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Revisión

KIDMED test; prevalence of low adherence to the Mediterranean Diet in children and young; a systematic review

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Abstract

Introduction: **during the last decades, a quick and important modification of the dietary habits has been observed in the Mediterranean countries, especially among young people. Several authors have evaluated the pattern of adherence to the Mediterranean Diet in this group of population, by using the KIDMED test.**

Objectives: **the purpose of this study was to evaluate the adherence to the Mediterranean Diet among children and adolescents by using the KIDMED test through a systematic review and meta-analysis.**

Methods: **PubMed database was accessed until January 2014. Only cross-sectional studies evaluating children and young people were included. A random effects model was considered.**

Results: **eighteen cross-sectional studies were included. The population age ranged from 2 to 25 years. The total sample included 24 067 people. The overall percentage of high adherence to the Mediterranean Diet was 10% (95% CI 0.07-0.13), while the low adhesion was 21% (IC 95% 0.14 to 0.27). In the low adherence group, further analyses were performed by defined subgroups, finding differences for the age of the population and the geographical area.**

Conclusion: **the results obtained showed important differences between high and low adherence to the Mediterranean Diet levels, although successive subgroup analyzes were performed. There is a clear trend towards the abandonment of the Mediterranean lifestyle.**

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Key words: *Kidmed. Mediterranean Diet. Adherence. Meta-analysis.*

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TEST KIDMED; PREVALENCIA DE LA BAJA ADHESIÓN A LA DIETA MEDITERRÁNEA EN NIÑOS Y ADOLESCENTES; REVISIÓN SISTEMÁTICA

Resumen

Introducción: **en las últimas décadas se ha observado una modificación rápida e importante de los hábitos dietéticos en los países mediterráneos, especialmente entre los jóvenes. Varios autores han evaluado el patrón de adhesión a la Dieta Mediterránea en este grupo de población, mediante el uso de la prueba KIDMED.**

Objetivos: **el objetivo de este estudio fue evaluar la adhesión a la Dieta Mediterránea entre los niños y adolescentes mediante el uso de la prueba KIDMED a través de una revisión sistemática y un metaanálisis.**

Métodos: **la base de datos PubMed fue revisada hasta enero de 2014. Los estudios incluidos solo fueron los transversales que evaluaron a niños y a jóvenes. Se consideró un modelo de efectos aleatorios.**

Resultados: **se incluyeron dieciocho estudios transversales. La edad de la población varió de 2 a 25 años. La muestra total incluyó 24.067 personas. El porcentaje global de alta adhesión a la Dieta Mediterránea fue del 10% (IC del 95%: 0,07 a 0,13), mientras que la baja adhesión fue del 21% (IC 95%: 0,14 a 0,27). Nuevos análisis por subgrupos definidos fueron realizados en el grupo de baja adhesión, encontrando diferencias para la edad de la población y para la zona geográfica.**

Conclusión: **los resultados obtenidos mostraron diferencias importantes entre alta y baja adhesión a la Dieta Mediterránea, a pesar de los sucesivos análisis de subgrupos que se realizaron. Existe una clara tendencia hacia el abandono del estilo de vida mediterráneo.**

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Palabras clave: *KIDMED. Dieta mediterránea. Adhesión. Metaanálisis.*

Introduction

The Mediterranean Diet (DM) includes not only an acknowledged food pattern but also several social and gastronomical aspects that characterize a certain lifestyle. It combines ingredients of the local agriculture, recipes and the traditional cooking methods of each geographical area within the Mediterranean basin, together with a regular and moderate physical activity practice[1]. It is an overall lifestyle that the modern science and the current recommendations invite us to adopt to improve our health. The MD is characterized by the intake of a great amount of vegetables, fruits, bread and other forms of cereal, rice, beans and nuts. It also includes virgin olive oil as the principal source of fat, moderate amounts of dairy products (basically cheese and yogurt), moderate amounts of fish, red meat in low amounts, and wine consumed in little quantities, normally accompanying meals. The importance of this dietary pattern is related to being a balanced and varied diet and providing most of the recommended macronutrients in their right proportion. It is characterized by a low content of saturated fatty acids and a high content in monounsaturated fatty acids, as well as high amounts of fiber and complex carbohydrates, and important amounts of antioxidants[1]. All of them play an important role in the prevention of cardiovascular and cerebrovascular diseases, diabetes, obesity, neurodegenerative illnesses and cancer, that have been attributed to the MD[2,3]. The MD was ascribed to the list of Intangible Cultural Heritage of UNESCO in November 2010, as a cultural monument of Greece, Italy, Spain and Morocco (decision 5.COM 6.41)[4].

In the last forty years, a quick and important modification of the dietary habits has been observed in the Mediterranean countries, especially among young people[5]. Several factors have contributed to those changes, such as less time and attention devoted to food acquisition and preparation, resulting in an increase in the consumption of processed foods, inadequate levels of consumption of products of animal origin, specially meat and meat products, an excessive intake of refined sugars, and a substantial increase of saturated fats and cholesterol in the diet[6,7].

