FUNCTIONAL FOODS: PREVENTION AND HEALTH IMPACTS IN INDIVIDUALS AND ITS RELATIONSHIP WITH ALZHEIMER'S DISEASE

ALIMENTAÇÃO FUNCIONAL: PREVENÇÃO E IMPACTOS NA SAÚDE DA PESSOA E A RELAÇÃO COM A DOENÇA DO ALZHEIMER

LA ALIMENTACIÓN FUNCIONAL: PREVENCIÓN E IMPACTOS EN LA SALUD DE LA PERSONA Y SU RELACIÓN CON LA ENFERMEDAD DE ALZHEIMER

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ABSTRACT: The Brazilian scenario has shown a significant increase in the cases of non-communicable chronic diseases, such as obesity, hypertension, osteoporosis, diabetes mellitus, cancer, and conditions affecting memory loss, such as Alzheimer's disease. This study aims to analyze and discuss the relevance of functional foods and their nutritional components in individual health and their relationship with Alzheimer's disease. The methodology adopted included a qualitative and descriptive literature review based on sources such as books, websites, and scientific articles, with a time frame covering the last fifteen years of research. The discussions arising from the results indicate that functional foods, including omega-3, have been shown to contribute to the maintenance of brain function, promoting improvements in memory and cognitive aspects. It is important to emphasize that research in this area is ongoing and necessary, especially concerning studying the human brain, given its complex nature.

KEYWORDS: Functional Foods. Nutritional Foods. Physical and Mental Health. Alzheimer's Disease.

***RESUMO**: O cenário brasileiro tem evidenciado um aumento significativo nos casos de doenças crônicas não transmissíveis, como obesidade, hipertensão, osteoporose, diabete mellitus, câncer e condições que afetam a perda de memória, como a doença de Alzheimer. O objetivo deste estudo é analisar e discutir a relevância da alimentação funcional e de seus componentes nutricionais no contexto da saúde individual e na relação com a doença de Alzheimer. A metodologia adotada incluiu uma pesquisa bibliográfica qualitativa e descritiva, baseada em fontes como livros, sites e artigos científicos, com um recorte temporal que abrange os últimos quinze anos de pesquisas sobre o tema. As discussões decorrentes dos resultados indicam que os alimentos funcionais, que incluem o ômega 3, têm demonstrado contribuir para a manutenção do funcionamento cerebral, promovendo melhorias na memória e nos aspectos cognitivos. É importante ressaltar que a pesquisa nessa área é contínua e necessária, especialmente no que se refere ao estudo do cérebro humano, dado seu caráter complexo.*

***PALAVRAS-CHAVE**: Alimentos Funcionais. Alimentos Nutricionais. Saúde Física e Mental. Doença do Alzheimer.*

***RESUMEN**: El escenario brasileño ha mostrado un aumento significativo de los casos de enfermedades crónicas no transmisibles, como la obesidad, la hipertensión, la osteoporosis, la diabetes mellitus, el cáncer y las condiciones que afectan a la pérdida de memoria, como la enfermedad de Alzheimer. El objetivo de este estudio es analizar y discutir la relevancia de los alimentos funcionales y sus componentes nutricionales en el contexto de la salud individual y en relación con la enfermedad de Alzheimer. La metodología adoptada incluyó una investigación bibliográfica cualitativa y descriptiva, basada en fuentes como libros, sitios web y artículos científicos, con un marco temporal que abarca los últimos quince años de investigación sobre el tema. Las discusiones derivadas de los resultados indican que los alimentos funcionales, incluyendo los omega 3, han demostrado contribuir al mantenimiento de la función cerebral, promoviendo mejoras en la memoria y en aspectos cognitivos. Es importante destacar que la investigación en este ámbito es continua y necesaria, especialmente en lo que se refiere al estudio del cerebro humano, dada su naturaleza compleja.*

***PALABRAS CLAVE**: Alimentos Funcionales. Alimentos Nutritivos. Salud Física y Mental. Enfermedad de Alzheimer.*

Introduction

Functional nutrition is a widely discussed and debated topic within the realm of healthcare professionals and among those who seek a healthier and more balanced approach to their well-being. However, it remains in a phase of analysis and investigation by the science of food. For a better understanding, functional foods are defined as nutrients, foods, or ingredients that can contribute to health promotion by reducing the risks of chronic or degenerative diseases that affect our bodies. Furthermore, a natural and healthy diet offers numerous benefits. On the other hand, the hectic lifestyle of modern times has led many people to opt for instant preparation foods, such as "fast food." These dietary choices have contributed to the increase in obesity statistics and the emergence of symptoms of metabolic diseases. This is due to the lack of nutritious and healthy eating and sedentary behavior, which are striking characteristics of modern life and are associated with high-stress levels.

