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SUMARIO ● SUMMARY ● RESUMO

Editorial

In this new issue of *MLS Health and Nutrition Research*, we celebrate not only the publication of the first issue of the fourth volume, but also the opportunity to continue building bridges between science and everyday reality. We live in times when health and nutrition have become topics of daily conversation, not only in laboratories and universities, but also in homes, schools and social networks. Therefore, this journal is not only an academic channel, but a living space where questions are transformed into knowledge and evidence inspires change. Thanks to all the authors who, with rigor and commitment, have relied on this platform to share research that does not remain on paper, but seeks to make a real difference.

In this edition, we present studies that address key issues in nutrition practice and research, both from prevention and from clinical and community intervention.

In the first article, a comparative analysis of the effect of the Mediterranean, ketogenic, DASH and MIND diets in the prevention of Alzheimer's disease is carried out. From a systematic review with rigorous criteria, it is highlighted that all diets show neuroprotective benefits, being the MIND diet the one that shows the greatest potential by combining elements of the Mediterranean and DASH diets. The study concludes that to enhance its effects, it is necessary to integrate it with physical activity and mental health strategies such as mindfulness.

From the field of school nutrition, the article entitled "Knowledge of nutrition labeling and labeling of packaged foods in school snacks by adolescents from an educational institution in Asuncion" offers a perspective on the understanding of nutrition labeling by Paraguayan schoolchildren. The results show that although the majority correctly identify calories, there are knowledge gaps in key aspects such as dietary fiber, which raises the need to reinforce nutrition education in schools.

The article "Effect of a nutritional-educational intervention with a Mexicanized Mediterranean diet (MDM) on anthropometry and biochemistry in overweight and obese adults in Mexico" presents the results of a six-week intervention that achieved significant improvements in several metabolic, biochemical and anthropometric parameters. The DMM, based on local foods equivalent to Mediterranean foods, demonstrates the feasibility of adapting healthy patterns to diverse cultural contexts.

The following study focuses on time-restricted feeding as an alternative strategy in obesity. Through review of recent clinical trials, it is evident that this strategy, aligned with circadian rhythms, offers promising results for weight loss and metabolic control, although further longitudinal evidence is required to validate its clinical application.

Finally, the article "Community conception of malnutrition and medical treatment in rural areas" presents qualitative research conducted in rural communities in Mozambique, where child malnutrition persists despite the policies implemented. The study shows that community perception, traditional practices and distrust of medical services are determining factors in the prevalence of malnutrition. The findings emphasize the need for integrated interventions that respect the sociocultural context and promote health education effectively.

With this edition, we reaffirm our commitment to open, rigorous science with a real impact on society. We invite researchers, practitioners and students to continue to use *MLS*

Health and Nutrition Research as a platform to share their contributions, and to strengthen the bridge between academic research and professional practice in health and nutrition.

Dr. Iñaki Elío Pascual
Editor in Chief
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Comparative analysis of the effect of the Mediterranean, Ketogenic, DASH and MIND diets on the prevention of Alzheimer

Análisis comparativo del efecto de las dietas Mediterránea, Cetogénica, DASH y MIND

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ABSTRACT

The aim of this literature review is to examine and contrast four dietary patterns to evaluate their influence on Alzheimer's prevention. The need for this study arises from the lack of a comprehensive analysis definitively confirming the effectiveness of these diets in preventing this disease. An exhaustive literature review was conducted, including clinical trials, systematic reviews, meta-analyses, online books, guidelines, etc. However, only articles from studies, clinical trials, and controlled randomized trials were used for discussion. Exclusion criteria were: publication period of 5 years, articles published in indexed journals and in databases such as PubMed, COCHRANE, or Google Scholar, with an impact factor equal to or greater than 1.5. It has been evidenced that the four diets can offer benefits in Alzheimer's prevention. However, when selecting the most effective diet in Alzheimer's prevention, it is necessary to consider different types of nutritional approaches such as engaging in physical activity to improve cognitive decline. It has been demonstrated that the four investigated diets offer significant benefits in Alzheimer's prevention. Although the MIND diet emerges as a promising strategy, combining the benefits of the Mediterranean and DASH diets. Integrating this diet with practices such as mindfulness and physical activity is important to promote long-term brain health and reduce the risk of cognitive decline, thus maximizing Alzheimer's prevention.

Palabras clave:
Deterioro cognitivo, enfermedad de Alzheimer, prevención de Alzheimer, dieta Mediterránea, dieta Cetogénica, dieta DASH, dieta MIND.

RESUMEN

El objetivo es examinar y contrastar cuatro patrones alimenticios para evaluar su influencia en la prevención del Alzheimer. La necesidad de este estudio surge de la falta de un análisis exhaustivo que confirme de manera definitiva la efectividad de estas dietas en la prevención de esta enfermedad. Se ha realizado una revisión bibliográfica exhaustiva en la que se han incluido ensayos clínicos, revisiones sistemáticas ,metaanálisis, libros online, guías... etc. Sin embargo, para realizar la discusión solo se utilizaron artículos de estudios, ensayos clínicos y ensayos aleatorios controlados. Los parámetros de exclusión fueron:

	antigüedad de 5 años, artículos publicados en revistas indexadas o bases de datos como Pubmed, COCHRANE o Google Scholar, con un factor de impacto igual o superior a 1,5. Se ha evidenciado que las cuatro dietas pueden ofrecer beneficios en la prevención del Alzheimer. Sin embargo, para seleccionar la dieta más efectiva en la prevención de esta enfermedad es necesario tener en cuenta los diferentes tipos de abordajes nutricionales como la realización de actividad física conjunta para la mejora del deterioro cognitivo. Se ha demostrado que las cuatro dietas investigadas ofrecen beneficios significativos en la prevención del Alzheimer. Aunque la dieta MIND emerge como una estrategia prometedora, combinando los beneficios de las dietas Mediterránea y DASH. Es importante integrar esta dieta con prácticas como el mindfulness y la actividad física para promover la salud cerebral a largo plazo y reducir el riesgo de deterioro cognitivo, maximizando así la prevención del Alzheimer.

Introduction

Alzheimer's disease (AD) is the most common form of dementia, accounting for at least two-thirds of cases in people over the age of 65. It is characterized by a gradual onset and steady progression that adversely affects various cognitive and behavioral functions, interfering with daily activities. This disease is the sixth leading cause of death in adults and affects 50 million people worldwide, with a projection of 152 million by 2050 (1) .

AD is a complex disorder influenced by genetic factors and modifiable lifestyle habits. Currently, there are no effective drugs to halt or slow its progression, highlighting the urgent need to better understand the disease and develop more effective therapies. Neuroimaging research has shown that dietary choices can significantly impact the brain, suggesting that dietary interventions may be preventative measures against AD.

To meet this public health challenge, it is essential to adopt comprehensive and multidisciplinary approaches. The adoption of healthy eating habits, regular exercise and cognitive stimulation are crucial strategies to reduce the incidence of dementia, especially in the elderly. One study has shown that lower adherence to the Mediterranean diet is associated with greater impairment in AD-related brain areas, indicating that following this diet may be beneficial for brain health (2-4).

Other studies have evaluated the impact of ketogenic diet and medium-chain triglycerides in people with mild to moderate AD, and it has been observed that folate deficiency increases the risk of Alzheimer's disease, highlighting the importance of adequate folate intake. The MIND diet, which combines aspects of the Mediterranean diet and the DASH diet, may improve cognitive ability in older people, suggesting that following these dietary guidelines may be an effective strategy to prevent cognitive decline (5-9).

Definition of Alzheimer's Disease

Alzheimer's disease (AD) is the most common form of dementia. The term "dementia" comes from the Latin "demens," meaning "to be out of one's mind", and has been used since the 13th century to describe mental disorders. AD was identified in 1906 with a case of presenile dementia. This disease progresses continuously and, on average, sufferers live between 4 and 8 years after diagnosis, although some cases can last up to 20 years.

AD is complex and is characterized by multiple interrelated pathological events, such as metabolic, neurovascular, inflammatory, bioenergetic and systemic processes, including ischemic white matter lesions. Unlike normal aging, AD is a progressive neurodegenerative condition that affects memory, thinking, decision making, communication, problem solving, personality and mobility (1,4).

In addition to these changes, there is a significant loss of neurons, chronic inflammation, extensive DNA damage, mitochondrial dysfunction, alterations in energy metabolism and prolonged oxidative stress. Oxidative damage is one of the earliest events in the progression of AD. These processes contribute to the complexity of the disease and its devastating impact on cognitive function and quality of life (1).

However, not all people with brain pathologies experience cognitive dysfunction; some maintain their function through cognitive resilience (10). Cognitive and physical activities in old age are associated with better cognitive scores, independently of brain pathologies. Identifying modifiable lifestyle factors is crucial in AD research. Diet, in

particular, has been linked to cognitive decline and AD, so it is essential to delve deeper into how diet influences cognitive health and the prevention of neurodegenerative diseases such as Alzheimer's disease.

Causes

Low cognitive reserve, often associated with low educational level, is one of the main hypotheses explaining early cognitive impairment and the onset of AD. Adult hippocampal neurogenesis (AHN) is essential for maintaining cognitive reserve, and diet plays a critical role in creating an environment conducive to AHN. A diet rich in essential nutrients such as monounsaturated (MUFA) and polyunsaturated (PUFA) fats, fiber-rich carbohydrates and protein, along with probiotics and prebiotics, has been found to correlate with improvements in mental health (2). In addition, maintaining an adequate sleep pattern and regular exercise are also associated with these mental health benefits (10).

The most reliable method of identifying mild cognitive impairment in the early stages of Alzheimer's disease is through neuropsychological testing. Recently, volumetric magnetic resonance imaging has emerged as an accurate tool for measuring volume changes in the brain (1). In Alzheimer's patients, this technique shows specific shrinkage in the medial temporal lobe, although hippocampal atrophy is also related to normal age-related memory decline, limiting its usefulness as a definitive method for early detection of the disease (4).

The exact role of volumetric magnetic resonance imaging in the diagnosis of Alzheimer's is not yet fully defined, and although it provides valuable information on brain structural changes, its definitive contribution to diagnosis is still under study (1). Functional brain imaging techniques such as PET, fMRI and SPECT are also being investigated to analyze dysfunction in specific regions of the medial temporal and parietal lobe. Although they hold promise in early detection and monitoring of the disease, their definitive role in diagnosis is yet to be determined, and their integration into full clinical diagnosis is an active area of research (13).

Even with a thorough history, complete physical exam, and high-quality testing, diagnosing the specific type of dementia with certainty can be challenging (4). Some patients may experience cognitive decline that, although objective, is not severe enough to affect daily tasks, being categorized as mild cognitive impairment. However, a significant proportion of people with mild cognitive impairment will develop dementia within 5 to 7 years (1).

According to the stage of cognitive impairment, they can be classified into: Preclinical or presymptomatic (13), mild cognitive impairment (12), dementia (6).

Treatment and Prevention

Alzheimer's disease currently lacks a definitive cure, but there are treatments that help alleviate symptoms and improve patients' quality of life (1). These treatments include cholinesterase inhibitors and partial NMDA receptor antagonists (4), which work by increasing acetylcholine levels and blocking specific receptors to reduce calcium accumulation in nerve cells.

Since there are no specific treatments to stop Alzheimer's disease, increasing emphasis has been placed on its prevention. Evidence suggests that a diet rich in antioxidants can improve cognitive function, highlighting the importance of adopting healthy dietary habits to reduce the risk of developing this disease (6). The

Mediterranean, DASH and MIND diets have been shown to be associated with protection against cognitive decline, suggesting that following these dietary patterns may help preserve cognitive function and delay the development of neurodegenerative disorders (14).

Prospective studies have confirmed that reducing the intake of saturated and transunsaturated fats, and increasing the intake of antioxidant nutrients and B vitamins, can slow cognitive decline. These findings underscore the importance of maintaining healthy eating habits to optimize cognitive function (12).

Diet plays a crucial role in the generation of new neurons, while cognitive training facilitates the integration of these neurons into existing neural networks. Therefore, it is essential to combine proper nutrition with mental exercise to maintain and improve brain function (12).

Effective prevention of cognitive decline and dementia requires comprehensive approaches that address several aspects of lifestyle simultaneously. This includes interventions in areas such as physical activity (15), diet, mental exercise, social relationships, and stress management, with the goal of promoting long-term brain health and reducing the risk of cognitive decline and dementia (13).

Dietary Intervention

Diet plays a crucial role in the prevention of Alzheimer's disease (AD) through lifestyle changes (16) through lifestyle changes. The literature on dietary interventions has grown, showing that modifying diet can improve cognitive function and reduce the risk of mental decline. However, variability in evaluation methods limits the ability to draw robust conclusions about the brain health benefits of these interventions (17).

Evidence suggests that a healthy diet may prevent cognitive decline related to aging (18), based on prospective epidemiological studies. Although these studies have been encouraging, more research is needed to fully understand this relationship and to establish precise guidelines on the most beneficial diet in the long term (16).

Dietary patterns with high vegetable and fruit consumption correlate with better cognitive scores. Diets such as Mediterranean, DASH, and MIND have been associated with improved cognitive, behavioral and brain function. These findings support the idea that a healthy diet can preserve cognitive function and delay neurodegenerative processes, although more research is needed to confirm them (2).

Several dietary patterns, such as the Mediterranean diet and the DASH diet, have demonstrated neuroprotective properties, reducing the risk of cognitive impairment (19). The ketogenic diet may improve cognition in mild cognitive impairment by regulating brain metabolism and reducing inflammation (20). The MIND diet, combining principles of the Mediterranean and DASH diets, may decrease the risk of cognitive decline, offering a promising strategy to prevent dementia (13).

Mediterranean Diet

The Mediterranean diet, typical of coastal regions of the Mediterranean Sea such as Greece (21), Italy, southern France, Crete, Spain, and some areas of the Middle East, is considered a model of healthy eating in modern Western society. It is characterized by the abundant consumption of plant foods, moderate intake of dairy products, fish and

poultry, and the use of olive oil as the main source of fat, while limiting the consumption of eggs and red meat (22).

Foods in the Mediterranean diet include green leafy vegetables, legumes, nuts, almonds, pistachios, fresh fruits and whole grains (6). Olive oil, a monounsaturated fat rich in alpha-linoleic acid (an omega-3 fatty acid), is essential in this diet because of its cardioprotective benefits (14). Marine products provide omega-6 fatty acids, which further enhance their cardioprotective properties. Moderate consumption of wine, especially red wine, is also associated with metabolic benefits, such as improved lipid metabolism (22).

It is recommended to consume three to nine servings of vegetables per day, one-half to two servings of fruit, and one to 13 servings of cereals, in addition to up to eight servings of olive oil daily. It is suggested to include at least three servings of oily fish and legumes per week, to use white meat instead of red meat, and to moderate the consumption of red wine at meals (22).

This diet provides approximately 2200 calories per day, with 37% of total fat intake (18% monounsaturated and 9% saturated) and 33 grams of fiber, benefiting digestive and metabolic health. It is advised to limit consumption of soft drinks to less than one per day, baked goods and commercial sweets to less than three times per week, and fat spreads to less than one serving per day. In addition, the intake of red and processed meats should be restricted to less than once a day (23).

Following the Mediterranean diet correlates with a slowing of cognitive decline and a lower incidence of AD. Epidemiological studies have shown that high adherence to this diet in older adults is associated with a lower risk of cognitive decline (24). Recent research indicates that adopting a healthy diet such as the Mediterranean diet could have a significant impact on cognitive health during aging, demonstrating potential in the prevention of neurodegenerative diseases such as Alzheimer's disease (25). One specific study suggested that extra virgin olive oil therapy may reduce the risk of progression from mild cognitive impairment to AD by decreasing fibrinolytic factors and AD-associated proteins such as tau and Aβ amyloid, as well as the oxidative stress biomarker MDA (26).

These findings highlight the importance of healthy dietary choices and specific interventions to preserve cognitive health during aging (23).

Ketogenic Diet

In 1921, Russell Wilder introduced the ketogenic diet to treat epilepsy and coined the term “ketogenic diet” (27). In the 1970s, the diet gained popularity and has been the subject of numerous studies as a treatment for various medical conditions (28). This dietary approach is characterized by high fat and low carbohydrate intakes (29) and low carbohydrate intake, with the goal of facilitating weight loss, improving mental clarity and increasing energy levels (30).

The exact cause of weight loss induced by the ketogenic diet is not completely clear. It is suggested that this could be due to water loss, fat oxidation, or a reduction in total caloric intake. The diet typically involves 55% to 60% fat, 30% to 35% protein and 5% to 10% carbohydrates. On a 2,000 calorie diet, this equates to about 20 to 50 grams of carbohydrates per day (29).

Normally, carbohydrates are the main source of energy for the body. However, by reducing their intake to less than 50 grams per day, insulin secretion decreases, leading the body into a catabolic state (31). This depletes glycogen stores and activates gluconeogenesis and ketogenesis in body tissues (20).

There are four types of ketogenic diets: the standard long-chain triglyceride (LCT), the medium-chain triglyceride (MCT) ketogenic, the modified version of the Atkins diet (MAD) and the low glycemic index approach (LIG) (9).

In studies with animal models of Alzheimer's disease (AD), the ketogenic diet has been shown to delay cognitive decline (32). In humans, a reduction in neuroinflammation and amyloid and tau accumulation has been observed. In addition, ketone bodies may have a neuroprotective effect against beta-amyloid toxicity (27).

DASH Diet

The dietary approach known as DASH got its start in the 1990s with funding from the National Institutes of Health (NIH) to investigate dietary interventions to treat hypertension (33). This dietary approach promotes a balanced diet(33), which includes a variety of foods such as vegetables, fruits, lean meats and dairy products, as well as the incorporation of essential micronutrients (34). A cornerstone of the DASH diet is the reduction of sodium intake to about 1,500 mg per day, along with a preference for fresh and minimally processed foods, similar to other dietary patterns recommended for cardiovascular health (35).

The DASH diet recommendations encourage a balanced, nutrient-rich, low-sodium diet to maintain healthy blood pressure and promote overall wellness. It is suggested to consume at least five daily servings of a variety of vegetables and fruits, opting for those with a low glycemic index to stabilize blood sugar levels. As for carbohydrates, it is recommended to consume about seven servings a day of healthy options such as whole grains, legumes and fiber-rich vegetables. It is also advisable to limit lean meat consumption to approximately two servings per day, preferring options such as skinless chicken, turkey and lean cuts of meat (33).

It is also recommended to incorporate nuts and seeds in the diet 2 to 3 times per week as a source of healthy fats, proteins and fiber. The DASH diet emphasizes the consumption of healthy fats such as extra virgin olive oil, avocados, nuts and fish rich in omega-3 fatty acids to promote cardiovascular health (23). As for proteins, it is suggested to prioritize vegetable sources such as legumes, soy products, nuts and seeds, and to limit the consumption of processed and cured meats (36).

Both the DASH and Mediterranean diets offer protection against several health conditions, including hypertension, obesity, cardiovascular disease and diabetes. These conditions have also been associated with increased cognitive impairment. However, studies have shown that physical activity combined with the DASH diet can improve neurocognition in adults at risk for Alzheimer's disease, suggesting that the two should be maintained in tandem for optimal benefits in metabolic function and quality of life (37). The combination of these healthy diets can play a crucial role in protecting both the body and mental health over time (23).

MIND Diet

The MIND diet, a fusion of the Mediterranean and DASH diets (38), has been associated with decreased cognitive decline and reduced risk of Alzheimer's dementia in older adults. This diet, influenced by the dietary patterns of both of the above diets, includes a variety of foods and nutrients considered beneficial to brain health (39). Research has revealed that following the MIND diet can slow cognitive decline in older

adults and reduce the likelihood of developing Alzheimer's dementia, according to four relevant domains: executive function, perceptual speed, episodic memory and semantic memory. These results suggest that the MIND diet may be a promising strategy for maintaining brain health and preventing cognitive decline associated with aging (17).

The MIND diet is based on a set of 10 food groups considered beneficial for the brain, such as green leafy vegetables, additional varieties of vegetables, nuts, berries, legumes, whole grains, fish, poultry, olive oil and moderate consumption of wine (12). On the other hand, 5 unhealthy food groups that should be limited are identified, such as red meat, butter and margarine sticks, cheeses, bakery products and sweets, as well as fried and fast foods (12).

The MIND diet offers detailed nutritional recommendations, such as daily consumption of three or more servings of whole grains and at least six servings per week of leafy green vegetables, along with an additional variety of vegetables per day (12). Weekly consumption of berries, fish and poultry, as well as beans and nuts, is also recommended. Olive oil is promoted as the main source of fats, while moderation in alcohol consumption is suggested, allowing for one daily serving of wine (12).

On the other hand, the consumption of foods such as red meat, fast food, fried foods and pastries is discouraged, limiting them to specific weekly portions. These nutritional recommendations are based on dietary guidelines of the Mediterranean and DASH diets (12).

The MIND diet promotes the consumption of foods rich in nutrients such as vitamin E, folate, β-carotene, lutein-zeaxanthin and flavonoids, which possess antioxidant, anti-inflammatory and neuroprotective properties. For example, vitamin E, present in green leafy vegetables and nuts, acts as an antioxidant, protecting neurons from damage caused by oxidative stress (39).

Method

This paper focuses on a literature review that analyzes the impact of the Mediterranean, ketogenic, DASH and MIND diets in the prevention of Alzheimer's disease. The aim is to determine which of these diets has a greater preventive effect against this disease. An exhaustive search of scientific articles related to the topic was conducted, including clinical trials, systematic reviews and meta-analyses, among other resources. Studies published in the last five years, from 2019 to 2024, in English or Spanish, and available in indexed journals and databases such as PubMed, COCHRANE and Google Scholar, with an impact factor equal to or greater than 1.5 were selected.

The literature search was conducted from November 20, 2023 to June 2, 2024. The following are the terms used in the search for articles.

• “Cognitive impairment”: a total of 2,450 articles were obtained from this search, of which 6 were used for this review.

