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Comparison of five international indices of adherence to the Mediterranean diet among healthy adults: similarities and differences

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BACKGROUND/OBJECTIVES: To compare five indices of adherence to the Mediterranean Diet (MD) among adults living in the Mediterranean region.
SUBJECTS/METHODS: A total of 100 healthy Lebanese adults aged between 18 and 65 years. Face-to-face interviews to collect sociodemographic and medical information, to take anthropometric measurements, and to fill a validated, culturally adapted, food frequency questionnaire (FFQ). The score for each item was calculated following the recommendations for each corresponding index. The five MD indices were Mediterranean Diet Scale (MDScale), Mediterranean Food Pattern (MFP), MD Score (MDS), Short Mediterranean Diet Questionnaire (SMDQ), and the MedDiet score.
RESULTS: Significant correlations were detected between items with *P*-values < 0.001. Minimal agreement was seen between MDScale and MedDiet score and maximal agreement between MDS and MedDiet score. Univariate and multivariate analyses showed that MDS and MedDiet scores had significant correlations with fiber and olive oil intake, main components of the MD. MDScale showed a significant correlation with waist-to-hip ratio and with total energy intake but none of the five indices was correlated to body mass index (BMI).
CONCLUSIONS: The indices that showed the highest correlation with variables related to the MD are the MDScale and the MedDiet score; therefore, they can be used to assess our future study populations. Based on the current results, more than half of the study population was non-adherent to the MD and adherence to this diet did not appear to protect against being overweight (BMI $\geq$ 30).

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INTRODUCTION

Researchers nowadays have become interested in the holistic approach to human diets rather than focusing on the relationship between a single nutrient or food and diseases [1]. One specific dietary pattern that caught the attention of researchers since the mid-1900s, the Mediterranean diet (MD), has been shown in multiple studies to have numerous health benefits for cardiovascular diseases [2], type 2 diabetes [3], dementia [4], degenerative diseases [5], cancer [6], and obesity [7].

The Mediterranean region is culturally, religiously, and economically very diverse and is an area with multiple agricultural patterns, which makes it complicated to define a single, pure MD. However, the eating habits of people around this region share the same elementary components, which have been shown in many studies to have protective health effects. Traditionally, these main components are vegetables, legumes, fruits and nuts, unrefined cereals, olive oil, a moderate intake of fish, low to moderate intake of dairy products, a low intake of meat and poultry, and moderate alcohol intake during meals [8].

Researchers have created different scoring methods to assess the adherence of a population to the MD and have applied them in epidemiological studies among Mediterranean [9] and non-Mediterranean [10] populations. Among the indices used internationally to assess MD adherence, we were interested in comparing the following: Mediterranean diet scale (MDScale) described by Trichopoulou *et al.* [9], Mediterranean food pattern (MFP) reported by Gonzalez *et al.* [11], the MD score (MDS) system

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described by Leighton *et al.* [12], the short Mediterranean diet questionnaire (SMDQ) reported by Zito *et al.* [13], and the MedDiet score presented by Panagiotakos *et al.* [14].

The MDScale, the oldest MD adherence assessment index, was created in Greece in 1995 and revised in 2003 to assess the effect of the MD on total mortality. This index is the only one included in this study that uses a sex-specific median calculation as a cut-off for each of the 9 food groups [9]. The MFP index was developed in Spain for use in assessing the large PREDIMED (Prevención con Dieta Mediterránea) cohort and studying the relationship between the adherence to the MD and the effect of MD on many health parameters [15]. The SMDQ is a short and non-time-consuming questionnaire developed in 2016 in Southern Italy to evaluate the correlation between adherence to the MD and the onset of functional gastrointestinal disorders [13]. The MDS index, developed in 2009 by Leighton *et al.* [12], was intended for evaluating the feasibility of using a translation of the MD in a non-Mediterranean country, Chile, and to assess its effects on metabolic syndrome [12]. Finally, the MedDiet index , created in Greece in 2005, included predefined cut-off portions and was proposed to be a good alternative for the sex-specific median MDScale; it has been used in many studies, including the Attica study in Greece and the CARDIO2000 case-control study [16].

All MD indices have inconsistencies among them because they differ in the following: Number of components (nutrients, foods, or food groups intake); classification categories for each item; measurement scales; statistical parameters (mean, median, or tertiles of daily intake); and the contribution of each component (positive or negative) to the total score [17]. Thus, the aim of this study was to evaluate and compare within the same sample population five international MD scoring systems for assessing adherence to the MD, to establish cut-off points for each score, and to examine correlations between MD adherence (measured with each index) and anthropometric, nutritional, and sociodemographic data.

SUBJECTS AND METHODS

Participants

The study included 100 Lebanese participants and is a part of a large cross-sectional study evaluating the adherence of the Lebanese population to the traditional MD and the relationships between diet, depression, anxiety, and quality of life. The study population included individuals from all regions geographic districts within Lebanon who were not suffering from any acute or chronic illnesses and were between 18 and 60 years old. The sample size (N) was determined by applying the formula published by Tabachnick and Fidell [18]; $n = 50 + 8$ m which is based on using the number of independent variables (m) that will be included in the multivariate analysis model. The six independent variables selected for inclusion in this study's model were: Fiber, olive oil, and total energy intake, monounsaturated/saturated fatty acid ratio, age, and waist-to-hip ratio (WHR). The inclusion of those six variables resulted in a minimum sample size of 98 participants. The following participant types were excluded from the study: Pregnant and breastfeeding women, women who gave birth less than 6 months ago, and persons who suffered from an acute medical condition the week before possible enrollment in the study.

The study protocol was approved by the Institutional Review Board and the Ethic Committee of Saint-Joseph University Beirut, Lebanon (USJ-2016-62). All participants gave their written consent before recruitment.

Dietary assessment

Dietary intake was assessed by using a semi-quantitative food frequency questionnaire (FFQ) administered by trained researchers. The FFQ used in this study was previously developed and validated for use with the Lebanese population by our research team, and it includes 157 items that are highly representative of the MD [19]. The FFQ uses household measures and pictures of real food, to help subjects estimate their food intake [19]. For each participant, the intake of each food item (g/day) was calculated and entered into Nutrilog SAS nutritional software (version 2.30 for Windows; Marans, France) for detailed nutrient-based analysis. Following this analysis, individual serving sizes were calculated in order to be used in conjunction with each scoring item. Finally, participant physical activity was assessed by using the short version of the International Physical Activity Questionnaire (IPAQ; http://www.ipaq.ki.se/). In addition, the following data were collected for each participant and included in the analysis: Age (continuous in years), sex, income per month, marital status, education, family history of obesity (a positive family history of obesity was indicated if the mother, father, or both were reported as obese), smoking, height, weight, waist circumference, and hip circumference.