Functional foods contain bioactive components capable of modulating the body's physiology, contributing to the maintenance of physical and mental health. Currently, nutrition plays a crucial role in the development of balanced diets and maximizing healthy nutritional intake, acting in disease prevention and health promotion. It is important to emphasize that functional foods should not be considered substitutes for medications, but their fundamental nutritional functions benefit people's health. They play an essential role in preventing and reducing the risk of various diseases. Therefore, besides providing academic and practical guidance to nutrition professionals, it is necessary to understand that dietary re-education, focusing on prevention, can contribute to avoiding impacts on physical and mental health. The balanced use of functional foods can be a valuable strategy in this process, highlighting the importance of these foods for health and their role in people's daily lives.

The effects of functional foods have been the subject of study, being identified as having satisfactory outcomes directly related to various pathologies, such as hypertension, cancer, diabetes, bone diseases, Alzheimer's disease, and cardiovascular, inflammatory, gastrointestinal, and intestinal conditions. This occurs not only based on individual physical patterns but also considering mental patterns, thus transcending the mere visceral activity of the body. Various factors can impair the quality of life and overall health, and awareness of the importance of healthy foods is one of the initial steps in promoting good health. Therefore, the research problem addressed in this study is investigating whether adopting functional nutrition offers and contributes to health promotion, resulting in significant improvements in a person's

overall health. To what extent does knowledge and practice of functional nutrition ensure physical and mental well-being, and what is the relationship between this and Alzheimer's disease?

The general objective of this research is to study and discuss the importance of functional nutrition and the influence of its nutrients on people's health and its relationship with Alzheimer's disease. The specific objectives of this study encompass the following aspects: to conceptualize functional nutrition, to understand the factors and conceptions aimed at promoting individual health, to identify classifications and active compounds that contribute to physical and mental health, and to list strategies related to functional foods for physical and psychological well-being, as well as their relationship with Alzheimer's disease.

This research is necessary so that, based on theoretical foundations, a better understanding of the functionality of functional foods can be achieved as an integral part of the lives of individuals pursuing a healthy lifestyle. It is paramount that people prioritize prevention over treatment. Drawing from various sources in the field, this research contributes to the notion that functional nutrition plays a significant role in pursuing physical and mental health. However, the population often remains unaware of the preventive effects of a healthy, practical diet, let alone what functional nutrition signifies in an individual's life.

Therefore, this research assumes primary relevance, particularly concerning the education of nutritionists, who can rely on solid scientific knowledge to guide individuals toward more beneficial habits and raise awareness about the importance of such behavior changes, promoting the adoption of healthy habits. Furthermore, this research holds social significance by positively impacting people's outlook on life, improving the population's lifestyle, resulting in individuals with better physical health and, consequently, more balanced mental health. It also plays a crucial role in the academic community, providing a solid scientific foundation that can support future research, simultaneously promoting the "functional inclusion" of families and expanding the research field through the production of additional articles and investigations.

The type of research conducted corresponds to a Literature Review in an integrative manner, wherein books, dissertations, and selected scientific articles were researched through data sources. It is a bibliographic, qualitative, and descriptive research based on books, websites, and scientific articles, with discussions by authors addressing the researched topic and presenting relevant studies on the importance of functional nutrition for individual health. The temporal scope encompasses the last fifteen years in articles, including more classical

authors within this period. The descriptors or keywords for data source searches are: functional nutrition, healthy foods, physical and mental health, and Alzheimer's disease. The inclusion criteria for this research are studies relevant to the specified period that address functional nutrition for the individual as a whole. The exclusion criteria pertain to studies that do not fit the items in the methodology description.

In the following sections, three chapters developed based on the researched studies and related to the research objectives will be presented. The first chapter addresses conceptualizing functional foods and factors or concepts related to personal health. The second chapter discusses classifications and active compounds that enhance physical and mental health. The third and final chapter deals with the prevention and impacts of functional foods on physical and psychological health and their relationship with Alzheimer's disease. Finally, final considerations will be presented, bringing forth relevant insights studied in this research and the references that guided this study.

Conceptualization of functional foods and understanding factors and concepts of personal health

The reality experienced by most individuals prompts reflections on the type and quality of the food they incorporate into their daily routines, as choices play a fundamental role. In addition to dietary choices, there is also an observed shift in certain habits, such as an increase in dining out, previously considered occasional but now occupying a significant space in family dynamics and the lives of those who work outside the home, encompassing both workdays and weekends. This current scenario characterizes the Brazilian reality, which has adopted a form of nutrition marked by fast meals, commonly known as "fast food." These meals away from home have become standard practices for many families, replacing traditional homemade lunches. This lifestyle has led to nutritional deficits, as choices often gravitate toward processed foods, instant preparations, and foods high in fried content, usually prepared in communal settings (MORAES; COLLA, 2006).