• “Alzheimer disease”: a total of 1,082 articles were obtained from this search, of which 5 were used for this review.

• “Alzheimer prevention”: a total of 324 articles were obtained from this search, of which 2 were used for this review.

• "Mediterranean diet": a total of 441 articles were obtained from this search, of which 2 were used for this review.

• "Ketogenic diet": a total of 166 articles were obtained from this search, of which 1 was used for this review.

• "DASH diet": a total of 108 articles were obtained from this search, of which 1 was used for this review.

• "MIND diet": a total of 42 articles were obtained from this search, of which 3 were used for this review.

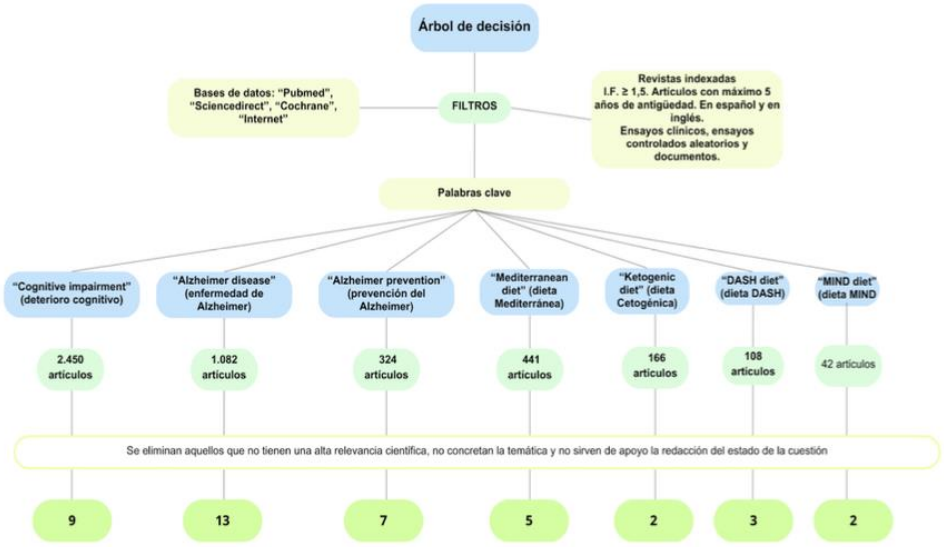

Figure 3 - Decision tree for choosing used articles searched with keywords.

Finally, 11 experimental articles were used for the discussion section.

Results

A randomized trial by Hoscheidt et al (2022) (24) examined the impact of the Mediterranean diet compared with the Western diet on amyloid beta (Aβ) levels in cerebrospinal fluid and cerebral perfusion. The results suggest that the Mediterranean diet may benefit adults with normal cognition by increasing Aβ levels, whereas, in those with mild cognitive impairment, a decrease in these levels is observed. In addition, the Mediterranean diet was found to increase cerebral perfusion, in contrast to the Western diet which reduces it. These findings underscore the neuroprotective potential of the Mediterranean diet and its ability to counteract the negative effects of the Western diet on cognitive health.

On the other hand, a randomized trial carried out by Tsolaki and colleagues (2020) (21) suggests that consumption of extra virgin olive oil and a higher intake of polyphenols may have a positive impact on preventing or slowing cognitive decline. Both studies highlight the importance

of the Mediterranean diet, rich in olive oil and polyphenols, as an effective strategy in the prevention of Alzheimer's disease and the maintenance of cognitive health.

The clinical trial by Ruiz-Rizzo et al (2024) (13) highlights the importance of physical activity and adherence to the Mediterranean diet in improving cognitive health, especially verbal memory over time. It suggests that the combination of a Mediterranean diet and an active lifestyle may be an effective strategy for preserving cognitive function in aging.

Finally, a cohort study based on a randomized controlled clinical trial conducted by Domínguez-López et al (25) focused on vitamin B12 provides additional insight. It suggests that, in an elderly Mediterranean population at high cardiovascular risk, changes in blood vitamin B12 levels are linked to improvements in memory function, but this effect is only apparent in those with high adherence to the Mediterranean diet. This finding highlights the importance of the interaction between specific nutrient intake and overall dietary pattern in the protection of cognitive functioning.

In summary, these studies support the idea that the Mediterranean diet not only promotes cardiovascular health, but may also play a crucial role in the prevention of cognitive decline and Alzheimer's disease.

As for the ketogenic diet, it has emerged as a possible intervention in the prevention and management of Alzheimer's disease (AD). Two recent studies provide valuable insights into the role of ketosis in this pathology.

The randomized crossover trial by Phillips MCL et al. 2021 (7) explored the effects of a modified ketogenic diet for 12 weeks in patients with AD in a hospital clinic. The results indicated positive changes in cardiovascular risk factors, together with mild adverse effects. This study highlighted high retention, adherence and safety rates, suggesting that the ketogenic diet can improve daily function and quality of life in patients with AD, crucial aspects for those living with dementia.

On the other hand, the clinical trial by Fortier M et al. 2021 (8) examined the effects of a ketogenic beverage with medium-chain triglycerides on mild cognitive impairment. The results revealed significant improvements in cognitive outcomes, possibly due to increased blood ketone levels. These findings highlight the importance of further research on the impact of diet-induced ketosis on the progression of AD.

Research conducted by Wright KD et al. 2021 (38) presents findings regarding the prevention of Alzheimer's disease through the implementation of the DASH diet. This pilot study evaluated the feasibility and acceptability of a combined intervention, Mindfulness in Motion (MIM) and Dietary Approaches to Stop Hypertension (DASH), specifically in older African Americans with both mild cognitive impairment and hypertension.

The results obtained indicate a significant improvement in adherence to the DASH diet, as well as in mindfulness, stress management and systolic blood pressure.

On the other hand, the two randomized clinical trials with 2x2 factorial design conducted by Smith PJ et al. (37) and Blumenthal JA et al. (36)investigated the independent and combined effects of aerobic exercise (AE) and the DASH diet in older adults with mild cognitive impairment and cardiovascular risk factors.

Only one of them showed that both physical activity and the DASH diet had beneficial effects on metabolic function (37). However, the other found significant improvements in executive functioning associated with physical activity, while the DASH diet showed no significant effect (36).

These findings suggest good potential for the DASH diet as a preventive strategy for Alzheimer's disease in individuals with mild cognitive impairment.

In the context of the MIND diet and its role in the prevention of Alzheimer's disease, a randomized controlled trial was conducted by Barnes LL et al. 2023 (34) which compared the cognitive effects of the MIND diet with a similar control diet, both with mild

caloric restriction. Participants were randomly assigned to follow one of the two diets, with the aim of promoting weight loss.

The results revealed improvements in global cognition scores in both groups up to year 3. However, for those with cognitive impairment and a family history of dementia, no significant differences were observed between those following the MIND diet and those following the control diet during the same period.

On the other hand, another randomized control trial by Krueger KR et al. 2022 (17) focused on the relative efficacy of the MIND diet in preventing cognitive decline and reducing brain atrophy in older adults at risk for Alzheimer's dementia.

The results indicated that the MIND cognitive battery is complete and valid, covering four different domains of cognitive function.

Discussion and Conclusions

In this literature review based on current scientific evidence, it has been shown that the four diets investigated: the Mediterranean diet, the Ketogenic diet, the DASH diet and the MIND diet, may offer significant benefits in the prevention of Alzheimer's disease.

Articles on the Mediterranean diet highlight its numerous benefits, which go beyond the promotion of cardiovascular health. This diet is rich in antioxidants, monounsaturated (MUFA) and polyunsaturated (PUFA) fats, fiber-rich carbohydrates and proteins, as well as probiotics and prebiotics, which are associated with the reduction of oxidative stress, the prevention of which is crucial, since oxidative damage is one of the first events in the progression of neurodegenerative diseases such as AD.

Regarding the articles on the ketogenic diet, evidence suggests that this diet may have beneficial effects in several aspects, such as improving cardiovascular risk factors or increasing cognitive function in patients with mild cognitive impairment.

A study in animal models of Alzheimer's disease has shown a delay in cognitive decline, while in humans a reduction in neuroinflammation and amyloid and tau accumulation has been observed. In addition, it has been shown that ketone bodies could exert a neuroprotective effect against beta-amyloid toxicity.

However, it is important to note that this dietary approach should not be applied in isolation, nor maintained over time, as it can produce different nutritional deficits, and in specific cases, can produce fatigue, headaches, nausea and dizziness, in addition to being a very restrictive diet and can be very limiting when making nutritional choices.

Avoidance of ischemic white matter injury is crucial in the prevention of Alzheimer's disease. Although the DASH diet has been promoted for this purpose, there is insufficient scientific evidence to support the application of the DASH diet on an individual basis to prevent Alzheimer's disease.

Therefore, it is recommended to adopt a holistic approach that combines the Mediterranean diet with complementary practices such as mindfulness, physical activity, among others.

Regarding the MIND diet, significant improvements in global cognition are shown compared to a similar control diet, although benefits may vary depending on certain factors. Studies highlight the relevance of diet as a viable strategy to prevent Alzheimer's disease, combining the benefits of the Mediterranean diet and the DASH diet.

This diet is composed of 10 food groups beneficial to the brain, rich in polyphenols and micronutrients such as vitamin E, folate, β-carotene, lutein- zeaxanthin and

flavonoids, which possess antioxidant, anti-inflammatory and neuroprotective properties. Vitamin E acts as an antioxidant protecting neurons from damage related to oxidative stress caused by free radicals.

In conclusion, the four diets investigated have been shown to offer significant benefits in the prevention of Alzheimer's disease. Although the MIND diet emerges as a promising strategy, combining the benefits of the Mediterranean and DASH diets.

Likewise, it is essential to adopt a holistic approach that combines this diet with other complementary interventions such as mindfulness and physical activity to promote long-term brain health and reduce the risk of cognitive decline and thus maximize the prevention of Alzheimer's disease.

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Knowledge of nutrition labelling and warning labels on foods included in school snacks by adolescents in an educational

Conocimiento del etiquetado nutricional y sellos de advertencia en alimentos incluidos en la merienda escolar por adolescentes de una institución educativa de asunción

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ABSTRACT

Food labeling and warning labels are the information presented on food products as a means of transmitting information to the consumer about nutritional value, ingredients and quality. The study evaluated the knowledge of nutritional labeling and labeling of packaged foods as a school snack option in adolescents aged 12 to 15 years in an educational institution in Asunción in 2023, through a descriptive observational study, with the application of a self-administered questionnaire to 69 schoolchildren, with an average age of 13 years. 88,4% of the students recognized the calorie information on the label, while 59,4% did not identify the information on dietary fiber. These data are similar to previous studies, where the calorie component of nutritional labeling is the data of greatest interest to the consumer and the dietary fiber content is the data of least interest. The school canteen was the place where the snack was purchased (66,77%), these data coincide with another previous study, where the school canteen or canteen is the main establishment providing food to students. 31,9% of students opted for packaged juices daily; This finding of type and frequency of packaged foods coincides with other studies, where schoolchildren show a preference for packaged fruit juice every day. In conclusion, the majority of students know the information on nutritional labeling and food labeling, although areas for improvement are identified for the identification of certain nutrients.

RESUMEN

Palabras clave:
etiquetado nutricional, rotulado de alimentos, adolescentes, conocimiento.

El etiquetado y sellos de advertencia en alimentos es la información presentada en los productos alimentarios como medio para transmitir información al consumidor sobre el valor nutricional, ingredientes y calidad.

El estudio evaluó el conocimiento del etiquetado nutricional y sello de advertencia de alimentos envasados como opción de merienda escolar en adolescentes de 12 a 15 años en una institución educativa de Asunción en el 2023, mediante un estudio observacional descriptivo, con la aplicación de un cuestionario autoadministrado a 69 escolares, con una media de edad de 13 años. El 88,4% de los estudiantes reconoció la información de calorías en el etiquetado, mientras que 59,4% no identificó la información sobre fibra alimentaria. Estos datos son similares a estudios previos, donde el componente caloría del etiquetado nutricional es el dato de mayor interés del consumidor y el contenido de fibra alimentaria el de menor interés. La cantina escolar fue el lugar de adquisición de la merienda (66,7%), estos datos coinciden con otro estudio previo, donde el comedor o cantina escolar, es el establecimiento principal proveedor de alimentos a los estudiantes. Un 31,9% de estudiantes optó por jugos envasados diariamente; este hallazgo de tipo y frecuencia de alimentos envasados coinciden con otros estudios, donde los escolares muestran preferencia por el jugo de frutas envasado todos los días. En conclusión, la mayoría de los estudiantes conoce la información del etiquetado nutricional y el sello de advertencia de los alimentos, aunque se identifican áreas de mejora para la identificación de ciertos nutrientes.

Introduction

In the context of food and nutrition education, human beings receive, from birth and throughout their lives, behavioral norms and positive or negative reinforcement, which are influential in making decisions, from food choices to food consumption. It is a pedagogical work, which allows us to become aware of the importance of human needs and leads us to revalue our own food culture. Therefore, food and nutrition education should be aimed at promoting good eating habits or modifying those eating habits, involving all members of the educational community; children, parents, teachers and administrators (1).

The nutritional concern in Latin American countries with malnutrition problems is manifested in the development of food policies and programs, as well as in educational strategies, to modify the prevalence of the two key poles: obesity and overweight, on the one hand, and malnutrition, on the other. This double burden of undernutrition throughout the life course affects individuals, households and peoples in the present and in the future, given the development of these prevalences, whose nutritional situation in Latin America is pressing (2). Therefore, Latin America and the Caribbean face innumerable challenges, one of which is the phenomenon of nutritional transition, characterized by the coexistence of chronic malnutrition (anemia and short stature) together with obesity and overweight, which are linked to the high number of chronic noncommunicable diseases (3).

In some countries, such as Brazil, Argentina and Colombia, specific pedagogical strategies are being developed that include food and nutrition education, seeking to strengthen eating habits in order to achieve comprehensiveness, diversity and access to a healthy diet. For this, it is necessary to modify the way in which school actors relate to the knowledge of families and their own, for its integration into the dynamics of daily school work (4).

Currently in Paraguay, childhood obesity and overweight constitute an emerging public health problem that requires a health promotion intervention from a preventive perspective in terms of healthy eating habits, in order to reduce morbidity and mortality due to chronic non-communicable diseases such as hypertension, type 2 diabetes, heart disease, among others (3). Some healthy behaviors during adolescence make it possible to counteract those health problems in adulthood. In childhood it is essential, since this is the stage of optimal development and growth, as well as biopsychosocial maturation, which is why it is necessary for children/adolescents to consume nutritious and healthy food. Irregular consumption of meal intervals, which has been evidenced as a consequence of unhealthy eating styles in adolescents, is also a consequence of the metabolic syndrome in adulthood. Fruits and vegetables are fundamental components of a healthy diet. Most chronic diseases were attributed in 2010 to the relationship with unhealthy eating, mainly low consumption of fruits and vegetables, and excess sodium, alcohol and physical inactivity (5).

The World Health Organization mentions that nutritional diseases due to excess can be identified through nutritional diagnosis, using the body mass index (BMI), whose formula is a division between weight (in kilograms) and height (in meters squared), this estimate can affirm the presence of overweight (BMI ≥ 25) or obesity (BMI ≥ 30) (3).

In Paraguay, the National Action Plan for the Prevention and Control of Chronic Noncommunicable Diseases 2014-2024 is underway, contemplating strategies for the prevention and monitoring of NCDs, and the accompaniment of the Paraguayan Dietary Guidelines, with recommendations to promote healthy and balanced diets for families; in

addition, the School Feeding Program has been implemented, seeking adequate food, which benefits the development of schoolchildren (6).

The latest data from Paraguay's second National Survey of Noncommunicable Diseases 2022 revealed that the prevalence of overweight and obesity among children and adolescents aged 5 to 19 years was 34% in 2016, up from 13% in 1975. In other words, both the prevalence of overweight and obesity increased significantly in all age categories (7). According to the report of the National Food and Nutrition Institute (INAN) 2022, within the Food and Nutrition Surveillance System (SISVAN), the malnutrition situation is low in schoolchildren (1.5%) and overweight presents worrying figures. Overweight and obesity were 21.1% (n=2755) and 13.0% (n=1694), respectively, which together would correspond to 1/3 of the population of overweight students (34.1%) (8).

The high prevalence of Chronic Non-Communicable Diseases (NCDs) is a global and national public health problem, the causes of which are multifactorial and associated with unhealthy lifestyles. Industrialized foods are high in simple sugars, saturated fats, trans fats, sodium and low in protein, healthy fats and fiber, so their excessive consumption predisposes to the appearance of these diseases (7).

Paraguay is characterized by a significant epidemiological transition in the area of nutritional disorders. In this sense, the coexistence of diseases due to nutritional deficit, such as malnutrition and micronutrient deficiencies, and excess, including obesity and diseases related to overweight, can be observed. This situation reflects a double burden of disease, where public health conditions must simultaneously address problems of malnutrition and overnutrition. Research has shown that the development of cardiovascular disease, especially coronary heart disease, begins in childhood. This early onset is closely linked to the same risk factors identified in adults: sedentary lifestyle, which limits the physical activity necessary for healthy development; obesity, which results from an inadequate diet and lack of exercise; high blood pressure, which can begin to manifest itself in childhood; dyslipidemia, which involves abnormal blood lipid levels; and family history, which genetically predisposes individuals to develop these conditions. This epidemiological context highlights the need to implement public health strategies that focus on both prevention and treatment of these diseases from an early age, promoting healthy lifestyle habits and managing risk factors from childhood (9, 10).

Therefore, it was essential to regulate the canteen service in the country's official and private educational institutions, since this is a service that should provide nutritious and healthy food to the educational community during different times of the day, so the Ministry of Education and Science (MEC) drafted Resolution No. 12774/03, dated September 26, 2003 (11). The School Feeding Program of Paraguay (PAEP) is currently in force. Its purpose is to contribute to the formation of a healthy lifestyle, through education and the incorporation of appropriate habits, by means of the development and promotion of food and nutrition education. The document establishes a list of permitted foods, among which are: fruits, milk and derivatives, fruit salad, cereal bars, cereals without sugar, crackers, cracker-type crackers, and sweet cookies without filling, peanuts and other types of nuts, fruit or vegetable juice, traditional milk-based desserts (Rice pudding, cream, pudding, candial, mazamorra), muffins, milk-based ice cream, chipa and chipitas, gelatins, pies (Fugazza, vegetable pies, pascualinas), pororó, hard-boiled egg, pizzas, fruit pies and tarts, vegetable, cheese, ham and cheese sandwiches, baked empanadas, foods prepared with vegetables, mineral water. In addition, there is a list of foods that are not allowed: packaged products with high salt or sugar content, very sugary or carbonated beverages are not allowed because of their high caloric content, since they favor the appearance of overweight or obesity and predispose to the appearance of Chronic Non-Communicable Diseases - NCDs (4).

Food nutrition labeling provides consumers with information on the content and type of nutrients to facilitate appropriate selection according to their needs or health conditions. At the regional level, there are several studies on the subject, although the results are divergent; today the format or presentation that is simpler and easier to interpret by the consumer is being debated, and the figure of front-of-food labeling is gaining relevance (12).

Ten countries in Latin America and the Caribbean have enacted ENPFE legislation or regulations. Five countries have implemented frontal nutrition warnings in the form of black octagons (Argentina, Chile, Mexico, Peru, Uruguay) and two countries have enacted regulations that are in the process of implementing similar systems (Colombia and the Bolivarian Republic of Venezuela). Ecuador uses a traffic-light warning seal that is not necessarily located on the main panel of the package; Brazil will implement a model with black rectangles and a magnifying glass; and the Plurinational State of Bolivia approved the adoption of a traffic-light ENPFE, which has not yet been implemented (13).

In Paraguay, Law No. 7092/23 on Frontal Warning Labeling of packaged foods has been enacted with the purpose of establishing mandatory frontal warning labeling on processed and packaged foods marketed in the national territory in the absence of the consumer, according to their nutritional composition of sugars, saturated fats and sodium. The scope of this law emphasizes that packaged foods in whose final composition the critical nutrient content of sugars, saturated fats and sodium exceeds the values established by regulation in accordance with this law, must include indelible warning seals for each critical nutrient, as appropriate, on the main surface of the product package and of the multiple or collective package: "HIGH IN SUGARS"; "HIGH IN SATURATED FAT"; "HIGH IN SODIUM". The enforcement authority is the Ministry of Public Health and Social Welfare. The characteristics of the front warning labeling:

a) Seal in the form of a black magnifying glass, white background, and in its interior the text in capital letters "HIGH IN SUGARS"; "HIGH IN SATURATED FATS"; "HIGH IN SODIUM"; and whose size will be established in the regulation of the present law, according to the characteristics of the container and the size of the main exhibition surface of the same, being able to apply the requirements of this law, through a complementary label;

b) It may not be partially or totally covered by any other element;

c) It shall be indelible and shall be written in Spanish.

The following terms are defined in the Law:

a) Sugars: are all monosaccharides and disaccharides present in a food that are digested, absorbed and metabolized by humans. Polyols are not included.

b) Consumer: natural persons who purchase or receive food in order to satisfy their food and nutritional needs.

c) Saturated fats: triglycerides containing fatty acids without double bonds, expressed as free fatty acids.

d) Critical nutrients: are those for which there is convincing or probable scientific evidence associating their excessive consumption with the development of non-communicable diseases, such as sodium, sugars and saturated fats.

e) Nutrient profiling: is the classification or categorization of foods according to their nutritional composition for reasons related to disease prevention or health promotion.

f) Front-of-package nutrition labeling: is the simplified declaration of specific nutrients on the front side of the standardized food package, provided with symbols and texts (14).

As part of the harmonization of front-of-food nutritional labeling in Mercosur, the National Institute of Food and Nutrition (INAN), under the Ministry of Public Health, conducted a survey in September 2021, to compare the preference between two models of front-of-food labeling (black octagon and magnifying glass). A total of 841 adults from all over the country participated in the online survey. The model with the black octagon was the most valued, with 71% of choice; while the version with the magnifying glass format obtained the remaining 29% of preference or approval. This front nutritional labeling shows the consumer in a graphic and simple way, such as sugar, sodium and fat levels, being a strategy in force for the fight against obesity and chronic non-communicable diseases of nutritional origin (15).