Indices for measuring adherence to the MD

In order to select the appropriate indexing methods for use in our study, we conducted an electronic search using online databases like PUBMED, Scopus, and EMBASE using combinations of the following keywords: Mediterranean diet, score, tool, adherence, and other associated terms. Our aim was to obtain the original studies about the inception and development of related scoring systems that were published prior to January 2018. We chose the most well-documented, the longest and the shortest, the most difficult one, and the one that was easiest to apply. Table 1 presents the five selected indexing tools and summarizes their dietary components and portion sizes.

Mediterranean diet scale (MDScale)

This scoring system, created by Trichopoulou *et al.* [9] in 1995 and revised in 2003, is sample-specific and uses sex-specific median values as cut-off points for each dietary component. It was first applied to elderly people in rural Greek villages to evaluate the relationship between dietary pattern and overall mortality; subsequently, it has been used in many prospective and case-control studies [20,21]. The MDScale is comprised of 9 items: Vegetables, legumes, fruits and nuts, dairy products, cereals, meat and poultry, fish, the ratio of monounsaturated to saturated fatty acids, and alcohol. The total score for the MDScale ranges from 0 (minimum MD adherence) to 9 (maximum MD adherence). For beneficial components like vegetables, legumes, fruits and nuts, cereal, and fish, one point

Table 1. Description of five dietary indexing methods used to assess adherence to the Mediterranean diet.

Mediterranean diet components	MDScale		MFP		MedDiet score			MDS			SMDQ	
	Included in the index	Portion / cut-off	Included in the index	Portion / cut-off	Included in the index	Portion / cut-off: Criteria for minimum score 0 point	Portion / cut-off: Criteria for maximum score 5 points	Included in the index	Portion / cut-off: Criteria for minimum score 0 point	Portion / cut-off: Criteria for maximum score 1 point	Included in the index	Portion / cut-off
Vegetables	Yes	1 if consumption at or above the sex-specific median	Yes	$\geq$ 2 serv/d	Yes	Never	> 18 serv/m	Yes	< 1 ser/d	$\geq$ 3 serv/d	Yes	$\geq$ 1 serv/d
Fruits	Yes (fruits and nuts together)	1 if consumption at or above the sex-specific median	Yes	$\geq$ 3 serv/d	Yes	Never	> 18 serv/m	Yes	< 1 serv/d	> 2 serv/d	Yes	$\geq$ 1 serv/d
Nuts	Yes (fruits and nuts together)	1 if consumption at or above the sex-specific median	Yes	$\geq$ 3 serv/week	No			Yes (nuts and legumes together)	< 1 serv/week	$\geq$ 2 serv/week	No	
Legumes	Yes	1 if consumption at or above the sex-specific median	Yes	$\geq$ 3 serv/week	Yes	Never	> 18 serv/m	Yes (nuts and legumes together)	< 1 serv/week	$\geq$ 2 serv/week	Yes	$\geq$ 2 serv/d
Cereals	Yes, but without any specification about the type of cereal	1 if consumption at or above the sex-specific median	No		Yes (Only non-refined cereals)	Never	> 18 serv/m	Yes (whole-grain cereals only)	< 1 serv/day	$\geq$ 2 serv/day: 1 point	Yes (white bread with rice or whole-grain bread)	White bread ($\leq$ 1 serv/d) AND Rice ($\leq$ 1serv/week) or whole-grain bread ($\geq$ 5 serv/week)
Fish	Yes	1 if consumption at or above the sex-specific median	Yes	$\geq$ 3 serv/week	Yes	Never	> 18 serv/m	Yes	< 1 serv/week	> 2 serv/week	Yes	$\geq$ 3 serv/d
Meat	Yes (red meat and poultry together)	1 if consumption below the median	Yes (red meat and processed meat)	$\leq$ 7 serv/week 1 serv = 100-150 g)	Yes (red meat and products)	> 18 serv/m	Never	Yes (separating fatty meat and lean meat)	Fatty and processed meat: > 2 serv/week Lean meat: < 2 serv/week	Fatty and processed meat: < 1 serv/week Lean meat: > 4 serv/week	Yes	$\leq$ 1 serv/d
Chicken	Yes (red meat and poultry together)	1 if consumption below the median	No		Yes	> 18 serv/m	Never	No			No	
Potatoes	No		No		Yes	Never	> 18 serv/m	No			No	
Dairy Products	Yes (without specifying the fat content)	1 if consumption below the median	No		Yes (only full-fat dairy products)	> 18 serv/m	Never	Yes (separating full-fat/not fermented and low-fat/fermented)	Full-fat or not fermented: < 1 serv/d low-fat or fermented: < 1 serv/d	Full-fat or not fermented: < 1 serv/d low-fat or fermented: $\geq$ 2 serv/d	No	
Sweets	No		Yes	< 3 times/week	No			Yes (sugar)	> 8 tsp/d	< 4 tsp/d	No	
Olive oil	No		Yes	$\geq$ 4 tbsp/d	Yes	Never	Daily	Yes (with canola oil)	< 0.5 tsp/d	> 3 tsp/d	No	
Vegetable oils	No		No		No			Yes	> 8 or < 2 tsp/d	4-8 tsp/d	No	
Monounsaturated/ saturated fatty acid ratio	Yes	1 if consumption at or above sex-specific median	No		No			No			No	

Table 1. continued

Mediterranean diet components	MDScale		MFP		MedDiet score			MDS			SMDQ	
	Included in the index	Portion / cut-off	Included in the index	Portion / cut-off	Included in the index	Portion / cut-off		Included in the index	Portion / cut-off		Included in the index	Portion / cut-off
						Criteria for minimum score 0 point	Criteria for maximum score 5 points		Criteria for minimum score 0 point	Criteria for maximum score 1 point		
Herbs and spices	No		Yes	≥ 2 times/week	No			No			No	
Avocado	No		No		No			Yes	< 0.5 unit/week	> 3 units/week	No	
Alcohol	Yes (without mentioning the type of alcoholic drink)	Men: 1 if between 10 and 50 g/d Women: 1 if between 5 and 25 g/d	Yes (limited to wine only)	≥ 7 glasses of wine per week	Yes (any type of alcoholic beverage)	< 300 mL/d: 5 points	> 700 or 0 mL/d: 0 point	Yes (limited to wine only)	> 1 glass/d for women > 2 glasses/d for men	≤ 1 glass/d for women ≤ 2 glasses/d for men Moderate and usually with meals	Yes (only wine)	≥ 1 glass/d

serv, serving; d, day; m, month; tbsp., tablespoon; tsp, teaspoon; g, gram; mL, milliliter.
MDScale, mediterranean diet scale; MFP, mediterranean food pattern; MDS, MD score; SMDQ, short mediterranean diet questionnaire.

is assigned to those whose consumption is below the sex-specific median amount. For components without proven beneficial health outcomes such as dairy products and meat and poultry, one point is assigned to those whose consumption is below the sex-specific median. For ethanol consumption, one point is assigned to men who consume between 10 and 50 g per day and to women who consume between 5 and 25 g a day. Finally, to score lipid intake, the monounsaturated to saturated fatty acids ratio is calculated. Since its creation, the MDScale has been used in hundreds of studies in Mediterranean and non-Mediterranean countries, including studies involving the Spanish cohort and the SUN project in which the MDScale was used to assess changes in dietary habits after a follow-up period of 10 years [22]. In a study conducted in 2015 in the United States, a high adherence to the MD, as assessed by using the MDScale, was associated with a low risk of cardiovascular disease [23].