The high incidence of inadequate dietary habits is directly related to individuals' lifestyles, and this reality has undergone recent transformations, which are reflected in weight gain and mood alterations that affect both physical and mental health. These changes are influenced by a series of determinants, such as environmental, sociocultural, behavioral, and physiological factors, as well as sensory stimuli. All these elements directly impact eating

behaviors and, consequently, an individual's health. For these reasons and others, the discussion surrounding the shift in dietary habits, emphasizing components capable of serving as preventive and homeostatic measures in both physical and mental well-being, is prominent in society.

Distinctions can be made between the concepts of functional foods and nutraceuticals. According to Moraes and Colla (2006), functional foods produce beneficial effects on people's health, going beyond essential nutritional functions, as they contain biologically active components or substances found in particular nutrients. As for nutraceuticals, as the same source continues, they result from the combination of the terms "nutrition" and "pharmaceutical" and refer to the study of phytochemical components present in foods.

The introduction of functional foods began in Japan during the 1980s when notions about these foods and their usage spread. The Japanese started recognizing the physiological functionality of these foods and their nutritional nature. They deemed them specific for health promotion, and this perception correlated with the increase in the life expectancy of the Japanese population (MORAES; COLLA, 2006). Due to this increase and the concern for the health and longevity of the Japanese, a government program encouraged the population to adopt a new approach to foods, attributing to them "medicinal" properties and promoting them as functional foods aimed at promoting health.

In Raud's research (2008), relevant confirmations are also provided regarding the key factors that explain the success of functional foods in people's daily lives.

> Functional foods, which promise to aid in treating or preventing diseases, are the latest trend in the thriving food market in the early 21st century. Yogurts, margarines, fermented milk, cereals, mineral waters, and so forth promise to assist in treating or preventing diseases. These are key factors explaining the success of functional foods, with a growing concern for health and well-being and regulation changes leading to a significant revitalization of the dairy product market (RAUD, 2008, p. 85, our translation).

Functional foods are nutrients or non-nutritive substances associated with beneficial effects on human health. However, the concept that functional nutrition is considered food capable of promoting an individual's well-being is accepted in the United States, Europe, and Brazil. It is important to emphasize that, first and foremost, these foods should present essential nutritional functions and subsequently offer preventive procedures and other health benefits. According to Santos *et al.* (2012) supported by scientific evidence, functional foods have

become a new trend in the market, establishing an intrinsic relationship between nutrition and health.

> Health-conscious consumers are increasingly seeking functional foods to improve their health and well-being. In recent years, the development of new technologies, especially in biotechnology and food processing, has enabled the food industry to create new products, considering the prospects of gains in this area (SANTOS *et al.,* 2012, p. 2, our translation).

In this regard, individuals concerned about health observe the high incidence rates of diseases, as indicated by the World Health Organization (WHO) and Health Surveillance Agencies. In this context, the emergence of studies on functional foods has brought about an understanding of their impacts, characterized by producing physiological or metabolic effects to prevent certain diseases or maintain human body functions.

> Their effects have been primarily studied in conditions such as cancer, diabetes, hypertension, Alzheimer's, bone, cardiovascular, inflammatory, and intestinal disorders. For functional foods to be effective, their regular consumption is necessary, coupled with an increased intake of fruits, vegetables, whole grains, meat, soy milk, and foods rich in omega-3 (VIDAL *et al.,* 2012, p. 44, our translation).

Regular consumption of functional foods can benefit the body, contributing to optimized performance, which is reflected in a significant improvement in the immune system protection of those who consume them in their daily routine. The chemical composition of these foods, as highlighted by researchers Vital *et al.,* (2012), is classified based on their origins and components, divided between natural and artificial. In the search for components that meet the objectives of this research, it is imperative to prioritize elements of natural origin. We cannot ignore that products made with functional ingredients represent a remarkable advancement in the food industry.

> Functional foods can be found for human consumption in natural and artificial. Specialized and authorized companies manufacture the latter. Natural forms include foods that contain fatty acids (linoleic, omega-3 and 6, and limonoids), fibers, probiotics (lactobacilli and bifidobacteria), phenolic compounds (resveratrol, isoflavone, and zeaxanthin), and carotenoids (beta-carotene, lycopene, lutein) (VIDAL *et al*., 2012, p. 50, our translation).

In contemporary society, it is increasingly common to observe the emergence of symptoms such as fatigue, mood swings, and others, which often lead to the development of diseases of various origins. Such signs and health conditions are primarily attributed to the lifestyle individuals adopt. According to the citation below, the authors emphasize that many

chronic diseases have become more prevalent in our society due to dietary patterns and lack of physical activity, as presented by Silva *et al.* (2016).

> The Brazilian scenario reflects increased non-communicable chronic diseases (NCDs) such as obesity, systemic arterial hypertension, osteoporosis, diabetes mellitus, and cancer. It is estimated that NCDs are responsible for 72% of deaths in Brazil, affecting the population of all social classes but more pronounced in groups with lower education, income, and the elderly. As a result, concern for food quality becomes a priority for the population, leading them to adopt dietary patterns that promote health improvements (SILVA *et al*., 2016, p. 134, our translation).

