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Adherence to the Mediterranean diet and frequency of food consumption in high school students in Valencia – Spain

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ABSTRACT

Introduction: Adolescence represents a crucial developmental stage for addressing and modifying eating patterns that may contribute to the prevalence of overweight and obesity.

Objective: The aim of this research was to assess adherence to the Mediterranean diet (AMD) and the frequency of food consumption among secondary school adolescents in Valencia.

Method: The PREDIMED questionnaire was utilized to evaluate AMD, in conjunction with a food consumption frequency questionnaire administered to a cohort of 166 students aged 12 to 17 years.

Results: The primary findings of the study reveal that AMD is unrelated to weight or sex, with a higher percentage of normal-weight adolescents exhibiting high AMD. Conversely, there are instances of overweight students with high AMD and obese students with low AMD. The high AMD cohort tends to consume fruits and vegetables only 0 to 2 days a week, while dairy products are consumed 6 to 7 times a week. In contrast, the low AMD group consumes nuts, legumes, fruits, and vegetables 3 to 5 times a week. Both groups demonstrate a low daily intake of foods high in sugar and fat, along with a similar consumption frequency of cereals, starch, and tubers, with a higher representation of 3-5 times per week.

Conclusion: The findings suggest that a high AMD does not necessarily correlate with good health. Other variables, such as dietary food frequency, play a significant role in determining weight for age. Similarly, a low AMD in conjunction with a diet rich in healthy foods can contribute to good health in students.

KEYWORDS

Adolescent Nutrition, food habits, dietary patterns, health promotion, balanced diet, diet quality, lifestyle, school health, public health

INTRODUCTION

Malnutrition, in its diverse forms, presents a substantial global public health challenge. Presently, there is a dual burden of malnutrition, encompassing undernutrition and overweight, particularly prevalent in low- and middle-income countries[1]. Inappropriate dietary practices are contributing to the escalation of overweight and obesity, which have significantly increased over the past four decades compared to undernutrition. In 2016, a significant global issue emerged as more than 340 million children and adolescents were affected by excess malnutrition, with a prevalence of 18-19% in adolescent girls and boys respectively. This issue intensified by 2022, with over 390 million children and adolescents aged 5-19 years experiencing overweight, of whom 160 million were obese[2]. In Europe, individuals aged 11-15 exhibited overweight and obesity rates ranging from 11-33% and 10-23% respectively, with the highest prevalence observed in Mediterranean countries[3].

The ALADINO study, which stands for Surveillance of Nutrition, Physical Activity, Child Development, and Obesity in

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Spain, has revealed that over 30% of children and young people are overweight or obese, with boys being the most affected[4]. The 2016 Valencian Community Health Survey shows that the rate of overweight and obesity among children aged 2-17 has decreased compared to the 2010 survey, with 11.5% and 16.3% being overweight, and 9.3% and 12% being obese[5]. However, despite this reduction, overweight and obesity continue to pose a significant public health challenge in 2022, affecting 30% of children and adolescents, with a higher prevalence in boys than in girls. In the context of adolescent health, while gender differences in overweight do not yield significant disparities, this is not the case with obesity, where boys exhibit a higher incidence compared to girls. Moreover, it is observed that excess weight carries a more pronounced negative social impact among individuals from underprivileged social backgrounds and those with lower educational attainment[6]. Hence, it is imperative to prioritize nutrition, followed by physical activity, to mitigate the rising rates of overweight and obesity among adolescents in specific national contexts.

In childhood and adolescence, the presence of poor habits, unhealthy lifestyle choices, and a high body mass index may contribute to adverse alterations in metabolism and physiology, potentially resulting in endocrine disorders associated with childhood obesity[7]. Dyslipidemia emerges as a significant indicator in this demographic, amplifying the susceptibility to cardiovascular diseases in adulthood, a major contributor to global mortality rates. In addition to physical health implications, excessive weight can precipitate psychological and social challenges, including anxiety, depression, and the potential onset of eating disorders[8]. The perception of body weight has been found to correlate with low self-esteem, dissatisfaction with body image, increased likelihood of binge eating, and heightened risk of anxiety and depression. In children and adolescents, this perception is associated with overweight or obesity, thereby amplifying the susceptibility to chronic diseases[9]. Addressing overweight in children and young people is essential to prevent the development of chronic diseases. It is estimated that targeting this issue could potentially reduce up to 80% of cases of coronary heart disease and 90% of type 2 diabetes. Additionally, these measures have the potential to prevent approximately 30% of cases of certain cancers[10].