The aim of this study was to conduct a systematic review and a meta-analysis to evaluate the adherence to the MD among children and adolescents using the results of cross sectional studies that have used the KIDMED test.

Materials and methods

The PubMed database was accessed using the term "KIDMED" to identify the most relevant studies. Only cross-sectional studies carried out in children and young people (between 2 and 25 years old) and published from January 2004 to January 2014 were included. In addition, the reference list of the retrieved articles was searched to find other relevant articles. Papers were considered eligible for inclusion if they a) were cross-sectional studies, b) used the KIDMED test as a tool to evaluate the adherence to the MD in children and youths, c) evaluated the adherence to the MD, d) were conducted during the last decade. The exclusion criteria applied were: a) studies which used different categories to express the results of the KIDMED test, b) studies which did not include the results of the test KIDMED and c) studies which analyzed the same population group (repeated results).

After the selection process, data were extracted from each study and organized using a standard form. The data selected were the following: name of first author, country and year of publication, place where the study was conducted, data collection year, sample size and age range of the participants for each study. Furthermore, percentages of adherence to the MD were assess for each study.

KIDMED test: The KIDMED test (Mediterranean Diet Quality Index for children and teenagers) is a tool to evaluate the adherence to the MD for children and youths. It was developed and validated by Serra-Majem et al.[7].

The index ranges from 0 to 12 and is based on a 16-questions test that can be self-administered or conducted by interview (pediatrician, dietitian, etc.). Questions denoting a negative connotation with respect to the MD are assigned a value of -1, and those with a positive aspect +1 (Table I). The sums of the values from the administered test are classified into three levels: 1) >8, optimal Mediterranean Diet; 2) 4–7, improvement needed to adjust intake to Mediterranean patterns; 3) ≤3, very low diet quality[8].

Statistical analysis

The adherence to the MD, obtained with the KIDMED index, was assessed. The method used to systematically review the results was a formal meta-analysis[9]. A random effects model was considered to be more appropriate than a fixed-effect model.

First we conducted a meta-analysis using the studies with the percentages with high adherence to the MD and after a meta-analysis using those with low adherence. With the information of the percentages, we calculated the pooled effect as the average of the high adherence and the low adherence to the MD.

We used the DerSimonian & Laird's model[10] to pool the adherence values across the studies. The formula we used to estimate the weighted average was:

$$\mu_w = \overline{X}_w = \frac{\sum wX}{\sum w}$$

Where μ_w is the weighted average of a series of data: $X = \{x_1,x_2,x_3,.....x_n\}$ "X" is the repeated value, which correspond the weights: $W = \{w_1,w_2,w_3,.....w_n\}$ "W" is the number of times that "X" occurs, the weight. So, the weighted average (μ_w) is the sum of each study's product and their weight, divided all the studies weight.

Table I
KIDMED test to assess the Mediterranean Diet adhesion8

KIDMED test	*Scoring*
Takes a fruit or fruit juice every day	+1
Has a second fruit every day	+1
Has fresh or cooked vegetables regularly once a day	+1
Has fresh or cooked vegetables more than once a day	+1
Consumes fish regularly (at least 2–3/week)	+1
Goes >1/ week to a fast food restaurant (hamburger)	-1
Likes pulses and eats them >1/week	+1
Consumes pasta or rice almost every day (5 or more per week)	+1
Has cereals or grains (bread, etc) for breakfast	+1
Consumes nuts regularly (at least 2–3/week)	+1
Uses olive oil at home	+1
Skips breakfast	-1
Has a dairy product for breakfast (yoghurt, milk, etc)	+1
Has commercially baked goods or pastries for breakfast	-1
Takes two yoghurts and/or some cheese (40 g) daily	+1
Takes sweets and candy several times every day	-1
KIDMED Index	*Adherence to Med Diet*
Score ≤ 3 points	Poor
Score 4-7 points	Medium
Score ≥ 8 points	High

[8]Adapted from: Serra-Majem, L.; Ribas, L.; García, A.; Pérez-Rodrigo, C.; Aranceta, J. Nutrient adequacy and Mediterranean Diet in Spanish school children and adolescents. *Eur J Clin Nutr.* 2003; *57*, 35–9.

The formula to estimate the weight (*wi*) of each study was: $wi = 1 / Vi + \tau^2$, where *Vi* is the variance of each study and τ^2 is the inter-study variance.

Besides, we calculated a 95% confidence interval (CI) for the pooled estimated of the effect size:

$$95\%\ CI = pooled\ effect \pm (1.96 \times SE\ pooled)$$

where the lower limit was:

$$p - Z\sqrt{\frac{p(1-p)}{n}}$$

and the higher limit was:

$$p + Z\sqrt{\frac{p(1-p)}{n}}$$

Where, the value of "Z" was 1.96, "p" was the percentage of people with low adherence to the MD and "n" was the sample size.

