analysis by Ni et al. [22], which demonstrated a significant reduction in postoperative complications ($RR = 0.66$; $p = 0.005$) in patients undergoing hepatectomy under the ERAS protocol. These findings reinforce the role of ERAS in reducing postoperative physiological stress and improving clinical outcomes.

However, the rate of hospital readmission presented heterogeneous results among the studies. While some studies have indicated a reduction in readmission in patients

undergoing ERAS, others have suggested an increased risk, especially in gastric surgeries23,24. The meta-analysis by Huang et al. [24] pointed out that, although ERAS significantly reduced the length of hospital stay and the risk of pulmonary complications, there was a significant increase in the risk of readmission ($p = 0.007$), possibly due to the high precocity of hospital discharge in some protocols.

The applicability of ERAS in minimally invasive surgeries has also been a topic of increasing interest. According to the review by Li et al.[22], the combination of the ERAS protocol with laparoscopic surgery showed additional benefits, such as shorter recovery time for bowel function and lower postoperative opioid use. However, some authors suggest that laparoscopy, by itself, already reduces surgical stress, and the addition of ERAS may not bring significant additional benefits22. Thus, the optimization of protocols should consider the surgical approach used.

Another important point in the discussion is the variation of results according to the type of abdominal surgery. In hepatectomy, for example, the implementation of ERAS resulted in a reduction in hospitalization time by 2.77 days and a 19.69-hour shorter time for first evacuation ($p < 0.0001$)[23]. On the other hand, in pancreaticoduodenectomy, the impact of the protocol was more limited, with some studies showing no significant difference in the length of hospital stay[20]. This suggests that the complexity of the procedure may influence the effectiveness of ERAS.

In the context of emergency surgery, the applicability of the ERAS protocol is still controversial. The meta-analysis by McKechnie et al.[25] indicated that, although there was a reduction in the length of hospital stay for emergency gastrointestinal surgeries, the quality of the evidence is considered low to very low, due to the variability in the inclusion criteria and outcomes evaluated. In addition, modification of the ERAS protocol for critically ill patients may be necessary to ensure its safety and efficacy.

The methodological analysis of the reviewed studies reveals that those with greater scientific rigor tend to present more robust results. Randomized controlled trials (RCTs) included in this review demonstrated a significant reduction in length of hospital stay and postoperative complications, while observational studies showed greater variability in findings[20,21]. This highlights the importance of well-designed, larger-sample clinical trials to consolidate the evidence on the benefits of ERAS in different surgical settings.

Finally, the implementation of the ERAS protocol faces logistical and institutional challenges. Adherence to the protocol requires a multidisciplinary approach, involving surgeons, anesthesiologists, nurses, and physical therapists20. In addition, the lack of standardization between studies makes it difficult to compare results and create universal

guidelines. However, the growing acceptance of ERAS in international guidelines suggests that its application will continue to expand in the coming years.

In conclusion, the findings of this systematic review corroborate the efficacy of the ERAS protocol in reducing the length of hospital stay and postoperative complications in several abdominal surgeries. However, the variability of results in different types of procedures and the need for greater standardization of protocols indicate that new high-quality studies are essential to refine and adapt ERAS to the specific needs of each patient and surgical procedure.

CONCLUSION

The findings confirm that the ERAS (*Enhanced Recovery After Surgery*) protocol is an effective strategy to optimize postoperative recovery in abdominal surgeries, significantly reducing the length of hospital stay and the incidence of complications. The studies analyzed demonstrated that patients undergoing ERAS had shorter hospitalizations, especially in gastrointestinal and hepatic procedures, with significant reductions in length of stay. These results indicate that the ERAS protocol may be an efficient approach to minimize the impacts of surgery, promoting a faster and safer recovery.

However, the effectiveness of ERAS can vary according to the type of surgery and the individual conditions of the patients. While some studies have pointed to significant reductions in postoperative complications, others have not identified significant differences between the ERAS and control groups, suggesting that the applicability of the protocol should be adapted to each surgical procedure. In addition, the hospital readmission rate showed inconsistent results, indicating that factors such as the quality of postoperative follow-up may influence this outcome. Thus, future research should explore the determinants of variability in the efficacy of ERAS in different clinical settings.

Finally, the need for additional studies with longer follow-up time stands out as one of the main limitations of the current literature. Many studies have restricted their analyses to the length of hospital stay or up to 30 days after surgery, which may not capture late complications and long-term impacts on patients' recovery. In addition, the heterogeneity in the methodological criteria makes it difficult to compare the results between different studies. Thus, future investigations should include robust randomized controlled trials and extended follow-up, allowing for a more comprehensive evaluation of the efficacy of the ERAS protocol and its applicability in different patient profiles and types of surgery.

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EMOTIONAL INTELLIGENCE IN MATH CLASSES: A WAY TO OVERCOME ANXIETIES AND STRENGTHEN SKILLS

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ABSTRACT

Emotional intelligence (EI) plays a fundamental role in the teaching and learning of mathematical concepts in basic education, directly influencing the cognitive and socio-emotional development of students. This study aims to analyze the relationship between emotions and mathematics learning, highlighting the importance of developing emotional intelligence to overcome challenges, build self-confidence and improve academic performance. The methodology adopted consists of a literature review focused on the intersection between emotions and mathematical learning processes. The study investigates how emotional factors, such as resilience, motivation, self-confidence, and emotional regulation, impact the assimilation of mathematical concepts and problem solving. In addition, it explores the role of educators in creating a welcoming and emotionally safe environment that favors learning and minimizes math anxiety. Pedagogical strategies and educational policies that promote the development of emotional intelligence in mathematics teaching are also analyzed, contributing to a more effective, inclusive and enriching teaching-learning process. Ultimately, the study proposes practices that can be adopted by educational institutions to integrate EI in the teaching of mathematics, enhancing both academic performance and the integral development of students.

Keywords: Emotional intelligence. Emotions. Mathematical learning. Basic education. Socio-emotional development.

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INTRODUCTION

The development of emotional intelligence (EI) in mathematics teaching has become a topic of growing interest in the areas of education and psychology, especially in basic education. EI, as defined by Daniel Goleman (1996), involves skills such as self-knowledge, self-regulation, motivation, empathy, and social skills. These capabilities are fundamental not only for the emotional well-being of students, but also for building a solid foundation for learning mathematical concepts, directly influencing cognitive development and overcoming academic challenges.

The object of this study is the analysis of the importance of emotional intelligence in the teaching of mathematics and its influence on the performance and formation of students in basic education. Mathematics, often associated with feelings of anxiety and frustration, requires a learning process that goes beyond logic and memorization, also involving emotional and motivational aspects. Building self-confidence, the ability to deal with mistakes and persistence in the face of challenges are determining factors for students to develop a positive relationship with the discipline.

In addition, this study proposes to understand how EI can be integrated into the teaching of mathematics, promoting a more welcoming and emotionally safe school environment. Schools play a crucial role in mediating students' emotions, contributing to the reduction of math anxiety and encouraging more meaningful and participatory learning. Pedagogical strategies that stimulate critical thinking, collaborative work, and problem-solving can favor not only mathematical development, but also the formation of emotionally resilient individuals prepared to face academic and social challenges.

The inclusion of EI in the school curriculum has been shown to be an effective tool to improve the learning of mathematics, as pointed out by recent studies (Carneiro; Lopes, 2020). Educational programs that promote emotional regulation, intrinsic motivation, and students' self-esteem can minimize difficulties associated with learning mathematics and strengthen students' autonomy (Belém, 2022). In addition, the need for systematic implementation of EI in schools' Political-Pedagogical Projects (PPPs) is highlighted by Sousa, Menezes, and Alves (2024), ensuring that social-emotional education is treated with the same seriousness as the teaching of curricular content.

Mathematics, being an essential discipline for the development of logical and analytical reasoning, can largely benefit from approaches that value emotional intelligence. The fear of error and the belief that some people were "not born for mathematics" are barriers that can be overcome with methodologies that stimulate students' confidence and perseverance. Creating a positive and emotionally safe learning environment can result in

increased student participation, greater motivation to solve mathematical problems, and consequently better academic performance.