Mediterranean food pattern (MFP)

This 14-item scoring system was developed by *Martinez-Gonzalez et al.* [15] for assessment of a large Spanish cohort in the PREDIMED study. The MFP tool consists of 14 questions representing the MD (independent of the FFQ) with responses being 'yes' or 'no' and with a final score ranging from 0 to 14. A value of 1 point is assigned if the component criterion was met. Many studies have used this tool to assess the MD adherence of their population, for example, the studies of Vidal-Peracho *et al.* [24] in Spain and Savanelli *et al.* [25] in Italy.

Mediterranean diet score (MDS)

The MDS assessment score was described by *Leighton et al.* [12] and used in a study of Chileans [26]. The MDS questionnaire includes 14 beneficial (vegetables, legumes and nuts, fruits, whole-grain cereals, lean meat, fish and shellfish, low-fat and fermented dairy products, vegetable oils, olive and canola oils, avocado and moderate wine consumption ideally with meals) or detrimental (fatty meat and processed meat; full-fat dairy products not fermented; sugar; and excessive or no wine consumption) components. The particularity of this tool is the distinction made between avocado, olive oil, canola oil, and vegetable oils. A score value of 0, 0.5, or 1 is assigned to each item depending on the frequency of consumption and the nutritional quality. This MDS total ranges from 0 indicating minimal adherence to 14 for maximal adherence [12]. The MDS was used in a cross-sectional online survey of 24,882 Chilean adults in order to study the transferability of the MD to a non-Mediterranean country and determine the diet's association with chronic disease risk in Chile [26].

Short mediterranean diet questionnaire (SMDQ)

The SMDQ, developed in Italy and reported *Zito et al.* [13], is based on 9 questions that can be used to assess the frequency of consumption of 9 typical food categories. One point is attributed to each category when the food consumption meets the criteria and the total SMDQ score ranges from 0 to 9. The SMDQ index was created in Italy in 2016 to study the correlation between adherence to the MD and the onset of functional gastrointestinal disorders [13].

Mediterranean diet score (MedDiet score)

Following similar principles of other MD assessment tools, the MedDiet scoring system, created by Panagiotakos *et al.* [16] in Greece, includes the following food groups: non-refined cereals (whole bread, pasta, rice, other grain, biscuits, etc.), fruit, vegetables, legumes, potatoes, fish, meat and meat products, poultry, full-fat dairy products (like cheese, yogurt, and milk), as well as olive oil and alcohol. A number ranging between 0 and 5 is assigned to each item of the 11 food groups according to their frequency of consumption per month (*i.e.*, Never, 1-4, 5-8, 9-12, 13-18, and > 18 servings per month scored as 0, 1, 2, 3, 4, and 5, respectively). The total score for all items in the MedDiet index ranges from 0 to 55 with higher values indicating greater MD adherence. This score has been used in various contexts, for example, in 2015 it was used in a study of the association between internet usage patterns and adherence to the MD among employees in South West England [14]. Another example is a study assessing the relationship between diet quality and cardiovascular morbidity in Elafonisos Island, Greece in 2017 [27].

Statistical analysis

Statistical analysis was performed by using a software program (IBM SPSS Statistics for Windows, Version 24.0, released 2016; IBM Corp. Armonk, NY, USA). The alpha error was set at 0.05. Mean and standard deviation (SD) values were obtained for continuous variables and frequencies for categorical variables.

The normality of the distributions of each of the continuous variables was evaluated using the Kolmogorov-Smirnov test. Spearman or Pearson correlation coefficients were used to evaluate the association between two continuous variables. Questionnaire scores were dichotomized using the 50th percentile as the cut-off for each index, thereby classifying participants as having either low or high MD adherence. Student's *t* or Mann-Whitney test were performed to compare continuous variables between two groups. ANOVA or Kruskal-Wallis tests were used to compare continuous variables among three or more groups. Five logistic regression models were created with one categorical dependent variable (each score) and several explanatory independent variables (daily energy intake, fiber intake [g/day], percentage fat contribution to total caloric intake and daily olive oil intake in grams, body mass index [BMI], waist circumference, WHR, and household crowding index) Explanatory variables that were unrelated to the scores, based on univariate analysis results with P-values > 0.200, were excluded from the logistic regressions.

RESULTS

Study population

A total of 100 participants of which 52% are men were included in the study. Table 2 summarizes the anthropometric and sociodemographic characteristics of the study population.

MD adherence scores

MD adherence scores for each of the five scoring systems examined in this study were calculated for each participant and the 50th percentile was applied as the cut-off in order to

Table 2. Sociodemographic and anthropometric characteristics of the participants (n = 100).

Characteristics	Mean ± SD / n (%)
Age (yrs)	33.03 ± 12.76
Crowding index	0.93 ± 0.42
Energy (kcal)	2,239.54 ± 827.19
Fat (%)	36.17 ± 6.18
Fibers (g/day)	16.46 ± 6.11
Olive oil (g/day)	7.97 ± 6.526
WC (cm)	89.86 ± 20.29
WHR	0.928 ± 0.1719
Gender	
Male	52 (52.0%)
Female	48 (48.0%)
BMI[1)]	
Underweight	8 (8.0%)
Normal weight	39 (39.0%)
Overweight	31 (31.0%)
Obese	22 (22.0%)
Smoking	
No	58 (58.0%)
Ex-smoker	5 (5.0%)
Smoker	36 (36.0%)
Alcohol	
No	24 (24.0%)
Ex drinker	4 (4.0%)
≤ 1 drink/week	42 (42.0%)
> 1 drink/week	30 (30.0%)
Education level	
Elementary	8 (8.0%)
Secondary	23 (23.0%)
University	69 (69.0%)

[1)] WHO cut-offs: BMI < 18.5: Underweight, 18.5 ≤ BMI < 25: Normal, 25 ≤ BMI < 30: Overweight, BMI ≥ 30: Obese

homogenize the results of the five indices (Table 3). For each scoring system, the majority of the participants were non-adherent to MD; the percentages of non-adherence were as follow: 70% (MFP), 53% (MDScale); 52% (SMDQ); 54% (MDS); and 54% (MedDiet score).