Other countries mentioned in their research include the United Kingdom and the United States, which have also defined functional foods as primarily nutritious and containing substances that promote health. Around 1991, claims related to disease risk reduction for certain foods became permissible in the United States, provided they were supported by scientific evidence and followed the consensus of qualified researchers. In Europe, permission for the marketing of functional foods began in 1996 when a European Commission was created to regulate this category of foods. From the perspective of health and science, functional nutrition plays a crucial role in growth, development, and differentiation, acting as a metabolic substrate and reducing the incidence of diseases, among other benefits (GIUNTINI, 2018).

In their research, Vieira and Pierre (2018) highlighted that a balanced diet can offer individuals health benefits, preventing chronic diseases. Their investigations, conducted through a literature review and systematic research from data sources, led to these conclusive findings:

> The food industry is in a constant process of transformation. Functional foods are still considered "new foods" due to the lack of research and consumption history. This necessitates new theoretical and practical studies on the technologies surrounding this type of food. However, there is already substantial evidence that a proper and balanced diet can prevent various diseases, including cancer and vascular diseases (VIEIRA; PIERRE, 2018, p. 8, our translation).

After a comparative analysis of various sources and authors attesting to the effectiveness of functional foods, particularly emphasizing their remarkable success in the early 21st century, a widespread lack of knowledge about their functionality and even their conceptualization still exists. This limits the dissemination of these foods in society, depriving many individuals of the benefits they could provide regarding well-being. More excellent promotion and awareness

on the subject could result in improved health outcomes, as many diseases related to sedentary lifestyles and poor dietary habits could be prevented.

After examining the definitions and perspectives of various authors in their research on functional foods, it is pertinent to address how claims about these foods are regulated in Brazil. In the country, claims about functional foods are governed by laws that recognize both nutrients and non-nutritive substances with functions related to growth, development, health maintenance, and disease prevention (GIUNTINI, 2018).

Around 1999, four promulgated resolutions established the basis for regulating functional foods. These are: RDC No. 16/1999A1; RDC No. 17/1999; RDC No. 18/1999 e RDC No. 19/1999. ANVISA recognized these four resolutions that deal with legislation on functional foods, and with the implementation of these laws approved in 1999 (BRASIL, 1999a; 1999b; 1999c; 1999d), a regulatory framework was established.

Subsequently, in 2002, RDC No. 02/2002 approved the Technical Regulation for bioactive substances and isolated probiotics with claims of functional and/or health properties (BRASIL, 2002). In the current context of Brazil, approximately 20 components (nutrients and non-nutrients) have approved applicable claims. However, the list is subject to changes due to continuous advances in scientific research. Therefore, it is paramount to stay updated by regularly consulting ANVISA's website (GIUNTINI, 2018).

> In Brazil, ANVISA determines that a functional food must have active and health-related properties. The first property is related to the metabolic or physiological role that the nutrient or non-nutrient plays in the human body's growth, development, maintenance, and other normal functions. The second property states, suggests or implies a relationship between the food or ingredient and a disease or health-related condition (BRASIL, 1999 apud CAÑAS; BRAIBANTE, 2019, p. 2017-2018, our translation).

There is still no global consensus to define functional foods, and various terms are used interchangeably, such as nutraceuticals, nutritional foods, medicinal foods, "Vitafoods[3]," fortified foods, and dietary supplements. The topic has been the subject of extensive research and study in Brazil and worldwide as a possibility for enhancing physical and mental health. In the next section of this study, classifications and compounds with the potential to improve or promote physical and psychological health will be presented.

[3] A company with extensive experience serving the food and beverage industries, providing comprehensive support in developing new products.

Classifications and functional compounds that enhance physical and mental health

Functional foods and their compounds can be classified in two ways: by source, which can be of natural origin, whether plant, animal, or microbial. According to researcher Giuntini (2018), in addition to the mentioned sources, plant-based ones are also considered functional, such as non-carotenoid terpenoids, organosulfur compounds, phenolic compounds, phenolic acids, lignans, phytosterols, polyols. These active compounds can be found in foods such as soy, tomatoes, cruciferous vegetables, flaxseeds, garlic, citrus fruits, green tea, dark red grapes/red wine, oats, and prebiotics (such as fructans, resistant starch, and lactulose), all of them playing a relevant role in promoting physical and intestinal health. Research conducted by Carvalho *et al.* (2006) emphasizes that vegetables not only offer benefits to the body but also can act as preventive agents for chronic diseases.