The Mediterranean dietary pattern has been widely acknowledged as one of the healthiest eating patterns globally. Research indicates that this diet is abundant in fiber, antioxidants, and mono- and polyunsaturated fatty acids, while being low in trans-fatty acids and sugary products. This not only promotes healthy weight maintenance but also decreases the risk of cardiovascular and hypertension disease, subsequently leading to reduced mortality[11]. Moreover, some studies propose that the Mediterranean diet may serve as a protective factor for overall mental health[12].

When considering the well-being of children and adolescents, it is crucial to acknowledge their limited autonomy in shaping their lives, including their dietary choices. These decisions, with far-reaching implications for their future, are often influenced by parents, caregivers, community leaders, government authorities, obesogenic environments, influential international corporations, and business leaders pursuing commercial interests[13]. This situation gives rise to significant inquiries concerning the essential health policies and strategies required to effectively address this issue. Since the early 2000s, numerous strategies have been implemented globally. These include the World Health Organization's Global Strategy on Diet, Physical Activity and Health, the European Food and Nutrition Action Plan 2015-2020 in Europe, and in Spain, the NAOS strategy (Strategy for Nutrition, Physical Activity and Obesity Prevention) since 2015[14]. The objective of these strategies is to foster healthy eating, promote physical activity, and prevent obesity in the populace. Furthermore, this initiative aims to improve key metrics such as fruit and vegetable consumption, obesity prevalence, and levels of physical activity. It also engages in collaborative efforts with the food industry and promotes healthy behaviors within environments such as schools and workplaces.

METHODS

The current study utilized a quantitative approach with an observational-descriptive methodology and a cross-sectional design, involving data collection at a specific point in time, without intentional intervention or manipulation of the study variables.

Sample

The research was conducted with a sample of 166 participants selected using non-probability purposive sampling from two schools in Valencia, Spain. The participants were chosen based on availability as provided by the authorities of the educational institutions. At the first school, questionnaires were administered to students in the 1st to 3rd year of ESO (Compulsory Secondary Education), while at the second school, students in the 1st and 2nd year of Baccalaureate were included. The questionnaires were developed for the purpose of assessing adherence to the Mediterranean diet (AMD). Additionally, participants were required to visit the Hospital Universitario y Politécnico La Fe in order to undergo measurement of their anthropometric data, encompassing weight, height, and body mass index. For the interpretation of anthropometric data, we used the World Health Organization's Z-score for child growth patterns based on BMI-for-age. The classifications are as follows: between 1 and - 1 (Normal weight), >1 or 2 (Overweight), >3 (Obesity), -2 (Acute malnutrition), -3 (Chronic malnutrition). Data collection was conducted by healthcare staff in the educational centers. The database created from this data collection was utilized for the research. Prior to participation, both the participants and their

legal representatives were duly informed about the studies objectives and provided their consent by signing an informed consent form prior to their involvement.