In this way, integrating EI into the teaching of mathematics in basic education can contribute not only to the academic development of students, but also to their formation as critical individuals who are emotionally prepared to deal with challenges. Schools have a role to play in ensuring that mathematics learning takes place in an inclusive way, encouraging positive thinking, collaboration, and resilience in the face of difficulties. The implementation of pedagogical strategies based on EI can thus promote more effective, pleasurable and meaningful teaching, preparing students for a more promising academic and professional future.

METHODOLOGY

To study the state of knowledge on the influence of emotions and the development of emotional intelligence (EI) in the teaching of mathematics in basic education, the first step consisted of accessing the Catalog of Theses & Dissertations – CAPES, a database that brings together a wide variety of academic research defended in graduate programs in Brazil. Strategic keywords were used, such as "emotional intelligence", "mathematical learning", "emotions" and "basic education", in order to refine the search and identify studies directly related to the investigated theme.

MATERIALS AND METHODS

To survey the state of knowledge on the subject, the first step consisted of accessing the Catalog of Theses & Dissertations – CAPES, a database that brings together academic research defended in graduate programs in Brazil. The search was carried out using strategic keywords, such as:

- "emotional intelligence",
- "mathematical learning",
- "emotions and basic education",
- "math anxiety,"
- "emotional regulation and academic performance",
- "motivation in mathematical learning".

The search was refined using Boolean operators to increase the accuracy of the results. Combinations such as:

- "emotional intelligence" AND "mathematics teaching" AND "school performance",

- "emotions" OR "math anxiety" NOT "basic education",
- "mathematical motivation" AND "pedagogical strategies".

These combinations allowed restricting the results to research that specifically addresses the relationship between emotions, emotional intelligence and mathematics teaching in basic education, excluding studies that were not directly related to the focus of the investigation.

INCLUSION AND EXCLUSION CRITERIA

The selection of studies followed strict inclusion and exclusion criteria to ensure the relevance of the studies analyzed.

Inclusion Criteria

- Works published between 2018 and 2023, ensuring the timeliness of the research analyzed.
- Studies that deal with the relationship between emotional intelligence and mathematical learning in basic education.
- Research that addresses pedagogical strategies to reduce mathematical anxiety and develop socio-emotional skills.
- Works available in the Catalog of Theses & Dissertations – CAPES, ensuring access to studies reviewed and defended in recognized graduate programs.

Exclusion Criteria

- Works that address emotional intelligence without a direct relationship with mathematical learning.
- Studies that analyze other levels of education, such as basic education or higher education, without focusing on basic education.
- Surveys that did not present a clear methodology or that did not contain relevant empirical data.

ANALYSIS PROCEDURES

After obtaining the studies, a detailed reading of the titles, abstracts and summaries of each selected research was carried out. This process allowed the identification of the methodological approaches used, the main objectives of the studies and their most relevant results.

Subsequently, the works were categorized according to the following thematic axes:

1. The influence of emotions on mathematical performance: studies investigating how anxiety, motivation and resilience affect mathematical learning.
2. Pedagogical strategies based on emotional intelligence: research that analyzes teaching methodologies that incorporate EI to improve the assimilation of mathematical concepts.
3. The role of teachers in the development of emotional intelligence: studies that highlight the importance of teacher training to deal with students' emotions and create a safer and more stimulating learning environment.
4. Educational policies focused on emotional intelligence and mathematics teaching: research that discusses the implementation of educational programs that include the development of EI in mathematics teaching.

At the end of the analysis, 92 studies were identified as relevant to the study, and from this selection, 15 studies were chosen as the main reference. These works were considered the most significant for their in-depth approach to the relationship between emotional intelligence and mathematics teaching, providing empirical evidence on the impacts of emotions on academic performance.

DATA ANALYSIS

To systematize the data extracted from the analyzed researches, an interpretative approach was used, based on the comparison between the findings of the different investigations. Key topics of analysis included:

- The impact of math anxiety on student learning.
- The relationship between self-confidence and performance in mathematics.
- The influence of emotion regulation on mathematical problem-solving ability.
- The role of the school environment and the teacher in the construction of a more welcoming and motivating mathematical teaching.
- The effectiveness of pedagogical interventions based on emotional intelligence in the teaching of mathematics.

The results of this analysis allowed us to identify patterns and trends in research on the subject, in addition to pointing out gaps in the literature that can guide future investigations.

METHODOLOGICAL CONSIDERATIONS

It is important to highlight that the choice of literature review as the methodology of this study is due to the need to understand the current state of knowledge about the relationship between emotional intelligence and mathematics teaching. Although experimental and observational studies can provide concrete empirical data, the literature review allows for a broader analysis, bringing together different theoretical and methodological perspectives to consolidate an overview of the subject.

In addition, the selection of studies within a recent period (2018-2023) ensures that the findings analyzed are aligned with contemporary educational discussions, especially with regard to new pedagogical approaches and educational policies aimed at the teaching of mathematics.

Based on this methodology, it is expected that this study will contribute to broaden the understanding of the importance of emotional intelligence in the teaching of mathematics, providing theoretical subsidies for the formulation of educational strategies that promote more effective, welcoming and motivating learning for basic education students.

RESULTS

The results of this research demonstrate that emotional intelligence (EI) plays a central role in the teaching of mathematics in basic education, impacting not only the academic performance of students, but also their relationship with the discipline and their motivation to learn. The studies analyzed show that the teaching of mathematics is often associated with high levels of anxiety and stress, which can compromise learning and discourage students from engaging in the discipline (Carneiro; Lopes, 2020). The absence of pedagogical strategies that consider the emotional aspects of mathematical learning contributes to an unwelcoming environment, reinforcing the fear of error and reducing students' self-confidence.

The survey revealed that math anxiety is one of the main obstacles to learning and is directly related to poor student performance. This negative emotional factor can be triggered by several reasons, such as the traditional approach to the discipline, which emphasizes memorization and speed in solving calculations to the detriment of conceptual understanding (Belém, 2022). In addition, the lack of emotional support and encouragement of critical thinking within the school environment can reinforce feelings of inadequacy and aversion to mathematics. The study by Fernandes (2023) points out that students who face high levels of mathematical anxiety have less persistence in the face of challenges and

avoid situations that require cognitive effort in the subject, hindering their academic progress.

Another relevant factor identified is the essential role of the teacher in the development of students' emotional intelligence. Studies have shown that teachers who have well-developed socio-emotional skills are more effective in creating a positive learning environment and helping students deal with mathematical anxiety (Goleman, 1996; Pontes, 2020). However, the research also showed that most educators do not receive specific training on emotional intelligence, which makes it difficult to apply pedagogical strategies that consider the emotional aspects of learning (Sousa; Mark; Alves, 2024). This gap in teacher training can result in approaches that are not very sensitive to the emotional reality of students, reinforcing the cycle of frustration and demotivation in relation to mathematics.

The analysis of the studies points out that pedagogical methodologies that incorporate emotional intelligence can contribute significantly to the reduction of mathematical anxiety and to the increase of student engagement. Strategies such as game-based learning, collaborative teaching, and valuing error as part of the learning process have been shown to be effective in strengthening students' confidence and stimulating critical thinking in solving mathematical problems (Belém, 2022; Fernandes, 2023). The research by Comazzetto et al. (2016) highlights that learning environments that promote emotional regulation and empathy favor the construction of self-confidence, making the teaching of mathematics more accessible and less intimidating.

In addition, the results indicate that the inclusion of emotional intelligence in the school curriculum is still limited, despite the growing appreciation of socio-emotional skills in education. The National Common Curriculum Base (BNCC) recognizes the importance of emotional development for the integral formation of students, but the implementation of specific strategies for the teaching of mathematics has not yet occurred systematically in schools (Sousa; Mark; Alves, 2024). Silva's (2019) research shows that the absence of curricular guidelines that integrate EI into mathematical teaching makes many schools prioritize traditional methodologies, leaving aside more innovative and humanized approaches.