Significant positive correlations showing high levels of agreement between the results of the five indices were observed ($P < 0.001$), with the highest correlations between the MDS and MedDiet scores (percentage agreement 76%; r = 0.69; $P = 0.000$) and between the MDS and SMDQ scores (percentage agreement 76%; r = 0.681; $P = 0.000$). Moderate correlations were detected between the MDScale and the other indices (0.389 < r < 0.480), and there was a minimal correlation between the MDScale and MedDiet scores (percentage agreement: 65%; r = 0.424; $P = 0.000$). Correlation quality was evaluated according to Cohen with an r value between 0.3 and 0.5 being a moderate correlation and an r higher than 0.5 indicative of a high correlation [28].

Adherence to MD and explanatory variables

Univariate regression analyses showed that the MDScale, SMDQ, and MDS indices showed significant positive correlations with fiber ($P = 0.000$, 0.021, and 0.035, respectively) and olive oil ($P = 0.012$, 0.000, and 0.000, respectively) intakes as well as with the monounsaturated/saturated fatty acids ratio ($P = 0.002$, 0.019, and 0.005, respectively), indicating that a high adherence to the MD was correlated with high intake levels of dietary fiber and olive oil and a high monounsaturated/saturated fatty acids ratio. In addition, the MDScale showed a significant positive correlation with WHR ($P = 0.001$) and total energy intake ($P = 0.02$). In contrast, none of the five indices were correlated to BMI ($P > 0.05$). However, the SMDQ ($P = 0.002$), MDS ($P = 0.040$), and MedDiet score ($P = 0.048$) indices were positively correlated

Table 3. Scores for MD adherence derived from five dietary assessment indices (n = 100) and % of agreement between them

MD Index	MD adherence score				
	Minimum	Maximum	Mean	SD	50th percentile
MFP	3	14	7.71	1.972	8.00
MDS	2	12	6.29	1.914	6.00
MedDiet score	12	39	29.3	4.927	30.00
SMDQ	0	6	4.22	1.276	4.00
MDScale	1	8	4.44	1.513	4.00
		MFP	MDS	MedDiet Score	SMDQ
MDS	r	0.774	1		
	P-value	< 0.001			
	% of agreement	74			
MedDiet score	r	0.616	0.690	1	
	P-value	< 0.001	< 0.001		
	% of agreement	72	76		
SMDQ	r	0.557	0.681	0.656	1
	P-value	< 0.001	< 0.001	< 0.001	
	% of agreement	66	76	70	
MDScale	r	0.436	0.480	0.424	0.389
	P-value	0.000	0.000	0.000	0.000
	% of agreement	67	71	65	69

Spearman or pearson correlation coefficients r are presented; *P*-value < 0.05 indicates a significant association. Based on Cohen [28]: Moderate correlation (0.3 < r ≤ 0.5); High correlation (r > 0.5)
MD, mediterranean diet; MFP, mediterranean food pattern; SMDQ, short mediterranean diet questionnaire; MDScale, mediterranean diet scale; MDS, MD score.

Table 4. Results of univariate analyses of the associations between each of the five categorized MD adherence indices and the list of continuous explanatory variables

	Mean ± SD									
	MFP		MDScale		SMDQ		MDS		MedDiet score	
	Low (n = 70)	High (n = 30)	Low (n = 53)	High (n = 47)	Low (n = 52)	High (n = 48)	Low (n = 54)	High (n = 46)	Low (n = 54)	High (n = 46)
Age (yrs)	32.19 ± 12.60	34.31 ± 12.20	31.64 ± 12.53	34.70 ± 12.98	29.29 ± 12.10	37.19 ± 12.35	30.67 ± 11.74	35.91 ± 13.47	31.04 ± 12.22	35.48 ± 13.12
	P = 0.409		*P* = 0.233		*P* = 0.002		*P* = 0.04		*P* = 0.048	
BMI (kg/m^2)	26.45 ± 5.45	24.62 ± 4.99	25.41 ± 5.68	26.23 ± 5.13	25.89 ± 6.05	25.69 ± 4.71	25.52 ± 5.91	26.17 ± 4.83	26.08 ± 5.59	25.47 ± 5.25
	P = 0.950		*P* = 0.449		*P* = 0.852		*P* = 0.588		*P* = 0.578	
Waist circumference (cm)	90.74 ± 18.46	89.25 ± 24.38	87.29 ± 19.4	93.53 ± 22.59	91.12 ± 24.62	89.25 ± 16.63	88.29 ± 19.93	92.50 ± 22.37	90.73 ± 22.75	89.63 ± 19.17
	P = 0.723		*P* = 0.140		*P* = 0.659		*P* = 0.322		*P* = 0.796	
Waist-to-hip ratio	0.92 ± 0.16	0.96 ± 0.21	0.88 ± 0.117	1 ± 0.215	0.94 ± 0.21	0.93 ± 0.15	0.90 ± 0.11	0.98 ± 0.23	0.94 ± 0.20	0.93 ± 0.16
	P = 0.326		*P* = 0.001		*P* = 0.871		*P* = 0.025		*P* = 0.855	
Total energy intake (kcal/day)	2,184 ± 835	2,369 ± 808	2,060 ± 803	2,442 ± 816	2,214 ± 855	2,267 ± 804	2,243 ± 87	2,235 ± 79	2,226 ± 820	2,255 ± 844
	P = 0.308		*P* = 0.020		*P* = 0.752		*P* = 0.964		*P* = 0.86	
Fat (g)	86.02 ± 36.2	98.99 ± 37.48	84.51 ± 37.6	96 ± 35.5	88.64 ± 39.34	91.29 ± 34.39	89.16 ± 38.11	90.80 ± 35.79	88.95 ± 36.60	91.04 ± 37.59
	P = 0.108		*P* = 0.076		*P* = 0.721		*P* = 0.826		*P* = 0.779	
Fat (%)	35.54 ± 6.51	37.66 ± 5.13	36.66 ± 6.10	35.63 ± 6.30	35.8 ± 6.36	36.58 ± 6.03	35.80 ± 6.34	36.61 ± 5.96	35.96 ± 6.36	36.42 ± 6.03
	P = 0.116		*P* = 0.409		*P* = 0.531		*P* = 0.520		*P* = 0.712	
Fibers (g)	15.18 ± 5.91	19.44 ± 5.59	13.81 ± 5.20	19.44 ± 5.70	15.12 ± 6.22	17.91 ± 5.71	15.27 ± 6.25	17.85 ± 5.70	15.27 ± 5.99	17.85 ± 6.02
	P = 0.001		*P* = < 0.001		*P* = 0.021		*P* = 0.035		*P* = 0.034	
Olive oil (g)	6.61 ± 5.47	11.13 ± 7.71	6.43 ± 5.55	9.7 ± 7.14	5.63 ± 5.55	10.50 ± 6.61	5.79 ± 5.29	10.53 ± 6.95	6.30 ± 5.75	9.93 ± 6.88
	P = 0.001		*P* = 0.012		*P* < 0.001		*P* < 0.001		*P* = 0.005	
Monounsaturated/ saturated FA ratio	1.19 ± 0.38	1.23 ± 0.35	1.10 ± 0.31	1.32 ± 0.39	1.12 ± 0.33	1.29 ± 0.38	1.11 ± 0.32	1.31 ± 0.39	1.17 ± 0.34	1.25 ± 0.39
	P = 0.570		*P* = 0.002		*P* = 0.019		*P* = 0.005		*P* = 0.263	