A test of heterogeneity was calculated, estimating Q statistics, which follows a chi- square distribution with degree of freedom n-1, being "n" the number of studies included in the analysis. The I^2 index measures the extent of the heterogeneity. The cut-off point to detect the heterogeneity was placed in 10% (p=0.1). A lower p-value than 0.1 for this statistic indicates the presence of heterogeneity somewhat compromises the validity of the pooled estimates[11].

Because significant heterogeneity was clearly evident in the pooled analysis estimated for all studies combined, possible sources of heterogeneity were considered through a subset analysis carried out only in the low adherence group. We considered gender (male and female), age (less than 12 years and over 12 years old), group of countries (Western countries: Spain[12-18] and Chile[19] and Eastern countries: Greece[20-24], Italy[25,26], Cyprus[27,28] and Turkey[29]) and the representativeness of the sample.

The 3.1.0 version (R Development Core Team, 2014) of the statistical package R-meta was used to conduct the statistical analyses.

Results

Thirty-eight articles were identified in the initial search strategy. After applying the inclusion and exclusion criteria, eighteen cross-sectional studies were selected for the meta-analysis (Roccaldo et al. 2014[25]; Vassiloudis et al. 2014[20]; Grosso et al. 2013[26]; Grao Cruces et al. 2013[13]; Rodríguez R et al. 2013[19]; Costarelli et al. 2013[21]; Prado C et al. 2011[14]; Pérez et al. 2011[15]; Durá et al. 2011[12]; Sahingoz et al. 2011[29] ; Farajian et al. 2011[22] ; Arvaniti et al. 2011[23]; Mazaraki et al. 2011[24]; Lazarou et al. 2010 [27]; Díaz A. et al. 2010[16]; Lazarou et al. 2010[28]; Mariscal-Arcas et al. 2009[17] and Serra-Majem et al. 2004[18]).

Descriptive characteristics of the included studies are presented in the Table II. The population included children and teenagers with ages between two and twenty-five years. The eighteen studies included 24.067 participants with individual study sizes ranging from 81 in the study by Lazarou et al.[27] to 4786 in the study by Farajian et al.[22]. Two of the included studies were conducted in Italy, five in Greece, seven in Spain, one in Chile, one in Turkey and two in Cyprus.

Figure 1 shows the adherence to the MD by categories of the KIDMED index in the included studies. The percentages of adherence ranged from 2.9% as low adherence, 48.6% as medium adherence and 48.5% as high adherence in the study by Mariscal et al.[17] to 46.8% of low adherence, 48.9% of medium adherence and 4.3% of high adherence in the study by Farajian et al.[22]. The Lazarou et al.[27] study shows the results of medium and high adherence together.

In order to summarize the results, we performed the pooled analysis shown in figure 2 and 3. On average, the pooled estimation of the percentage of high adherence to the MD was 10% (CI 95% 0.07-0.13). The pooled estimation of the percentage of low adherence was 21% (CI 95% 0.14-0.27). However, substantial heterogeneity was present in both analysis ($I^2 = 99.7\%$, $p<0.0001$).

Besides, we carried out additional meta-analyses by subgroups in order to investigate which variables might act as potential effect modifiers of the adherence, but only in the group of low adherence to the MD. When the studies were categorised by gender, the percentage of low adherence to the MD in the male population was 21% (CI 95% 0.13-0.30). However, a significant heterogeneity was found ($I^2 = 99.3\%$, $p<0.0001$) (Fig. 4). Similar values were obtained for females. The percentage of low adherence to the MD was 21% (CI 95% 0.13-0.30). Also, in this analysis significant heterogeneity was found ($I^2 = 99.4\%$, $p<0.0001$) (Fig. 5).

Grouping the studies by age range, the percentage of low adherence to the MD in children less than 12 years was 27% (CI 95% 0.09-0.44) and in those over

Table II
Summary of the main characteristics of the eighteen studies

Author	*Country*	*Year of publication*	*Data collection year*	*Sample size*	*Age (years)*
Roccaldo et al.[25]	Italy	2014	2009	1740	8-9
Vassiloudis et al.[20]	Greece	2014	2010	528	10-12
Grosso et al.[26]	Italy	2013	2011	1135	13-16
Grao Cruces et al.[13]	Spain	2013	2011	1973	11-18
Rodríguez et al.[19]	Chile	2013	-	799	18 -25
Costarelli et al.[21]	Greece	2013	-	359	13-16
Prado et al.[14]	Spain	2011	-	519	13-14
Pérez et al.[15]	Spain	2011	1998-99	119	6-9
Durá et al.[12]	Spain	2011	2008-2009	570	18-25
Sahingoz et al.[29]	Turkey	2011	2009	890	12-14
Farajian et al.[22]	Greece	2011	2008-2009	4786	10-12
Arvaniti et al.[23]	Greece	2011	2005-2006	700	10-12
Mazaraki et al.[24]	Greece	2011	2008	365	12-17
Lazarou et al.[27]	Cyprus	2010	2006-2007	81	6-12
Ayechu et al.[16]	Spain	2010	2007-2008	1956	12-16
Lazarou et al.[28]	Cyprus	2010	2004	823	9-13
Mariscal-Arcas et al.[17]	Spain	2009	-	3190	8-16
Serra-Majem et al.[18]	Spain	2004	-	3534	2-24