The relationship between emotional intelligence and academic performance was also a strongly evidenced aspect in the analysis of the studies. Albuquerque's research (2019) points out that emotionally balanced students demonstrate greater ability to concentrate and better performance in solving mathematical problems. Likewise, Pontes (2020) highlights that students with greater emotional regulation have greater resilience in the face of challenges, remaining motivated even in the face of difficulties. These findings reinforce

the need to develop educational policies that encourage the strengthening of emotional skills in the context of mathematics teaching.

Another highlight was the relationship between emotional intelligence and school dropout. Studies such as those by Bucco (2022) and Cruz (2021) indicate that the lack of emotional support in the school environment can contribute to the abandonment of the discipline and, in more serious cases, to school dropout. The difficulty in dealing with frustration and fear of failure in mathematics can cause students to give up on their educational path, reinforcing inequalities in access to knowledge and opportunities for professional development. Moura's (2020) research also points out that the absence of programs aimed at emotional intelligence can aggravate students' demotivation, negatively impacting their academic trajectory.

The implementation of emotional intelligence programs focused on mathematics has proven to be a promising solution to address these challenges. Studies such as those by Sampaio (2018) and Silva (2021) highlight that pedagogical strategies that value emotional self-regulation, empathy, and intrinsic motivation have the potential to transform students' experience with the discipline. These approaches not only improve academic performance but also contribute to the formation of individuals who are better prepared to deal with emotional and cognitive challenges throughout life.

The findings of this research reinforce the need for a pedagogical rethinking of the teaching of mathematics, incorporating emotional intelligence as a fundamental tool for learning. Teacher training should include the development of socio-emotional skills, allowing teachers to be prepared to deal with students' emotional difficulties and create a more positive teaching environment. In addition, educational policies should encourage the implementation of innovative methodologies that value both the cognitive and emotional development of students.

Thus, the results indicate that the integration between emotional intelligence and mathematics teaching can generate positive impacts on both academic performance and student well-being. Overcoming math anxiety, building self-confidence, and developing resilience are essential aspects of ensuring more meaningful and accessible learning. However, for these changes to occur effectively, a joint effort is needed between teachers, educational managers, and public policy makers, ensuring that emotional intelligence becomes a structuring pillar of mathematics teaching in basic education.

DISCUSSION

After analyzing the selected publications, we can highlight some relevant information on the topic of emotional development and emotional intelligence (EI) in basic education. One of the studies addresses the importance of pedagogical practices aimed at the emotional development of children in basic education. The research seeks to understand how the formation of socio-emotional skills from early childhood can influence children's learning and well-being in this context (Fonseca, 2021).

Another study highlights the importance of using data mining techniques to predict emotional behaviors that may impact child development. Through the analysis of data from children in daycare centers and preschools, this work seeks to identify patterns and indicators that can help in the early identification of emotional and behavioral difficulties, enabling more effective interventions to promote a healthy learning environment. This research analyzes data such as behavior records, participation in collective activities, interaction with classmates and teachers, and other relevant information, using data mining techniques to identify hidden patterns, trends, and correlations that may be associated with emotional development in basic education (Silva, 2021).

A complementary study highlights the psychosocial approach as an important strategy to promote the emotional development of children in basic education. Through an intervention project, this research seeks to offer emotional and motivational support to the little ones, aiming to strengthen their ties with the school environment and encourage a positive and enriching experience. The intervention project aims to offer emotional and social support to children, addressing psychological, emotional and socialization issues that can influence their integral development. Through planned activities, the project seeks to create a welcoming and motivating environment for children to feel an active part of the school community (Cruz, 2021).

Psychosocial intervention in basic education can encompass several activities, such as group dynamics to strengthen self-esteem and teamwork, encouraging participation in playful activities, and developing socio-emotional skills. One of the main aspects addressed in this type of intervention is the identification of factors that may be negatively influencing the emotional development of children, such as family difficulties, socialization problems or challenges in interacting with educators. From this identification, personalized strategies are proposed for each child, in order to overcome these difficulties and promote a more favorable environment for healthy development.

The research also evaluates the effectiveness of the intervention project over time, monitoring the impact of the actions taken on strengthening children's emotional skills. This

allows for continuous adjustments and improvements in the strategies adopted, ensuring that the intervention is increasingly efficient and adapted to the specific needs of children.

The psychosocial approach to emotional development in basic education is extremely relevant, as it recognizes that the development of emotional skills is closely linked to children's well-being and learning. By investing in mental health and emotional well-being from childhood, the project seeks to promote a healthier and more welcoming school environment, where children feel motivated and encouraged to explore and learn, building a positive relationship with education (Cruz, 2021).

The relationship between learning difficulties and emotional development in basic education is addressed in another research, which seeks to understand how motivation and emotional support can be maintained and encouraged in basic education as a way to promote an inclusive and welcoming learning environment. The study discusses how emotional difficulties can impact young children's learning process and how early interventions can be effective in mitigating these effects (Sivinski, 2020).

Additional related research explores the relationships between emotional development, gender issues, and the importance of play in basic education. The investigation offers a more in-depth analysis of how sociological and cultural issues can influence children's emotional development and the construction of their social identity (Almeida, 2020).

Sociological analysis can bring to light structural and cultural factors that contribute to emotional development in basic education, such as social inequalities, unequal access to educational resources, and social expectations. By understanding these issues, research can contribute to the formulation of more inclusive and equitable pedagogical practices in basic education.

In addition to social and psychological issues, the family environment is also considered a relevant factor in the emotional development of children. Other research provides important information about educators' perceptions of how the family environment can affect children's emotional development and how the school can work in partnership with families to promote healthy development (Moura, 2020).

Another study offers insight into how integrated pedagogical practices can influence children's emotional and cognitive development in basic education. The research explores how the articulation between emotional, social, and cognitive development can provide a more complete education, which combines theoretical knowledge with significant pedagogical practices (Albuquerque, 2019).

The concept of emotional intelligence popularized by Daniel Goleman (1996) is the theoretical basis of this set of studies, being defined as the ability to recognize our own feelings and those of others, to motivate ourselves and to manage emotions well within ourselves and in our relationships. It identifies five main components of EI: self-awareness, self-regulation, motivation, empathy, and social skills. Goleman (1996) argues that these competencies are fundamental not only for emotional well-being but also for children's socialization and integral development, suggesting that educational programs that incorporate EI development can significantly improve children's emotional well-being, relationship skills, and social adaptation.

Saviani (2021) proposes that education should go beyond the mere transmission of technical-scientific knowledge, also encompassing the development of critical and social capacities. This vision aligns perfectly with the development of EI, as it promotes essential skills such as self-knowledge, empathy, self-regulation, and social skills. These skills are fundamental not only for the cognitive and social development of children, but also for the formation of conscious and engaged citizens from childhood.

The preliminary results of this survey (Belém, 2022; Bucco, 2022; Cruz, 2021; Fernandes, 2023; Bridges, 2020; Silva, Daniel De Andrade, 2018) indicate that the inclusion of EI development programs in the basic education curriculum has a positive impact on children, showing that those with higher EI have better social adaptation, greater satisfaction with school life, and better relationship skills. In addition, another study suggests that EI is fundamental for the development of socio-emotional skills that are highly valued in the integral education of children (Comazzetto et al., 2016).

CONCLUSION

This study highlighted the relevance of emotional intelligence (EI) in the teaching of mathematics in basic education, demonstrating how the integration of socio-emotional strategies in the teaching-learning process can positively impact the academic and personal development of students. From the literature review, it was found that EI, as defined by Goleman (1996), involves fundamental competencies such as self-knowledge, self-regulation, motivation, empathy and social skills, which play an essential role in building confidence and facing mathematical challenges.

The research highlighted that mathematical anxiety is one of the main obstacles to learning the subject, and is often associated with negative experiences, lack of emotional support, and teaching methodologies that do not consider individual student differences. In this sense, the adoption of pedagogical practices that incorporate emotional intelligence

can significantly contribute to reducing stress and strengthening student motivation, providing a more positive and inclusive learning environment. Valuing error as part of the learning process, encouraging persistence, and promoting active methodologies have been shown to be effective strategies to make mathematics teaching more accessible and less intimidating.