Student's *t* and Mann-Whitney tests; *P*-value < 0.05 is significant
MD, mediterranean diet; MFP, mediterranean food pattern; MDScale, mediterranean diet scale; SMDQ, short mediterranean diet questionnaire; MDS, MD score.

Table 5. Results of multivariate analyses: Factors significantly correlated to each MD adherence index

		B	Standard error	df	*P*-value	OR	95% CI for OR	
							Lower	Upper
MFP	Fiber	0.147	0.048	1	0.002	1.158	1.055	1.273
	Olive oil	0.124	0.041	1	0.002	1.132	1.045	1.226
MDScale	Gender	1.436	0.565	1	0.011	4.205	1.390	12.717
	Waist/hip ratio	5.977	2.192	1	0.006	394.416	5.371	28,962.64
	Energy	0.001	0.000	1	0.025	1.001	1.000	1.001
	Fiber	0.250	0.069	1	< 0.001	1.284	1.122	1.470
	Olive oil	0.106	0.042	1	0.011	1.112	1.024	1.207
	Monounsaturated/saturated FA ratio	2.023	0.831	1	0.015	7.559	1.483	38.517
SMDQ	Age	0.060	0.020	1	0.003	1.062	1.021	1.105
	Fiber	0.092	0.042	1	0.029	1.096	1.010	1.190
	Olive oil	0.145	0.046	1	0.001	1.156	1.057	1.264
	Monounsaturated/saturated FA ratio	0.515	0.704	1	0.464	1.674	0.421	6.646
MDS	Age	0.030	0.019	1	0.118	1.030	0.992	1.069
	Waist/hip ratio	2.158	1.565	1	0.168	8.650	0.403	185.787
	Fiber	0.150	0.057	1	0.008	1.162	1.040	1.300
	Olive oil	0.141	0.046	1	0.002	1.151	1.052	1.260
	Monounsaturated/saturated FA ratio	1.103	0.712	1	0.121	3.014	0.747	12.162
MedDiet score	Age	0.037	0.018	1	0.048	1.037	1.000	1.076
	Fiber	0.074	0.037	1	0.043	1.077	1.002	1.158
	Olive oil	0.093	0.036	1	0.010	1.097	1.022	1.178

B, beta; df, degrees of freedom; OR, odds ratio; CI, confidence interval; FA, fatty acids; MD, mediterranean diet; MFP, mediterranean food pattern; MDScale, mediterranean diet scale; SMDQ, short mediterranean diet questionnaire; MDS, MD score.

with age, indicating that MD adherence was higher in elderly individuals (Table 4).

The results in Table 5 were derived by multivariate analyses using logistic regression models. The study participants' adherence to the MD assessed by using the MDScale provided the highest number of significant associations among the selected parameters: Gender ($P = 0.011$), WHR ($P = 0.006$), total energy intake ($P = 0.025$), fiber intake ($P = 0.000$), olive oil intake ($P = 0.011$), and monounsaturated/saturated fatty acids ratio ($P = 0.015$).

The other four indices showed correlations similar to those obtained via the univariate analysis of sociodemographic, nutritional, and anthropometric parameters. The MFP index was significantly correlated with both fiber and olive oil intakes (both $P = 0.002$), which was also observed for the MDS index (fiber and olive oil intakes; $P = 0.008$ and 0.002 respectively). Similarly, the SMDQ index was correlated with fiber and olive oil intake, but it was also correlated with age ($P = 0.029$, 0.001, and 0.003, respectively). Likewise, the MedDiet score was also shown to be associated with age, fiber, olive oil, and age ($P = 0.043$, 0.010, and 0.048, respectively).

DISCUSSION

The importance of the MD has been widely reported in several studies to have a protective effect on mortality [29] and metabolic diseases [30], as well as on numerous chronic degenerative diseases and even depression [31]. In those studies, different assessment methods were used to determine the study participants' adherence to this dietary pattern, and those methods used different components and category cut-offs. However, little attention has been given to the differences in the characteristics of these indices (cut-off points, components, portion sizes, etc.).

In this cross-sectional study, five component scoring systems used to assess adherence to the MD were compared in terms of anthropometric measures (BMI, WC, WHR, gender, and age) and several dietary components characteristic of the MD (fibers, olive oil, total fat intake, and monounsaturated/saturated fatty acids ratio).

Our results show that most of the study participants were not following a traditional MD. These findings are in accord with those described by Issa *et al.* [32] in 2011 in a study conducted in the rural areas of Lebanon and those reported in the PREDIMED study, which included 7,447 participants in Spain [15]. Our results also support those in another study conducted in 2017 in Lebanon, which pointed out a shift in dietary habits toward a Western dietary pattern that is rich in saturated fatty acids and refined cereals and sugar [33].

The results obtained by the five indices assessed in this study were highly correlated to each other (P-values < 0.001) and gave homogeneous results. This interesting finding may be due to the fact that the same FFQ with same portions was used in each of the five index scoring systems and the same interviewer administered each of the index interviews. In addition, in order to homogenize the results we used a 50th percentile cut-off instead of using predefined cut-offs as has been suggested by Martinez-Gonzalez *et al*. [34] and Parlapani *et al.* [35] as an optimal way to rank individuals as either high or low adherent to the MD. Papazian *et al.* [36], in a study of a population of pregnant women, and using the same indices as those used in the present study, reported similar percentage agreements between the index scores: 84% between MDS and MFP compared to 74% agreement in the present study and 64% between MDScale and MFP compared to 67% in the present study.