Adherence to the Mediterranean diet

To evaluate adherence to the Mediterranean diet, we employed the validated PREDIMED - prevention with Mediterranean diet-[15] and Food Consumption Frequency questionnaires[16]. The PREDIMED questionnaire, comprising 14 questions, is utilized to assess adherence to this dietary pattern by examining the consumption of foods characteristic of the diet. This includes high intakes of olive oil, vegetables, pulses, fish, nuts, white meat, and the use of sofrito (a mixture of onion, tomato, garlic, and leek cooked with olive oil). Additionally, it takes into account moderate consumption of red meat, processed meat, butter, margarine, cream, sugary drinks, wine, and non-homemade pastries. A score of 9 or above on this instrument indicates strong adherence to the Mediterranean diet. Owing to the reliability of its results, this tool has been extensively utilized in research[17,18]. The Food Consumption Frequency Questionnaire is composed of 45 items that inquire about the weekly frequency of consumption of various foods. This instrument enables the assessment of the habitual consumption of different food groups. The analysis of the Mediterranean diet encompassed various food groups, including Cereals, starch, and tubers (such as whole bread, rice, and pasta, and potatoes), Dairy products (including milk, yogurt, and cheese), Nuts (such as different types of nuts), Foods high in sugar or fat (e.g., chocolates, sweets, ice cream, and bakery products), Legumes (encompassing different types of legumes), Meats (encompassing fish, seafood, poultry, and beef), and Vegetables and fruits (encompassing various types of fruits, vegetables, and salads). The Drinks category was excluded from the analysis due to the inclusion of alcoholic beverages, which do not align with the study's focus. Furthermore, the Other Products category was omitted because it encompassed a heterogeneous mix of healthy and unhealthy foods. Nevertheless, questions regarding these categories were incorporated to offer additional context and enrich the discussion. Furthermore, it has been extensively utilized in academic research due to its ease of reproducibility and validity[19-21].

However, one of the main limitations of this study is its observational nature, which may introduce some ambiguity and subjectivity. The accuracy of the responses provided is assumed, but cannot be guaranteed. Therefore, this type of study should be viewed as generating hypotheses that need to be tested in clinical trials.

Statistical Analysis

To analyze the anthropometric data and the results of the Mediterranean diet adherence questionnaire, the study employed descriptive statistics and Pearson's correlation test with a 95% confidence level. The analysis was conducted using SPSS v.25 for Windows (Statistical Package for the Social Sciences; Chicago, Illinois). Data from the PREDIMED questionnaire and the Food Consumption Frequency Questionnaire underwent analysis utilizing R software (version 1.1.456 - 2009-2018 RStudio, Inc.) and the Tidyverse package. Bar charts were generated to visualize the distribution of consumption of various food groups in relation to adherence to the Mediterranean diet, employing the ggplot2 library. Furthermore, to achieve a more comprehensive analysis of factors linked to food consumption, models were fitted using the lme4 package.

Ethical aspects

This study received approval from the Ethics Committee of the University of Valencia under procedure number HI549632894683. The approval confirms that the research adheres to the principles outlined in the Declaration of Helsinki, the Council of Europe Convention on Human Rights, and the current regulations in Spanish legislation regarding biomedical research, personal data protection, and bioethics.

RESULTS

Table 1 presents the analysis of socio-demographic data from a sample of 166 participants, indicating that 44.5% (n=74) were male and 55.4% (n=92) were female, aged between 12 and 17 years. Notably, 68.6% of adolescents, encompassing both genders, demonstrated high AMD, while

Table 1. Adherence to the Mediterranean diet and body mass index

Adherence	High ADM		Low ADM		p.v
	%	n	%	n	
BMI Ranges					0.116
Thinness	0	0	3.8	2	
Underweight	7	8	3.8	2	
Normal weight	71.1	81	69.2	36	
Overweight	14.9	17	9.6	5	
Obesity	7	8	13.5	7	
Sex					0.691
Male	45.6	52	43.3	22	
Female	54.4	62	57.7	30	