The findings of this study also reinforce that the teacher plays a crucial role in the development of students' emotional intelligence. However, the lack of teacher training focused on EI represents a significant challenge for the implementation of strategies that favor emotional regulation in mathematics teaching. Teachers who have a greater mastery of socio-emotional skills are able to create a more welcoming teaching environment, promoting student engagement and confidence in the subject. Thus, the need for teacher training in this field should be emphasized, ensuring that educators have the necessary tools to deal with the emotional challenges faced by students.

In addition, this study highlighted that the integration of emotional intelligence into the teaching of mathematics is still limited in the curricular guidelines of basic education, despite the growing recognition of the importance of socio-emotional skills. Although the National Common Curriculum Base (BNCC) emphasizes the need for students' emotional development, the practical implementation of these guidelines still faces structural and methodological barriers. It is essential that educational policies advance in this direction, encouraging the creation of specific programs that promote EI in the context of mathematics.

Another relevant point addressed was the relationship between emotional intelligence and school dropout. The studies analyzed showed that students who cannot deal with their emotions in relation to mathematics tend to develop a block in relation to the subject, which can lead to demotivation and, in more serious cases, to school dropout. The absence of emotional support in the educational environment reinforces the idea that mathematics is a difficult and inaccessible subject, negatively impacting the academic trajectory of students. Thus, the development of policies and practices that favor emotional resilience and motivation in the teaching of mathematics can be a determining factor for reducing school dropout and for the academic success of students.

In view of these findings, it is concluded that the inclusion of emotional intelligence in the teaching of mathematics should be treated as an essential strategy to improve learning and promote a more humanized education. The teaching of mathematics cannot be just a technical process of memorizing formulas and procedures, but must also consider the

individual emotions and challenges of students, ensuring that everyone has access to meaningful and equitable learning.

Therefore, it is recommended that schools, teachers, and educational managers adopt concrete strategies to strengthen emotional intelligence in mathematics teaching, promoting more welcoming and stimulating learning environments. In addition, public policies should more effectively include programs aimed at the socio-emotional development of students, ensuring that EI is incorporated into the school curriculum in a systematic way.

Finally, this study contributes to the debate on the need to rethink the teaching of mathematics from a broader perspective, which values both the cognitive and emotional development of students. The promotion of emotional intelligence in mathematics teaching not only improves academic performance, but also prepares students to face future challenges with more confidence, resilience, and autonomy, contributing to their integral formation as critical and participatory citizens in society.

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COST-EFFICIENCY STUDY OF A MINIMALLY INVASIVE TECHNIQUE CALLED THE ABE TECHNIQUE OF MANIPULATIVE NEUROMODULATION OF PAIN BY PROPRIOCEPTIVE RELOAD

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ABSTRACT

This report presents the results of the implementation of the Abe Manipulative Pain Neuromodulation Technique in the treatment of patients with chronic pain, highlighting its clinical efficacy and its positive impact on public finances. The project, already underway in the municipality of Mauá, demonstrated a 50% reduction in operating costs, with a reduction in the number of sessions from 10 to 5 and in the service time from 60 to 20 minutes per session. In addition, the waiting list for treatment fell from 1,700 to 127 patients in just one year. The financial analysis shows that, when treating about 55 thousand people affected by low back pain (prevalence of 21.6% among SUS users), the projected savings with the adoption of the technique can reach up to R$ 10.6 million in relation to conventional treatment. The cost of care for each patient was significantly reduced, while the effectiveness of the treatment provided pain relief for 91% of patients. With these results, city halls have the opportunity to implement a service that not only improves the quality of life of the population, but also optimizes the use of public resources, reducing costs with prolonged treatments and directly impacting the municipality's ability to serve more people quickly and efficiently.

Keywords: Abe technique. Manipulative neuromodulation of pain. Chronic pain disorders.

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INTRODUCTION

Chronic pain is a complex and widespread health condition that results in higher costs to the health system and reduced productivity among working-age adults, compromising the individual's ability to perform daily activities and limiting their permanence in paid employment. Adding to this, patients with chronic pain often face mental health issues, such as intensifying symptoms of depression and anxiety.

The costs associated with chronic pain impose a considerable burden on public health in several countries. Data in Australia shows that chronic pain affected up to 3.2 million adults in 2018, costing the economy $12.2 billion

Australian in health costs and $48.3 billion in productivity losses. In the United States, an estimated 50.2 million adults suffered from chronic pain, resulting in a significantly higher number of days lost from work due to chronic pain (10.3 days vs 2.8) and a cost to the economy of $300 billion in 2019[1].

In Brazil, chronic pain is a significant public health problem: it is estimated that the prevalence of chronic pain ranges from 23.02% to 76.17%, with a national average of about 45%. The pain is more frequent among women and intensifies with advancing age, especially after the age of 50. The most common type of chronic pain identified is possibly nociceptive pain, followed by neuropathic and nociplastic. Epidemiological studies indicate that the region of Brazil (Table 1) with the highest prevalence among the included studies was the Midwest (56.25%), followed by the South (46.70%), Southeast (42.20%) and Northeast (41.70%)[2].

Table1.Prevalence of chronic pain by geographic region (Aguiar DP et al, 2021)[2]

Regiões do País	Prevalência média	95% IC
Nordeste[b]	41,70	23,02 a 42,30
Centro-Oeste[c]	56,25	12,41 a 100,1
Sudeste[a]	42,2	30,05 a 54,34
Sul[a]	46,70	36,07 a 57,34
Norte	-	-
Total[a]	45,59	39,44 a 51,74

IC = Intervalo de Confiança; a = teste T para amostra única; b = teste de Wilcoxon; c = teste T para amostra única, entretanto, somente 2 estudos foram incluídos.

Studies by CAPESESP (National Health Foundation Employee Pension and Assistance Fund) on the budgetary aspect of chronic pain, carried out with a sample of 2,188 individuals who responded to an online survey on the presence of pain without

apparent food, showed that the estimated annual impact of chronic pain on the Operator was more than R$ 7.3 million/year4.

Systematic review and meta-analysis articles have shown that the cost of a patient with chronic pain in a public health system such as the Unified Health System (SUS) in Brazil is essential to take into account a series of factors and variables associated with treatment, including consultations, procedures, supplies and the allocation of human resources. The methodology for this calculation may vary according to the objective of the study, but a simplified approach, adjustable to the particularities of each clinical and management scenario, can be used to provide an initial estimate of the costs involved1,4,5.

As a base formula for cost-efficiency calculations, we have:

$$C_{tratamento\ i} = \frac{(C_{consultas\ i} + C_{insumos\ i} + C_{rh\ i} + C_{infraestrutura\ i}) \times N_{sessões\ i}}{R_{eficácia\ i}}$$

Where:

i = individual, patient

^{C}tratamento i = Total cost of treatment i adjusted for efficacy

^{C}consultas i, Cinsumos i, Crh i, Cinfraestrutura i = Detailed costs for treatment i

^{N}sessões i = Number of sessions required for treatment i

^{R}eficácia i = Effectiveness of treatment i (in terms of pain reduction or clinical improvement)

DEPLOYMENT

In March 2023, a project to implement care for patients with chronic pain using a new efficiency and effectiveness technique was presented to the Health Department of the Municipality of Mauá (SSM)-SP, where 15 professionals would be trained and qualified to apply the methodology in the Basic Health Units (UBS) and the Specialized Rehabilitation Center (CER). Going through a bidding process (ELECTRONIC AUCTION 032/2023), the work began in August 2023, with the coordination of Primary Care, where initially the services were centralized in Specialized Care. The Chronic Pain Disorders Treatment Center (CTD) was installed on the premises of the CER, responsible for the general administration of the patients specifically referred.

BASE-CALCULATIONS

According to the IBGE, the Municipality of Mauá has 429,380 inhabitants, 60% of whom use SUS (257,628).

For a cost-efficiency comparison, the workloads, time and number of consultations/day of physiotherapists were considered according to the norms of RESOLUTION No. 444, of April 26, 2014 of the Federal Council of Physiotherapy and Occupational Therapy (COFFITO), fees established by the SSM for Physiotherapist II/Grade C.