These strategies are aimed at combating obesity and chronic non-communicable diseases of nutritional origin. In the article Cardiovascular risk factors in schoolchildren and adolescents in a rural community of Amambay, Paraguay, we sought to determine the cardiovascular risk factors in children and adolescents attending two public schools in a rural community of Bella Vista Norte, and found a low prevalence of cardiovascular risk factors related to dyslipidemias. A high prevalence of cardiovascular risk factors related to sedentary lifestyle, passive smoking and low consumption of vegetables and fruits was found (9).

Data from SISVAN 2022 in Paraguay reflected data from the school population, according to age range, between 10 and 15 years of age represented the group with the highest prevalence of overweight and obesity, 23.6% and 14.6%, respectively (8).

When purchasing food at the canteen, schoolchildren are far from adult supervision to help them make their choices. The final decision is the schoolchild's, influenced by factors such as social trends, the media, peer pressure and the presence or absence of disease. The affordable price of processed or ultra-processed products often ends up being convenient, so the industry has also been busy introducing and offering visually appealing, low-cost, easy-to-buy and easy-to-consume treats (2).

For this reason, it is important to provide them with nutritional education and follow up on their food choices, since school children spend many hours of the day in educational institutions, where, in addition to acquiring academic/school training, it is an environment conducive to the development of eating habits for life.

It is considered relevant to evaluate the knowledge of nutritional labeling and labeling of packaged foods as a school snack option in adolescents aged 12 to 15 years who attend a subsidized educational institution in Asuncion in the 2023 school year, applying a self-administered questionnaire with an electronic Google form, the researcher prepared the questionnaire for the study, including sociodemographic data and data on knowledge and practices in reading the labeling and labeling of packaged foods, place of purchase, frequency and type of food preferred by adolescents as a school snack option. From the review conducted, the empowerment of the schoolchild, parental responsibility, the food industry and the protection of the state are proposed as bioethical considerations to be taken into account.

In this way, this research aims to show the imperative need to accompany the implementation of public health measures from an early age. These measures should not only focus on disease prevention and treatment, but also on the promotion of healthy habits and behaviors that can last a lifetime. By establishing healthy behavior patterns from childhood, we seek to positively influence health and well-being during adulthood, thereby reducing the incidence of chronic diseases and improving the quality of life of the general population.

Method

Type and design of research

Cross-sectional descriptive observational study.

Population

Target population: adolescents of both sexes aged 12 to 15 years.

Accessed population: adolescents of both sexes aged 12 to 15 years who attended a subsidized educational institution in Asunción during the 2023 school year.

Inclusion criteria: Adolescents of both sexes aged 12 to 15 years who attended a subsidized educational institution in Asunción a subsidized educational institution in Asunción during the school year 2023, and had the consent of their parents or legal guardians.

Exclusion criteria: adolescents who did not give their consent or were absent on the day of data collection.

Sample

Non-probabilistic simple random sampling.

Sample size considering that the total number of students enrolled for the year 2023 from seventh to ninth grade in the selected school was 130 students, this total was included to carry out the research work and it was not necessary to calculate the sample size, since it was considered a small amount.

A total of 69 adolescents of both sexes aged 12 to 15 years who attended a subsidized educational institution in Asunción during the 2023 school year participated in the study a subsidized educational institution in Asuncion during the 2023 school year, who met the selection criteria who met the following selection criteria.

Recruitment for the study was carried out among schoolchildren aged 12 to 15 years who attended a subsidized educational institution in Asunción during the 2023 school year, with the prior institutional permission of the institution's authorities, and whose parents or legal guardians gave their informed consent to participate.

Data were collected from schoolchildren if, at the time of data collection, they gave verbal assent. The informed consent form included the objectives of the study and the study methodology.

Data collection instrument and technique

The data were collected through a self-administered questionnaire using a Google® Forms electronic form, developed by the author of the research to achieve the objectives, including demographic data, and data on knowledge and practices regarding food labeling and labeling reading habits, as well as food purchasing habits for school snacks. The questionnaire had the following 3 sections, section 1: questions on demographic aspects (age and grade), section 2: questions on food labeling and labeling reading habits, section 3: questions on type and frequency of food purchases for school snacks.

Validation of the instrument

A test of the instrument was developed for a group of master's degree nutrition students familiar with the research topic to assess whether the questions successfully captured the research variables and then the terminology was adjusted to facilitate the students' understanding of the instrument.

Data processing

The data were downloaded through the Excel®™ spreadsheet and then analyzed through SPSS® version 22 software for statistical processing.

Quantitative data are presented as mean and standard deviation. Qualitative variables are expressed as absolute frequency (n) and relative frequency as a percentage (%).

Data quality control

The data were collected electronically from a Google Forms® electronic form, which ensured that the data were recorded, since the survey setup provided for the marking of fields with mandatory responses before progressing through each section of the electronic survey. Likewise, when downloaded into an Excel® 2016 spreadsheet and subsequently the database analyzed in SPSS® version 22, it guaranteed the non-modification of the data originally captured.

Ethical considerations

Data collection through the digital survey was carried out with the prior consent of the educational institution for the use of the data contained therein. The ethical aspects according to the Declaration of Helsinki were respected.

No personal data of the participants were recorded in the database used for statistical processing of the data, thus respecting confidentiality and protecting the privacy of identity and other binding personal information.

Each participant had the possibility of freely withdrawing from the survey and leaving it at any time without this having any repercussions in the school area, in terms of scores or final grades in the subjects taken at his or her school level.

In compliance with the principle of beneficence, the institution will receive a report with the results obtained from the students who were part of the investigation, once the investigation is finished.

It was ensured that participants were treated without discrimination, regardless of gender, age, race and others.

Results

Sociodemographic characteristics of the sample.

The present study involved 69 schoolchildren who attended a subsidized educational institution in Asunción during the 2023 school year, with an average age of

13 ±0.73 years, most of them female (n=37.54%), most of them belonging to the 8th grade (n=48.70%). Table 1.

Tabla 1. Características sociodemográficas de los escolares (n=69).

Variable	n	%
Edad (años)		
12	6	8,7
13	30	43,5
14	29	42,0
15	4	5,8
Sexo		
Femenino	37	53,6
Masculino	32	46,4
Nivel educativo		
Séptimo grado	14	20,3
Octavo grado	48	69,6
Noveno grado	7	10,1
Total	**69**	**100**

Knowledge of nutritional labeling and labeling of packaged foods for decision making at the time of purchase of a food for school snacks by adolescents.

When evaluating the knowledge of the nutritional labeling information on each of its components, it was found that 61 (88.4%) of the schoolchildren reported knowing this information about the calories provided by the product, while 41 (59.4%) students reported that they did not identify this information about dietary fiber. Figure 1.

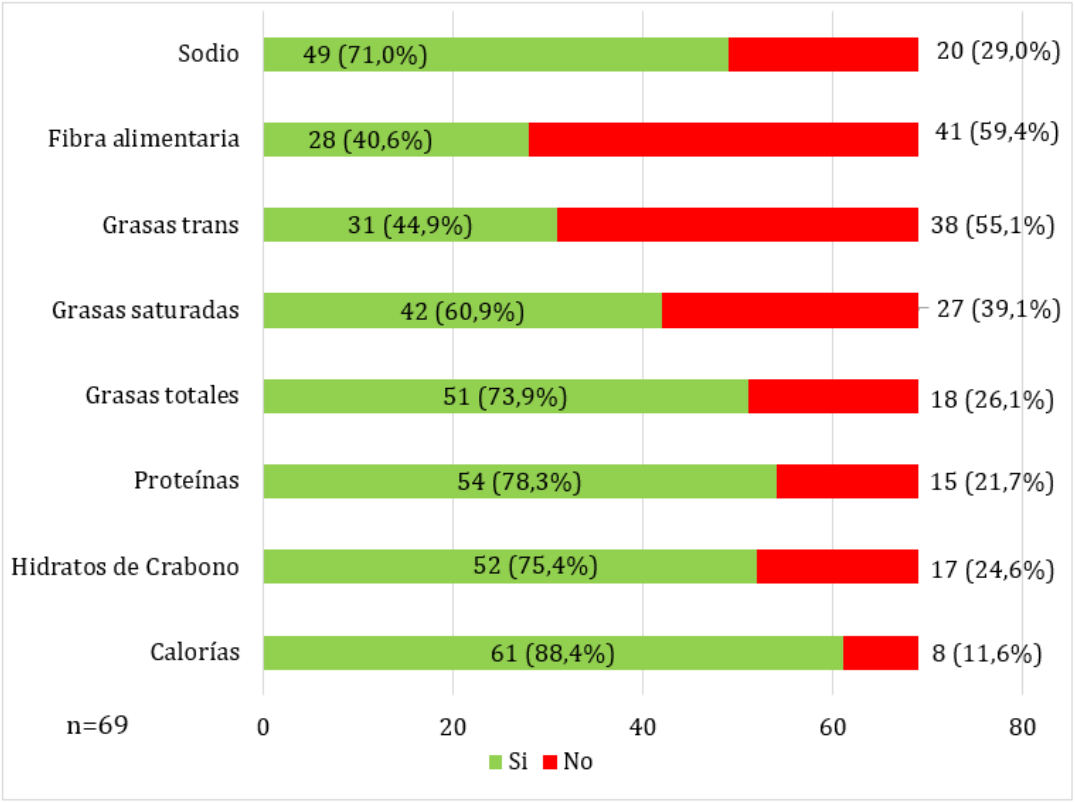

Figura 1. Conocimiento de la información del etiquetado nutricional en los productos envasados por los escolares de la muestra (n=69).

In relation to the icons on the food labeling when evaluating the knowledge of the information on the food components, it was found that 56 (81.2%) students in the sample reported knowing the information icon on the excess sugars provided by the product, while 47 (68.1%) students reported knowing the information icon on the excess sodium provided by the product. Figure 2.

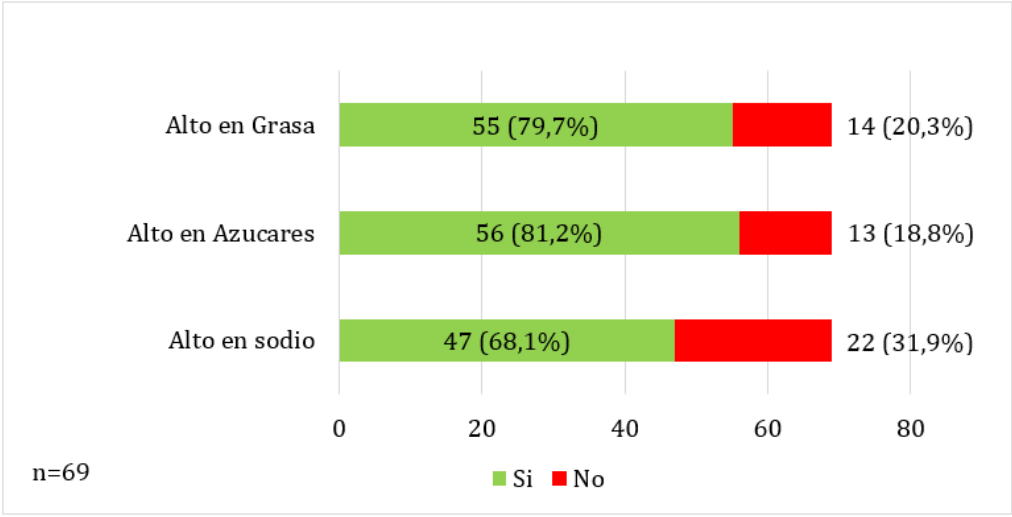

Figure 2. Knowledge of the information on the labeling of packaged school snack foods by schoolchildren in the sample (n=69).

Place of acquisition of school snack by the sampled students.

When evaluating the place the place of purchase of school snacks, it was found that 46 (66.7%) students bought food at the school canteen, while the rest of the students reported bringing their school snacks from home. Figure 3.

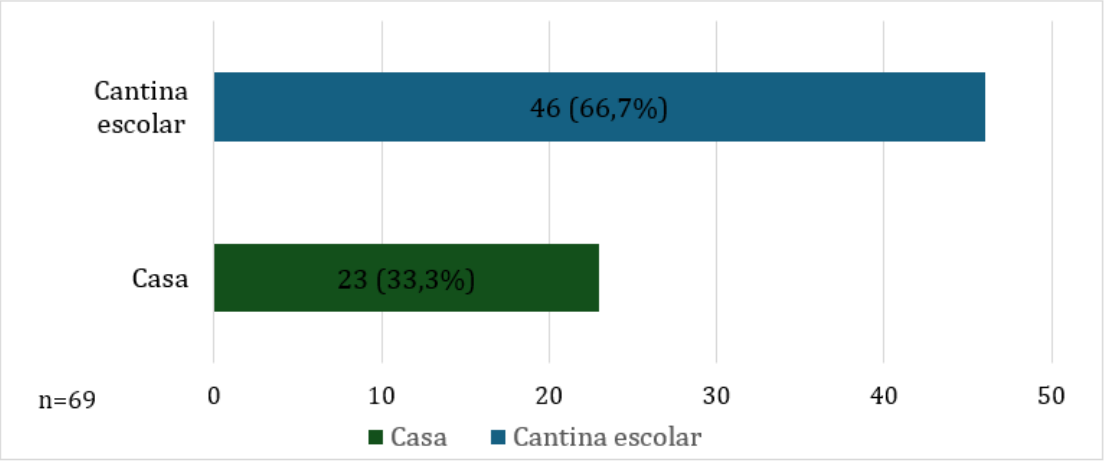

Figure 3. Place of acquisition of school snack by students in the sample (n=69).

Type and frequency of food purchases for school snack by students in the sample.

In the present study, in which 69 schoolchildren participated, it was observed that 22 (31.9%) schoolchildren consumed packaged juices every day, most of the schoolchildren 49 (71.0%) said they did not consume snacks (yes-yes) and 42 (60.9%) consumed sugary cereals as a school snack option. Table 2.

Tabla 2. Tipo y frecuencia de compra de alimentos para la merienda escolar por los estudiantes de la muestra (n=69).

Variable	Frecuencia de compra y consumo (n=69)				
Alimentos	Todos los días n (%)	Tres veces por semana n (%)	Dos veces por semana n (%)	Nunca n (%)	Total de escolares
Galletitas dulces	9(13,1%)	10(14,5%)	25(36,2%)	25(36,2%)	69
Galletitas saladas	3(4,4%)	8(11,6%)	23(33,3%)	35(50,7%)	69
Yogurt	5(7,2%)	11(16,0%)	16(23,2%)	37(53,6%)	69
Chocolatada	4(5,8%)	11(16,0%)	17(24,6%)	37(53,6%)	69
Gaseosa	18(26,1%)	14(20,3%)	24(34,8%)	13(18,8%)	69
Jugo envasado	22(31,9%)	14(20,2%)	22(31,9%)	11(16,0%)	69
Chocolate en barra	3(4,4%)	7(10,1%)	20(29,0%)	39(56,5%)	69
Yes-yes	2(2,9%)	3(4,4%)	15(21,7%)	49(71,0%)	69
Papas fritas	3(4,4%)	10(14,5%)	27(39,1%)	29(42,0%)	69
Cereales azucarados	4(5,8%)	5(7,2%)	18(26,1%)	42(60,9%)	69
Otros (empanada, hamburguesa, pizza, sándwich)	26(37,7%)	16(23,2%)	14(20,3%)	13(18,8%)	69

Discussion and conclusions

The school population of a subsidized educational institution in Asunción that participated in the study was 69 students, where the average age was 13 ±0.73 years, most of the students in the total sample were female (n=37;53.6%), mostly in the 8th grade (n=48;69.6%). These data are similar to those of the study: Reading, interpretation and use of nutrition labeling in the purchase decision of adults in a neighborhood of Asunción, where the total sample consisted of 100 respondents, most of whom were women (63%) the total sample consisted of 100 respondents, the majority of whom were women (63%), however, the difference is the adult population, with an average age of 34.6±13 years with an average age of 34.6±13 years old compared to this research, which is based only on schoolchildren (16) school children (16).

When evaluating the knowledge of the nutritional labeling information on each of its components, it was found that 61 (88.4%) of the schoolchildren reported recognizing this information regarding the calories provided by the product, while 41 (59.4%) students reported that they did not identify this information regarding dietary fiber. In other research: in the study "Knowledge of the adult population about food nutrition labeling", 44% of those studied identified the calorie component in the nutrition labeling information (17). Another finding that correlates with the results of this research is found in: "Reading, interpretation and use of nutrition labeling in the purchase decision of adults in a neighborhood of Asunción", the greatest interest of the participants was the information regarding the following components of nutrition labeling in decreasing order: calories, total fat, sodium, protein, carbohydrates and type of fat, and, finally, dietary fiber (1); similar to what was verified in the present study where the majority recognized in the labeling the information corresponding to calories, macronutrients and sodium, and in less frequency the information regarding trans fats and dietary fiber.

When assessing the place of purchase of school snacks, it was found that 46 (66.7%) students bought food at the school canteen, while the rest of the students reported bringing their school snacks from home. In "Alimentación escolar y educación alimentaria: tendencias recientes en la investigación en América Latina entre 2005 y 2021" (School feeding and food education: recent trends in research in Latin America between 2005 and 2021), the school canteen is referred to as the establishment of most of the food where quality nutrients are provided, and even more time in school (double schooling of students, for example), therefore, the canteen is the protective establishment of the nutritional status of children (2). A limitation of the present study is that it did not evaluate fruit consumption in schoolchildren.

In the present study, we evaluated the type and frequency of packaged foods as an option for school snacks. We observed that 22 (31.9%) schoolchildren consumed packaged juices every day, most of the schoolchildren 49 (71.0%) said they did not consume snacks (yes-yes) and 42 (60.9%) consumed sugary cereals as an option for school snacks. These findings relate to the study: "Food consumption habits of primary school children in two schools in Havana", where schoolchildren show preference for bottled fruit juice in 75 students (75%) (18). That is to say, depending on what the canteens offer students as snack options, they will be the options available to them, often even options without nutritional labeling and front labeling, with the absence of healthy food options, so it will be difficult to improve the eating habits of schoolchildren and the levels of obesity and overweight, if these measures are not properly controlled.

One limitation of this study is that it is a cross-sectional study, in terms of possible information bias. Another limitation is that the study was conducted in only one

educational institution with a sample size of 69 students. Nor does it address teachers, parents or guardians

The persistence of obesity rates, according to the latest SISVAN data, is striking, which is why the role of nutritional education in schoolchildren is considered important [8].

In Paraguay, health promotion educational campaigns are currently being promoted on nutritional labeling and the different product models in the region, with front labeling as a strategy to prevent and control overweight and obesity in schoolchildren, given the positive experiences in other countries in the region.

Conclusions

The school population studied, 69 students from the Subsidized Educational Institution of Asunción, was mostly female, with an average age of 13 ± 0.73 years, most of them belonging to the eighth grade.

The main place of food acquisition has been the school canteen.

Adolescents are aware of the nutritional labeling of packaged foods when selecting school snacks, distinguishing calories as the main component, while in relation to data on dietary fiber information, students reported that they did not identify this information.

In relation to the icons on food labeling, adolescents reported knowing the components of the food, mainly distinguishing the information on the excess sugars provided by the product.

This research shows that knowledge of nutritional labeling and food labeling is frequent, however, despite this familiarity with the nutritional information present on packaged products, it does not seem to significantly influence their decisions at the time of acquiring their school snack. This suggests that, although students may identify components such as calories, sugars, and fiber, this information is not the primary factor guiding their food choices during school recess. This finding underscores the need to implement more effective educational strategies that not only inform about nutrition, but also motivate students to apply this knowledge in a practical way in their daily food consumption decisions in the school environment.

Recommendations

It is considered relevant to carry out actions focused on at-risk groups, relating the socioeconomic level and associating it with a nutritional diagnosis, in order to define the relationship between nutritional status and the selection of foods for school snacks and, in turn, to follow up on other meals eaten by schoolchildren at home during the day, in order to determine in future research the average daily consumption of packaged foods versus fresh processed foods.

The reading of nutritional labeling and labeling of packaged foods occurs frequently in school children, but not their correct interpretation, even when selecting other processed foods as a school snack option, they choose very copious foods, high in fat, so it is important to establish nutritional education strategies that facilitate the interpretation of the components of the front labeling.

It is important to have a nutritionist in each educational institution to be able to carry out follow-up, nutrition education and health promotion tasks in conjunction with INAN.

Conflicts of interest

We declare that the work submitted for publication in the MLS Health & Nutrition Research Journal is original and has not been and is not currently under review by any journal or conference. Likewise, we are responsible for the content of this and I agree that our names appear as the author. Finally, we declare that we do not have any conflict of interest in those activities that could introduce bias in the results of the work.

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Effect of a Nutritional-Educational Intervention with a Mexicanized Mediterranean Diet (DMM) on the Anthropometry and Biochemistry of Overweight and Obese Adults in Mexico

Efecto de una intervención nutricia-educativa con dieta mediterránea mexicanizada (DMM) en la antropometría y bioquímica de adultos con sobrepeso y obesidad en México

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ABSTRACT

Mexico has high rates of obesity and overweight, associated with chronic non-communicable diseases. The Mediterranean diet (MD) has been shown to be useful in combating cardiovascular diseases, obesity, diabetes and metabolic syndrome; it is adaptable to Mexico since it can use local foods with a nutritional density similar to those of the Mediterranean. The objective of the study was to evaluate the effect of a nutritional-educational intervention with the Mexicanized Mediterranean Diet (MMD) through anthropometry, glucose, lipids, insulin and interleukin 6 in overweight or obese adults in Mexico. A longitudinal, prospective 6-week study. The MMD intervention group involved 16 subjects and the control group with a regular diet involved 13. All received nutritional education. Anthropometric measurements and blood tests were taken. In the group treated with DMM, weight and BMI decreased in 75% of participants, 62.50% reduced body fat percentage, 37.50% visceral fat, waist-to-height (W/H) ratio in 32%, waist-to-hip (W/H) ratio and waist circumference in 25%. Glycemia

decreased in 12.5%, insulin and HOMA decreased in 62.5%, glycated hemoglobin in 43.5%, triacylglycerols, cholesterol and LDL in 68.75%, VLDL in 62.5%, atherogenic index in 75%, IL-6 in 100%, HDL increased in 50%. Adherence to DMM improved with education. The Mixed Effects Model Analysis Test and the Fisher LSD Test were used to perform multiple comparisons between groups after finding a significant difference. The intervention with MMD had an effect on the reduction of weight and anthropometric-biochemical parameters in the population, reaffirming the effects of MMD evidenced in the scientific literature.