> Epidemiological studies conducted in animals have shown that specific components of fruits and vegetables can prevent cancer and coronary diseases directly or through complex interactions with the body's metabolic and molecular processes. These studies led the United States Food and Drug Administration (FDA) to approve claiming that such foods benefit health. According to ADA Reports (1999), the recommended intake of fruits and vegetables is five to nine servings (cup, unit, or average slice) per day (CARVALHO *et al*., 2006, p. 398, our translation).

Next, we have probiotics, which consist of live microorganisms of specific strains whose function is to maintain the intestinal microbiota balance. These microorganisms are found in fermented milk, yogurts, and other dairy products, playing a fundamental role in favoring gastrointestinal functions and reducing the risk of constipation and colon cancer.

Regarding omega-3 and omega-6 fatty acids, attention is focused on their relevance in the prevention and impacts on physical and mental health. As Mancini Filho (2015) observed, fatty acids present in triglycerides can be classified as saturated and unsaturated. Among unsaturated fatty acids, polyunsaturated ones have more than one double bond in their structure and are considered essential for the human body. An example is the fatty acids of the linoleic acid family. Omega-3 fatty acids, on the other hand, are characterized by the presence of double bonds in their molecular structure.

> The presence of these fatty acids in the body is related to reducing blood viscosity, increasing relaxation of the endothelium of coronary arteries, and being associated with the upregulation of genes involved in homeostasis regulation, such as the enzyme 7-alpha-hydroxylase, the type B1 scavenger receptor, and the LDL receptor (MANCINI FILHO, 2015, online, our translation).

According to Cañas and Braibante (2019), functional foods can be classified based on the bioactive components these foods possess, considering their chemical structure, characteristics, properties, and the health benefits they provide. Some examples of these substances include carotenoids, flavonoids, unsaturated fatty acids, omega-3 and omega-6, and dietary fiber.

Functional foods of plant origin can be classified based on these bioactive components. Firstly, carotenoids are highlighted, such as beta-carotene, lycopene, and lutein, which are natural pigments found in plants, flowers, and fruits with a wide range of colors, ranging from yellow to more vibrant shades like red. These carotenoids can be found in foods such as tomatoes, red guava derivatives, red bell peppers, watermelon, green leafy vegetables, corn, papaya, and others. These substances offer various benefits to physical and mental health, including reducing cholesterol levels, the risk of certain types of cancer, protection against muscle degeneration, and acting as antioxidants (CAÑAS; BRAIBANTE, 2019).

Another important class is flavonoids, phenolic compounds primarily identified in vegetables. They possess antioxidant, vasodilatory, and anti-inflammatory properties that benefit people's health. As highlighted by authors Cañas and Braibante (2019) in their research on these components and characteristics:

> According to their chemical and biosynthetic characteristics, these compounds are classified as: anthocyanins, flavanols, flavanones, flavones, flavonols, and isoflavonoids. Anthocyanins are the substances responsible for giving a blue or red color to plant-based foods (CAÑAS; BRAIBANTE, 2019, p. 219, our translation).

Functional foods of animal and microbial origin can be found in fish and fish oils, such as sardines, salmon, tuna, anchovy, and vegetable oils like olive oil. As highlighted by authors Cañas and Braibante (2019), flaxseeds and walnuts also belong to functional foods of animal origin, performing functions such as reducing LDL cholesterol, anti-inflammatory action, and essential contributions to developing the brain and retina in newborns.

Another substance mentioned is chitosan, an animal-based fiber that can improve plasma cholesterol levels. Among dietary fibers, beta-glucan stands out and can be found in whole grains such as oats, rye, and barley, as well as in legumes like soybeans, peas, and beans, along with vegetables, fruits with skins, and stems. These fibers are essential in reducing the risk of colon cancer and improving bowel function (CAÑAS; BRAIBANTE, 2019).

Additionally, it is essential to mention two substances negatively associated with dementia, copper and aluminum. It is believed that these elements may contribute to the progression of the pathological process of Alzheimer's Disease (AD). On the other hand, substances with anti-inflammatory properties are of great interest in this field of research, considering the neuroinflammation present in the disease. An example is docosahexaenoic acid (DHA), which has been shown to have anti-amyloid bioactivity and cholesterol reduction capacity, a factor associated with the risk of AD, in addition to exerting neuroprotective activity.

The primary foods rich in omega-3 include deep-sea fish such as cod, shark, tuna, and salmon. In addition to fish, flaxseed is an excellent source of omega-3. The term "omega" is often used to indicate the position of the carboxylic bond, as stated by Cañas and Braibante (2019) in their studies. They further emphasize that these combinations for the formation of omega-3 and omega-6 are essential and indispensable for various functions in the body, especially in brain biological functions, such as the constitution of cell membranes and the transmission of synaptic impulses and neuronal connections.

After this classification of functional foods and the emphasis placed on foods that can influence brain function and are considered indispensable for the body, the next chapter will address components related to Alzheimer's disease and overall health.