- Weekly workload: 30 hours
- Attendance: 6 to 12 patients/day
- Monthly fee R$4580.04

As a treatment reference, we addressed low back pain (ICD M63.8) because it is the pathology with the highest prevalence of chronic pain in Brazil. The treatment time of chronic low back pain described in the literature was 2 sessions for low-risk patients, 8 sessions for medium-risk patients, and 12 sessions for high-risk patients6. Considering that the patients referred are medium and high risk, we established 10 treatment sessions as an average for the consultations.

Therefore, performing a simple calculation for the value of a patient's care, we have:

- 1 physiotherapist: 30h/week x 4 weeks (1 month) = 120h 1 h of care = 120h:
- 1 hour of service = 120h: R$ 4.4580,04 = R$ 38.17

In the 2019 study by Malta et al., analyzing the National Health Survey with 88,531 adults, it was found that 19,123 (21.6%) were affected by chronic back pain3.

Considering that of the 257,608 SUS users in Mauá, 21.6% are affected by low back pain, we have 55,647 people, which means that R$ 2,124,070.72 of resources would be needed for care for 1 session of this population. If each affected individual is included in the number of sessions indicated for physiotherapy of 10 sessions, the values must be multiplied by 10, or 21.2 million reais.

EXECUTION

Before the execution of the project, the waiting list for physiotherapy care was 1,700 people.

The CTD-Mauá project began on July 3, 2023, where pilot services began in September of the same year, adding up to a total of 312 services by December. In the period between January and July 2024, 896 consultations were carried out.

METHODOLOGY

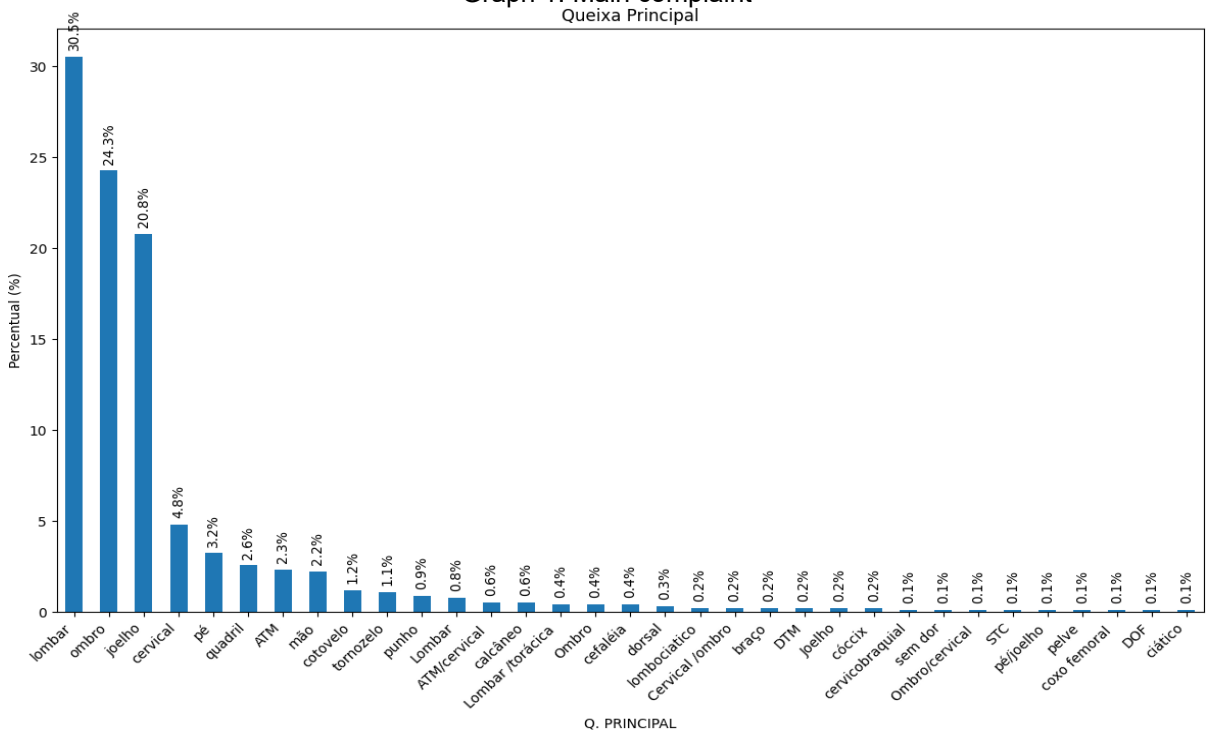
The treatment protocol was established based on:

- in 1 session time: 20 minutes
- Number of Sessions: 5 sessions

RESULTS

Considering only the data of the 896 patients treated from January to July 2024, 309 (30.5%) were cases of low back pain (Graph 1).

Graph 1. Main complaint



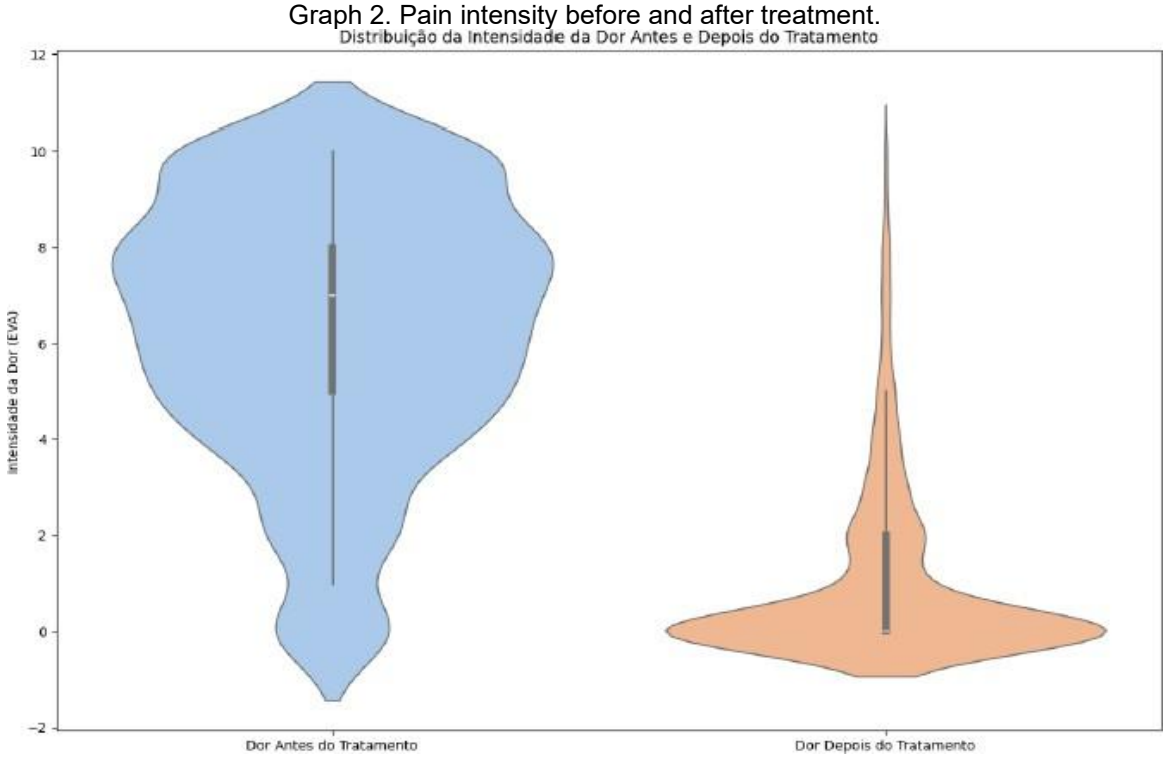
Information related to the duration of pain persistence, it was observed that 48.10% of the patients (430) suffer from persistent pain from 3 to 8 years, highlighting this range as the most common among those attended; 32.55% of patients (291) report persistent pain for 10 years or more, indicating a significant number of chronic cases. Only 10.18% (91) of the patients have had pain for less than 1 year, while 9.17% (82) have experienced pain for 1 to 2 years (Table 2).