RESUMEN

Palabras clave:
Dieta mediterránea mexicanizada, sobrepeso, obesidad

México presenta elevadas tasas de obesidad y sobrepeso, asociadas con enfermedades crónicas no transmisibles. La dieta mediterránea (DM) ha demostrado ser útil para combatir enfermedades cardiovasculares, obesidad, diabetes y síndrome metabólico; es adaptable a México ya que puede emplear alimentos locales con densidad nutricional similar a los mediterráneos. El objetivo del estudio fue evaluar el efecto de una intervención nutricia-educativa con Dieta Mediterránea Mexicanizada (DMM) a través de la antropometría, glucosa, lípidos, insulina e interleucina 6 en adultos con sobrepeso u obesidad de México. Estudio longitudinal, prospectivo de 6 semanas. El Grupo intervenido con DMM involucró a 16 sujetos y el grupo control con dieta habitual a 13. Todos recibieron educación nutricional. Se tomaron medidas antropométricas y exámenes de sangre. En el grupo intervenido con DMM, el peso y el IMC disminuyeron en 75% de los participantes, el 62.50 % redujo porcentaje de grasa corporal, el 37.50 % de grasa visceral, el índice cintura-talla (C/T) en el 32%, el índice-cintura/cadera (C/C) y la circunferencia de cintura en el 25 %. La glucemia disminuyó en el 12.5 %, insulina y HOMA disminuyeron en el 62.5 %, la Hemoglobina glucosilada en el 43.5%, los triacilgliceroles, colesterol y LDL en el 68.75%, VLDL en el 62.5 %, el índice aterogénico en el 75%, IL-6 en el 100 %, la HDL se incrementó en el 50%. La adherencia a la DMM mejoró con la educación. Se utilizó la Prueba de Análisis de modelos de efectos mixtos y la Prueba de Fisher LSD para realizar comparaciones múltiples entre grupos con diferencia significativa. La intervención con DMM tuvo efecto en la reducción del peso y de los parámetros antropométricos-bioquímicos en la población reafirmando los efectos de la DM evidenciados en la literatura científica.

Introduction

The worldwide prevalence of obesity has tripled in the last 40 years (1). Mexico has the highest rates of obesity and overweight in the world (2). In Mexico, 33% of school-age children, 35% of adolescents and more than 75% of adults experience obesity or overweight (3)(4), which are associated with the development of chronic noncommunicable diseases. The positive imbalance in energy consumption is the main cause. There is a higher energy intake and a decrease in energy expenditure, leading to fat accumulation. Diet determines body weight gain and at the same time is a tool in the prevention, management and treatment of these disorders (1). Health and nutrition surveys conducted in Mexico have shown that the food quality of the Mexican population is not adequate and that a large part of the population does not comply with the dietary recommendations. There is an excessive consumption of added sugars and saturated fats, low intake of fruits, vegetables, legumes or seafood and nuts (4). Throughout history, diet has played a crucial role in sustaining human life. It encompasses the consumption of common foods and specific groups of people and is closely related to cultural practices, lifestyle and food availability (5). Each type of diet has different nutritional profiles, emphasizing specific groups, macronutrients and bioactive components that can exert various effects on aging processes and disease risk. Understanding the influence of various types of diet and related diseases can serve as a basis for personalized dietary recommendations and lifestyle interventions aimed at promoting healthy aging and mitigating age-associated morbidities (5). Sustainable healthy diets promote a higher intake of plant-based foods and a lower intake of animal-based foods, and the Mediterranean diet (MD) is an excellent example (6). Recent studies show that a sustainable healthy diet based on the Mediterranean diet is associated with lower weight, body mass index (BMI), waist circumference, waist-to-hip ratio, trunk fat, total fat and lean mass (7) (8). Its richness consists of the nutritional contribution of the foods that constitute its base, the mono and polyunsaturated fatty acids, vitamins A, C and E, antioxidants and lycopenes that it contains. It is rich in vegetables, legumes and fruits, whole grains, olive oil, seeds and nuts, fish, low-fat dairy products and wine, accompanied by a low intake of red meat and sodium. Fresh vegetables are consumed in lightly cooked salads dressed with olive oil. The Mexicanized Mediterranean diet (DMM) arises as an adaptation of the DM to Mexico, which has points of contact with the milpa diet, as well as with the traditional Mediterranean diet. It promotes the consumption of very common and representative foods of Mexico such as corn, avocado, cocoa, legumes, almonds, chia, nopales, chayote, chard, watercress, zucchini, cilantro, jicama, peanuts, pepitas, pistachios, guava, tuna, zapote, corn, amaranth, oats, yucca, sweet potato, potato, rice and lentils, among others (9). It is a healthy eating pattern that combines products from the traditional Mediterranean diet with Mexican foods with similar nutritional properties. Evidence points to its richness in fiber, antioxidants, polyphenols such as resveratrol, beta-glucans and fructooligosaccharides (10).

The use of avocados stands out, as Mexico is the world's leading producer of avocados. They are rich in vitamins, minerals, fiber and phytochemicals. Avocado consumption has been associated with reduced risk of metabolic syndrome, cardiovascular disease, and overweight or obesity due to increased satiety and decreased appetite (11). It also provides a high percentage of fatty acids, approximately 15% of its weight, predominantly monounsaturated fatty acids such as oleic acid. It is proposed that the high concentrations of these monounsaturated fatty acids in avocados can improve the lipid profile, as well as reduce body weight in people with obesity (11) (12). Beta-

sitosterol, one of its bioactive components, regulates cholesterol levels and reduces the risk of atheroma plaque formation. They are rich in fiber, including soluble hemicelluloses and pectins, which are metabolized by intestinal microorganisms to produce short-chain fatty acids (12) (13). Furlan et al stated in their study that participants who consumed for 6 days a hyperlipidemic diet where butter was replaced by avocado oil improved the postprandial profile of insulin, glycemia, total cholesterol, low-density lipoproteins, triglycerides and inflammatory parameters, such as C-reactive protein and interleukin-6. In addition, they proposed that avocado pulp oil from Mexican variants has been shown to exhibit marked anti-inflammatory activity by inhibiting the Cox 1 and Cox 2 cyclooxygenase enzymes in a similar manner to ibuprofen (14). Ford et al. proposed that adding avocado to salsa improves the absorption of vitamin A, as well as lycopene and beta-carotene, while adding it to salad increases the absorption of alpha-carotene, beta-carotene and lutein. It helps to absorb beta-carotene from tomato sauce, carrots and improves the conversion of beta-carotene to vitamin A, as well as lutein and zeaxanthin which accumulate in the macula of the retina and correlate with lutein concentrations in the brain (12).

Cocoa is another outstanding component; it is a 100% Mexican food with a marked therapeutic aspect. Regular consumption of cocoa powder and/or dark chocolate has been associated with decreased anthropometric parameters in overweight and obese individuals such as body weight, body mass index and waist circumference (15). Natural cocoa has a regulating effect on glucose and insulin levels (9) (15). Due to the high level of polyphenols and derived products, it is a natural source of antioxidants in Latin American diets and contains the highest concentration of flavonoids. The advantages of its consumption include glycemic control, cardioprotective, anticarcinogenic, anti-inflammatory and antioxidant properties (15). Scientific evidence suggests that it reduces glucose levels and the risk of diabetes, increases nitric oxide, which regulates blood pressure and reduces hypertension. The presence of phenolic phytochemicals and flavonoids in cocoa beans provide protection at the cellular level against oxidative stress and free radical damage. It boosts mood and cognitive performance and delays aging (15). Chia seeds are a functional food that is present in this type of diet.It presents a high content of polyunsaturated fatty acids, mainly α-linolenic acid, which represents approximately 60% of all its fatty acids. They are considered the richest vegetable source of omega-3 fatty acids with anti-inflammatory, brain-enhancing, psychological and cholesterol-lowering properties (16)(17). Its ratio of omega-6 and omega-3 acids is correct. It is a vegetable protein source, being protein between 18 and 24% of its mass (16) (17). Research shows that chia seeds have a great nutritional profile and tremendous health-enhancing characteristics. It is reported to improve blood lipid levels, reduce blood pressure, blood glucose and also strengthens the immune system and has antimicrobial action. They have the ability to suppress the most common current chronic diseases and several types of cancer (17).

Nopal cactus is a cactus of Mexican origin, it is known for its high concentration of polyphenols that exhibit antioxidant and anti-inflammatory properties. It is considered a functional and prebiotic food; it is rich in soluble and insoluble fiber. It is used as an anti-ulcerogenic antiulcerogenic, antioxidant, antidiarrheal, anti-inflammatory, hypoglycemic, neuroprotective and antihypercholesterolemic. Its composition is very rich in ascorbic acid, vitamin E, carotenes, dietary fiber, amino acids and antioxidant compounds. It is widely used in traditional Mexican medicine (11). The consumption of nopal cactus lowers blood levels of glucose, total cholesterol, c-HDL and triglycerides in patients with obesity (18). The soluble fiber it contains is related to a decrease in glucose, cholesterol and triglyceride levels and an increase in c-HDL. This cactus has gallic acid in its flowers,

which exhibits high antioxidant activity, which collaborates in the reduction of DNA damage and elimination of radicals (18)

Nutritional education interventions have proven to be useful strategies to modify behaviors and habits in populations of any age. They are the complement for planning actions to prevent and control diseases related to overweight and obesity. Their characteristics, methods and forms of teaching must be tailored to the population group for which they have been designed, being similar in different geographical locations. The task is not simple; among the challenges to be overcome is to contribute to reducing health and food security problems in the populations, as well as to promote long-term behavioral change related to food. The objective of this study was to determine the effect of a nutritional-educational intervention combined with the Mexicanized Mediterranean Diet (MDM) on anthropometry and biochemistry in overweight and obese adults from northern Mexico. This study is one of the first to evaluate the effects of the Mexicanized Mediterranean Diet (MDD) on anthropometric and biochemical variables in overweight or obese adults in Mexico.

Method

The study consisted of a longitudinal and prospective nutritional-educational intervention with a 6-week follow-up. It was approved by the Ethics Committee of the Universidad Internacional Iberoamericana (UNINI) with registration CR-155 and complied with the guidelines of the Declaration of Helsinki. A total of 29 subjects participated and 2 groups were randomly formed. All of them signed the informed consent form. Group 1 intervened with DMM involved 16 subjects and Group 2 control with Habitual Diet 13 subjects. Inclusion criteria included being between 18 and 78 years of age, and having a body mass index (BMI) of overweight or obesity, having signed the informed consent form, having an approving attitude towards changing eating habits, willingness to adhere to the proposed dietary plan and attending the educational sessions. Both groups received the same nutritional education. Anthropometric measurements and blood determinations were performed at baseline and after 5 weeks of the intervention.

Collection of personal data:

An instrument was designed to carry out anamnesis and evaluate nutritional status, medical history, food allergies or intolerances, medication, and the use of mineral and vitamin supplements. The instrument was self-administered and included a food consumption frequency questionnaire, as well as the 24H reminder a nutrition knowledge assessment questionnaire and a questionnaire of adherence to the Mexicanized Mediterranean diet (DMM).

Anthropometry:

The Tanita Fitscan BC-533 body analyzer scale was used to determine current weight, fat percentage and visceral fat percentage. The Seca 213 stadiometer was used to determine height, using the validated technique for measuring height. Weight and height measurements were required to determine the Body Mass Index (BMI) which was analyzed by age and sex. A Body Flex Sana Flex anthropometric tape was used to determine wrist circumference, waist circumference and hip circumference in order to calculate the waist-to-hip ratio (WHR) and waist-to-height ratio (WHR).

Blood samples:

Determinations of 9 metabolites were made: glucose, insulin, glycosylated hemoglobin, LDL, HDL, VLDL, triacylglycerides, total cholesterol, Interleukin 6 in two measurements. The samples were processed at the Clinical Analysis Laboratory of the University of Monterrey, Nuevo Leon, Mexico.

Educational-nutritional intervention:

The educational intervention consisted of 2 face-to-face individual counseling sessions and 3 group counseling sessions. Individual counseling included explanation of the DMM meal plan and food combining, review of laboratory tests, as well as personal nutritional and anthropometric assessment. They were informed of the need to moderate the consumption of salt, simple sugars and saturated fats and were invited to make changes in their eating habits, with emphasis on reducing the consumption of ultra-processed foods and increasing the consumption of fiber and foods with high nutritional density.

Design and establishment of the Food Plan:

DMM's dietary plan included carbohydrates, lipids and proteins in adequate amounts to meet the requirements of the correct diet according to NOM-043 (4). It was designed according to the Mexican System of Equivalents (SMAE) on an individualized basis. In group 1 the proposed diet was hypocaloric, with a deficit of 500 kcal from the Total Energy Expenditure (TEE). Basal energy expenditure (BEE) was calculated according to the Harris Benedict equation for women and men. Calories were distributed 55 % carbohydrates, 20 % proteins and 25 % lipids (5). The fat used was olive oil for cold preparations and avocado oil for cooking. Regular consumption of vegetables (2 servings per day free quantity), fruits (3 servings/day), legumes (3 times/week), fish (3 times/week), red meats and sausages were reduced to occasional consumption (1 time/week). Four meal times were maintained to control insulin levels, with overnight fasting without consuming food from 10 to 12h. Components of the pre-Hispanic Mexican diet such as corn, beans, nopal, chia, avocado and cacao were included.

Statistical analysis:

Prism Graph Pad software version 9.5.1 of the year 2023 was used. The Shapiro-Wilk test was used to contrast the fit or not to the normal distribution. The variables analyzed showed a normal distribution. The level of statistical significance considered was $p=0.05$ and $p<0.05$. The mixed-effects model analysis test and the Fisher LSD were used to perform multiple comparisons between groups after finding the existence of significant difference.

Results

In group 1 consuming the DMM meal plan 75 % of the members decreased their weight and BMI after the intervention, 62.5 % reduced body fat percentage, 37.5 % visceral fat, waist/height ratio by 32 %, waist/hip ratio and waist circumference by 25 % as shown in Table 1.

Table 1. Percentage of participants with variations in anthropometric parameters after the intervention in group 1 and 2

Parameters	**Group 1** **DMM Intervention**	**Group 2** **Habitual Diet Control**
Weight	75%	46.15 %
BMI	75%	46.15 %
Waist circumference	25 %	46.15%
Waist-to-size ratio	32%	53.84%
Waist/hip ratio	25%	53.84 %
Percentage of fat	62.50 %	61.3 %
Visceral fat	37.50 %	23.07 %

Figure 1 shows the results of the Fisher LSD test for anthropometry, denoting the existence of statistically significant difference in 5 parameters which are: Weight, BMI, waist/height ratio, waist/hip ratio, waist circumference analyzed in the DMM Intervention group at measurement 1 (pre-intervention) and measurement 2 (post-intervention). This statistically significant difference indicates that the values are substantially different according to statistical tests, which means that the numbers are reliably different and that there was a noticeable change. Table 2 shows the p-values for all the parameters analyzed, demonstrating the existence of values of $p=0.05$ or $p<0.05$ for the aforementioned parameters in group 1, however, in group 2 no significant difference was found when comparing the parameters.

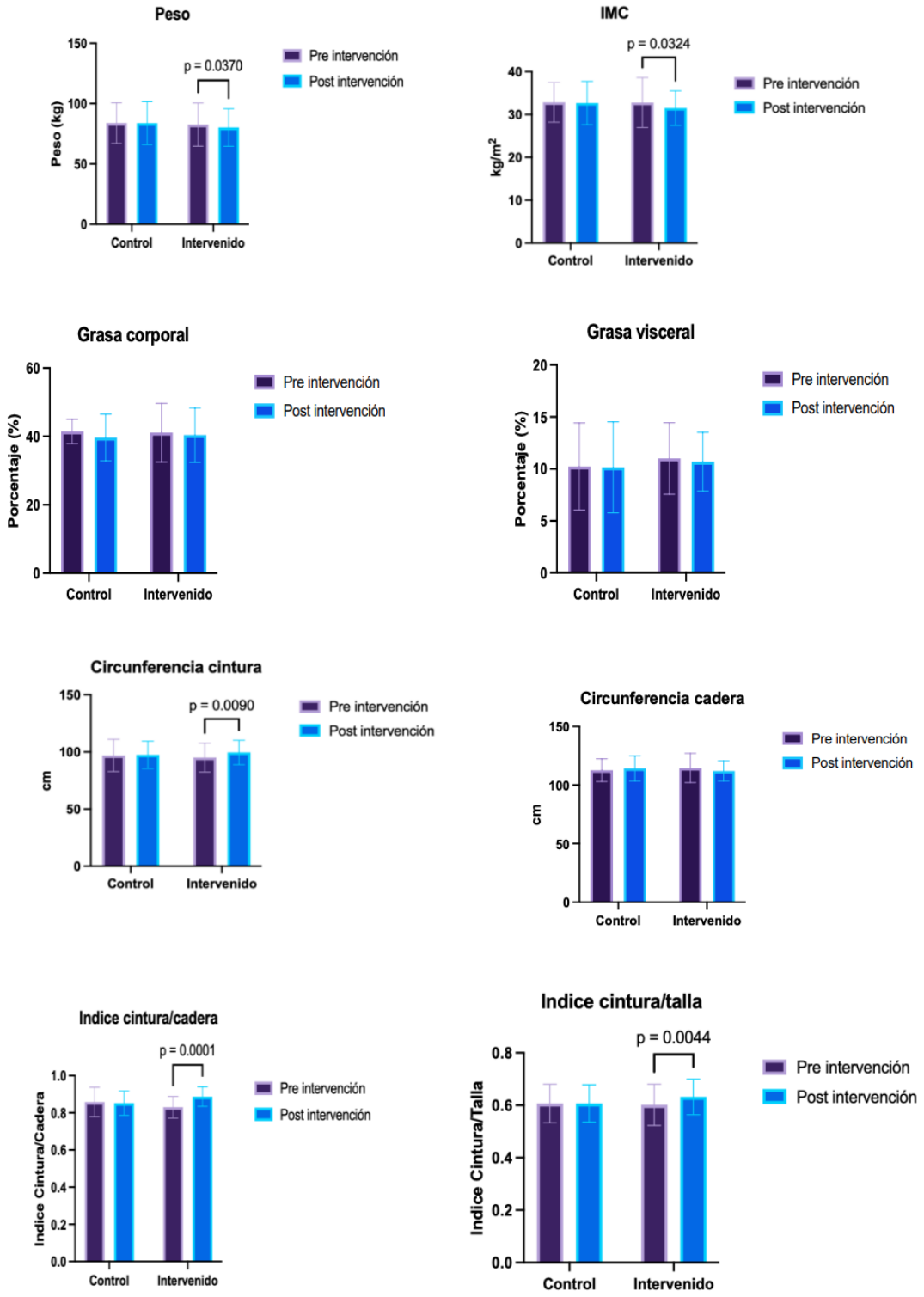

Figure 1. Comparison of anthropometric parameters (Weight, BMI, Body Fat, Visceral Fat, Waist Circumference, Hip Circumference, Waist/Hip Ratio and Waist/Height Ratio) between the control and intervention groups before and after the intervention

Table 2. P values obtained in the analysis of the anthropometric parameters of groups 1 and 2

Parameters	Group 1 Intervention DMM Pre and post intervention	Group 2- Usual Diet Control Pre and post intervention	Group 1 vs Group 2 Pre	Group 1 vs Group 2 Post
Weight	p=0.0370	p=0.921	p=0.8399	p=0.5742
BMI	p=0.0324	p=0.7945	p=0.9764	p=0.5326
Waist circumference	p=0.0090	p=0.7484	p=0.6937	p=0.6623
Hip circumference	p=0.0658	p= 0.2964	p=0.6439	p= 0.5763
Waist-to-size ratio	p=0.0044	p=0.9942.	p=0.8482	p=0.3649
Waist/hip ratio	p=0.0001	p=0.662	p=0.2281	p=0.0797
Body fat percentage	p=.0.5185	p=0.1379	p=0.8315	p=0.8231
Visceral fat	p=0.2788	p=0.8079	p=0.5824	p=0.7024

Table 3 shows the variations presented in the biochemical parameters before and after the intervention. In the DMM intervention group, glycemia decreased by 12.5 %, insulin and HOMA index by 62.5 %, glycosylated hemoglobin decreased by 43.5 %. Triacylglycerols and total cholesterol decreased in 68.75% of the population. As for lipoproteins, HDL increased in 50% of the interventional population, LDL decreased in 68.75% of the group, VLDL in 62.5%. The atherogenic index decreased by 75% and Interleukin 6 (IL-6) was reduced in 100% of this population.