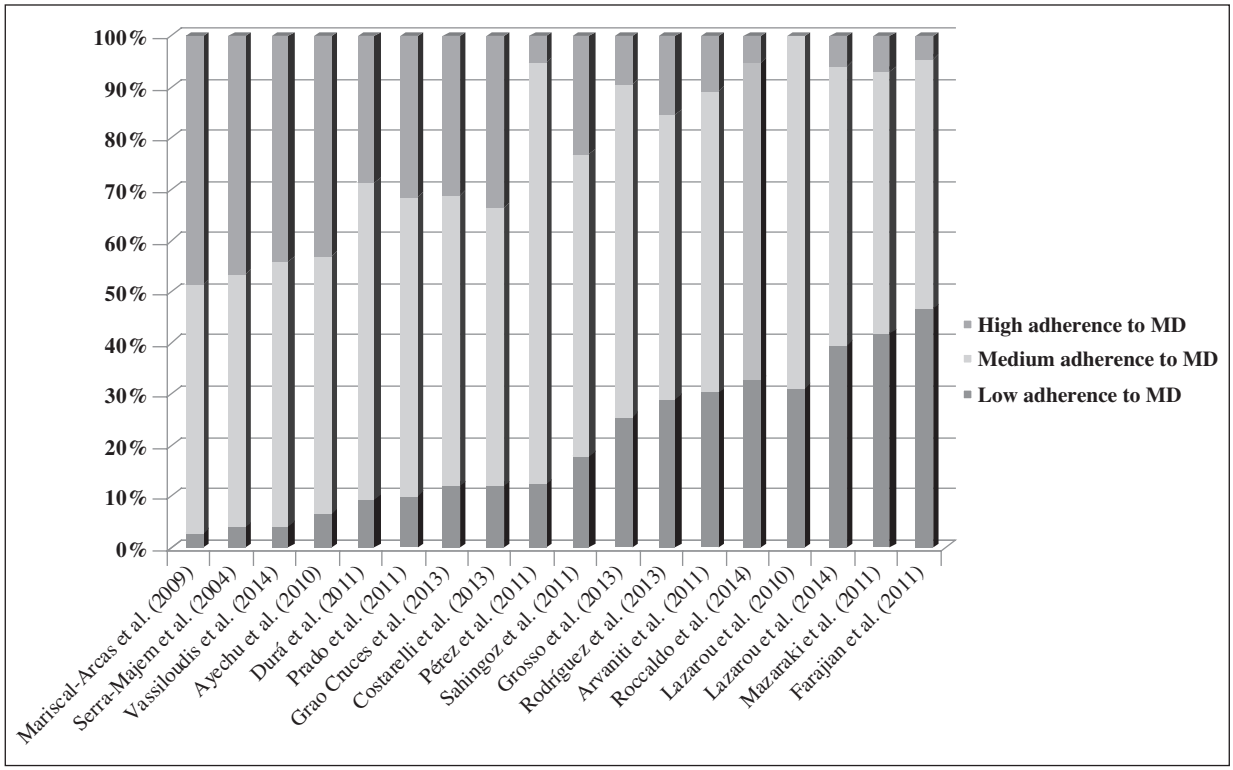

Fig. 1.—Adherence to the Mediterranean Diet assess by the KIDMED index in the studies included in the analysis.

12 years was 19% (CI 95% 0.12-0.26). However, substantial heterogeneity was found in both groups respectively: $I^2 = 99.6\%$, $p<0.0001$ (Fig. 6) and $I^2 = 98.5\%$, $p<0.0001$ (Fig. 7).

In the analysis by country group, the percentage of low adherence to the MD was 28% (CI 95% 0.17-0.39) for Greece, Cyprus and Turkey (Eastern countries) and 11% (CI 95% 0.07-0.14) for Spain and Chile (Western countries). In both groups significant heterogeneity was found ($I^2 = 99.4\%$, $p<0.0001$ (Fig. 8) and ($I^2 = 98.3\%$, $p<0.0001$) (Fig. 9) respectively.

Overall, the percentage of low adherence to the MD in the studies with representative samples was 22% (CI 95% 0.13-0.30) (Fig. 10). However, in the analysis, significant heterogeneity was found ($I^2 = 99.8\%$, $p<0.0001$). The percentage of low adherence to the MD in those studies with no representative samples was 18% (CI 95% 0.10-0.26) and also, significant heterogeneity was found ($I^2 = 97.6\%$, $p<0.0001$) (Fig.11).