Table 2. Time of pain.

Categoria Tempo da DOR	Frequência (n)	Percentual (%)
Menos de 1 ano	91	10,18
De 1 a 2 anos	82	9,17
De 3 a 8 anos	430	48,10
10 anos ou mais	291	32,55

The evolutionary analysis of the 896 patients attended, as illustrated in the following graph, demonstrates a significant reduction in pain intensity after the intervention. Initially, patients had a wide distribution of pain levels, with a higher concentration in the range of 6 to 8 on the visual analogue scale (VAS). After treatment, most patients reported significantly lower pain intensity, with values concentrated between 0 and 2 on the VAS scale (Graph 2).

Graph 2. Pain intensity before and after treatment.

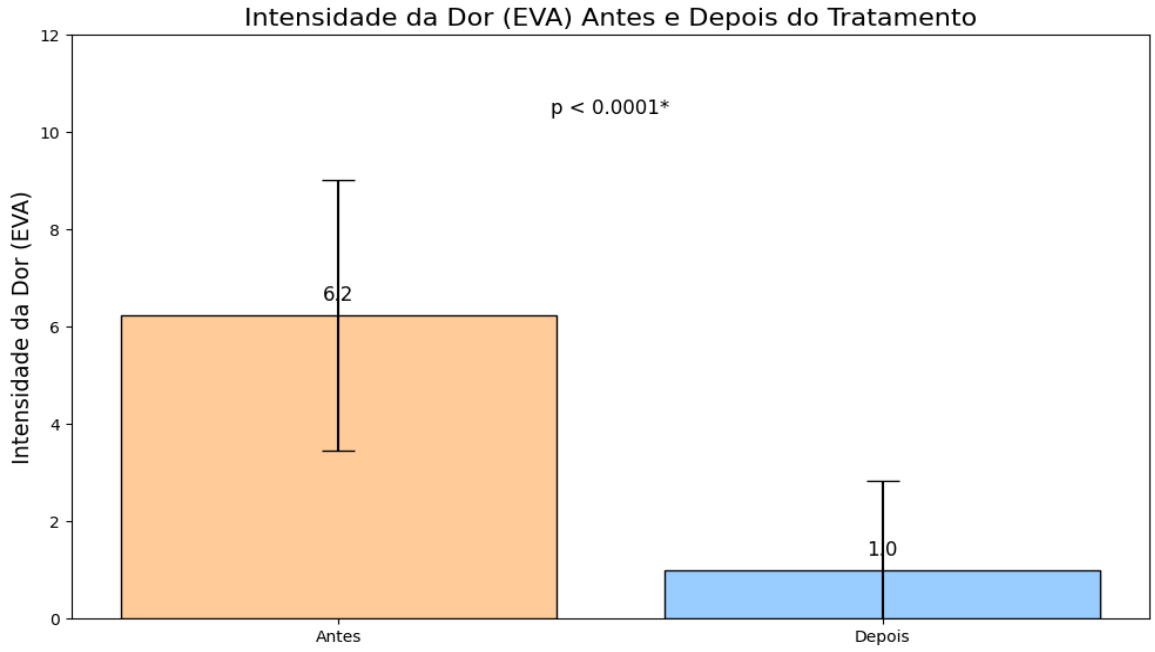


The data indicate that the intervention was effective for most patients, with a significant reduction in median pain intensity. More than 91% of patients experienced a decrease in pain sensation, while only 8.7% (approximately 78 patients) did not respond to treatment satisfactorily.

Therefore, the intervention provided a significant improvement in the quality of life of most patients, reducing pain to minimal levels for many of them.

Graph 3 below shows that the mean pain intensity increased from 6.25 (before) to 1.00 (after) the treatment. This significant reduction in mean pain is corroborated by the table of descriptive statistics, which shows a median that evolved from 7.0 (before) to 0.0 (after the intervention).

Graph 3. Mean and standard deviation, before and after treatment.



DISCUSSION

It was possible to observe the effectiveness of the technique and the reduction of the time of one session (60 minutes to 20 minutes) and the number of sessions from 10 to 5 sessions when applying the new methodology, meaning a reduction in operational costs and savings of 50% of the resources used for care, not only of one, but a range of chronic painful pathologies.

In July 2024, it was found that the waiting list for care reduced from 1,700 to 127 cases, resulting in the renewal of the contract for another 12 months.

CONCLUSION

In view of the data, it is possible to verify the improvement in the cost-efficiency ratio in the system, which is focused on outpatients.

The next challenge lies not only in the decentralization of Specialized Care to Primary Care (care in the UBSs) with outpatients, but also in the care of hospitalized patients.

However, it was observed that for the complete establishment and systematization it will be necessary 2 more years of work (cycle of 3 years per project).

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ASSOCIATION OF ACIDOSIS WITH LOSS OF MUSCLE STRENGTH IN CHRONIC HEMODIALYSIS PATIENTS

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ABSTRACT

Objective: To analyze the effect of acidosis, by means of bicarbonate levels, on muscle strength (FM) in patients with renal failure undergoing hemodialysis (HD). **Methodology:** This is a cross-sectional study in patients undergoing chronic HD at a dialysis clinic in Joinville, Santa Catarina, between March and July 2023. All patients aged between 18 and 65 years and with a dialysis duration of more than 3 months were included in the study. The values of bicarbonate, a variable of main interest, were analyzed by means of blood gas analysis. FM, the outcome variable, was evaluated using the *Sit-to-Stand test* and upper limb dynamometry. Clinical and laboratory variables and dialysis adequacy were also considered. The effect of the variable of interest on the outcome was evaluated using multivariate logistic regression in an explanatory model. **Results:** Of the 90 patients, the mean age was 48.8 years, and 62.2% were male. Systemic arterial hypertension was found in 84.4% of the sample, followed by diabetes (24.4%) and stroke in 21.1%. The presence of loss of strength was found in 24 (26.7%) patients. There was no difference in the median bicarbonate values between patients with or without loss of strength. Bicarbonate values were not associated with a higher risk of strength loss (crude OR = 0.94; 95% CI 0.78-1.13; p= 0.505). Even after adjusting for other confounding variables, bicarbonate levels were not associated with the outcome studied (adjusted OR=0.83; 95% CI 0.66-1.04; p=0.0012). **Conclusion:** In the sample studied, acidosis, verified by bicarbonate values, was not associated with FM loss.

Keywords: Chronic kidney disease. Muscle Strength. Bicarbonate. Metabolic acidosis.

INTRODUCTION

Chronic kidney disease (CKD) has been consolidated as one of the main public health concerns in Brazil(1). According to the last census of the Brazilian Society of Nephrology (SBN) in 2021, about 153,831 patients were undergoing treatment, of which 95.3% are undergoing hemodialysis (HD)(1). Sarcopenia has been found in approximately 13 to 33% of this population, contributing to higher morbidity and mortality (3,4). Among the mechanisms associated with sarcopenia, acidosis has still been little studied in HD patients.

Sarcopenia is characterized by the progressive loss of muscle mass and strength, with direct implications for the functionality and quality of life of dialysis patients(3,4). Although sarcopenia is often found in patients undergoing chronic HD, it is not yet consistently evaluated in HD services. According to a study involving 62 dialysis centers in Brazil, only 23 (37%) routinely evaluated the presence of sarcopenia(2).

Several factors contribute to the development of sarcopenia in patients undergoing HD, including reduced physical activity, anorexia, loss of nutrients during HD, accumulation of uremic toxins, vitamin D deficiency and the use of multiple drugs, such as oral hypoglycemic agents and antihypertensive drugs(3).

In addition, chronic metabolic acidosis, a common complication among patients with renal failure undergoing hemodialysis, may also be related to the presence of sarcopenia in this population(4). Although acidosis is a common situation among patients with renal failure, and not always completely corrected in dialysis therapy(5), it is believed that its presence may favor the occurrence of sarcopenia due to increased muscle catabolism, reduced protein synthesis and activation of pro-inflammatory pathways(15,16). However, few studies have focused on the role of acidosis in the presence of sarcopenia among HD patients in Brazil. The objective of this article was to investigate the impact of metabolic acidosis, as assessed by bicarbonate levels, on FM in patients with chronic renal failure undergoing hemodialysis.