The protective effect of dietary fiber and monounsaturated fatty acids from olive oil have been well-documented, particularly by the PREDIMED clinical trial [37,38]. These two dietary components are prominent in the traditional MD and are included in all the indexing systems created to assess MD adherence [39]. Each of the five indices studied herein was significantly correlated with fiber and olive oil intakes (P-values < 0.05). Fiber intake is represented by the scores given for fruits, vegetables, legumes, nuts, and whole-grain cereals, and, along with olive oil, they are considered the backbone of the MD and the main elements used to characterize adherence to this dietary pattern [40]. According to Trichopoulou *et al*. [9] high MD scores are characterized by high intakes of fibers and olive oil. Three of the evaluated indices (MDScale, SMDQ, and MDS) showed significant correlations for the monounsaturated to saturated fatty acids ratio, a key factor in the MD ($P = 0.002$, $P = 0.019$, and $P = 0.005$ respectively) [41].

In addition, the MDScale index was positively associated to WHR and total energy intake, as was also observed by Alkerwi *et al*. [42] in a cross-comparison study in Luxembourg where the MDScale was used along with other diet quality indices but was the only index to show an association between an increase in total energy intake and greater MD adherence.

None of the indices in the present study were correlated to BMI, which is similar to the results reported by Trichopoulou *et al.* [43] and *Rossi et al.* [44]. The lack of an association may be explained by the presence of confounding factors, such as the reduced level of physical activity that can be observed nowadays, combined with nutrition transition consequences. Even when following an MD eating pattern, Lebanese adults nowadays tend to eat larger food portions and exhibit a higher total energy intake and a reduced physical activity level, which will consequently result in a higher BMI [45].

The SMDQ, MDS, and MedDiet score indices were positively correlated to age. These results could be attributable to the reported high consumption of "trendy" and "westernized" food by young members of the population [46].

Logistic regression models of the association between each MD index score and the chosen parameters showed significant and important correlations for the MDScale index, results of which showed linkages to all of the MD characteristic components (*i.e.*, gender, WHR, energy intake, fiber and olive oil intakes, and monounsaturated/saturated fatty acid ratio). In an attempt to design and validate a novel MD index, Monteagudo *et al*. [47] considered the MDScale as the gold standard suggesting its use as a reference tool. Our findings support that suggestion, corroborating the usefulness of the MDScale as a reliable tool for MD assessment purposes. The MedDiet score also showed significant correlations with MD parameters such as age and fiber and olive oil intakes, suggesting that it could be considered a good alternative, with the inclusion of predefined normative cut-off points, to the sex-specific median-related MDScale. Zaragoza *et al*. [48], in a 2018 review in which five MD assessment indices were compared, showed that the MedDiet score, compared to the other indices, provides the best evidence of MD adherence. The MedDiet score is particularly useful because, for each of the assessed food groups, five classifications are possible; thus, it is deemed more representative of the consumption of MD food items. The SMDQ index also showed good correlations with age and, fiber and olive oil intakes; however, the cut-off suggested for fish intake (≥ 3 portions/day) is not attainable in the region we studied because of low fish availability and high selling prices for fish and seafood [49]. The MDS index, created in Chile, included specific items that are culturally representative of their region (e.g., avocado and canola oil) that are not typical in the Mediterranean region in our study.

The MedDiet score and MDScale indices had a minimal level of agreement between them (65% agreement), which can be anticipated because the MDScale is a sex-specific, median-related scoring system without predefined portions or cut-offs, and provides an index ranging from 0 to 9, based on determining the daily intakes of 9 foods. In contrast, the MedDiet score index ranges from 0 to 55 based on 11 food groups that represent the MD; moreover, it includes predefined portions and cut-offs for each group and assesses the frequency of consumption per month. On the other hand, the highest inter-index correlation (76%) was reported between MDS and MedDiet score. Both the MDS and MedDiet score MD assessment tools are based on similar food groups (e.g., separation of fatty and lean meats and full-fat and low-fat dairy products) and they use predefined portions and cut-offs.

Despite the amount of effort undertaken to create a method for assessing the MD, there remain limitations to their use among populations that differ from the one where the tool was validated initially. First, there is a lack of uniformity in the components of this diet: for example, some studies only take into account wine consumption, while others consider alcohol in general as a component. Another example is potatoes are reported together with other vegetables in some studies but considered as an independent food group in other studies. Moreover, nuts are considered in some indices as belonging to fruits while others consider them as a separate food group. In addition, even within the same food group, the number of servings may differ markedly among the indices; for example, the MDS uses 2 servings of fish/week while the SMDQ uses 3 servings/day.

To increase the consistency among indices, there is a need to develop a consensus on the use of some components, such as combining or separating fatty and lean meats, full-fat and low-fat dairy products, and unrefined and any cereals. Another important limitation is that many traditional food items, such as green leafy vegetables, bulgur, tahini, and spices, that are widely consumed in many Mediterranean countries, including Lebanon, are not included in the available indices and these exclusions can affect the relevance of the obtained MD adherence score. Finally, the monounsaturated/saturated fatty acids ratio is only included in one index, the MDScale. In the other indices, fatty acids are assessed by examining olive oil intake, a source of monounsaturated fatty acids (omega 9), but there is no assessment of saturated fatty acid intake.

Human dietary patterns are highly influenced by cultural and genetic differences among populations and consequently, every index that assesses dietary patterns should be adapted to the characteristics of the studied population. Therefore, the number of components included, the contribution of each component, and the index scoring criteria must be population specific in order to increase the reliability of the result and the concordance between MD adherence scores. Even though many differences and inconsistencies were observed in calculating the five indices in this study, our results are relatively homogeneous. The five indices performed adequately in measuring adherence to the MD because the index values were derived from the same validated FFQ, were based on common dietary items, and the interviews were run by the same researcher. To our knowledge, this is the first study comparing five MD assessment tools for application to a population of Lebanese adults.

In conclusion, while Mediterranean dietary habits are still present in some populations, we are living in an era with a progressive shift away from the traditional MD, mainly in younger generations. This trend underlines the need for an overall dietary renaissance and a resurgence of the traditional MD, which may be encouraged by investing scientific research efforts into developing practical dietary indices and guidelines. The results for the five MD assessment indices analyzed in this study showed that two indices are of particular interest for MD assessment, the MDScale and the MedDiet score. The produced showed relatively coherent and homogeneous performances in assessing MD adherence in an adult Lebanese population; thus, we recommend their combined use in future research aimed at developing an MD action plan.