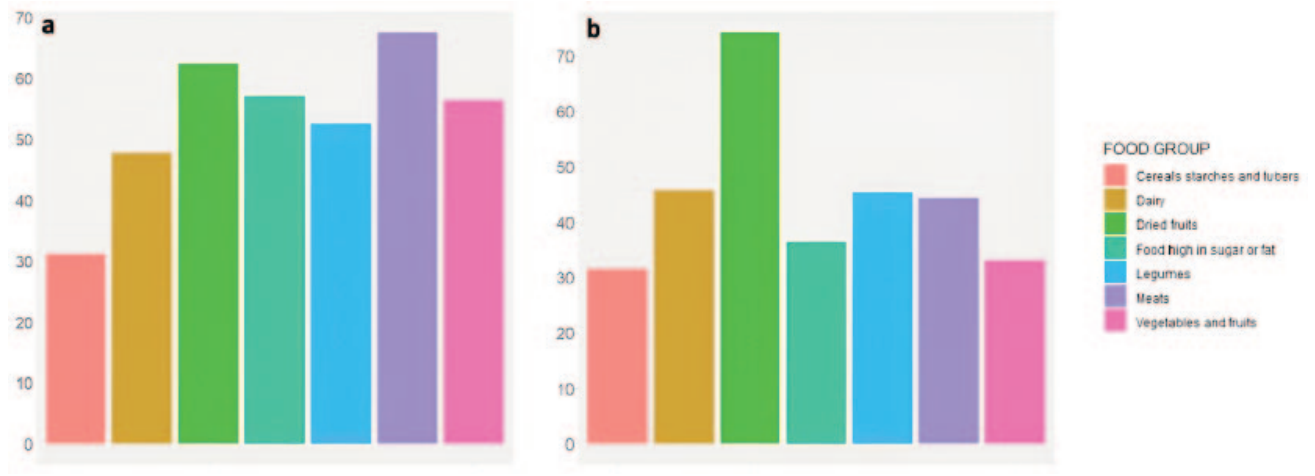
AMD: adherence to the Mediterranean diet. BMI: body mass index. Pearson's correlation test at 95% confidence level. p.v: *p*-value.

31.4% exhibited low adherence. The research findings indicate that there is no statistically significant association between adherence to the Mediterranean diet (AMD) and body mass index (BMI). The data suggests that a majority of individuals, irrespective of their AMD level, maintain a normal weight. Among those with high AMD, 14.9% were found to be overweight, while in the low AMD group, 13.5% were classified as obese. Notably, thinness was not prevalent in either group. Furthermore, the analysis revealed no significant variations in the variables, thus establishing that AMD does not exert an influence on body weight, regardless of gender.

In Figure 1, the depicted data illustrates the dietary habits of individuals with high and low AMD in relation to the consumption frequency (0-2 times per week) of specific food groups. The data reveals that 56.5% of the high AMD group consumes vegetables and fruits only a few times a week, while this figure stands at 33.1% in the low AMD group. Furthermore, the high AMD group exhibits a higher prevalence of consuming other healthy food groups, such as dairy, nuts, legumes, and meats, only 0-2 times per week (47.7 - 67.6 - 57.1 - 52.5%), as compared to the low adherence group (45.8 - 44.4 - 36.4 - 45.4 %). In contrast, the low AMD group (74.3%) consumes unhealthy foods high in sugar or fat only twice per week, whereas the high AMD group (62.5%) also consumes them twice per week. This indicates that the low AMD group consumes a lower quantity of superfluous foods throughout the week. Similarly, the intake of cereal, starch, and tubers demonstrates a comparable pattern, with both groups consuming these foods twice a week (31.2 y 31.5 % for high and low adherence respectively).