Table. 3. Percentage of participants with variations in biochemical parameters after the intervention in group 1 and 2

Biochemical parameter	Group1 DMM Intervention	Group 2 Usual Diet Control
Blood glucose	12.5 %	30.76%
Insulin	62.5 %	61.53%
HOMA Index	62.5 %	53.84%
Glycosylated hemoglobin	43.5 %	15.38%
Triacylglycerides	68.75%	69.23%
Total cholesterol	68.75 %	46.15%
HDL	50% increased their values	69.23% increased their values
LDL	68.75%	53.84%
VLDL	62.50 %	69.23 %
Atherogenic Index	75%	76.92%
Interleukin 6	100 %	53.84%

Figure 2 shows the results of the Fisher LSD test for glucose, insulin, HOMA index, glycosylated hemoglobin, triglycerides, cholesterol in the control and intervention groups before and after the intervention. Figure 3 shows the comparison of the Fisher LSD test results for LDL, HDL, VLDL, atherogenic index, Interleukin 6 between the control and intervention groups before and after the intervention. Table 4 shows the p values for all the biochemical parameters analyzed, showing in group 1 the existence of a statistically

significant difference between the values of glycemia and interleukin 6; however, group 2 shows the existence of a statistically significant difference in the values of glycemia, HDL, atherogenic index and interleukin 6, demonstrating the positive effects of nutritional education even without being accompanied by a dietary plan.

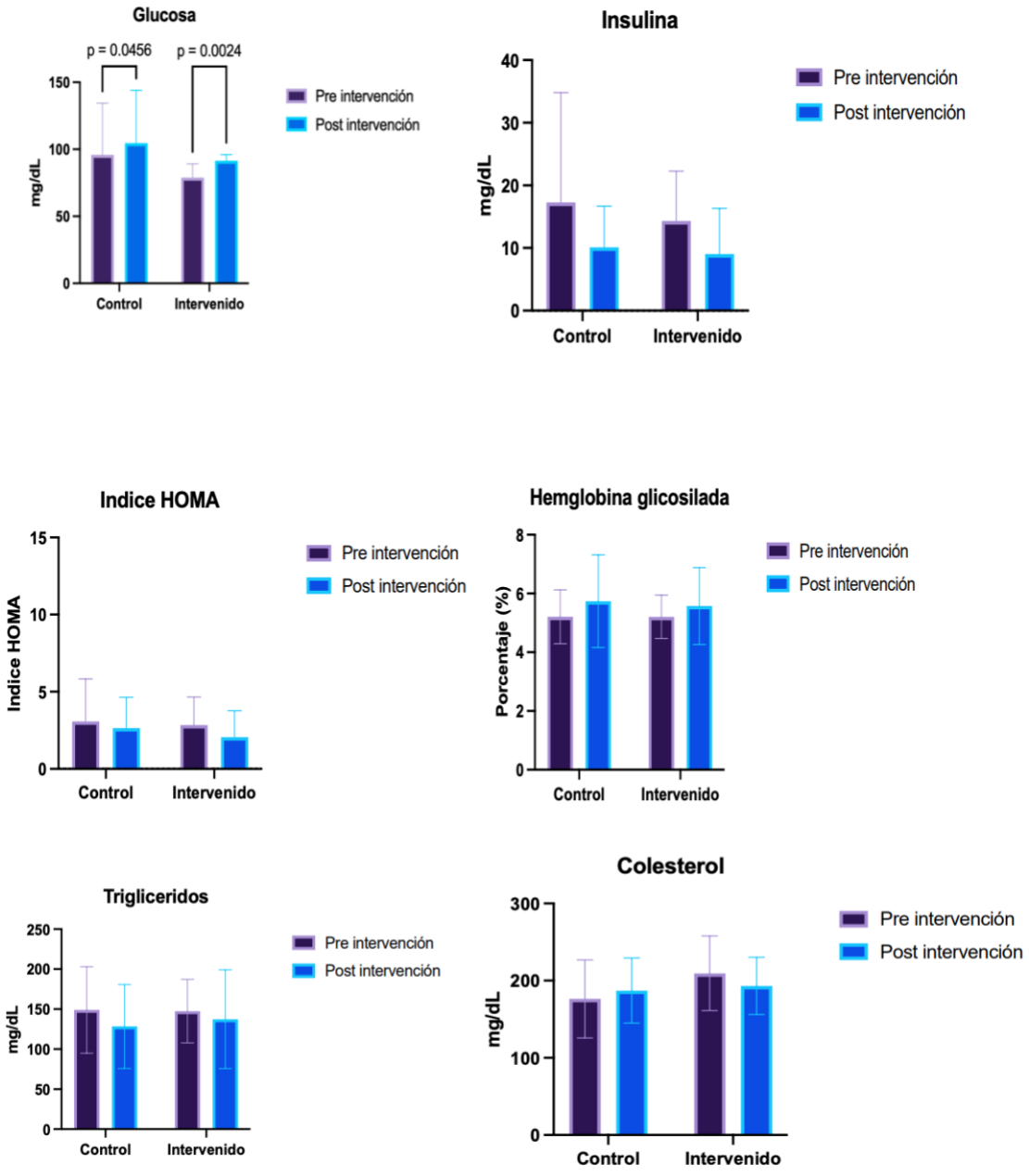

Figure 2. Comparison of biochemical parameters (glucose, insulin, HOMA index, glycosylated hemoglobin, triacylglycerides, cholesterol) between the control and intervention groups before and after the intervention

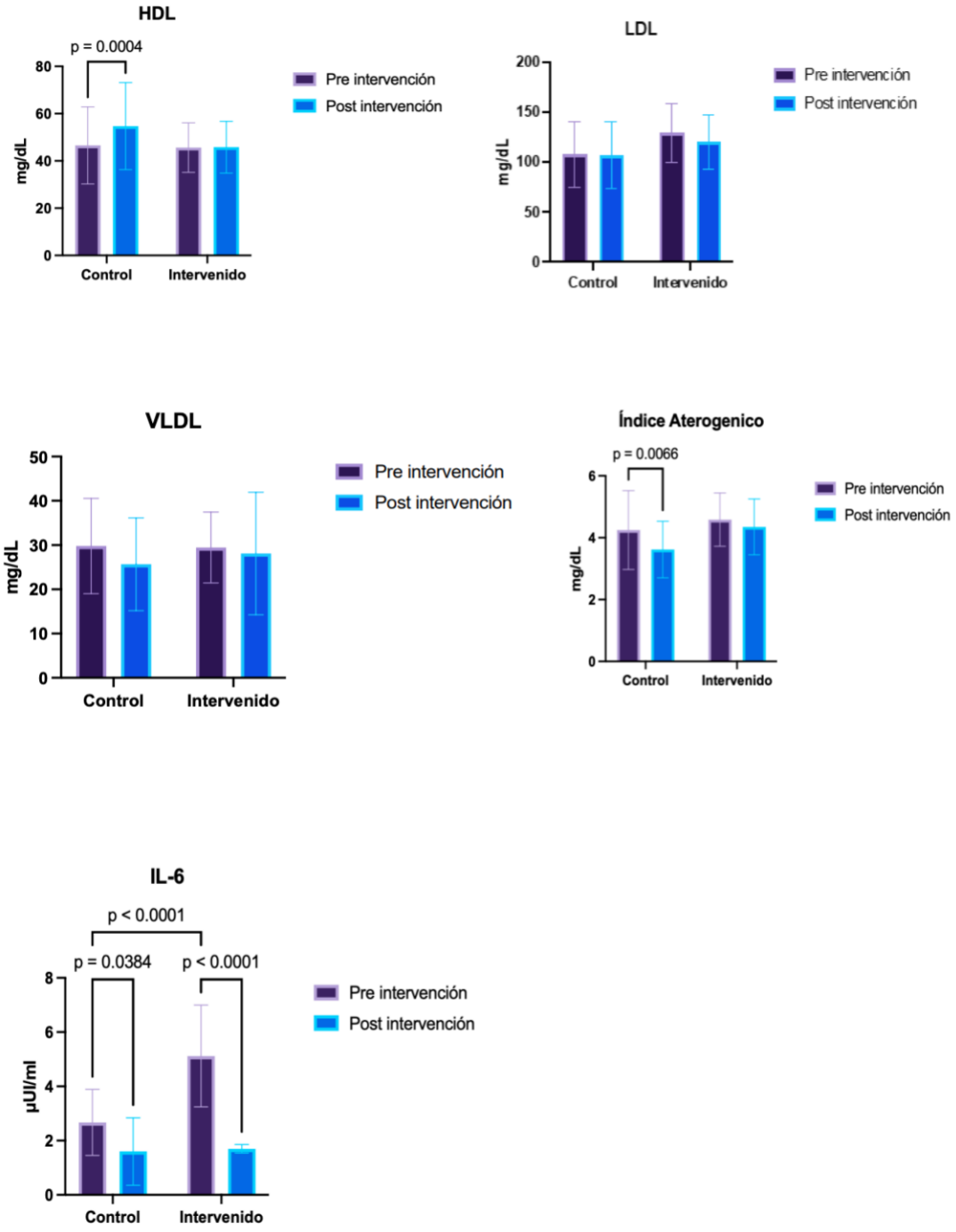

Figure 3. Comparison of biochemical parameters (LDL, HDL, VLDL, Atherogenic Index, Interleukin6 (IL6)) between the control and intervention groups before and after the intervention

Table 4. P values obtained in the analysis of the biochemical parameters determined in the intervention and control groups

Parameters	**Group 1 Intervention DMM Pre and post intervention**	**Group 2 Control Usual Diet Pre and post intervention**	**Group 1 vs Group 2 Pre**	**Group 1 vs Group 2 Post**
Blood glucose	p=0.0024	p=0.0456	p=0.0954	p=0.1944
Insulin	p =0.158	p=0.0766	p=0.371	p=0.7413
HOMA Index	p=1.142	p=0.5855	p=0.3118	p=0.7507
Glycosylated hemoglobin	p=0.3255	p=0.2144	p=0.9973	p=0.725
Triacylglycerides	p=0.3257	p=0.0763	p=0.9607	p=0.6129
Total cholesterol	p=0.0814	p=0.2833	p=0.0588	p=0.7246
HDL	p=0.9181	p=0.0004	p=0.8604	p=0.1036
LDL	p=0.097	p=0.8909	p=0.077	p=0.2652
VLDL	p=0.5477	p=0.1051	p=0.9471	p=0.535
Atherogenic Index	p=0.2312	p=0.0066	p=0.3679	p=0.0516
Interleukin 6	p=<0.0001	p=0.0384	p= <0.0001	p= 0.8359

Figure 4 shows the comparison of the values of the DMM diet adherence questionnaire in the group that consumed this diet. There was a marked improvement in adherence after the educational nutrition intervention.

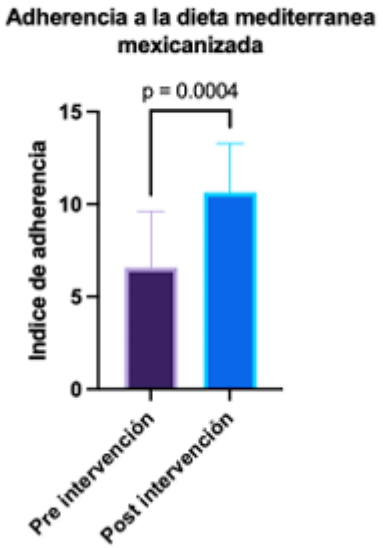

Figure 4. Comparison of DMM adherence values in the DMM intervention group before and after the intervention

Figure 5 shows a qualitative analysis of the dietary changes produced in the intervention group. A greater use of avocado oil for cooking, which went from not being used to being included in the consumption of 31.25% of the subjects, increased the use of olive oil for cooking and seasoning, as well as the consumption of fruits and vegetables daily, decreased the consumption of sugary and/or carbonated beverages daily and of

commercial pastries daily. The consumption of red meat, hamburgers, sausages and cold meats was reduced and chicken was preferred, and the consumption of seafood and fish was increased. Nut consumption was incorporated into the daily diet in 56.25% of the participants, being one of the most important changes. Consumption of avocado and guacamole remained very high, as did daily consumption of legumes.

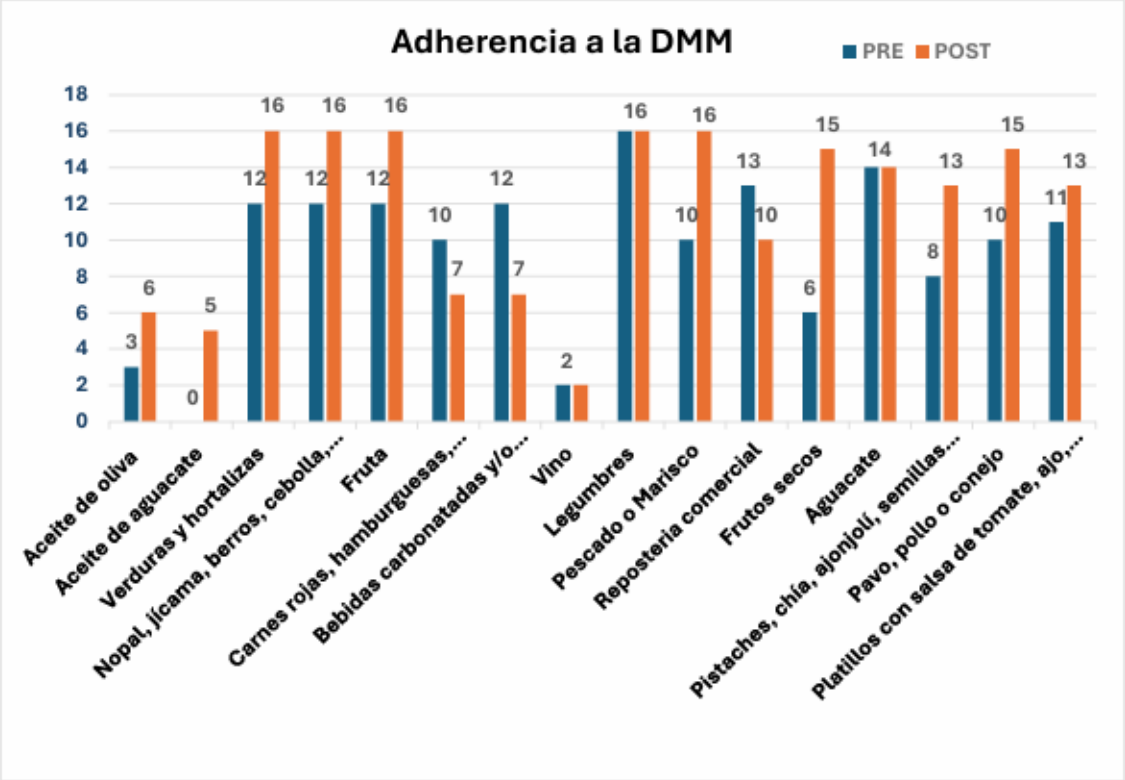

Figure 5. Dietary changes related to DMM adherence in the pre-intervention and post-intervention DMM intervention group

Figure 6 reflects the behavior of basic nutrition knowledge acquired in the sessions during the educational intervention in all participants. There was an increase in the level of nutritional knowledge in all subjects regardless of the group to which they belonged in the study.

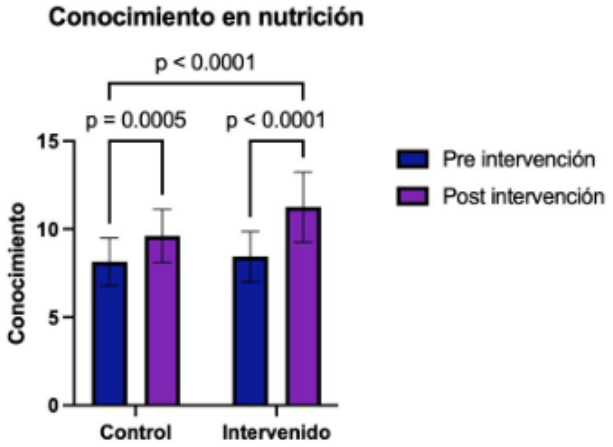

Figure 6. Comparison of the acquisition of basic nutrition knowledge before and after the intervention in the DMM intervention and DH control groups

We can comment that in group 1 with the intervention, 100% of the members increased their score in the post-intervention questionnaire, also the scores achieved were of higher value as well as the difference in the number of points obtained in the pre and post questionnaires when compared to group 2 control with habitual diet where 84.61 % of the subjects increased their score. We can affirm that the combination of the application of this DMM dietary strategy with a custom-designed plan and nutritional counseling educational sessions resulted in greater awareness and adherence to the dietary strategy, facilitating weight loss and a decrease in comorbidities. In the control group with a habitual diet, receiving nutritional counseling also had a positive influence on the results, but to a lesser extent than in the intervention group.

During the study, constant communication was maintained, as well as support by telephone and in the individual and group sessions, where existing doubts were clarified, which led to an approach that favored effective support.

Discussion and Conclusions

The Mediterranean diet is inversely associated with adiposity, the risk of type 2 diabetes and cardiovascular disease (6). The success of this diet is due to the synergy of its components and not the effect of a single individual food or nutrient. The Mediterranean diet has been associated with a better metabolic state due to its correct omega 3: omega 6 ratio, as well as its high content of fiber, antioxidants and polyphenols with anti-inflammatory properties (7). López Olivares et al. proposed that a better body composition of the individual is associated with a greater adherence to the Mediterranean diet and a better physical, mental and quality of life (19). Bastías et al. showed that participants with a low consumption index had a higher risk of obesity and higher anthropometric values, which is consistent. In individuals who consumed it frequently, the loss of body weight was greater, as well as the decrease in visceral ectopic obesity (20). According to the results of Bastías et al; in our study we were able to achieve a reduction in most of the anthropometric parameters of the group with DMM, due to the

consumption of plant foods with low energy density and low glycemic load, which favors weight loss, as well as the high amount of fiber contained in the predominant foods, which leads to increased satiety. Estruch et al. in their study found that this diet is more effective for weight loss than other low-carbohydrate or low-fat diets (21). According to Rinott et al the Green-MED diet led to the greatest reduction in body weight, followed by the Mediterranean diet and the normal diet. These MED and Green-MED diets improved cardiometabolic markers, including Framingham risk, body weight, blood pressure, HOMA-IR, and plasma leptin (22).

The present DMM study contributed to promoting a decrease in body weight of more than 4% among the participants, which was present in 37.5% of the intervention group. Di Rosa et al. state that body weight loss of close to 5% can improve overall health (23) 5% can improve overall health (23). This author demonstrated that healthy weight is considered a risk modifier and has favorable effects on blood pressure, glucose metabolism, and cardiac and vascular problems. DMM in this study decreased BMI in 75 % of the members and reduced waist circumference in 25 % of the members of the intervention group. Sahrai et al. reported a positive relationship between high glycemic index of foods, high BMI and large waist circumference size in Mexican women, showing that greater adherence to the Mediterranean diet is associated with smaller waist circumference (24); these results are consistent with our findings.

The pathogenesis of cardiovascular diseases that are associated with obesity begins before the actual cardiovascular event, which detonates as the alarming event. It is important to emphasize the need to act preventively in anticipation of health damage. Clinical assessment of body fat distribution is very important. When there is an increase in central or visceral abdominal fat, it is necessary to detect the alteration of biochemical and clinical disorders that are completely related. These include insulin resistance, type 2 diabetes mellitus, arterial hypertension and ischemic heart disease. When we evaluate abdominal fat by anthropometry it guides us to look for the presence of dysglycemia which is caused by insulin resistance or beta cell dysfunction or both. In the present study, these parameters were evaluated and cases were detected that urgently needed professional help and nutritional guidance, which were referred for review by an internist and endocrinologist. Montemayor et al. commented that increased waist circumference is related to visceral fat accumulation, which causes hepatic inflammation, oxidative damage and hepatic steatosis (25). Adherence to the DMM allowed the reduction of the waist-to-hip ratio (WHR), body fat and visceral fat, which was determined by the high consumption of fiber, as well as by the knowledge of nutrition acquired through nutritional education, which allowed improving the selection of foods and their combinations, reducing the consumption of ultra-processed foods, which coincides with what has been reported in the literature by Bauce et al (26) and other studies (20,23,24).

The Mexicanized Mediterranean Diet (MMD) in the intervention group decreased glycemia, Insulin, HOMA index, and glycosylated hemoglobin. Vitale et al. related that the 8-week consumption of the traditional Mediterranean Diet improved post-meal glucose and insulin responses and increased the insulin sensitivity index, due to the effect of viscous dietary fiber that causes a delay in carbohydrate digestion and lower glucose spikes, coincides with our results (27). Zatterale et al. reported that high adherence to the Mediterranean Diet is associated with a lower risk of type 2 diabetes mellitus, showing an improvement in HbA1c concentrations and lipotoxicity (28). Paz Graniel, et al. reported that high adherence to the Mediterranean Diet had a beneficial effect on lipoprotein profile and glucose, due to the effect of omega-3 acids that can reduce lipolysis in adipose tissue and thus the outflow of free fatty acids into the circulation decreasing insulin resistance (29). Huo et al. report that the Mediterranean diet improves metabolism in

individuals with diabetes (30). Salas et al point out that the Mediterranean diet enriched with extra virgin olive oil or nuts can help subjects at high risk of cardiovascular disease due to its high content of unsaturated fatty acids, fiber and polyphenols with synergistic action to counteract inflammatory and oxidative stimuli, decreasing the atherosclerotic process and the progression of diabetes. (31). The Mediterranean Diet is high in vitamins E and C, minerals such as magnesium and potassium that control blood pressure, improve endothelial function and insulin sensitivity, as well as reduce oxidative stress and inflammation. All these properties together result in a less atherogenic profile in subjects who consume it and a reduced risk of diabetes (31).

The levels of the different types of lipids were also modified in this intervention. The Mexicanized Mediterranean diet contributed to decrease the concentration of triacylglycerides, as well as total cholesterol and LDL, coinciding with the report by Bastías et al. that suggests the cardioprotective role of the Mediterranean diet (20)(32). Furlan et al. reported that healthy subjects consumed for 6 days a hyperlipidemic diet where butter was replaced by avocado oil extracted from the pulp and showed an improvement in the postprandial profile of insulin, glycemia, total cholesterol, low density lipoproteins, triglycerides and inflammatory parameters, such as C-reactive protein (CRP) and interleukin-6 (IL-6) (14). He demonstrated that avocado pulp oil from Mexican variants exhibits anti-inflammatory activity by inhibiting cyclooxygenase enzymes in a manner similar to ibuprofen. Damasceno et al. proposed that participants assigned to consume the Mediterranean Diet supplemented with 30 g of mixed nuts per day reduced the number and size of LDL particles, as well as increased HDL concentrations after the 1-year intervention. These results are linked to the LDL-lowering effect of nuts; in our intervention with DMM, nut consumption increased, which could be related to the LDL concentrations determined (32). Paz Graniel et al reported that the use of this diet reduced the size and quantity of LDL, a result that coincides with ours (29). Schwingshackl, L. et al. suggest that the Mediterranean Diet produces changes in markers of inflammation and endothelial function, including reduction of C-reactive protein, interleukin-6 and flow-mediated dilatation (33). In the present study, IL-6 values decreased in 100 % of the members of the DMM intervention group.