Prevention and Impacts of Functional Foods on Physical and Mental Health and their Relation to Alzheimer's Disease

When addressing the prevention and impacts of functional foods on chronic diseases (physical) and diseases that affect cognitive functions and memory (mental), it can be affirmed that much of what we consume can play a preventive role closely related to our daily habits. These habits encompass both dietary choices and the inclusion of supplements, as well as physical activity. This relationship has shown beneficial results for the body and its overall well-being.

It is important to understand that in the human body, these habits work in an interconnected manner, as many visceral activities are interrelated and affect one another. For example, intestinal microbiota impacts a person's mental health, and this interconnection influences the immune and central nervous systems. Therefore, foods play a fundamental role as a means of protection and prevention for the body. However, it is crucial to emphasize that these foods should not be used in isolation or as substitutes for treating established diseases.

They can, however, complement a change in habits and lifestyle. Polyunsaturated fatty acids, such as omega-3 and omega-6, play essential roles in the development and functioning of the brain and retina (MARTIN *et al.,* 2006).

> Lipid components, especially fatty acids, are present in various life forms, performing important functions in the structure of cell membranes and metabolic processes. Linoleic and alpha-linolenic acids are necessary in humans to maintain cell membranes, brain functions, and nerve impulse transmission under normal conditions. These fatty acids also participate in the transfer of atmospheric oxygen to the bloodstream, hemoglobin synthesis, and cell division, and they are called essential because they are not synthesized by the body from fatty acids derived from de novo synthesis (MARTIN *et al*., 2006, p. 762, our translation).

When addressing topics related to brain functions and nerve impulse transmission, which involve synapses and the entire mechanism that supports neuronal functioning, it is assessed regarding overall mental health's cerebral functioning. This is intrinsically linked to issues such as depression and diseases that affect individuals' executive and cognitive functions, including an illness that currently concerns many people due to its high incidence rates and impact on mental health: Alzheimer's disease. Alzheimer's is the leading cause of dementia, comprising a set of brain disorders resulting in the loss of intellectual and social abilities. In this disease, brain cells degenerate and die, leading to a progressive decline in memory and mental function.

According to Armentano *et al.* (2009), the aging process is associated with deficits in episodic memory and the control of neuropsychological functions, primarily related to reduced information processing, attention, inhibitory processes, and cognitive flexibility. These deficits are explained by the hypothesis of aging of the frontal system and the losses that occur with advancing age.

As for Alzheimer's disease, the consumption of omega-3 brings benefits to mental health, as they control blood pressure and have an anti-inflammatory effect, helping with many conditions of metabolic syndrome, autoimmune diseases, PMS symptoms, mood, and other common symptoms in modern life. Omega-3 consumption has been shown to contribute to maintaining brain function improving memory and cognitive aspects. In addition, B-complex vitamins, such as B12, folic acid, and B6, play an important role in treating Alzheimer's disease, as they are related to reducing homocysteine levels in the human body.

> Among the main functions of fatty acids (FA) are energy storage and participation as structural components of cell membranes. Moreover, they are

> precursors of substances like prostaglandins (which act on smooth muscle contractility and modulation of hormonal signal reception (GIUNTINI, 2018, p. 85, our translation).

In most human diets, fatty acids (FAs) containing EPA and DHA are primarily found in fish, such as mackerel, sardines, and salmon, as well as in many dietary supplements. They can also be found in other types of functional foods that are considered sources of fatty acids.

> Phytosterols occur naturally in cereals, oilseeds, and legumes and are mainly found in the oils of these plants, with higher concentrations in soybean, sunflower, and canola oils. They are also present in vegetables and fruits but in much smaller quantities. These compounds can be isolated for addition to products, which can then make functional claims (GIUNTINI, 2018, p. 87, our translation).

When referring to Alzheimer's disease, one cannot ignore specific correlations with the increase in LDL cholesterol, as it affects cardiovascular problems and directly impacts brain processes. The consumption of trans fats causes this, as studies indicate that elevated LDL cholesterol levels increase the risk of developing Alzheimer's with aging. However, the National Health Surveillance Agency (BRASIL, 1999c) has determined the prohibition of trans fats by the food industry and has established that by 2023, these substances must be reduced in their products. Trans fats are found in ice cream, cookies, microwave popcorn, margarine, and other products. Because these foods increase LDL cholesterol levels and are harmful to human health, it is advisable to avoid them to prevent adverse impacts on overall health.

Therefore, investing in fatty acids and seeking healthier foods is still the best preventive solution for various diseases, including Alzheimer's. In the case of this Alzheimer's research, investing in omega-3 fatty acids, such as EPA (eicosapentaenoic acid) and DHA (Docosahexaenoic Acid), is highly recommended. DHA, in particular, is an essential nutrient for the brain, as about 60% of the brain is composed of fat, and approximately 20% of that fat is DHA. Several studies have shown a positive relationship between DHA supplementation and increased resilience of neurons, as well as improved cognitive capacity.