Discussion

Our results indicated that the adherence to the MD varied considerably, regardless of the examined variables (gender, age, country and representativeness of the sample). The overall rate revealed that 21% of the surveyed population had low adherence to the MD versus a 10% with high adherence. The percentages differed significantly from the Mariscal et al.[17] study; who had a sample size of 3190 Spanish students between 8-16 years who reported that 2.6% of them had a low adherence to the MD to the Farajian et al.[22] study with a sample size of 4768 individuals from the Greek population of 10-12 years and with low adherence to the MD (46.8%). However, the results obtained in the meta-analysis were highly heterogeneous. After carrying out several subgroups analysis, a high evidence of heterogeneity still remained. The most relevant differences found were in relation to the age of the population: 27% of those under 12 years compared to 19% in those over 12 years and in Western countries with a 28% against an 11% in the Eastern countries. However, no differences were observed in the subgroup analysis by gender and by the representativeness of the sample.

Although there are different procedures to evaluate the level of adherence to the MD, the KIDMED test is an effective tool to assess the quality of food habits in children and young people. The test is based on the Mediterranean dietary pattern principles. It is easy to complete by the respondent, and easy to evaluate by the interviewer. It allows to assess the quality of the food habits and, specifically, determines the degree of adherence to the MD. Through the evaluation of the consumption of 16 components, it helps to identify people with unhealthy eating habits (the lower index) and those with sufficient amounts and proper proportions of nutrients intake (higher index), so that, its use was justified[31].

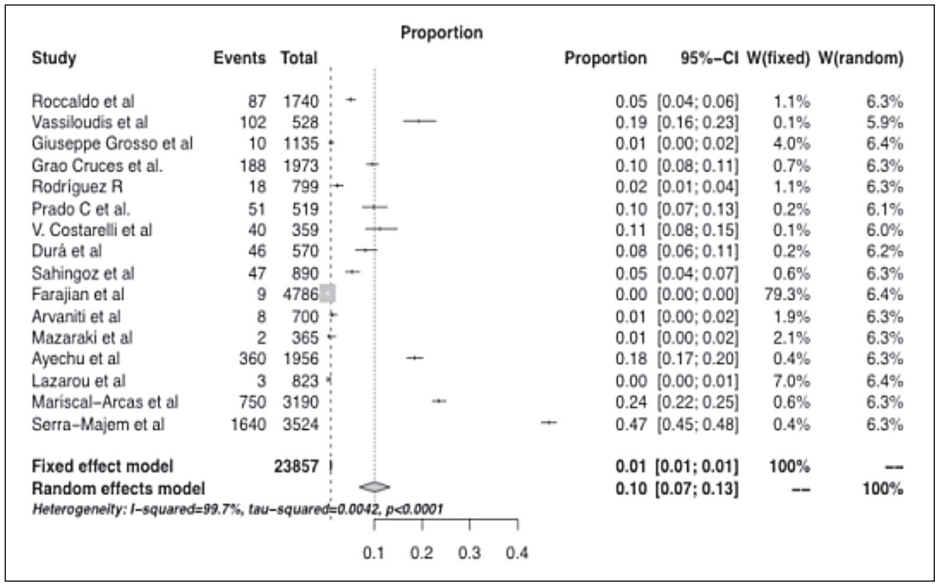

Fig. 2.—Effect size of the percentage of high adherence to the Mediterranean Diet in the eighteen studies.

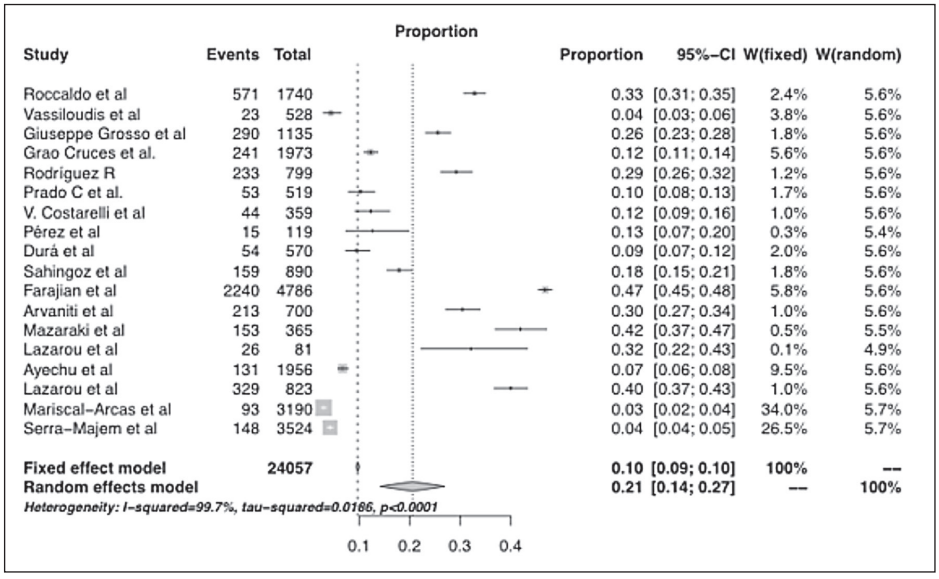

Fig. 3.—Effect size of the percentage of low adherence to the Mediterranean Diet of the eighteen studies.