This intervention with DMM involved the delivery of the personalized nutrition plan and its combination with nutrition education allowed adherence to DMM to increase considerably between the two measurements. Bastías et al. report that a high rate of adherence to the Mediterranean Diet leads to metabolic benefits in people with obesity. If adherence to this dietary pattern is greater, the lipid profile improves as well as endothelial function, and insulin resistance decreases. The stability of these markers leads to a lower proinflammatory state and consequently to a lower BMI (20). Navarro et al demonstrated the existence of a high level of adherence to DM in adult university students in Murcia at the same time as a change in eating habits. Nursing students consumed more than one serving of vegetables per day and Food Science and Technology students consumed more than one piece of fruit per day (34). Mancini et al. reported the broad impact of the Mediterranean Diet on health, these authors suggest that adherence to the DM is associated with a 50% lower risk of developing metabolic syndrome, in addition to achieving an increase in biomarkers associated with healthy aging and reducing the risk of mortality by 20 years (35). In their study, López Olivares et al. showed that subjects with greater adherence had better anthropometric profiles, physical conditioning and even mental health (19). In our study we demonstrated that if the population identifies the need to eat healthily it will be easier for them to adhere to a particular dietary strategy because they recognize that it is positive for their health. Mancini et al. proposed that to achieve significant weight loss and increase the likelihood of clinically producing results,

lifestyle modification through diet, behavioral therapy, and physical activity should be undertaken (35). It is worth mentioning that in our study there were very important qualitative changes such as the use of avocado oil for cooking, the use of olive oil, and an increase in the consumption of fish and seafood and nuts. There was a marked decrease in the consumption of daily sugary carbonated beverages, red meat, hamburgers, sausages, cold meats, as well as daily commercial pastries. Changes in eating habits occurred as a result of nutritional counseling and awareness-raising, which demonstrates the feasibility of educational intervention whether or not it is accompanied by a dietary plan.

The Mexicanized Mediterranean Diet is used to fight obesity, but it is also related to the improvement of other health conditions. Mendiola M et al. reported the positive effect of DMM in their longitudinal study in Mexican children with ASD who consumed this type of diet for 4 months. There was a greater attachment to this type of food by making the parents of the children aware of the importance of its consumption, educating them in the preparation and setting of the dishes. From a nutritional point of view, this attachment enhanced an increase in vitamin D levels, fiber, omega-3 and folate intake, as well as an increase in linear growth. The children's behavior showed that crying and impulsivity were reduced, as well as obsession between meal times, and there was an improvement in sleeping hours (10).

In the present study, the educational nutritional intervention was an appropriate option that achieved good results, as has been the case in similar studies. Arauz et al. developed a multidisciplinary educational intervention in diabetic patients in an urban community in Costa Rica, with the intention of modifying their dietary practices. Nineteen adults were included in the intervention group and 17 in the control group that continued with their normal routine. The educational part was structured in thematic weekly sessions, a food pattern was developed and the appropriate amounts that obese patients could consume, and changes in the current diet were suggested based on questionnaires. The consumption of total fat, saturated fat and cholesterol was reduced, the consumption of fruits and vegetables was increased, and eating schedules were organized in the intervention group after the nutritional education. For the clinical evaluation, lipid analysis, glycemia and glycosylated hemoglobin were determined, decreasing their values, as well as BMI in the intervention group (38). Fretes et al. conducted a three-month school-based educational intervention to assess fruit, vegetable and fish consumption in Chilean preschool and school children and their families. Knowledge about healthy eating was increased through six 90-minute cooking workshops to prepare food at home using new technologies such as videos and photography. Surveys and food questionnaires were completed before and after the intervention. Parents and teachers had basic knowledge of nutrition, but dietary intake was still unhealthy. Increased consumption of fruits and vegetables, as well as fish, was achieved. It was shown that it is possible to change eating habits by working together with the participation of the family, teachers and students, where personal motivation helps to achieve the objectives (39). Another nutritional intervention implemented in public middle schools in Toluca, Mexico with adolescents aged 11-12 years, focused on active learning, not only in offering knowledge in Nutrition but also in achieving the development of competencies that modify their eating habits using the theory of protective motivation which favored the change of attitude and self-efficacy. They learned to select the right foods, portions and balance, and self-manage their menus to achieve a balanced diet without restrictions. A satisfactory result was achieved since it changed the attitude towards food, as well as produced an increase in the perception of risk. The results showed an increase in self-efficacy in normal weight and overweight/obese youth, although it turned out that the

intervention time should be extended to 6 months or 1 year to achieve changes in the groups that lagged behind. The importance of health education demonstrated in this work how knowledge and active learning could change habits in a difficult population in terms of behavior management and convincing, such as adolescence (40). Montenegro et al. conducted a quasi-experimental study in which they evaluated knowledge about nutrition and food, nutritional status and food consumption in Chilean teachers and students before and after the intervention. The intervention included 9 educational sessions for teachers during 5 months on healthy eating topics. It was observed that there was a transfer of teacher/student knowledge; the students of the trained teachers showed a decrease in the consumption of unhealthy foods and an increase in knowledge. The nutritional status was not modified due to the short intervention time, although it was suggested to increase the application time and involve the family to enhance its effect (41). Fausto et al. conducted an educational intervention with mothers in a rural community in Jalisco, Mexico. The educational, food safety and physical activity aspects were developed. The educational intervention was participatory, promoting reflection on the most consumed foods and which should be avoided, the negative habits that should be changed and the existing positive habits that should be reinforced. It became evident that healthy habits can be adopted and maintained. The educational sessions were weekly 1-hour workshops during 6 months with topics such as labeling, menu preparation, portion calculation, hygienic food handling. There were positive changes in knowledge that were manifested in the consumption of certain foods and natural drinking water (42). Vega et al. proposed the implementation of a nutritional intervention for 4 months in teachers in training at the Complutense University of Madrid, where they applied questionnaires on the knowledge present in the dietary guides and breakfast habits in week 1 of the course and in week 14 to evaluate the knowledge acquired during the intervention. Statistically significant variations were presented in terms of knowledge acquired about Nutrition and in terms of breakfast characteristics (43). A descriptive cross-sectional study was carried out involving 120 university students between 18 and 30 years of age from the University of San Luis in Argentina. Their objective was to evaluate the consumption of foods containing prebiotics and probiotics and their effect on metabolic syndrome risk markers. Anthropometric measurements were taken, as well as biochemical markers such as glycemia, total cholesterol, HDLc, LDLc, triglycerides and VLDL. Consumption of prebiotics and probiotics was assessed using a food frequency questionnaire and Inulin intake in participants was calculated according to average inulin content values in different plant species. It was shown that students who consumed prebiotics regularly had lower BMI and weight than those who did not consume them, in addition to lower levels of glucose and total cholesterol (44).

Nutritional and educational interventions at any level can help slow the progression of obesity and related diseases, and can raise awareness of the need to practice a healthy and active lifestyle with proper nutrition and physical exercise, aspects to be taken into account when implementing these primary strategies. It is also a key factor to consider the time required to achieve the goal of body weight loss. Generally, if this is not taken into account, overweight or obese people can become demotivated and abandon the nutritional protocol. A real and achievable goal must be set, supported by the creation of lasting habits over time, thus bringing about lifestyle changes that can be sustained, in unison with healthy eating.

The Mexicanized Mediterranean Diet (MDM) proved to be a successful and feasible option to prevent and treat overweight and obesity in the population studied. The Mexicanized Mediterranean diet had a positive effect on body composition and improved anthropometric and biochemical parameters. This type of feeding caused a decrease in

the totality of anthropometric parameters in more than 25% of the members of the group intervened with DMM and in the biochemical parameters in more than 12.5% of these subjects. The educational intervention used in conjunction with the DMM plan contributed to improving the population's food culture and adherence to the proposed food plan. This strategy effectively promoted habit change, which can extend its duration and increase the level of knowledge and awareness of the population. The educational intervention increased the level of nutritional knowledge in all participating subjects.

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Conflict of interest

The authors declare that there are no conflicts of interest in the conduct of this study

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Time restricted feeding as an alternative dietary strategy in obesity

Alimentación restringida en el tiempo como estrategia alternativa en la obesidad

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ABSTRACT

Obesity, according to WHO ICD-11, is a chronic multifactorial disease characterized by excessive adiposity that impairs health. It is a growing global problem, with a prevalence of 44% in adults in 2022. In Spain, obesity affects 16.5% of men and 15.5% of women over 18 years of age. Dietary and nutritional strategies for its treatment include calorie restriction, intermittent fasting and time-restricted feeding (ART), which aligns intake with circadian cycles, showing benefits in reducing body weight. Recent studies highlight ART as effective, although the evidence is mixed.Time criteria (maximum 5 years old) and type of intervention (clinical trials) were determined for the search and literature review of scientific evidence related to time-restricted feeding and its impact on obesity. Pubmed was the main database used, from which a total of 13 clinical trials were analyzed in detail. Time-restricted feeding is a good alternative strategy for the treatment of obesity.

Palabras clave:
Alimentación en tiempo restringido, obesidad, crono nutrición, ayuno, pérdida de peso, restricción calórica.

RESUMEN

La obesidad, según la CIE-11 de la OMS, es una enfermedad crónica multifactorial caracterizada por adiposidad excesiva que perjudica la salud. Es un problema global en aumento, con prevalencia de 44% en adultos en 2022. En España, la obesidad afecta a 16,5% de hombres y 15,5% de mujeres mayores de 18 años. Las estrategias dietético-nutricionales para su tratamiento incluyen la restricción calórica, el ayuno intermitente y la alimentación restringida en el tiempo (ART), que alinea la ingesta con los ciclos circadianos, mostrando beneficios en la reducción del peso corporal. Estudios recientes destacan la ART como efectiva, aunque la evidencia es variada. Se determinaron criterios temporales (máximo 5 años de antigüedad) y de tipo de intervención (Ensayos clínicos) para la búsqueda y revisión bibliográfica de evidencia científica respecto a la alimentación restringida en el tiempo y su impacto sobre la obesidad. Pubmed fue la principal base de datos que se utilizó, de la cual se analizaron detalladamente un total de 13 ensayos clínicos. La alimentación restringida en el tiempo, es una buena estrategia alternativa para el tratamiento de la obesidad.

Introduction

According to the International Classification of Diseases (ICD-11) of the World Health Organization (WHO) (1), obesity is defined as: "a complex chronic disease defined by excessive adiposity that can impair health." In addition, this pathology is a risk factor for diseases such as diabetes mellitus, arterial hypertension, insulin resistance, dyslipidemia and cardiovascular diseases (2-6).

This is a growing health problem and constitutes a global epidemic. According to WHO (7), in 1990, 25% of adults were overweight and by 2022 the prevalence increased to 44% in adults over 18 years of age.

In Spain, according to data from the 2020 European Health Survey (8), the prevalence of obesity in men and women over 18 years of age was 16.5% and 15.5%, considering these growing figures and the potential damage to health that obesity entails, it is necessary to generate prevention and treatment strategies that are safe and sustainable over time (8).

Regarding the dietary-nutritional approach for the treatment of obesity, it is possible to point out that the main objective is to reduce body weight between 5% and 20% depending on the BMI and the primary strategy used to achieve this is caloric restriction (9). It has been suggested that one of the most determining factors for the success of these interventions is the patient's adherence to the nutritional plan; therefore, for the patient with obesity, a very restrictive dietary regimen may not be a sustainable strategy in the long term (10,11).

Time-restricted feeding (ART) is an emerging strategy that aims to maintain a daily feeding and fasting cycle consistent with circadian cycles in order to promote them (12) and has been the focus of numerous studies and discussion, as it has been shown to have benefits in terms of body weight reduction and cardio metabolic benefits (13), but the evidence so far has yielded mixed results.

Researching and analyzing the evidence that exists to date on this subject, in order to determine the effectiveness of time-restricted feeding in the treatment of obesity, can be of great help in establishing alternative nutritional strategies for patients for whom caloric restriction or nutrient restriction alone may lead to failure in their nutritional treatments for obesity, as well as a long-term strategy to sustain the weight loss achieved with caloric restriction *(14,15).*

The main objective of this study was to assess the efficacy of ART as an alternative nutritional dietary treatment for obesity. The specific objectives are to determine the impact of time-restricted feeding on obesity and to determine whether there are differences between starting the feeding window in the morning or late in the day.

***Dietetic-nutritional strategies in the treatment of obesity*.**

The main objective in the treatment of obesity is the reduction of body weight by 5% to 10% over a period of 6 months (although depending on the degree of obesity it can be as much as 20%), together with changes in the patient's lifestyle habits (9).

Currently, most of the evidence-based dietary-nutritional interventions for reducing body weight and improving metabolic health can be classified into 3 main approaches (16):

- Calorie restriction: there is a reduction in energy intake, but the timing and frequency of meals are not manipulated.
- Intermittent fasting: 1 or more fasting days are alternated with ad libitum feeding days.

- Time-restricted feeding or time-restricted feeding (ART): in a 24-hour period a fasting window (12 to 16 hrs) and a feeding window is established depending on the hours established in the fasting window.

Time-Restricted Feeding.

It is called time-restricted feeding that protocol that restricts the time in which food is consumed in a period of 24hrs, usually in 4-12h feeding windows and fasting periods of 12 to 16h (17). Some authors argue that this is a chrono-nutritional strategy, since the period of food consumption and fasting is synchronized with the cycles of circadian rhythms, and that the possible benefits are due to this interaction (17,18).

The flexibility of ART protocols allows people to maintain their individual eating pattern preferences, which can facilitate adherence (17).

Missing target

Method (14 points)

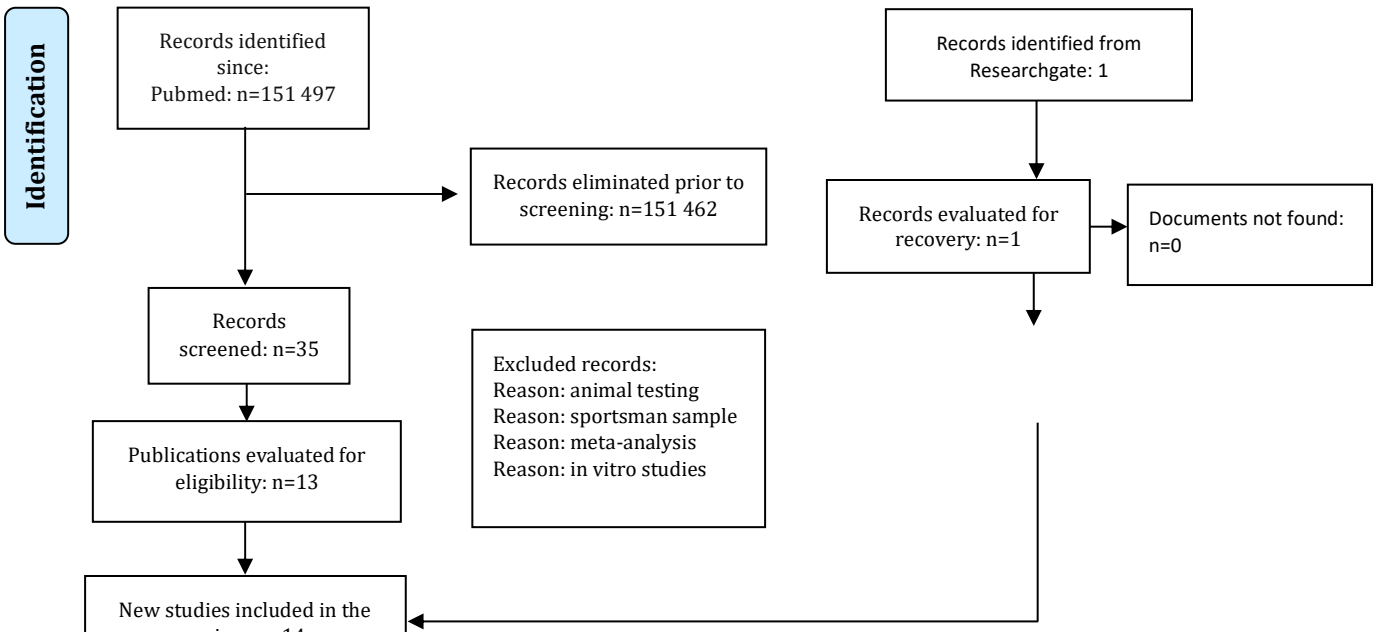
To conduct this research, which consisted of a literature search, key terms such as: time restricted feeding, overweight, body fat reduction, calorie restriction, early time restricted feeding, late time restricted feeding, circadian rhythm, etc. were determined and Boolean terms (AND AND AND OR) were used to further focus the results. Pubmed was used as the database, as can be seen in the article selection diagram (Figure 1).

On the other hand, the following search criteria were established: Articles not older than 5 years and only clinical trials.

For the selection of articles, the following exclusion criteria were established:

- Interventions in the sports or exercise population.
- Interventions in which programmed exercise was involved as part of the intervention.
- Meta-analysis.
- Animal or in vitro tests.
- Interventions that did not assess weight loss or body composition.
- Items that were not complete.

For the selection of papers, we considered interventions in which participants were overweight or obese, regardless of whether they also suffered from other diseases such as kidney disease, cancer or metabolic syndrome, as long as they evaluated weight loss and change in body composition.



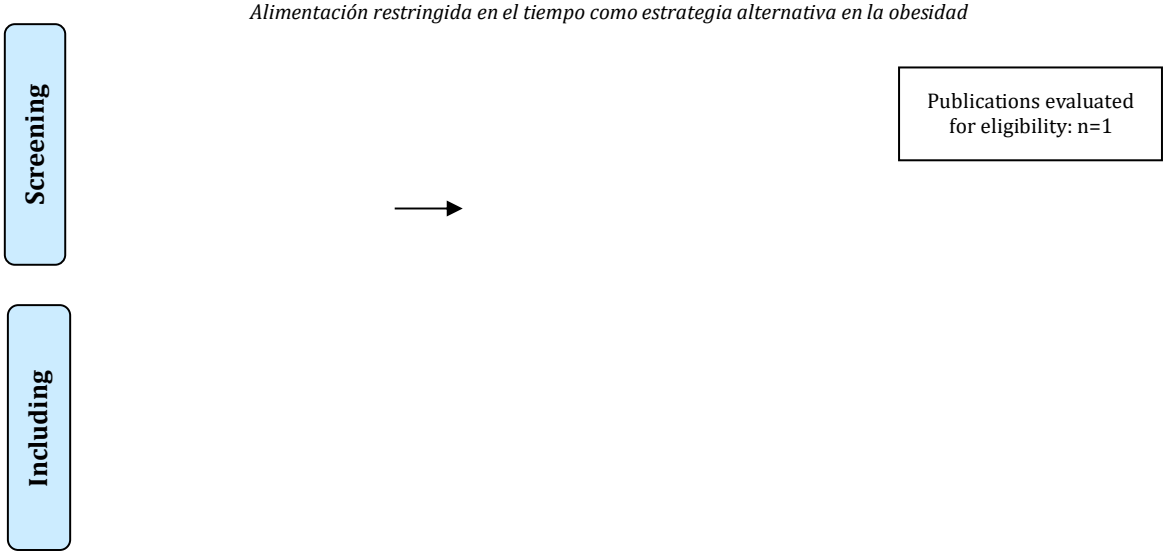


Figure 1. Study selection flowchart.

After the articles were selected, they were stored and reviewed in detail to prepare the main part of the work. Of the total number of articles reviewed, 13 were analyzed in depth. In the case of the data from the selected interventions, only those data and outcomes that were related to weight loss and body composition were used.
Of the 13 articles that were reviewed in depth, 8 of them were used for the section on ART and its impact on obesity and the rest for the section on the differences of ART protocols in their effect on obesity.

Results and Discussion (14 points)

In a recent randomized controlled trial, Lin S. et al. (19) analyzed the effectiveness of Time-Restricted Eating (ART) for weight loss and improvement of cardio-metabolic risk compared to traditional calorie restriction (CR). For 12 months, 90 participants were divided into three groups: one practicing ART with an 8-hour feeding window (12 to 8 p.m.), one with a 25% calorie reduction, and a control group that had a wider feeding window of 10 hours or more. The results showed a significant weight reduction in both the ART and CR groups, with no notable differences between the two in terms of weight loss. However, both approaches were more effective than the control group.

In previous studies, Wilkinson M. et al. (20) observed improvements in body composition and weight reduction with ART within 12 weeks. For their part, Steger F. et al. (21) highlighted benefits not only in cardio-metabolic markers, but also in mood when an early ART protocol was followed. However, other studies have shown mixed results. Lowe et al. (22) found that ART was less effective compared to more structured diets. Meanwhile, De Oliveira et al. (23) and Schroeder J. et al. (24) observed moderate improvements in body composition with ART, although without significant changes in blood markers.

Recent studies on Time-Restricted Feeding (ART) highlight important differences between early (ARTt) and late (ARTm) feeding protocols, with several investigations showing greater metabolic benefits associated with ARTt. Xie Z et al. (28) found that ARTt significantly improved insulin sensitivity, reduced fasting glucose, and promoted weight loss compared with ARTm and the control group, whereas Madjd A et al. (29) observed

greater weight loss in those who consumed an early versus a late dinner, highlighting the impact of meal timing on metabolic outcomes. Hatanaka et al. (30) also noted greater weight loss in those who started their feeding window earlier. Taken together, these studies suggest that meal timing, especially when performed early, offers advantages for weight loss and improvement of cardio-metabolic markers (28-34). All detailed information is presented in the tables below

Regarding time-restricted feeding and its impact on weight loss, this work compiles 8 interventions (19-27), with a total of 463 people. The results of these investigations provide evidence confirming that ART is an equally efficient strategy as caloric restriction for weight loss when performed in a caloric deficit protocol; however, (19) applied an ART protocol in which participants were allowed to eat ad libitum during the feeding window. At the end of this study, the ART group had a weight decrease and improvement in body composition similar to that of the control group, but the results obtained could be due to the fact that, like the control group, the participants involuntarily reduced their energy intake by -425kcal/day, which would explain that the weight loss in this group was due to an involuntary caloric deficit rather than an effect of ART per se.