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C.A. as the principal investigator, was responsible for the concept and the design of the study. N.O undertook the statistical analysis. L.R.K. and T.P were responsible for the concept and the design of the study. K.H helped in data analysis. All authors participated in the preparation of the manuscript and approved its final version.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Arvaniti F, Panagiotakos DB. Healthy indexes in public health practice and research: a review. Crit Rev Food Sci Nutr 2008;48: 317-27.
2. Martínez-González MA, García-López M, Bes-Rastrollo M, Toledo E, Martínez-Lapiscina EH, Delgado-Rodriguez M, Vazquez Z, Benito S, Beunza JJ. Mediterranean diet and the incidence of cardiovascular

disease: a Spanish cohort. Nutr Metab Cardiovasc Dis 2011;21: 237-44.
3. Martínez-González MA, de la Fuente-Arrillaga C, Nunez-Cordoba JM, Basterra-Gortari FJ, Beunza JJ, Vazquez Z, Benito S, Tortosa A, Bes-Rastrollo M. Adherence to Mediterranean diet and risk of developing diabetes: prospective cohort study. BMJ 2008;336: 1348-51.
4. Anastasiou CA, Yannakoulia M, Kosmidis MH, Dardiotis E, Hadjigeorgiou GM, Sakka P, Arampatzi X, Bougea A, Labropoulos I, Scarmeas N. Mediterranean diet and cognitive health: initial results from the Hellenic Longitudinal Investigation of Ageing and Diet. PLoS One 2017;12:e0182048.
5. Saulle R, Semyonov L, La Torre G. Cost and cost-effectiveness of the Mediterranean diet: results of a systematic review. Nutrients 2013;5:4566-86.
6. Schwingshackl L, Hoffmann G. Adherence to Mediterranean diet and risk of cancer: a systematic review and meta-analysis of observational studies. Int J Cancer 2014;135:1884-97.
7. Velázquez-López L, Santiago-Díaz G, Nava-Hernández J, Muñoz-Torres AV, Medina-Bravo P, Torres-Tamayo M. Mediterranean-style diet reduces metabolic syndrome components in obese children and adolescents with obesity. BMC Pediatr 2014;14:175.
8. Willett WC, Sacks F, Trichopoulou A, Drescher G, Ferro-Luzzi A, Helsing E, Trichopoulos D. Mediterranean diet pyramid: a cultural model for healthy eating. Am J Clin Nutr 1995;61:1402S-1406S.
9. Trichopoulou A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean diet and survival in a Greek population. N Engl J Med 2003;348:2599-608.
10. Gardener S, Gu Y, Rainey-Smith SR, Keogh JB, Clifton PM, Mathieson SL, Taddei K, Mondal A, Ward VK, Scarmeas N, Barnes M, Ellis KA, Head R, Masters CL, Ames D, Macaulay SL, Rowe CC, Szoeke C, Martins RN; AIBL Research Group. Adherence to a Mediterranean diet and Alzheimer's disease risk in an Australian population. Transl Psychiatry 2012;2:e164.
11. Martínez-González MA, Fernández-Jarne E, Serrano-Martínez M, Marti A, Martinez JA, Martín-Moreno JM. Mediterranean diet and reduction in the risk of a first acute myocardial infarction: an operational healthy dietary score. Eur J Nutr 2002;41:153-60.
12. Leighton F, Polic G, Strobel P, Pérez D, Martínez C, Vásquez L, Castillo O, Villarroel L, Echeverría G, Urquiaga I, Mezzano D, Rozowski J. Health impact of Mediterranean diets in food at work. Public Health Nutr 2009;12:1635-43.
13. Zito FP, Polese B, Vozzella L, Gala A, Genovese D, Verlezza V, Medugno F, Santini A, Barrea L, Cargiolli M, Andreozzi P, Sarnelli G, Cuomo R. Good adherence to Mediterranean diet can prevent gastrointestinal symptoms: a survey from Southern Italy. World J Gastrointest Pharmacol Ther 2016;7:564-71.
14. Papadaki A, Wood L, Sebire SJ, Jago R. Adherence to the Mediterranean diet among employees in South West England: formative research to inform a web-based, work-place nutrition intervention. Prev Med Rep 2015;2:223-8.
15. Martínez-González MA, García-Arellano A, Toledo E, Salas-Salvadó J, Buil-Cosiales P, Corella D, Covas MI, Schröder H, Arós F, Gómez-Gracia E, Fiol M, Ruiz-Gutiérrez V, Lapetra J, Lamuela-Raventos RM, Serra-Majem L, Pintó X, Muñoz MA, Wärnberg J, Ros E, Estruch R; PREDIMED Study Investigators. A 14-item Mediterranean diet assessment tool and obesity indexes among high-risk subjects: the PREDIMED trial. PLoS One 2012;7:e43134.
16. Panagiotakos DB, Pitsavos C, Stefanadis C. Dietary patterns: a Mediterranean diet score and its relation to clinical and biological markers of cardiovascular disease risk. Nutr Metab Cardiovasc Dis 2006;16:559-68.
17. Milà-Villarroel R, Bach-Faig A, Puig J, Puchal A, Farran A, Serra-Majem L, Carrasco JL. Comparison and evaluation of the reliability of indexes of adherence to the Mediterranean diet. Public Health Nutr 2011;14:2338-45.
18. Tabachnick BG, Fidell LS. Using Multivariate Statistics. 5th ed. Boston: Pearson/Allyn & Bacon; 2007.
19. Papazian T, Hout H, Sibai D, Helou N, Younes H, El Osta N, Khabbaz LR. Development, reproducibility and validity of a food frequency questionnaire among pregnant women adherent to the Mediterranean dietary pattern. Clin Nutr 2016;35:1550-6.
20. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis C, Lagiou P, Polychronopoulos E, Vassilakou T, Lipworth L, Trichopoulos D. Diet and overall survival in elderly people. BMJ 1995;311:1457.
21. Buckland G, Ros MM, Roswall N, Bueno-de-Mesquita HB, Travier N, Tjonneland A, Kiemeney LA, Sacerdote C, Tumino R, Ljungberg B, Gram IT, Weiderpass E, Skeie G, Malm J, Ehrnström R, Chang-Claude J, Mattiello A, Agnoli C, Peeters PH, Boutron-Ruault MC, Fagherazzi G, Clavel-Chapelon F, Nilsson LM, Amiano P, Trichopoulou A, Oikonomou E, Tsiotas K, Sánchez MJ, Overvad K, Quirós JR, Chirlaque MD, Barricarte A, Key TJ, Allen NE, Khaw KT, Wareham N, Riboli E, Kaaks R, Boeing H, Palli D, Romieu I, Romaguera D, Gonzalez CA. Adherence to the Mediterranean diet and risk of bladder cancer in the EPIC cohort study. Int J Cancer 2014;134: 2504-11.
22. de la Fuente-Arrillaga C, Zazpe I, Santiago S, Bes-Rastrollo M, Ruiz-Canela M, Gea A, Martinez-Gonzalez MA. Beneficial changes in food consumption and nutrient intake after 10 years of follow-up in a Mediterranean cohort: the SUN project. BMC Public Health 2016;16:203.
23. Sotos-Prieto M, Bhupathiraju SN, Mattei J, Fung TT, Li Y, Pan A, Willett WC, Rimm EB, Hu FB. Changes in diet quality scores and risk of cardiovascular disease among US men and women. Circulation 2015;132:2212-9.
24. Vidal-Peracho C, Tricás-Moreno JM, Lucha-López AC, Lucha-López MO, Camuñas-Pescador AC, Caverni-Muñoz A, Fanlo-Mazas P. Adherence to Mediterranean diet pattern among Spanish adults attending a medical centre: nondiabetic subjects and type 1 and 2 diabetic patients. J Diabetes Res 2017;2017:5957821.
25. Savanelli MC, Barrea L, Macchia PE, Savastano S, Falco A, Renzullo A, Scarano E, Nettore IC, Colao A, Di Somma C. Preliminary results demonstrating the impact of Mediterranean diet on bone health. J Transl Med 2017;15:81.
26. Echeverría G, McGee EE, Urquiaga I, Jiménez P, D'Acuña S, Villarroel L, Velasco N, Leighton F, Rigotti A. Inverse associations between a locally validated Mediterranean diet index, overweight/obesity, and metabolic syndrome in Chilean adults. Nutrients 2017;9:E862.
27. Kapelios CJ, Kyriazis I, Ioannidis I, Dimosthenopoulos C, Hatziagelaki E, Liatis S; PERSEAS Study Group. Diet, life-style and cardiovascular morbidity in the rural, free living population of Elafonisos island. BMC Public Health 2017;17:147.
28. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. Mahwah: Lawrence Erlbaum Associates, Publishers; 1988.
29. Sofi F, Macchi C, Abbate R, Gensini GF, Casini A. Mediterranean diet and health status: an updated meta-analysis and a proposal