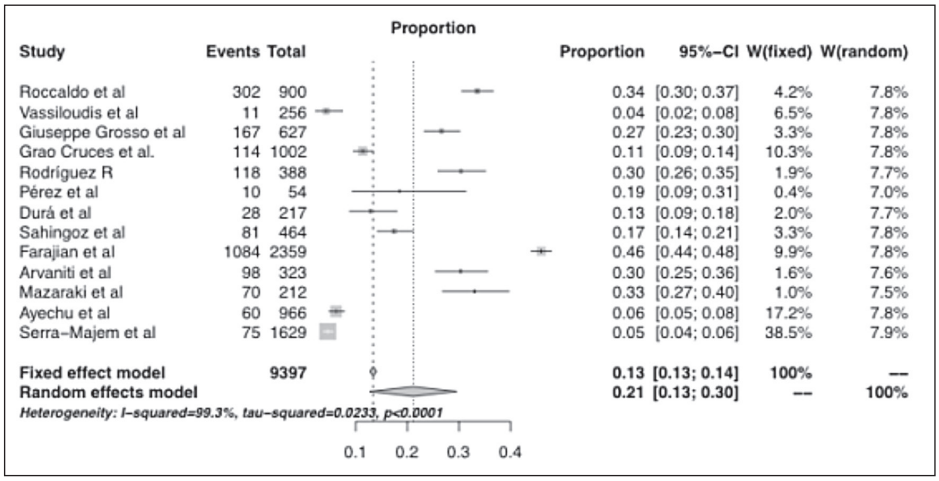

Fig. 4.—Effect size of the percentage of low adherence to the Mediterranean Diet in the 13 studies among males

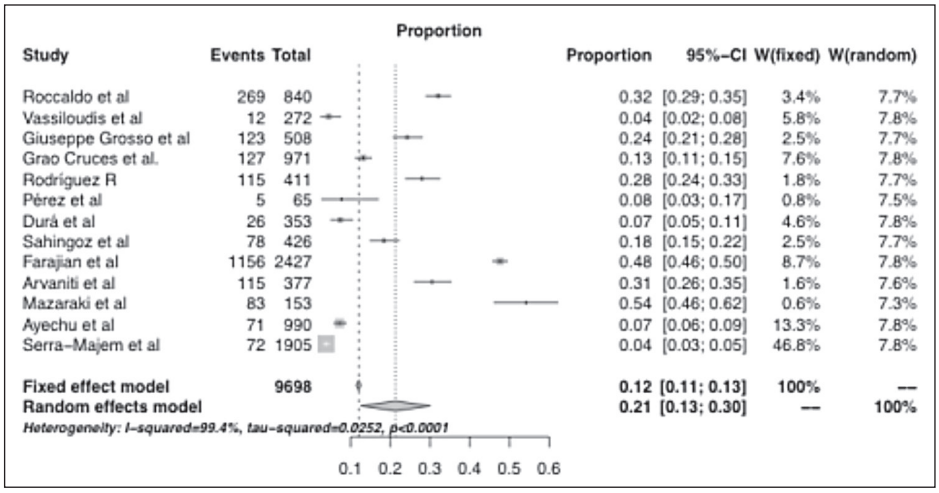

Fig. 5.—Effect size of the percentages of low adherence to the Mediterranean Diet in the 13 studies among females.

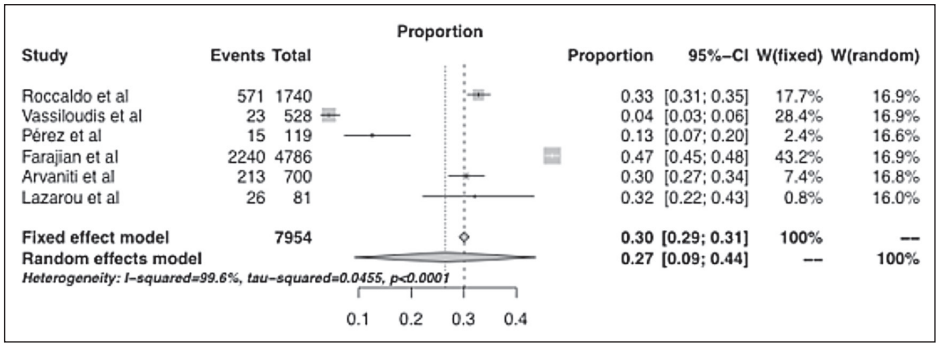

Fig. 6.—Effect size of the percentages of low adherence to the Mediterranean Diet in the 6 studies with children aged under 12 years old.