In contrast, 1 (25) of the 7 interventions found no major differences in body weight reduction with respect to the control group, Lowe D et al (25) concluded that the ART diet does not generate a greater benefit for body weight loss or changes in body composition, nor improvements in metabolic markers, compared to eating 3 meals a day, in this study it was seen that 65% of the weight lost was lean mass, so it may not be a good nutritional approach for patients with decreased lean mass. However, one of its major limitations is that there was no record of the quality of the food ingested, the distribution of nutrients (carbohydrates, proteins and lipids), nor the total energy intake, so the results could be influenced by these factors and not by an effect of the ART as such. 5 interventions used 8-hour feeding windows (19,21,24,25,27). In all of them, a statistically significant weight loss was observed in the ART group versus the control group, although it is difficult to determine that ART was the determining factor, since some of these interventions added caloric restriction to the protocol (21) and others did not (19-25), while in 2 of these interventions the protocol was adjusted to the nutrient needs of the study group (26,27), in summary, when the intervention protocol compared an ART protocol (with or without caloric restriction) versus a group which was subjected to a caloric deficit with no time restriction in the feeding window, the results had no significant differences, but the results were not significantly different, the results had no significant differences, but when comparing ART with a control group that did not maintain caloric deficit, the weight loss and change in body composition is significant, this could be explained by the involuntary reduction of energy intake during an 8h ART protocol observed by Lin S (19) in his study and that could explain the results that Wilkinson M et al, in 2020 (20), obtained with their study, which in addition to finding positive results in body weight reduction of 275g/week, also saw a decrease in the fat percentage of the ART protocol participants.

de Oliveira et al 2020 (23), in their intervention, -unlike the other interventions seen in this work-, after 12 weeks of intervention, did not find significant changes in the body weight of the participants of their intervention, however, they observed that there was a slight decrease in hip circumference and body fat, which leads them to suggest that this strategy could help in the management of obesity in the long term. They support them, explaining that the fasting state could generate a metabolic flexibility, mediating

processes in favor of fatty acid oxidation, which could explain the decrease in the final values of hip circumference and body fat.

Regarding the differences between starting the feeding window early and late, according to the studies compiled in this work, there is more evidence suggesting that starting the feeding window early has more benefits in terms of weight loss compared to feeding protocols whose feeding window starts late. However, there are few studies that directly compare those effects within the context of a late and early ART protocol (24), the other studies did not use protocols that shortened feeding windows, so it is difficult to extrapolate the results to an ART protocol context, however, the results of the studies presented here point in favor of starting the feeding window early. These results may be due to the interaction of metabolism and metabolic pathways with clock genes and circadian cycles, which in turn regulate hormonal pulses such as insulin, cortisol, melatonin, ghrelin, leptin, etc.. .

The objective of this literature review was to determine the efficacy of time-restricted feeding as an alternative nutritional dietary treatment for obesity and to determine whether there are differences in the effects on obesity between starting the feeding window early or late.

Table 1. Selected studies on time-restricted feeding and its effect on obesity.

Author, Year	***Type of study***	***Subjects/Groups Protocol and duration of intervention***	***Results***	***Conclusions***
Lin S et al, 2023 (19)	Randomized clinical trial.	n=90 people with obesity. GC: Power window ≥10h without restriction. ART: ART Protocol 8:16 (12am to 8pm) without caloric restriction. GRC: 25% caloric restriction Duration: 12 weeks	Significant decrease in body weight in the ART group compared to the control group, but not significant compared to the caloric restriction group. Weight loss control group: 0.81 kg [CI, -3.07 to 4.69 kg; P = 0.68]). ART: Average reduction of -425 kcal/day, weight loss: -5.42 kg (95% CI, -7.37 to -1.85 kg; P ≤ 0.01). GRC: Average reduction of -405 kcal/day, Weight loss**:**-5.42 kg (CI, -9.13 to -1.71 kg; P ≤ 0.01).	With respect to weight loss, ART is more effective compared to the control group, but is not more effective than caloric restriction
Wilkinson M et al, 2020 (20)	Single-group quasi-experimental pre-post study.	n= 25 adults ≥18 years GE: ART protocol 10:14 (10h feeding window) Duration: 12 weeks.	Decrease in body weight, fat % and waist circumference. Weight loss: -3.30±3.20 kg (-3%), p=0.00028 (average loss 275g/week) BMI: -1.09±0.97 kg/m2 (-3%), p=0.00011 Body fat: -1.01±0.91%(-3%), p=0.00013 Visceral fat index:-0.58±0.77 (-3%), p=0.004 Waist circumference: -4.46±6.72 cm (-4%), p=0.0097.	A 10-h ART intervention for 12 weeks, without an overt attempt to change physical activity or diet quality or quantity, may serve as a novel treatment for individuals with metabolic syndrome. The decrease in waist circumference correlated with weight change (p=0.017), with a decrease in the interval between meals (p=0.005) and a combined change in weight and interval between meals (p=0.004).
Steger F et al, 2022, 2023 (21-22)	Randomized clinical trial.	n=90 adults with obesity. GC: ≥12h feeding window + caloric restriction. ART: 8:16 time-restricted early feeding protocol (with feeding window from 7:00 until 15:00h) + caloric restriction. Duration: 14 weeks.	GC: Weight loss: −4.0 kg [-4.2%]; 95% CI, -5.1 to -2.9 kg; P < .001 ART: Weight loss: −6.3 kg [-5.7%]; 95% CI, -7.4 to -5.2 kg; P <0 .001. With respect to fat loss, in none of the groups was it significant.	ART is a valuable approach to improving weight, body fat, cardio metabolic health and mood.
De Oliveira Maranhão Maranhão Pureza IR et al, 2020 (23)	Randomized controlled clinical trial	n=58 women with obesity. GC: ART hypocaloric diet: 12:12 time-restricted feeding protocol + caloric restriction. Duration: 12 weeks	No major changes in body weight were found: −1.64%, 95% CI [-3.08; -0.19]%, p=0.02 Slight decrease in body fat and waist circumference.	The fasting state could generate metabolic flexibility, mediating processes in favor of fatty acid oxidation.
Schroeder J et al, 2021 (24)	Non-randomized controlled clinical trial	n=32 women with obesity. GC: Unmodified diet and lifestyle habits. ART: time-restricted feeding protocol 8:16 (feeding window from 12 pm to 8 pm) without caloric restriction. Duration: 12 weeks	Significant reduction in body weight, fat %, fat mass and waist circumference. In body weight and fat mass for the ART group, respectively were: (Start of rehearsal: (83.62kg ± 3.95) 3rd month: (80.24 ± 3.87)) and (Trial start: (36.91kg ± 2.30) 3rd month: (34.74 ± 2.24)) Control group: (Start of rehearsal: (87.14 ± 3.25) 3rd month: (88.49 ± 3.04)) and (Trial start: (39.74 ± 2.00) 3rd month: (40.59 ± 1.95)	ART is an effective dietary strategy to promote weight loss and decrease WC without notable changes in blood biomarkers.

Lowe et al, 2020 (25)	Randomized clinical trial	n= 116 overweight or obese adults. GC: 3 structured meals per day ART: 8:16 time restricted feeding protocol (feeding window from 12pm to 8pm). Duration: 12 weeks	Average weight loss of 1.70 kg in the ART group, however, 65% corresponded to lean mass, i.e., 1.10 kg of this weight loss was lean mass and only an average of 0.51 kg of fat mass.	(1) do not support the efficacy of ART for weight loss, (2) emphasize the importance of control interventions, and (3) offer caution about the possible effects of ERT on GLM. Future studies should be directed at understanding the effects of early versus late ART and protein intake or timing of intake as a means of compensating for loss of GLM.
Lao B et al, 2023 (26)	Non-randomized controlled clinical trial	n= 28 renal patients with overweight or obesity. GC: which was prescribed a high quality low protein diet, with no hourly restriction to eat ART: 8:16 (with the 8h feeding window starting at 7am) contemplating 3 meal times within that window. Duration: 12 weeks	GC: Weight loss: -0.4 ± 1.4 kg, Body fat: = -0.4 ± 1.8 kg, Visceral fat: -0.2 ± 0.8 ART: Weight loss: -2.8 ± 2.9 kg Body fat: -1.8 ± 2.4kg Visceral fat: -0.7 ± 0.9 Decrease in body weight, body fat mass, visceral fat.	ART can help improve renal function in moderate to severe CKD patients who are overweight and obese. This may be due to patients' weight loss, stable nutritional status and an increase in beneficial bacteria in the intestinal microbiota.
Vega C et al, 2024 (27)	Non-randomized open clinical trial	n= 21 patients with overweight or obesity and breast cancer. GC: Caloric restriction of 25% of total energy expenditure, distributed in 4 meals and 1 snack. ART: ART 8:16 protocol (8h feeding window). Duration: 12 weeks.	GC: Weight reduction: -3.02 kg Waist circumference: −4.14cm ART: Weight reduction: −6.84 kg Waist circumference: −7.5cm Weight loss and reduction of waist circumference in ART was greater than in the CG.	Both interventions are effective and statistically significant for weight loss and waist circumference reduction, with RFA showing potentially greater impact and better adherence. Changes in LDL, HDL, total cholesterol, triglycerides, glucose and insulin were not statistically significant.

GC: Control Group; ART: Time-restricted feeding; GRC: Caloric restriction group.

Table 2. Selected studies on the differences in the impact on obesity between starting early and starting late.

Author, Year	***Type of study***	***Subjects/Groups Protocol and duration of intervention***	***Results***	***Conclusions***
Xie Z et al, 2022 (28)	Randomized controlled trial.	n= 90 adults .GC: No restriction on meal times. ARTt: ART 8:16 protocol (between 6:00 am and 3:00 pm) without caloric restriction. ARTm: ART 8:16 protocol (between 11:00 am and 8:00 pm) without caloric restriction. Duration: 5 weeks.	Reduced energy intake: GC: (Δ = 64 ± 286 kcal/day) ARTt: (Δ = -240 ± 409 kcal/day) ARTt vs GR: p=0.001 (significant decrease) ARTm: (Δ = -159 ± 397 kcal/day) ARTm vs GR: p=0.01 (significant decrease) ARTm vs ARTt (no significant difference.) Weight (kg) and % fat: GC: (Δ = 0.3 ± 1.2 kg) (Δ = 0.42 ± 1.16%) ARTt: (Δ = -1.6 ± 1.4 kg) (Δ = -0.60 ± 1.22%) ARTt vs GR: p=0.042 and p=0.001 (significant decrease) ARTm: (Δ = -0.2 ± 2.2 kg) (Δ = -0.22 ± 1.70%) ARTm vs ARTt (no significant difference).	When comparing the 3 protocols, ARTt is more beneficial for body weight reduction and metabolic health.
Madjd A et al, 2021 (29)	Randomized clinical trial.	n= 82 women, Groups: EEM: Dinner between 19:00 and 19:30h + hypocaloric diet (500-1000kcal deficit and distribution of the caloric molecule: 17% Proteins / 23% lipids / 60% carbohydrates). LEM: Dinner between 10:00 p.m. and 10:00 p.m: 30 and 23:00h + hypocaloric diet (deficit of 500-1000kcal distribution of the caloric molecule: 17% Proteins / 23% lipids / 60% carbohydrates). Duration: 12 weeks.	EEM Group: Weight lost: −6.74 (SD 1.92)kg, BMI: −2.60 (SD 0.71) kg/m2, Waist circumference: −8 (SD 3.25) cm LEM Group: Weight lost: −4.81 (SD 2.22) kg, BMI: −1.87 (SD 0.85) kg/m2, Waist circumference: −6 (SD 3.05) cm, EEM vs LEM (p-value) : Weight lost: P< 0.001 BMI: P < 0.001, Waist circumference: P = 0.007The EEM group showed significant differences in weight, BMI and waist circumference reduction with respect to the LEM group.	In the short term, early dinner intake is more beneficial than late intake for weight loss, insulin sensitivity and lipid profile. Therefore, in overweight or obese individuals, dietary recommendations designed to achieve weight reduction should include advice on the timing of dinner intake, in addition to giving recommendations on overall energy intake.
Hatanaka et al, 2021 (30)	Second analysis of a randomized controlled clinical trial	n= 97 Adults G1: They started the feeding window at 6:48am. (25 men and 22 women) G2: They started the feeding window at 8:09am. (26 men and 24 women). Duration: 12 weeks	The weight loss of group 1 was -3.8 ± 2.7% vs. -2.2 ± 2.5% in group 2.	There was a greater effect on weight loss in those who started feeding earlier (however, they acknowledge many limitations).
Gu et al, 2020 (32)	Randomized controlled clinical trial	n= 20 Healthy people (10 men 10 women) LD: Late dinner 22:00h RD: Early dinner 18:00h Both groups received a dinner with an isocaloric distribution of nutrients (35% of daily kcal, 50% CHO, 35% lipids) Duration: 14 days, including 2 visits of 3 days and 2 nights to the research center.	LD caused a 4-hour shift in the postprandial period, overlapping with the sleep phase. Independent of this change, the postprandial period after LD was characterized by an increase in glucose, a delay in the triglyceride peak, and a reduction in the rate of oxidation of dietary fatty acids. LD did not affect sleep structure, however, it increased plasma cortisol.	Late dinner consumption induces the oxidation and mobilization of fatty acids, effects that could favor obesity.
Queiroz et al 2022 (33)	Randomized, parallel group, single-center trial.	n= 13 adults with overweight and obesity. CG (CR): Caloric deficit of 25% of their energy needs and feeding schedule from 8:00 a.m. to 8:00 p.m. eTRE: Early feeding protocol restricted in time 8:16 (with feeding window from 8:00 to 16:00h) + 25% caloric deficit with respect to their	GC: Weight lost: (−4.0kg; 95 % CI, -5.9, -2.1) Fat Mass: (−3.1 kg; 95 % CI, -4.3, -1.8) eTRE: Weight lost: (−4.2kg; 95 % CI, -5.6, -2.7) Fat Mass: (−2.9kg; 95 % CI, -3.9, -1.9) dTRE: Weight lost: (−4.8kg; 95 % CI, -5.9, -3.7) Fat Mass (-3.6kg; 95 % CI, −4.6, −2.5).	Under caloric restriction conditions, the three protocols (dTRE + CR, eTRE and CR) have similar effects on improving body composition and decreasing body weight.

		energy needs. dTRE: Late feeding protocol restricted in time 8:16 (with feeding window from 12:00 to 20:00h) + caloric deficit of 25% with respect to their energy needs. Duration: 8 weeks-		
Allison et al. 2021 (34)	Randomized crossover study	n= 12 Adults Protocol 1: Early feeding window (8:00 a.m. to 7:00 p.m.). Protocol 2: Power window late (12:00 to 23:00h). Washout period between protocols: 2 weeks Duration: 8 weeks	Results protocol 1 (Mean): PRE: Weight (kg): 65.4, Total fat (%): 27.6 Lean mass(%):14.5 POST: Weight (kg): 64.3, Total fat (%): 27.9, Lean mass(%):14.7 Results protocol 2 (Mean): PRE: Weight (kg): 64.8, Total fat (%): 28.0, Lean mass(%): 14.7 POST: Weight, (kg): 64.5, Total fat (%): 27.6, Lean mass(%): 15.	Eating earlier improves weight and several key metabolic outcomes in healthy individuals.

ARTt: time-restricted early feeding; ARTm: time-restricted midday feeding; GC: Control group; EEM: Early evening dinner; LEM: late evening dinner; LD: *Late dinner: late dinner; RD: Regular dinner: Early dinner; dRTE:* Late time-restricted feeding; eRTE: Early restricted feeding.

Conclusions

Considering the above, it is possible to conclude that early ART could be a good alternative strategy for the treatment of obesity, since it is as effective as caloric restriction. However, for the future, more studies are needed, with larger samples, to determine the mechanisms by which ART works and to confirm that the results are not mediated by caloric deficit.

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Community conception of malnutrition and medical treatment in rural areas: an alternative perception of the causes of prevalence of malnutrition in mozambique as a principle and basis for its containment

Concepción comunitaria sobre la desnutrición y tratamiento médico en zonas rurales: una percepción alternativa de las causas de prevalencia de la desnutrición en mozambique como principio y base para su contención

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ABSTRACT

Malnutrition is the most significant health challenge in Mozambique, affecting over 43% of children, especially in rural areas, despite interventions since 2006. While malnutrition is typically seen as a result of food insecurity, this study reveals that community understanding, perception, prevention, and treatment practices are crucial for effective intervention. Using a qualitative and descriptive approach, the research was conducted in Angónia district, Tete province, with 78 families randomly selected from three localities with the highest malnutrition rates. Structured interviews in Portuguese and the local language targeted individuals aged 13–50 with children under five. Results show that 88.83% of respondents confuse malnutrition with hunger and have not adopted preventive measures, and 59.29% prefer traditional treatments over medical care. Despite 89.35% reporting three daily meals, 23% of children exhibited developmental deficits typical of malnutrition, often without medical follow-up. The findings highlight the persistence of traditional beliefs, distrust in hospital services, and low adherence to medical recommendations, compounded by low education levels and reliance on subsistence farming. These sociocultural barriers, including myths, localism, and resistance to modernization, hinder the effectiveness of public health strategies. Thus, addressing malnutrition in Mozambique requires not only improving food security but also fostering culturally sensitive health education, strengthening community trust in health services, and integrating local beliefs into intervention programs to achieve sustainable progress in combating malnutrition

Palabras clave:
Desnutrición, seguridad alimentaria, tratamientos médicos en zonas rurales.

RESUMEN

La desnutrición es el principal desafío de salud en Mozambique, afectando a más del 43% de los niños, especialmente en zonas rurales, a pesar de las intervenciones desde 2006. Aunque la desnutrición suele asociarse a la inseguridad alimentaria, este estudio revela que la comprensión, percepción, prevención y prácticas de tratamiento en la comunidad son cruciales para una intervención eficaz. Utilizando un enfoque cualitativo y descriptivo, la investigación se realizó en el distrito de Angónia, provincia de Tete, con 78 familias seleccionadas al azar de tres localidades

con las tasas más altas de desnutrición. Se aplicaron entrevistas estructuradas en portugués y lengua local a personas de 13 a 50 años con hijos menores de cinco años. Los resultados muestran que el 88,83% de los encuestados confunde la desnutrición con el hambre y no ha adoptado medidas preventivas, y el 59,29% prefiere tratamientos tradicionales sobre la atención médica. Aunque el 89,35% reporta consumir tres comidas diarias, el 23% de los niños presenta déficits de desarrollo típicos de desnutrición, muchas veces sin seguimiento médico. Los hallazgos resaltan la persistencia de creencias tradicionales, la desconfianza en los servicios hospitalarios y la baja adherencia a recomendaciones médicas, agravadas por bajos niveles educativos y dependencia de la agricultura de subsistencia. Estas barreras socioculturales dificultan la efectividad de las estrategias de salud pública. Así, abordar la desnutrición en Mozambique requiere no solo mejorar la seguridad alimentaria, sino también fortalecer la educación en salud, la confianza comunitaria en los servicios de salud e integrar las creencias locales en los programas de intervención para lograr avances sostenibles.

Introduction

Malnutrition is recognized as an indicator of the quality of an individual's dietary processes, manifesting a lack of nutrients in the body due to food insecurity. In addition to the high cost of clinical treatment for the country, the high incidence of malnutrition jeopardizes the achievement of many of our country's international development commitments. The main types of malnutrition are chronic malnutrition, defined as low height for age, which differs from acute malnutrition, defined as low weight for height. This type of malnutrition can appear at any time of life and can be recovered from (1).

Mozambique is one of the countries located in southern Africa Australia in the SADC region, bathed by the Indian Ocean, one of the granaries of the agricultural surplus of Africa Australia, in recent days has been suffering from drought, political conflicts, terrorism, hunger, market inflation and unemployment. The situation of malnutrition in Mozambique, especially in Cabo Delgado, Nampula, Zambezia and Tete provinces is a reality that no one can deny, especially in rural areas.

In Mozambique, at least 44% of children suffer from chronic malnutrition, one in two children under the age of 5 fails to reach their physical, mental and cognitive growth potential (1) and 74.7% suffer from acute malnutrition. Tete province has an average of 43% chronic malnutrition in children under 5 (2, 3).

Despite various interventions against malnutrition in Tete province and in Mozambique in general, malnutrition levels are still high at 43 to 47% seventeen years into the fight against malnutrition (4). One of the biggest in Tete province, particularly in Angónia district, are the various actions and projects linked to agriculture, nutrition, support for the vulnerable, and a redoubling of government's efforts to put health services into practice closer to families, Apart from malnutrition, there are more cases of people living with HIV-AIDS, especially in rural communities where access to medical care has been precarious and historical, with a lack of medicines, catastrophic medical care and the influence of myths and fables linked to tradition.

"Malnutrition is responsible for approximately 55% of deaths worldwide, due to the high risk of death, children with malnutrition must be properly diagnosed and need good family and hospital follow-up. Success requires that various factors such as ideology, culture, schooling, food insecurity and poverty, among other associated problems, are carefully identified, prevented and resolved in the best possible way" (5).

The study of target group, different factors, strategies and policies directly linked to a disease are of the utmost importance in any activity developed to ascertain the real causes, consequences or impact caused on society. Through the results found, it is possible to design other methodologies to better achieve the objectives set. If the possible factors are not identified and the target group is better understood, for example, in the case of malnutrition, it is likely that the child will undergo clinical treatment and return home, and the disease will develop again and consequently affect other children, even if there has been community awareness of the disease. Several authors point to poverty, food insecurity, hunger, lack of schooling and access to hospital services as determinants of malnutrition.