METHOD

This is an observational, cross-sectional, descriptive and analytical study consisting of a non-probabilistic sample of 102 patients with renal failure on HD from a dialysis clinic in Joinville/Santa Catarina, Brazil. During March to July 2023, all patients on chronic hemodialysis therapy, aged between 18 and 65 years, HD therapy time equal to or greater than 3 months, and without hospital stay in the last 30 days were included in the study. Patients with residual diuresis >500ml/24 hours or with interdialytic weight gain (IPG) < 1% were excluded to allow the measurement of the simplified creatinine index (7). Patients who

changed their dialysis method during the study, those with physical limitations or those with limb amputation that made it impossible to perform the muscle assessment tests were also excluded. In addition, those with cognitive alterations or a previous diagnosis of dementia documented by the institution itself were excluded. All participants completed the informed consent form and the study was approved by the ethics committee of the University of the Joinville Region (CAAE nº 65523922.9.0000.5366).

VARIABLES COLLECTED

The variables considered were gender, age, comorbidities (hypertension, diabetes, stroke), type of vascular access, HD time, and body mass index (BMI). The mean of the last two values of dialysis adequacy (Kt/V), phosphorus, albumin, parathyroid hormone (PTH), hemoglobin, and interdialytic weight gain (IGG) for the current and previous month of the study was also considered. The simplified creatinine index (SCI) was evaluated as a marker of muscle mass, defined as a normalized rate of endogenous creatinine production, considering residual and dialyzed renal clearance, using the Canaud formula[a] ; (8). The lean tissue index (LTI) was estimated using the formula of Canaud et al[b]*;* (9). C-reactive protein (CRP) and blood gas analysis to assess bicarbonate levels were performed on blood samples collected at the beginning of the HD session, directly from the vascular access for the dialysis procedure, and were subsequently processed in a support laboratory in the same city. Regarding the evaluation of inflammatory markers, CRP measurement was conducted using the MULTIGENT PCR assay, a latex immunoassay designed for the accurate and reproducible measurement of CRP blood levels in serum and plasma. In addition, the bicarbonate dosage was performed using the GEM Premier 3000 system, which allows the measurement of blood bicarbonate by means of blood gas analysis. To assess the strength of the upper limbs, the Handgrip Strength (HGS), an analog Jamar hand-held dynamometer instrument was used. The evaluation was carried out through the measurement in kilogram (maximum of 100 kilos) force kgf, in a metallic structure and anatomical handle, easy to read with the pointer remaining at its maximum value during the test. The patient in a sitting position pulled the handle or lever of the dynamometer and kept it still for approximately two seconds, exerting only force. This process was carried out 3 times, with the highest result being recorded. The values considered as low FM were evaluated based on gender and age group, according to values obtained from a population without dialysis CKD in Brazil (12). To assess lower limb muscle strength (LLLL), the *Sit-to-stand test* (TSS) was used (10,11). To perform the TSS, the patient was initially seated in a chair without support arms, and for 30 seconds he had to sit and stand up without any

support of the arms, and the number of repetitions completed was considered. Both tests were performed before the HD session.

STATISTICAL ANALYSIS[1]

Categorical variables are presented by their frequency and percentage and numerical variables by their mean and standard deviation or median and interquartile variation. The chi-square test was used to compare categorical variables, and the *Student*'s *t-test* or *Mann-Whintey* test was used to compare the means of the quantitative variables, after verifying their normality using the Kolmogorov-Smirnov test. Altered dynamometry values were defined as those with measurements below the 50th percentile adjusted for age and sex, according to the reference population(10,12). The presence of altered strength was defined as all patients who had altered Dynamometry values and the sit-stand test in 30 seconds lower than the median found in the sample by sex (<10 for women or <11 for men). The means and frequencies of the variables analyzed between individuals were compared in relation to the presence or absence of strength loss using the *Student*'s t-test or Man-Whitney *test* to compare numerical variables and the chi-square test for categorical variables. We sought to analyze the association of bicarbonate values for the occurrence of altered force through an explanatory multivariate model. Thus, the crude odds ratio of bicarbonate values for the occurrence of force was reduced and adjusted for other potentially confounding variables was verified through Logistic Regression. All variables that modified the effect of the main variable of interest (bicarbonate) by 5% or more in the bivariate analysis were included in a final multivariate model, keeping sex and age fixed. A p< value of 0.05 was considered significant. The analyses were performed using the IBM SPSS statistical software, version 27.

RESULTS

From the initial total sample of 102 patients, 8 patients with residual diuresis >500ml or with RGI < 1% and 4 patients who changed dialysis methods before complying with the

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[1] Calculation of SCI

[a] SCI was calculated using the Canaud formula

SCI (mg/kg/day) = 16:21 + 1:12 * [1 if male; 0 if female] – 0:06 *age (years) – 0:08 * spKt/V urea + 0:009 * pre – dialysis SCr (lmol/L)

[b] LTI was estimated using the formula by Canaud et al.

Estimated LTI (mg/m²) = (SCI + Post HD weight (kg) * 0:029 +7:38)/(Body height (m)) ²

protocol were excluded from the study. The final sample of 90 patients had a mean age of 48.8 years, with 56 (62.2%) males, with systemic arterial hypertension (84.4%) and diabetes (24.4%) being the most prevalent comorbidities. The main vascular access for HD was the arteriovenous fistula in 78.9% of the sample. The median time on HD was 63.1 months, with an interquartile range (IQR) of 25.0/113.7 months. The presence of altered strength of both upper limb and lower limb was observed in 26.7% of the total sample. Other characteristics of the total sample are described in Table 1.

Table 1 - General Characteristics of the Sample

	Total Sample n=90	
Age, years; mean (SD)	48,8	11,5
Gender, male; total (%)	56	62,2
Comorbidities, yes; total (%)		
Diabetes	22	24,4
Hypertension	76	84,4
STROKE	19	21,1
Type of Vascular Access; Total (%)		
Fistula	71	78,9
Catheter	19	21,1
Time in HD, months; median (VIQ)	63,1	25,0/113,7
KT/V; Mean (SD)	1,4	0,3
Creatinine mg/dL; mean (SD)	10,7	2,9
Phosphorus, mg/dL; median (VIQ)	5,5	4,3/6,6
Albumin, mg/dL; mean (SD)	4,1	0,4
PTH, pg/ml; median (VIQ)	403,2	199,7/836,0
Hemoglobin, g/dL, mean (SD)	11,2	1,6
CRP-US, mg/L; median (VIQ)	0,46	0,2/1,4
Bicarbonate, mEq/L; Average (SD)	21,0	2,5
Dynamometry < 50th percentile, yes	63	70,0
30s SST, median (VIQ)	11	8,2/14,0
Men	11	10/14
Women	10	6,2/13
Changed strength, yes; total (%)	24	26,7
GPI, %; median (VIQ)	3,8	1,2
SCI, mg/kg/day; unit; mean (SD)	14,0	0,8
LTI, mg/m2; mean (SD)	16,2	2,6
BMI, kg/m2; median (VIQ)	23,6	21,6/28,4

SD=standard deviation; VIQ= interquartile variation (25/75th percentile); HD=hemodialysis; PTH=parathyroid hormone; hs-CRP = ultrasensitive C-reactive protein; 30s SST = sit-to-stand test; RG=interdialytic weight gain; SCI=simplified creatinine *index*; LTI= lean *tissue index;* BMI = body mass index.

The characteristics of the sample of patients without loss of strength (PFS) and with loss of strength (PFC) are shown in Table 2. PFS patients were younger (median age 48 years, IQR 41.8/55.0) compared to PFC patients (median 55.5 years, IQR 44.7/63.7; p=0.012). A higher prevalence of SAH was observed in SPF patients compared to PFC patients (89.4% versus 70.8%; p=0.047). In addition, patients with a lower Kt/v index ((Kt/v < 1.31, SD 0.27) showed a higher propensity for PF compared to those with a higher index (Kt/v≥ 1.48, SD 1.29), with a statistically significant difference (p=0.006).