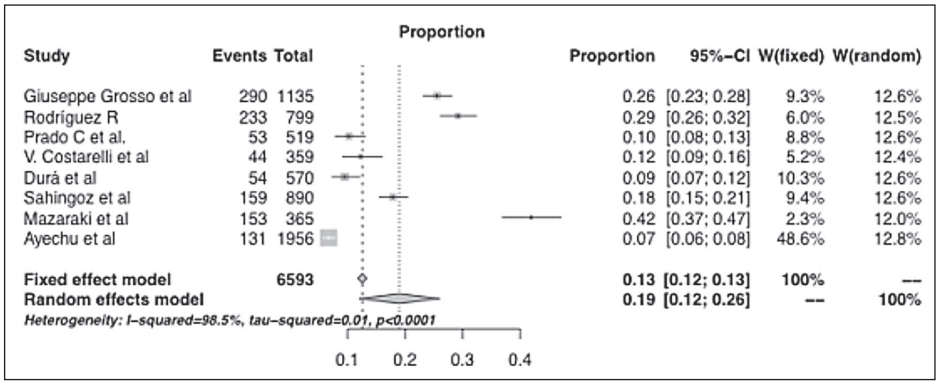

Fig. 7.—Effect size of the percentages of low adherence to the Mediterranean Diet in the 8 studies with children over 12 years old.

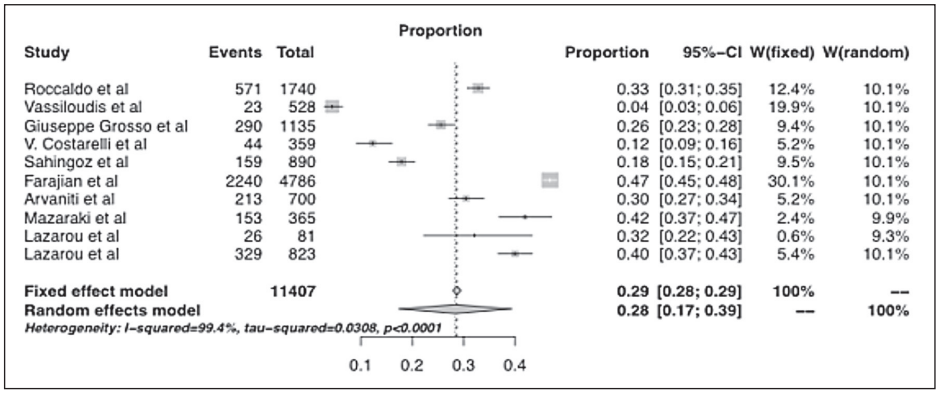

Fig. 8.—Effect size of the percentages of low adherence to the Mediterranean Diet in the 10 studies carried out in: Greece, Cyprus, Italy and Turkey.

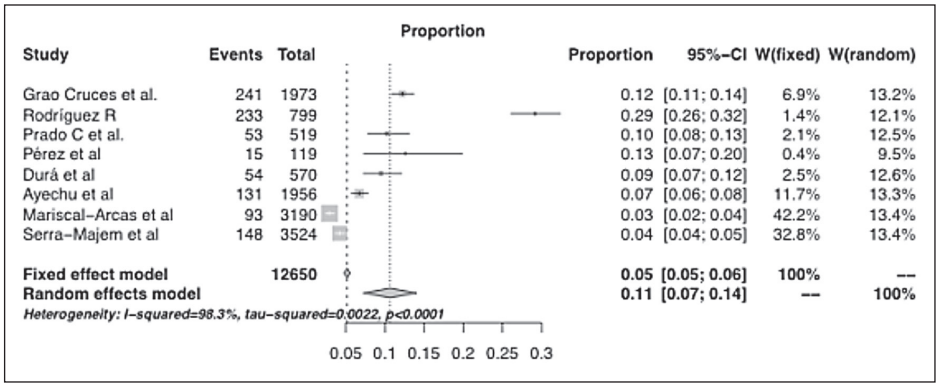

Fig. 9.—Effect size of the percentages of low adherence to the Mediterranean Diet in the 8 studies carried out in: Spain and Chile.