> The omega-3 fatty acids EPA and DHA are found in cold and deep-sea fish (e.g., mackerel, sardines, salmon). ALA (alpha-linolenic acid) is mainly found in soybean, canola oils, and flaxseed; ALA can be converted into EPA and DHA but in low percentages. The recommended intake is approximately 1.0 g/day. Phytosterols are mainly found in oilseeds and legumes, especially in soybean, sunflower, and canola oils. There are dairy products with added phytosterols. The recommended intake is approximately 2.0 g/day (GIUNTINI, 2018, p. 88, our translation).

Fatty acids have been extensively studied and analyzed to improve people's quality of life, prevent chronic diseases, and reduce the risk of dementia, such as Alzheimer's disease. The Ministry of Health recommends an ideal consumption of at least twice weekly to benefit health. Omega-3 fatty acids can significantly reduce the risk of Alzheimer's disease, providing benefits for physical and mental well-being.

Alpha-linolenic acids (ALA), of plant origin, are components of omega-3 and cannot be synthesized by mammalian tissues, so they must be obtained exclusively through diet. Since our bodies cannot produce them, it is essential to incorporate them into our diet. On the other hand, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), of animal origin, are bioactive compounds found in marine fish and are already in the active form for our body, providing various health benefits (GIUNTINI, 2018).

For Giuntini (2018), during the aging process, a decrease in omega-3 biomarkers in the brain is observed, as well as brain changes such as memory loss and cognitive function decline. In this context, a reduction in the amount of DHA in the hippocampus, the area responsible for memory, is noted. Studies show that aging is associated with a decrease in DHA, which, in turn, impacts the occurrence of the disease. Brain damage prevents the formation of new memories, which is why supplementation should be considered. However, this supplementation should be adopted preventively, meaning it should not be started only at seventy years old but instead considered from the age of forty or fifty, avoiding the manifestations of early symptoms and signs (GIUNTINI, 2018).

In addition to these considerations related to Alzheimer's disease, omega-3 fatty acids such as DHA also play a significant role as preventive supplements in various conditions, such as autoimmune diseases, cardiovascular diseases, hypertension, metabolic disorders, asthma, arthritis, intestinal inflammations, and offer additional benefits during pregnancy.

Seeking prevention through Immunonutrition diet therapy, based on interventions aimed at protecting the immune system, provides many people with an alternative to improving their quality of life. Almeida *et al.* (2020) highlight, in the context of the relationship between Alzheimer's and omega-3, that the high concentration of DHA provides perfect fluidity to plasma membranes, while B-complex vitamins play a fundamental role in neuronal function in Alzheimer's disease. In this sense, their research on analyzing these components indicated benefits for mental health, as several studies have shown that increasing DHA supplementation promotes neuronal development satisfactorily.

Discussion of Results

This section presents a comparative table of authors and their approaches to the proposed topic. The selection of articles was based on the inclusion of the analysis of functional foods and Alzheimer's disease, resulting in the choice of four pieces to compose this research. The identified authors are presented with the year of publication, the objective of their respective articles, and the main results achieved. After the table's presentation, an analysis of the results will be conducted, establishing connections between relevant points for formulating conclusions related to the theme and resolving the research problem.

In the search for data sources, descriptors resulted in 17,600 articles related to the topic, some addressing the disease and others dealing with functional foods. However, the selection prioritized articles that encompassed both functional or nutritional foods and Alzheimer's Disease, requiring that the title of such articles explicitly included the description of these two themes. Several articles were excluded due to a lack of access, and international research was discarded. The study focused mainly on national results and limited itself to articles published in recent years, from 2016 to 2021, addressing the relevant topic to support the discussion of the results.

Table 1 – Research Articles Table 2021

Authors/Year	Title	Objective	Main Results
Mendes *et al*., 2016	Avaliação do estado nutricional e consumo alimentar em pacientes com Doença de Alzheimer	It is assessing the nutritional status and dietary intake of Alzheimer's disease (AD) patients in a nursing home in the city of São Paulo.	Vitamin E can be considered a potentially effective treatment for AD, exhibiting significant variations in its antioxidant function and ability to enhance cognitive functions. Supplementation of folic acid, vitamin B12, and B6 may reduce the risk of cardiovascular disease, stroke, and dementia by lowering homocysteine levels.
Biguetti; Lellis; Dias. 2018	Nutrientes essenciais na prevenção da doença de Alzheimer	Discussing the primary nutrients that can aid in the prevention of this disease.	It can be stated that many nutrients and foods may contribute to reducing the incidence of AD. However, it is essential to emphasize that this consumption should occur throughout one's lifetime and be combined with a healthy diet.
Weber *et al*., 2019	Nutrição e Doença de Alzheimer no idoso: uma	Investigating whether diet and nutrition can	The studies and scientific evidence presented above

	revisão	contribute to the prevention or delay of Alzheimer's disease progression.	show that a healthy diet plays a protective role in brain health.
Almeida *et al*., 2020	A Doença do Alzheimer e suas relações com ômega-3 e as vitaminas do Complexo B	Identifying, in the scientific literature, studies on Alzheimer's disease and its relationship with omega-3 fatty acids and B-complex vitamins, considering the benefits of these micronutrients.	Studies on omega-3 fatty acids indicate their potential benefits for individuals with Alzheimer's disease by reducing markers of inflammation.