In this research, in a qualitative analysis, the sociocultural influence is determined as being one of the main factors in the prevalence of any disease, which can be more fatal to the extent that tradition, for example, is privileged over modernization by the community, and the conception of phenomena is insignificant, impacting on dyslexia due to the lack of understanding and misinterpretation of facts as time changes. "The prevention and control of malnutrition depends on broader and more efficient measures to combat poverty, hunger and social inclusion policies" (5). This means that the active participation of the target group, health professional technicians, and community dynamics in civilization, socialization and perception of phenomena in order to respond and correspond to the efforts made to combat malnutrition and any disease are factors that must be privileged, carefully analyzed and well structured.

The compression of different thoughts individuals within a society is a focal point for knowing how to deal with different individuals and follow up on sustainable development. In all programs and events involving human beings, it is imperative to carefully understand the particularities of each individual, from their culture, religion and beliefs, which will interfere with their behavior in any situation, whether it be socialization or civilization, which is worse when the information is not well explained and understandable to the target group.

In Mozambique, especially in rural areas, the use of tradition in the treatment of illnesses is still a reality that is passed down from generation to generation because it is believed that most illnesses that manifest in the family are associated with witchcraft.

Man by nature is a more complex being and his vital processes are difficult to understand. He can be understood as a phenomenon influenced by various socio-cultural factors that are reflected in his ethics and morality. Every individual is born, grows up and lives according to the values and customs of the social system they are part of, created from generation to generation, and their behavior and beliefs are assimilated through social interaction (6).

Each individual's culture is seen as an identity that represents their personality. Each society has its own culture, identified by the individual's behavior, which reflects their habits, social rules, intuitions, relationship with other social groups, following standards and norms that will influence them as they decide how to change (6, 7).

The notion of the individual is deeply historical. It is believed that man was submissive to the collectivity in which he was inserted, to relations of tradition, customs and a role previously determined by his birth, where life was organized by rigid and collective institutions that even today on certain campuses are more privileged, these statements dictate the individual behavior in his relationship with tradition, obedience, transformation and civilization (8).

Socialization consists of social learning, through which we learn social behaviors that are considered appropriate (7). Therefore, the conception of different thoughts as a set of criteria that regulate social life, especially when it comes to aspects that involve the transformation of a society, is very important for establishing fair relations, justice and the well-being of all.

If the target group is not carefully understood, the process of modernization and civilization may not be successful, simply because this group is immersed in models that are based on traditionalism and localism, even worse when local representatives are not part of this process. Although this is not straightforward, another determinant that forms part of the process is the level of education of the target group, which influences the understanding of phenomena and the interpretation of facts.

"Looking at the evolutionary processes of health, it has always been defined as the absence of disease or physical defects in the human body. This ranges from traditional magical-religious, cultural, mythological, modernization, civilization and socialization, passing from generation to generation, "through the simplistic conception of the absence of disease, the perception of facts, to the more comprehensive conception adopted by the World Health Organization" when these concepts are well introduced and familiarized in social life" (9, 10).

In this evolution, health was seen as a right of workers as a way of guaranteeing social insurance and keeping workers to benefit from good hospital care while those who didn't work always had precarious care (10, 11). It should also be noted that hospital services arrived late in rural areas, which further strengthened the rural community's idealization of hospital services as being only for the ruling class and a group of prominent people, and that in rural areas, services are always precarious, and it is only worth staying or resorting to tradition or dyslexia in the treatment of illnesses.

These facts may be the reasons why when it comes to health services or programs, rural communities have always felt excluded, which influences the lack of attention and follow-up treatment and the application of containment and prevention measures, not only in the field of malnutrition, but also in other diseases such as HIV-AIDS. However, putting these theories from different authors and the critical and empirical analysis, in the context of the view of different health processes, food or nutrition, disease and the demand for modern public health services, can be disturbing and not a priority for many, especially in rural areas, assuming it to be something normal, magical and spellbinding.

From this perspective, seeking health services has been seen as the last option, especially in rural areas, when a person is seriously ill, which leads to less efficiency and effectiveness of the different activities carried out to solve the public health situation. The community's understanding of malnutrition as a disease, its fatal course and that good nutrition or food is one of the main pillars for human physical and psychomotor development and can reduce the worsening of other diseases such as HIV-AIDS is the main key to success in dealing with and reducing cases of malnutrition in Mozambique and in the world, especially.

"Food insecurity, quality of life, very low food quality and quantity, poor access to drinking water sources, improved sanitation, access to treatment and health services, high levels of illiteracy in women, especially in sub-urban and rural areas, are indicators of the factors behind the high prevalence of infectious diseases and malnutrition in various communities" (2).

Adequate food is a fundamental human right, inherent to the dignity of the human person and indispensable to the realization of the rights enshrined in the Federal Constitution, LAW No. 11.346 of 2006, and the public authorities must adopt the policies and actions that are necessary to promote and guarantee the food and nutritional security of the population, community participation, transparency and cultural understanding of the public, in this process is to be based on the implementation of public health policies and sustainable strategies (12).

Food is a human right, i.e. choosing food out of biological necessity (13). Food security is treated as a question of insufficient availability of food capable of satisfying needs over many seasons, and can also refer to food insecurity due to poor use of food, food processing and food preservation. Malnutrition can also be the lack or excess of nutrients in the body, while hunger is the need or sensation of the body needing to be supplied with nutrients through food intake.

In short, good health is a human right, as is good nutrition to ensure social well-being and sustainable development. Failure to take this into account is practically unattainable and is considered a crime against human rights under the Human Rights Regulations (12).

Socio-cultural factors (localism and traditionalism) can lead to a delay in changing the way people are, and the way they socialize, combined with illiteracy, myths, fables, taboos, habits and customs. Looking at the life of the society studied, it can be believed and concluded that all families have at least two to three meals a day. What can be questioned is the lack of correct application of the few foods around them in order to have a healthy and balanced diet.

The other aspect that arises is the mental poverty of societies. In rural areas, on the other hand, mental poverty and negligence lead to failures in progress and diathesis in decision-making, to the detriment of the illiterate society, which has a tendency to assume, comply, create curiosity and follow developments and updates in its day-to-day life, putting all its learning into practice.

There is a difficulty in justifying the high levels of malnutrition in the district of Angónia since it is considered one of Mozambique's granaries. Furthermore, in rural areas you don't pay for energy, water, vegetables, maize, meat, among other things, what you need in economic terms are basic products such as rice, oil, soap, sugar, salt and phosphorus, to the detriment of urban areas where everything depends on economic conditions, but when evaluating cases of malnutrition, rural areas have higher levels of malnutrition compared to urban areas.

If the factors that are considered to be the protagonists of malnutrition have already been identified and nothing changes for the better, allowing for a more comprehensive understanding and perception of the phenomenon, as is the case in Angónia, which is one of the granaries of Mozambique's agricultural surpluses, the great challenge is to find the real problems, starting from the base and the communities where food is available, in order to study how mitigation programs are received and how malnutrition is understood, This is the responsibility of academics, researchers and the entire community with a social responsibility to try to understand how the world is and how it acts in the face of any situation and what its problems are and how to solve them.

Methodology

The research was conducted in Tete province, central of Mozambique, in Angónia district, Mateus Sansão Muthemba, Mphatamanga and Natcholi. Angónia is located in far north of Tete province, about 230 km from the capital city, at an altitude of 1,300 m, between parallels 14º 46'and 15º 14'South and between meridians 33º 46'and 34º 54'with an area of 3,427 km squared. It is bordered to the north and northeast by the Republic of Malawi, to the south and southeast by Tsangano District across Máue River, and to the west by Macanga District (14).

Figure 1 Map of Angónia district.

The choice of three localities followed the criterion of having the highest number of malnutrition cases per locality in district. According to the register map of malnutrition cases in Angónia District Health, Women's and Social Welfare Service. 23 families were selected from Mphatamanga locality, 25 from the Mateus Sansão Muthemba locality, and 30 from the Natcholi locality at random in different villages, totaling 78 families. This selection was based on the causal approach where the family that was found present in their home was interviewed.

For this purpose, se used a descriptive and qualitative methodology with the help of a survey, bibliographic review and direct participation, adopting the probabilistic method, to understand the idealism of each family in different locations from the point of view of their perception and conception of malnutrition and how they act in the face of malnutrition. The interview was conducted with a group of individuals aged between 13

and 50 (women and men). This criterion was drawn up because in these localities individuals of the above age were found with children under 5 years of age.

The survey was conducted on sheets of paper with well-structured closed and open questions to better gauge accessibility and their individual views on malnutrition. The questions were asked in the local language and Portuguese to make it easier for the target group to understand, as they have little schooling.

The interview ended with the following questions: Have you ever heard about malnutrition? What is malnutrition? How does malnutrition manifest? What causes malnutrition? What do you understand about hunger? Have you or someone else in your family or someone you know suffered from malnutrition? How was the person cured? Have you received instruction on preventing and containing malnutrition? How often have you participated in malnutrition programs? Do you trust and believe in hospital services? Why? How often do you go to the hospital when you or someone else in your family is ill? What type of treatment, between traditional and hospital-based, is most effective in treating illnesses? What is your level of education? What is your source of income? How many meals do you eat a day?

The data was submitted to the Microsoft office Excel version 2016 statistical system for processing and was calculated as a percentage and the variables were analyzed descriptively, interpreting and analyzing the interview data by constructing a grid of the answers, which allowed for the identification, grouping of similar and contradictory answers and the presentation of the results in a critical analysis.

In Angónia, there are around 444,613 inhabitants, most of whom are in rural areas with a low level of education. It is estimated that in every 10 homes more than 80% of the population has less than 10 years of schooling and those who claim to have studied can neither write nor read, and their source of income is rain-fed agriculture.

Results and discussion

After investigating the community's ideological conception of malnutrition and medical treatment in rural areas, it emerged that families in rural areas of the Angónia district are made up of between 3 and 10 members in all the neighborhoods studied, of whom 69.2 and 91.5% have not attended secondary school.

Table 1 Characterization by locality of families number (F) interviewed, level of education, source of income and total household (h) by zone. Own elaboration.

Localities	Number of F Interviewed	Schooling (%) < 10, > 10 class	Source of Income (%)	Total Family Household
Mphatamanga	23	< 69,2	100 (Agriculture)	125
Mateus Sansão Muthemba	25	< 95	100 (Agriculture)	138
Natcholi	30	< 91,5	100 (Agriculture)	180
Total	78	----------	100	**443**

Table 1, illustrates the results obtained in the survey for the variables of education level and source of income. In a universe of 78 interviewees, there was a high number of 91.5% in Mphatamanga, followed by 95% in Natcholi and 69.2% in Mateus Sansão Muthemba, of individuals with a low level of grade 10. Of these individuals, including

those above grade 10, it was found that 95% have problems reading and writing, or rather, can neither read nor write. On average, 100% of those interviewed live off dryland farming.

In a critical and empirical analysis looking at these results, the lack of schooling or the ability to read and write in an individual is a serious problem worldwide that can destroy a country or a society even if it has all the resources for its development. Education is the marma of development used worldwide in reference to Smith, David and Marx insofar as it facilitates the understanding of facts and the interpretation of phenomena.

Table 2 Percentage of individuals with no good perception of malnutrition, no trust in hospital services, no follow-up of hospital care and daily number of meals taken by each family.

Localities	Number of women interviewed	Conception of malnutrition	Trust with hospital services	Follow-up with hospital recommendation	Number of meals (day)
Ulónguè	23	86, 24%	46, 41%	37, 22%	94, 24% > 3 vezes
Domue	25	89, 15%	55, 24%	46, 00%	92, 41% > 3 vezes
Maue	30	91, 11%	76, 23%	49, 91%	81, 40% > 3 vezes
Total	78	----------	----------	----------	----------

According to the table above, the results show that in all the localities studied, an average of 89.35% of individuals have three meals a day, which shows a capacity and guarantee of the existence of minimum conditions for survival and the guarantee of the human right to food. Based on the results, it can be said that food insecurity due to food shortages may not be the real cause of the prevalence of malnutrition in Angónia when looking at the percentage of individuals who have three meals a day. This is a district that is a breadbasket for Mozambique's agricultural surpluses, emphasizing the importance of the inductive attributions of the existence of food in the district, but conclusions were drawn about the lack of knowledge of preparation techniques and the importance of food.

The interviewees claimed to be aware of the existence of malnutrition and to participate in malnutrition programs whenever possible. However, it was found that on average 44.37% of those interviewed do not follow hospital recommendations and 59.29% have no confidence in hospital services. These statements were made because there was allegedly social exclusion, a lack of good care in hospitals, a shortage of medicines and claims that it is difficult to follow hospital recommendations because they require patience, time and economic conditions.

The community studied showed dissatisfaction, which creates resistance to making decisions to adapt to modernization, which is associated with civilization and socialization. They also stated that the health technicians have developed nutritional education lectures using local material, coming to the conclusion that this community has a tendency to resist learning, dyslexia, ignorance, localism and traditionalism.

Similar results were found in a study of factors determining the level of adherence and follow-up to schizophrenia treatment, which concluded that around 50% do not follow or adhere to treatment (15).

"Increasing adherence depends a lot on improving the doctor's communication with his patient, if communication is poor especially when it addresses practical aspects of the condition or disease and its treatment and palpable side effects, this reveals that

the problem may not be solved, however, they show that socioeconomic variables, cultural and habit variables may have a stronger association with the level of adherence than those related to the disease or the treatment" (16) this thought reinforces the results found in this study taking into account that the interviewees relied on a lack of trust with hospital services showing a strong relationship with traditional treatment.

Other factors that "fail to address decisive issues for patient adherence are people's expectations about the treatment, side effects ("palpable effects"), life expectancy, and what kind of life we are talking about when it comes to malnutrition, are not mentioned, benefits of the proposed treatment are not always clear to people, (17) On the other hand, the empathy of the health workers and the direction of a good word for the patient can influence them not to adhere and even those who have already been there to start their treatment may not return to the hospital, worse when it comes to people from rural areas and with a low level of education.

It was found that around 88.83% of those interviewed confuse malnutrition with hunger, they believe that malnutrition does not exist if it is not hunger, if malnutrition existed due to a lack of food consumption or inadequate food consumption, according to the speculations and statements made by health technicians that malnutrition occurs due to a lack of food, then in 1990 to 1991 there would have been no one left due to malnutrition.

They claimed that at that time, hunger was greater than it is today, because at that time health services had not evolved and did not exist in many corners of the country, but thanks to tradition, various illnesses such as debilitation, blood replacement through roots and leaves, measles, diarrhea and other illnesses were overcome through traditional treatments, which is why tradition is better than hospitals where they only give paracetamol and always complain about a lack of medicines.

They went to say that a person can only suffer, lose strength and lose weight due to hunger and other illnesses, such as blood loss due to a spell, and that there is no justification for the possibility of losing blood naturally, which is already in the body without any magic or spell.

They said that malnutrition doesn't exist, it's just that the government is trying to maneuver people, monopolize systems and embezzle funds in the name of the people and in the name of malnutrition. They categorically showed that they believe in traditionalism and localism and that proper treatment in hospitals is currently for a certain group of prominent individuals, those who don't have money have always been an obstacle in health centers, currently to be attended you need to carry a sum of money to give the doctors or have an acquaintance which makes it difficult for rural communities.

In the classic study of hypertensive patients by Wilber and Barrow (1972), cited by Hart (1992), it was shown that half of hypertensive patients do not know they are hypertensive, half of those who know they are hypertensive do not treat it and half of those who are treated are not controlled. The same study extrapolates the same rule to patients with asthma and concludes that only 12% of people with chronic diseases are fully diagnosed, treated and monitored" (17). It can be considered that adherence to treatment comes from the conduct of the patient in making decisions under socio-economic, cultural, civilization, socialization, perception and conception influences of any phenomenon.

In a study of local interpretations of malaria and the discourse on traditional healthcare providers in the south of Mozambique in Chókwè, three healthcare providers were identified, the hospital doctors, Zione (church like healers) and witchdoctors, who in these societies treat the disease as being of sorcerous origin. The treatment of diseases has often been done by tradition because it is believed that in the *Zione* and the witchdoctor the spirit that causes the disease is extracted from the body and there are indications from the witchdoctor that it is worse when this witchdoctor is trusted to bring positive results (18).

Some interviewees also said that they had witnessed family members and other people they knew suffering from malnutrition. However, in order to be out of danger, they said they had used traditional means, others said they had used both because they had not had good results in hospitals after the technicians said it was malnutrition, others said that after going to hospital without success, they had stayed at home and the disease had gone away without any other treatment.

With regard to instructions for preventing and containing malnutrition, some said that whenever they go to health centers with children, they are told to fight malnutrition.

Regarding the frequency of treatment for illnesses in hospital while they are ill and the efficiency of traditional and hospital treatment, some said that they always go to hospital, while others said that it depends on the illness. When a person is very serious, it is best to have traditional and hospital treatment, because of Africanism, where there is illness, magic is never lacking, leading doctors and pills to be unable to treat the illness and alleviate the illnesses, highlighting the importance of traditional treatment.

In Mozambique, in most communities, myths, fables and the use of tradition in the treatment of diseases is still a caustic problem, especially in rural areas, which reinforces the need to invest in grassroots work and programs to transform the traditionalist community mindset and localism into a civilized and modernized mindset. This mentality has slowed down the development of many societies, culminating in the neutralization and overburdening of governments and health-related programs to reinforce public health programs.

Civilization and socialization, especially in rural areas, is still one of the biggest constraints, and one of the factors is that it affects various communities in different corners of the world in different areas such as perception, ideological conception of any disease, the way of eating and treatment of diseases.

Nowadays, there is a lot of idealism in rural communities about continuing to believe in their traditions and social influences, as well as in the academic community about the persistence of disease, hunger and other obstacles that affect communities. Despite the various works carried out aimed at mitigating these obstacles that plague communities, there are still many doubts and questions about the realities experienced worldwide. Although the use of traditional medicine is currently acceptable because traditional medicine plants are part of modern medicine in the treatment of diseases and the manufacture of drugs, these facts put the research community in a panic and a question mark.

The results described here regarding the points (negligence, perception, conception, civilization, socialization, traditionalism, localism and lack of application of correct techniques in the use of food) do not give affective conclusions as the main factors in the prevalence of malnutrition in Angónia or Mozambique, they only provide an overview of some of the factors that influence the prevalence and persistence of

malnutrition, and it is up to the various intellectuals to carry out an in-depth analysis and basic study into how beliefs, myths, the use of tradition, among other factors mentioned above, influence society and affect public health and the decision-making of societies in terms of resilience and nutritional sustainability.

Malnutrition has become a worldwide concern, the WHO and health ministries in general have developed preventive actions, while malnutrition shows progression rather than reduction, which has led nutrition to achieve worldwide recognition in recent years for emphasizing the importance of healthy eating in promoting public health and expanding hospital networks and health services closer to families and intensifying kinetic and scientific research (19).

These services provide subsidies for strategic food planning, appropriate use of food as a health promoter, efficient care and availability of health services, reducing the risk of illness and seeking to improve human well-being.

The level of malnutrition not only measures the degree of development, poverty and availability of food and the existence of good hospital conditions, but also measures the civilization of society, socialization, efficiency and effectiveness of the services developed at community level, adequate use of food and community participation, conception and perception of this phenomenon by communities.

Despite the many efforts made in the area of malnutrition, nutritional rehabilitation, nutritional resilience, nutritional education and the expansion of hospital services and networks, there are still high rates of malnutrition in the Angónia district and in Mozambique in general, ranging from 43% to 44% in all age groups (19, 20; 21). Combating any disease or situation requires everyone's involvement in order to emphasize certain activities that have been carried out successfully, so that they can help identify and contribute to assisting the activities of employees (3, 20, 21).

Several causes can be related to the occurrence of malnutrition in children, such as: immediate, adjacent and basic causes. The main immediate causes of chronic malnutrition are inadequate nutrient intake, high levels of infection and early pregnancy (3). The underlying causes of chronic malnutrition are food insecurity (especially limited access to and use of nutritious foods), poverty and inadequate health care practices. The root causes of chronic malnutrition, in addition to poverty, include low levels of education and gender inequality (3).

Having observed that there are various activities being carried out in the community linked to malnutrition, if the projects (activities) are operating properly, the district is providing food and there is an expansion of the school network and health services, the evaluation of the precursor indicators that allow us to understand each person's vision and how each situation is conceived and dealt with by different individuals in the same community is fundamental for better dealing with any phenomenon or disease.

Conclusion

In Angónia, conception, perception of malnutrition, localism and culturalism are one of the main pillars of the prevalence malnutrition. Some 88.83% of 78 interviewees confuse malnutrition with hunger, and the majority of people believe that malnutrition does not exist unless there is hunger. If malnutrition existed, in 1990 to 1991 there would have been no one left because it was a time when hunger was greater than it is today and health services had not evolved and did not exist in many corners of the country.

These communities have shown that, for them, hospital services are a step backwards where they are only indicated for a certain group of prominent people. For them, traditional treatment has been the best since ancient times and they believe that all illnesses are associated with African magic and are only possible with the use of both tradition and the hospital, verifying a diversification in the conception, perception of malnutrition, evolution of the world and its effects, changing times and their consequences, the influence of mythology and culturalism and how each phenomenon is conceived in these localities.

Approximately 44.37% of individuals do not follow hospital recommendations and around 59.29% have no confidence in hospital services, pointing to social exclusion, lack of good care in hospitals and medicines, which forces communities to resort other means of treating illnesses and dyslexia and ignorance in following hospital treatments.

Therefore, the community in question shows trends of resistance in decision-making, modification, civilization and socialization, which can be associated with localism and traditionalism. These reasons can be seen in the perceived existence of work done by health technicians to raise community awareness and training in nutritional education, but the prevalence of malnutrition remains a concern.

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