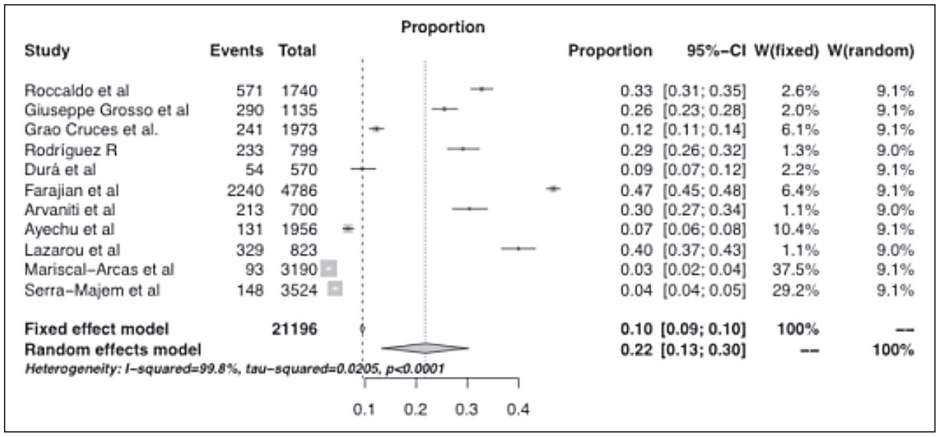

Fig. 10.—Effect size of the percentages of low adherence to the Mediterranean Diet in the 11 studies with representative samples of the population.

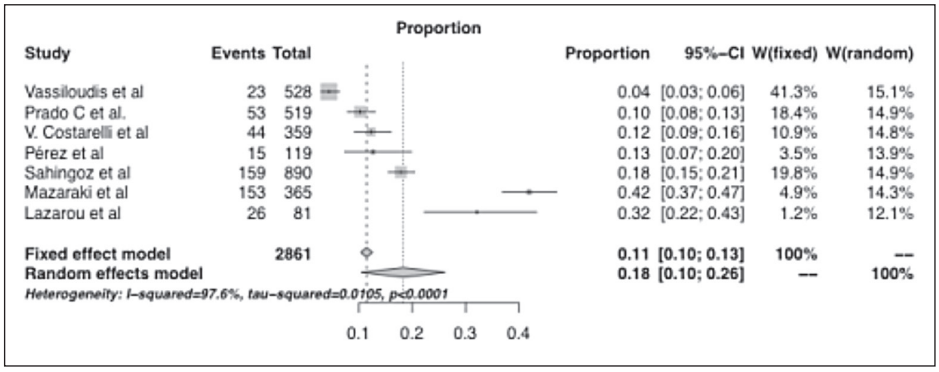

Fig. 11.—Effect size of the percentages of low adherence to the Mediterranean Diet in the 7 studies with non representative samples of the population.

However, the present analysis had some limitations: the studies included were cross-sectional studies, so causal relations could not be established. Furthermore, the number of studies that were eligible for inclusion in this meta-analysis was small, which limited the statistical power of the analyses. It is also important to consider the scientific quality of the original studies. Although evidence-based policies for clinical practice and public health programs, are increasingly based on the meta-analyses of compiled studies, the reliability of the conclusions achieved depend on the methodological quality of the original studies, the appropriateness of the study inclusion criteria, the thoroughness of the review and the synthesis of information[32]. In the studies included in the present review, the diet information was collected through a questionnaire, with no information about the exact quantity of food consumed. Furthermore, in most of the studies, the questionnaires were self-administered during school hours, which could lead to inadequate answers due to a deficient attention to the task and/or lack of student's memory at the time of filling them. This could have been avoided if interviews had been conducted by a nutrition professional and in a personalized manner. Another key aspect was the age of children and adolescents that could have modified the results. The

population considered ranged between 2 and 25 years. This is a large age range including children, adolescent and young adults, which could increase the possibility of finding unreliable results.

All these factors might have contributed to the heterogeneity found, that persisted despite various subgroups analyzes, which somewhat compromised the validity of the pooled estimates. Studies conducted in different geographical areas and with different time frame on different populations lead to different results. The studies included were based on population samples from six different countries: Chile, Cyprus, Spain, Greece, Italy and Turkey. All of them are Mediterranean countries (except Chile, which follows a similar dietary pattern to the MD). However, there were other important issues that might have explain to consider possible differences between the more traditional contexts; such is the case of the Sicily Island whose diet habits includes a high consumption of fried dishes or Las Palmas de Gran Canaria, where there is a significant consumption of stews and roasted maize meal.

Conclusion

The results obtained showed important differences between high and low adherence to the MD, although successive subgroup analyzes were performed. The low adherence was 21%, which indicates that there is a trend towards the abandonment of the Mediterranean lifestyle that could unfortunately result into the occurrence of adverse health events.

Given the effectiveness of the MD dietary pattern on its well-known health benefits[33], it is necessary to promote its consumption not only in non-Mediterranean countries but also in the Mediterranean countries themselves where adherence has been decreasing in the last decades[34], taking special attention on children and young people where there are a clear trend to the rapidly abandoning of the MD[35-37].

Finally, it is important to note that this work is a descriptive analysis. Then, the determinants of adherence to the MD should be interpreted with caution.

Conflicts of interest

The authors declare that they have no conflict of interest.

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Contributions

SG, NH and CR contributed to the design of the strategy for the literature search. LSM prepared the main outline of the manuscript. SG, NH, CR and MN selected the data and writing the manuscript. BR contributed to the selection of studies and data extraction. All authors contributed to the preparation of the final manuscript.

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