Albumin levels were significantly different between the groups, with lower albumin values in the PFC group compared to the SPF group (4.00 g/dL versus 4.20 g/dL; p = 0.006). The RGI index was also higher in the PFS group, compared to the PFC group (median of 3.94 versus 3.46; p = 0.040). Other comparative characteristics between the SPF and CPF groups are summarized in Table 2.

Table 2 - Characteristics of the sample by loss of strength (30s SST < median by sex [10 women and 11 men] and dynamometry below the median by sex and age)

	No loss of strength n=66 (73.3%)		With loss of strength n=24 (26.7%)		p-value
Age, years; median(VIQ)	48,00	41,75/55,00	55,50	44,75/63,75	0,012
Gender, male; total (%)	38	57,6	18	75,0	0,207
Comorbidities, yes; total (%)					
Diabetes	15	22,7	7	29,2	0,725
Hypertension	59	89,4	17	70,8	0,047
STROKE	15	22,7	4	16,7	0,771
Type of Vascular Access; Total (%)					0,771
Fistula	51	77,3	20	83,3	
Catheter	15	22,7	4	16,7	
Time in HD, months; median (VIQ)	57,38	24,12/112,67	66,42	31,22/125,55	0,625
KT/V; Mean (SD)	1,48	0,29	1,31	0,27	0,006
Creatinine mg/dL; mean (SD)	10,88	2,88	10,37	2,92	0,235
Phosphorus, mg/dL; median (VIQ)	5,30	4,30/6,42	5,90	4,60/7,12	0,262
Albumin, mg/dL; mean (SD)	4,20	4,00/4,40	4,00	3,70/4,10	0,006
PTH, pg/ml; median (VIQ)	403,25	198,32/804,05	359,00	196,80/1353,02	0,629
Hemoglobin, g/dL, mean (SD)	11,33	1,49	10,85	1,82	0,125
CRP-US, mg/L; median (VIQ)	0,42	0,19/1,14	0,57	0,25/2,00	0,290
Bicarbonate, mEq/L; Average (SD)	21,11	2,53	20,71	2,51	0,255
GPI, %; median (VIQ)	3,94	1,20	3,46	1,09	0,040
SCI, mg/kg/day; unit; mean (SD)	14,00	0,86	13,87	0,77	0,254
LTI, mg/m2; mean (SD)	15,45	14,21/17,87	16,35	14,56/17,90	0,584
BMI, kg/m2; median (VIQ)	23,59	21,56/28,22	24,14	21,35/29,36	0,722

30s SST = sit-to-stand test; SD=standard deviation; VIQ= interquartile variation (25/75th percentile); HD=hemodialysis; PTH=parathyroid hormone; hs-CRP = ultrasensitive C-reactive protein; RG=interdialytic weight gain; SCI=simplified creatinine *index*; LTI= lean *tissue index;* BMI = body mass index.

Table 3 shows the crude and bivariately adjusted odds ratio between bicarbonate levels for the occurrence of strength loss. Bicarbonate values were not associated with a higher chance of brute strength loss (OR=0.94; 95% CI 0.79-1.13) or after bivariate adjustment for other variables.

Table 3 - Crude and adjusted odds ratio between bicarbonate levels for the occurrence of strength loss

	OR	95% CI	p-value
Bicarbonate, mEq/L, per unit of increase	0,94	0,78-1,13	0,505
Tuned for:			
Age, years, per unit increase	0,91	0,74-1,12	0,367
Gender, male vs. female	0,92	0,75-1,11	0,379
Time in HD, months, per unit of increase	0,94	0,78-1,14	0,520
Access, arteriovenous fistula vs. catheter	0,93	0,76-1,12	0,443
Kt/V, per unit of increase	0,89	0,73-1,09	0,891

Diabetes, yes	0,93	0,77-1,13	0,468
Systemic Arterial Hypertension, yes	0,95	0,78-1,16	0,645
Stroke, yes	0,95	0,78-1,15	0,573
Phosphorus, per unit of magnification	0,94	0,78-1.13	0,507
PTH, per unit of augmentation	0,95	0,78-1,15	0,581
Albumin, per unit of increase	0,96	0,78-1,17	0,672
Hemoglobin, per unit increase	0,93	0,76-1,12	0,926
PCR-US, per unit of magnification	0,94	0,77-1,13	0,495
GPI (%), per unit of increase	0,89	0,73-1,09	0,276
SCI, per unit of increase	0,94	0,78-1,13	0,514
LTI, per unit of increase	0,93	0,77-1,13	0,475
BMI, per unit of magnification	0,93	0,77-1.13	0,485

HD=hemodialysis; PTH=parathyroid hormone; hs-CRP = ultrasensitive C-reactive protein; RG=interdialytic weight gain; SCI=simplified creatinine *index*; LTI= lean *tissue index;* BMI = body mass index

Table 4 presents the final multivariate model, including the values of Kt/v and GPI, which modified the effect of the main variable by 5% or more, in addition to sex and age. After adjusting for the other variables, bicarbonate values were not associated with FM loss (OR=1.05; 95% CI 0.99-1.11).

Table 4 - Multivariate analysis of the association between bicarbonate levels for the occurrence of strength loss by Logistic Regression

	OR	95% CI	p-value
Age, years, per unit increase	1,05	0,99-1,11	0,680
Gender, male vs. female	1,81	0,57-5,75	0,317
Kt/V, per unit of increase	0,16	0,02-1,21	0,076
GPI (%), per unit of increase	0,74	0,46-1,22	0,239
Bicarbonate, mEq/L, per unit of increase	0,83	0,66-1,04	0,112

RG=interdialytic weight gain

DISCUSSION

This study sought to evaluate the effect of acidosis, through bicarbonate levels, in patients with renal failure undergoing HD on FM. However, in the sample tested, the levels of acidosis did not demonstrate any significant association with the loss of FM(13).

About a quarter of the patients had loss of strength, and these patients were older and had lower albumin values. It was also observed that the PFS group was larger when compared to the PFC, when associated with SAH as a pathology. Strategies such as preserving or minimizing protein loss, adequate management of fluid intake, and dietary counseling are essential to mitigate these risks and improve clinical outcomes(14).

Although the correction of acidosis is associated with benefits, such as the reduction of protein catabolism and the improvement of nutritional status, with the potential to minimize muscle loss, our study did not identify this significant association(15). Some experimental studies carried out in developed animals show that metabolic acidosis plays a

significant role in the progression of CKD, contributing to metabolic and structural alterations that aggravate functional impairment(16,17).

This study is in agreement with other studies that also did not observe significant differences (15,18). These findings suggest that, in patients with CKD undergoing adequate hemodialysis, the correction of metabolic acidosis, reflected by normal bicarbonate values, can contribute to reduce muscle mass loss, but without a statistically evident relationship(19,20). These positive effects, by preserving kidney function and improving nutritional and metabolic parameters, help protect against muscle atrophy. In addition, other studies indicate that FM loss or sarcopenia are directly related to metabolic acidosis, which is aggravated in patients with CKD(21,22).

Some limitations and weaknesses of this study may be related to the method used to assess FM in patients, such as the handgrip test and the TSS, which could be specifically targeted to sarcopenia, also limiting an age range. This could be associated with other outcomes. Although the main hypothesis of this study has not been confirmed, our study found a relevant prevalence of patients with PFC verified by simple tests and with association with nutritional markers and adequacy of dialysis therapy. Thus, further studies are needed to deepen the findings found and their association with acidosis in these patients.

CONCLUSION

Although bicarbonate values did not show an association with loss of strength, a relevant prevalence of FBC patients was found in the sample studied. In addition, our findings suggest that factors related to dialysis adequacy may have some influence on this association between acidosis and loss of FM. Considering that the control of acidosis has been pointed out as one of the important factors in reducing the risk of muscle mass loss in patients with renal failure on HD, further studies are needed to deepen our findings.

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