Source: Elaborated by the authors.

In this way, the research analyzed and studied to address this topic indicates that nutrition and functional foods, based on specific components and vitamins, can improve physical and mental quality of life. However, the results of various studies and research relating Alzheimer's disease (AD) to functional or healthy eating have provided positive insights into people's lives. The survey conducted by Mendes *et al*. (2016), highlights the relevance of vitamin D, folic acid, vitamin B12, B6, and omega-3 in the dietary composition of individuals suffering from AD. Additionally, the study emphasizes the importance of a preventive approach and maintaining a healthy diet.

Analyzing the research by Bigueti, Lellis and Dias (2018) it is evident that they point to the prevention of AD through B-complex vitamins, vitamins C, D, and E, omega-3, and selenium, all of which have shown positive results. On the other hand, Weber *et al.* (2019), in their research, state that some vitamins and minerals are related to brain function and maintenance. However, they emphasize that B-complex vitamins, selenium, omega-3 fatty acids, EPA, DHA, and antioxidant vitamins such as A, C, and E have more significant potential in the brain and neuron system, representing important points of prevention for the disease.

The studies by Almeida *et al.* (2020) on the other hand, claim that there is no cure for Alzheimer's, but they emphasize that many research efforts reveal ways to prevent the disease through a healthy diet. All the investigated authors agree that food and vitamins comprehensively impact the human body. Unanimously, they assert that unhealthy eating and lifestyle habits can harm an individual's quality of life and health.

Final Considerations

The search for this topic arose due to the interest of numerous individuals in making changes to their dietary routines and seeking perspectives for a longer and healthier life. Through investigations in the field of food sciences, opportunities have emerged to propose changes that enable the promotion of people's health, which has significantly motivated the study. According to the research, responses from scientific investigations were obtained, yielding expected results indicating that functional foods contribute to improving health and strengthening disease prevention measures that currently represent global concerns.

With this theme and the research objective aimed at studying and discussing the importance of functional nutrition and all its nutrients in the context of people's health and their relationship with Alzheimer's disease, it became possible to observe that various foods can contribute to brain function and its connections. This underscores the relevance of adopting a diet based on functional foods, cultivating healthy habits in terms of nutrition, and engaging in non-sedentary physical activities. Exploring this theme made it evident that the impact of what is consumed and ingested by the body is noteworthy. Equally notable is the observation that in the aging process, there is a reduction in omega-3 biomarkers in the brain, which is correlated with brain changes such as memory loss and cognitive function. Consequently, the decreased amount of DHA in the hippocampus assumes significant importance, as this component (DHA) becomes crucial for developing robust physical and mental health, as indicated by the research results on the subject.

It was possible to confirm the research question regarding the relationship between functional foods and the reduction of various diseases, including autoimmune, cardiovascular, and Alzheimer's diseases. It is known that many more studies need to be conducted in this area, especially those related to the human brain, given its complexity. Therefore, it is relevant to highlight that several nutrients can positively correlate with the mitigation of AD. This leads to the conclusion that healthy diets, which include increased consumption of vegetables, fruits, probiotics, low or no alcohol consumption, adequate hydration, regular physical activity, and foods rich in EPA and DHA, among others, can significantly contribute to reducing the risk of developing Alzheimer's disease.

Even though the results are inconclusive, suggested lifestyle changes may offer additional benefits related to weight reduction and maintenance, cardiovascular health, and diabetes risk, and, importantly, do not entail harm. It is crucial to emphasize that no single food

item can replace others or should be consumed at the expense of others to prevent a specific disease. Different foods provide distinct vital substances for health. Therefore, a varied diet is essential.

Various research groups have extensively studied Omega fatty acids, resulting in numerous advancements in nutritional recommendations related to their physiological properties. In general terms, the development of this work and research itself has brought about a more refined analysis. Functional foods do not represent a cure for diseases but can contribute to the well-being and quality of life of individuals, as a combination of healthy and recommended foods promotes homeostasis in visceral activity and the central nervous system of the individual. In this regard, prevention through immunonutrition therapy, based on intervention principles for protecting the immune system, offers many people an option to pursue a higher quality of life.

Therefore, it is paramount to continuously conduct new research and analysis since nutritional health is cyclical and must remain under constant investigation and research for new approaches, aiming for future generations, given its scientific, social, and economic relevance and impact on the quality of life.

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