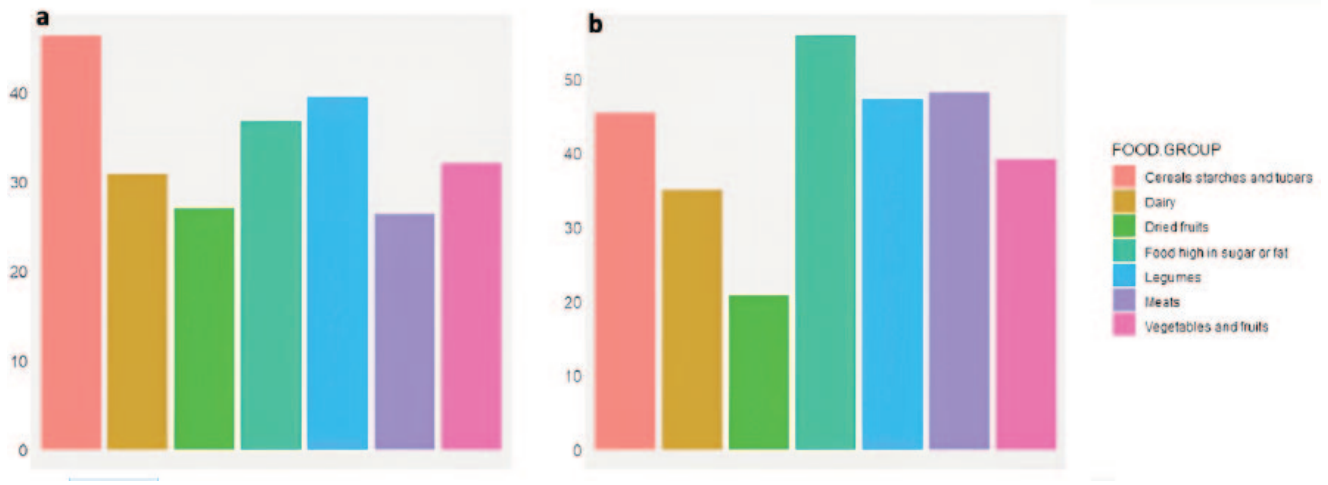
Figure 2 depicts the dietary patterns of individuals with AMD, showcasing their consumption of foods 3 to 5 days per week. The data reveals that adolescents with low adherence to the Mediterranean diet exhibit a higher frequency of consuming nuts (48.2% compared to 26.4% in high adherence) and legumes (55.9% compared to 36.8%) within the 3 to 5 times per week range. Moreover, the consumption of nutritious foods such as dairy, legumes, and vegetables and fruits 3 to 5 times per week is more prevalent in the low AMD group (35.1 - 55.9 - 39.2%) than in the high AMD group AMD (30.9 – 36.8 – 32.1%). In the other hand, the high AMD group (27%) demonstrates a higher frequency of consuming foods high in sugar or fat (3 to 5 times a week) compared to the low AMD group (20.8%). This implies that low AMD adolescents have a lower frequency of consuming unhealthy foods 3 to 5 times a week compared to high AMD adolescents. Additionally, both groups exhibit a similar percentage of intake of cereals, starch, and tubers (46.4 – 45.4% for high and low adherence respectively).

Figure 3 illustrates that both the high and low AMD groups have a higher frequency of food consumption, specifically 6 to 7 times per week. It is noteworthy that the low AMD group exhibits a higher intake of vegetables and fruits per week, constituting 27.7%, in contrast to the high AMD group at 11.4%. Moreover, adolescents with high AMD demonstrate a higher consumption of dairy products 6 to 7 times a week, with percentages of 21.4% and 19.2% for the low adherence group, respectively. Healthy foods such as nuts, legumes, and meats have similar consumption rates in both the low AMD group (7.7 - 7.7 - 7.4%) and the high AMD group (6.1 - 6.1 - 8%). When analyzing the almost daily consumption of differ-



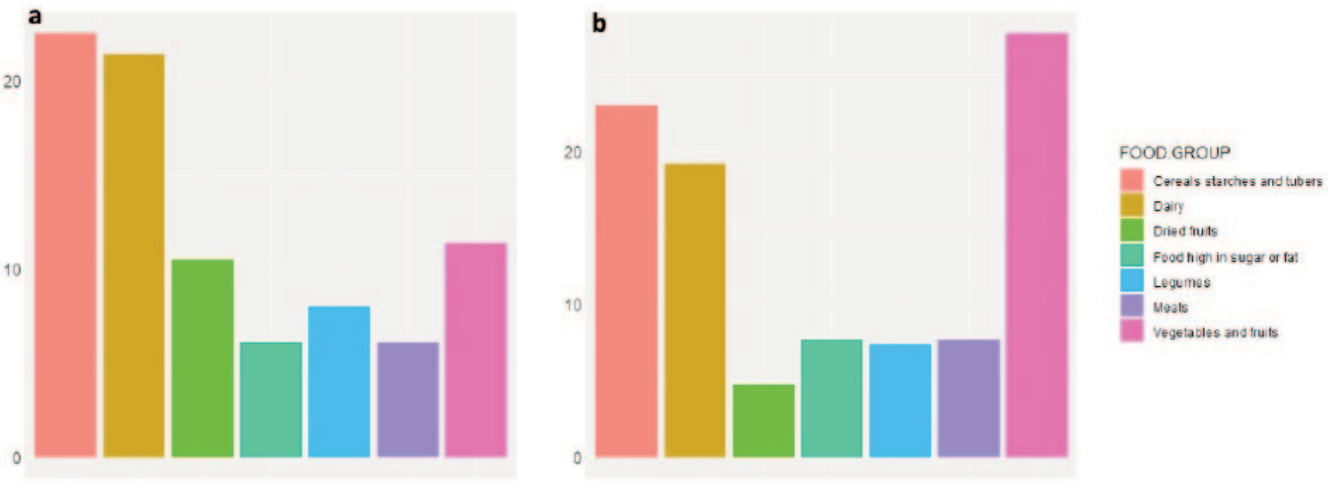
a: Group with high adherence to the Mediterranean diet. **b:** Group with low adherence to the Mediterranean diet. The vertical axis indicates the percentage of adherence to the Mediterranean diet.

Figure 1. Adherence to the Mediterranean diet and frequency of food consumption 0-2 times per week



a: group with high adherence to the Mediterranean diet. **b:** group with low adherence to the Mediterranean diet. The vertical axis indicates the percentage of adherence to the Mediterranean diet.

Figure 2. Adherence to the Mediterranean diet and frequency of food consumption 3-5 times per week



a: group with high adherence to the Mediterranean diet. **b:** group with low adherence to the Mediterranean diet. The vertical axis indicates the percentage of adherence to the Mediterranean diet.

Figure 3. Adherence to the Mediterranean diet and frequency of food consumption 6-7 times per week

ent food groups, there is low consumption of foods high in sugar or fat, with 4.8% for the low adherence group and 10.5% for the high adherence group. Similarly, in the 0 to 2 and 3 to 5 groups, the consumption of cereals, starch, and tubers shows a similar percentage of consumption (22.5 – 23% high and low adherence respectively).

DISCUSSION

The anthropometric data obtained from this study indicates that the majority of adolescents (70%) fall within the normal weight range. This is consistent with findings from diverse regions in Europe, which suggest a decline in the prevalence of overweight and obesity within this demo-

graphic[22]. The ALADINO study further reinforces this trend by demonstrating a reduction in excess weight since 2011, with stabilization observed between 2015 and 2019[23]. Furthermore, the Valencia Health Survey reveals low levels of overweight (less than 20%) and obesity (less than 10%) among adolescents, consistent with the results of our study, which found an average of 10% obesity and 12% overweight in this population[6]. In addition, numerous studies have indicated that overweight tendencies often manifest during childhood and persist into adolescence and adulthood. For instance, Geserick et al. observed that 90% of children with childhood obesity continued to exhibit the condition during adolescence[24]. Furthermore, additional research suggests that a significant proportion of overweight adolescents are predisposed to remain overweight into adulthood, consequently heightening their susceptibility to chronic non-communicable diseases[25].

The findings of this study revealed that 68.6% of adolescents exhibit a high adherence to the Mediterranean diet. Research conducted across several Spanish provinces, including Valencia, demonstrated that the majority of adolescents consistently adhere to this dietary pattern[26]. However, when adherence was analyzed in relation to body mass index, the findings indicated that adolescents with a higher adherence to the Mediterranean diet also had higher prevalence of obesity compared to those with low adherence. The apparent contradiction of this finding in relation to the traditionally associated weight control benefits of the Mediterranean diet may stem from unaccounted factors such as varying levels of physical activity, specific dietary consumption patterns, or disparities in the perception and reporting of food consumption. These results underscore the imperative for further investigations to elucidate the underlying factors contributing to this unexpected association. The influence of the Mediterranean diet on excessive weight has been established, indicating that optimal adherence to this diet may play a crucial role in disease prevention and maintenance of a healthy body weight. However, it should be noted that the Mediterranean diet is not the sole solution for addressing malnutrition[27]. Furthermore, recent research suggests that there is not a significant correlation between this type of diet and body weight[28].

In the context of dietary intake, it is pertinent to highlight that the regular consumption of fruits and vegetables by adolescents who closely adhere to the Mediterranean diet aligns moderately with the stipulated dietary standards. The Mediterranean diet advocates for a daily intake of 2 to 3 servings of fruits and vegetables, whole grains, as well as daily portions of dairy products, nuts, and olive oil, among other components. Furthermore, it recommends a weekly consumption of 3 to 4 servings of fish, 1 to 2 servings of eggs, and 1 serving of non-lean and red meats, with occasional indulgence in sweet food products[29].

The research reveals a marginal 9% variance in the non-adherence to the Mediterranean diet among adolescents, specifically in the consumption of fruits and vegetables. This trend is observed across multiple food categories, including dairy products, starches, cereals, tubers, nuts, and pulses. These results are consistent with the findings of Grams et al. (2022), indicating that Spanish children exhibit adequate intake of fruits, vegetables, fish, and dairy products, irrespective of their adherence to the Mediterranean diet[30].

The consumption of non-essential foods, such as chocolates, biscuits, cakes, and ice cream, is prevalent among adolescents with high adherence to dietary guidelines, often exceeding a frequency of three times a week and occasionally being consumed daily. This dietary behavior runs counter to the principles of the Mediterranean diet and suggests a shift towards a more Westernized dietary pattern. The consumption of these non-essential foods, particularly those classified as ultra-processed, has raised concerns in Spain due to the high sugar content present in over 80% of these products[31]. A meta-analysis has indicated a correlation between free sugars in the diet and their impact on blood pressure and serum lipids[32]. Moreover, adolescents with high adherence to ultra-processed foods tend to consume a greater quantity of beverages, including soft drinks and alcoholic beverages, compared to those with low adherence. It is essential to recognize that these beverages contribute significantly to the intake of empty calories and free sugars within this food category.

Based on the data presented, it is suggested that although Mediterranean countries exhibit a higher prevalence of overweight, adherents of a Mediterranean diet appear to face a reduced risk of developing coronary heart disease in the future, provided they adhere to the appropriate dietary guidelines[33]. It is important to note that persistent consumption of sugar-rich ultra-processed foods, as observed in the present study, may lead to additional health complications, even among those following a Mediterranean diet. It is imperative to consider that adolescence plays a pivotal role in shaping and modifying changes in both personality and lifestyle, as these dietary and physical activity patterns tend to persist into adulthood.

CONCLUSIONS

The study underscores a paradox in the adherence to the Mediterranean diet among adolescents. It reveals that while a significant proportion of those with high adherence restrict their consumption of superfluous foods high in sugars and saturated fats, they do not meet the recommended frequency of consumption for essential healthy foods such as fruits, vegetables, legumes, and nuts. This inconsistency suggests that self-reported high adherence does not necessarily correspond to an optimal dietary pattern, potentially contributing to the co-occurrence of overweight and obesity in this demographic. Inadequate consumption frequency of healthy foods may compromise the potential health benefits of the Mediterranean diet

and have adverse effects on the anthropometric indicators of adolescents.

Additionally, it was observed that adolescents with low adherence exhibited, in certain instances, a heightened frequency of consuming specific healthy foods. This raises questions about the reliability of using adherence classification as a predictor of a healthy dietary pattern. This finding underscores the necessity of redefining adherence assessment criteria to encompass not only the diversity of foods consumed, but also the frequency of consumption.

In light of these findings, it is advisable to implement educational and intervention strategies aimed at not only promoting adherence to the Mediterranean diet, but also ensuring an adequate frequency of consumption to maximize its benefits. Further research is imperative to explore the underlying factors contributing to suboptimal consumption frequency in adolescents with high adherence to the Mediterranean diet, with the aim of establishing more precise guidelines to steer this demographic towards a genuinely healthy dietary pattern. These endeavors are crucial for enhancing the long-term health of adolescents and mitigating the onset of chronic diseases in adulthood.

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