for a literature-based adherence score. Public Health Nutr 2014;17:2769-82.
30. Esposito K, Kastorini CM, Panagiotakos DB, Giugliano D. Mediterranean diet and metabolic syndrome: an updated systematic review. Rev Endocr Metab Disord 2013;14:255-63.
31. Rienks J, Dobson AJ, Mishra GD. Mediterranean dietary pattern and prevalence and incidence of depressive symptoms in mid-aged women: results from a large community-based prospective study. Eur J Clin Nutr 2013;67:75-82.
32. Issa C, Darmon N, Salameh P, Maillot M, Batal M, Lairon D. A Mediterranean diet pattern with low consumption of liquid sweets and refined cereals is negatively associated with adiposity in adults from rural Lebanon. Int J Obes (Lond) 2011;35:251-8.
33. Fakhoury-Sayegh N, Younes H, Heraoui GN, Sayegh R. Nutritional profile and dietary patterns of lebanese non-alcoholic fatty liver disease patients: a case-control study. Nutrients 2017;9:E1245.
34. Parlapani E, Agakidis C, Karagiozoglou-Lampoudi T, Sarafidis K, Agakidou E, Athanasiadis A, Diamanti E. The Mediterranean diet adherence by pregnant women delivering prematurely: association with size at birth and complications of prematurity. J Matern Fetal Neonatal Med 2017;13:1-8.
35. Martínez-González MÁ, Hershey MS, Zazpe I, Trichopoulou A. Transferability of the Mediterranean diet to non-Mediterranean countries. What is and what is not the Mediterranean diet. Nutrients 2017;9:E1226.
36. Papazian T, Serhal A, Hout H, Younes H, Tayeh GA, Azouri J, Moussa Lteif FH, Kesrouani A, Khabbaz LR. Discrepancies among different tools evaluating Mediterranean diet adherence during pregnancy, correlated to maternal anthropometric, dietary and biochemical characteristics. Clin Nutr 2019;38:1398-1405.
37. Guasch-Ferré M, Hu FB, Martínez-González MA, Fitó M, Bulló M, Estruch R, Ros E, Corella D, Recondo J, Gómez-Gracia E, Fiol M, Lapetra J, Serra-Majem L, Muñoz MA, Pintó X, Lamuela-Raventós RM, Basora J, Buil-Cosiales P, Sorlí JV, Ruiz-Gutiérrez V, Martínez JA, Salas-Salvadó J. Olive oil intake and risk of cardiovascular disease and mortality in the PREDIMED Study. BMC Med 2014;12:78.
38. Buil-Cosiales P, Zazpe I, Toledo E, Corella D, Salas-Salvadó J, Diez-Espino J, Ros E, Fernandez-Creuet Navajas J, Santos-Lozano JM, Arós F, Fiol M, Castañer O, Serra-Majem L, Pintó X, Lamuela-Raventós RM, Marti A, Basterra-Gortari FJ, Sorlí JV, Verdú-Rotellar JM, Basora J, Ruiz-Gutierrez V, Estruch R, Martínez-González MÁ. Fiber intake and all-cause mortality in the Prevención con Dieta Mediterránea (PREDIMED) study. Am J Clin Nutr 2014;100:1498-507.
39. Urquiaga I, Echeverría G, Dussaillant C, Rigotti A. Origin, components and mechanisms of action of the Mediterranean diet. Rev Med Chil 2017;145:85-95.
40. Willett WC. The Mediterranean diet: science and practice. Public Health Nutr 2006;9:105-10.
41. Matsumoto Y, Sugioka Y, Tada M, Okano T, Mamoto K, Inui K, Habu D, Koike T. Monounsaturated fatty acids might be key factors in the Mediterranean diet that suppress rheumatoid arthritis disease activity: the TOMORROW study. Clin Nutr 2018;37:675-80.
42. Alkerwi A, Vernier C, Crichton GE, Sauvageot N, Shivappa N, Hébert JR. Cross-comparison of diet quality indices for predicting chronic disease risk: findings from the Observation of Cardiovascular Risk Factors in Luxembourg (ORISCAV-LUX) study. Br J Nutr 2015;113:259-69.
43. Trichopoulou A, Naska A, Orfanos P, Trichopoulos D. Mediterranean diet in relation to body mass index and waist-to-hip ratio: the Greek European Prospective Investigation into Cancer and Nutrition Study. Am J Clin Nutr 2005;82:935-40.
44. Rossi M, Negri E, Bosetti C, Dal Maso L, Talamini R, Giacosa A, Montella M, Franceschi S, La Vecchia C. Mediterranean diet in relation to body mass index and waist-to-hip ratio. Public Health Nutr 2008;11:214-7.
45. Naja F, Nasreddine L, Itani L, Adra N, Sibai AM, Hwalla N. Association between dietary patterns and the risk of metabolic syndrome among Lebanese adults. Eur J Nutr 2013;52:97-105.
46. Nasreddine L, Hwalla N, Sibai A, Hamzé M, Parent-Massin D. Food consumption patterns in an adult urban population in Beirut, Lebanon. Public Health Nutr 2006;9:194-203.
47. Monteagudo C, Mariscal-Arcas M, Rivas A, Lorenzo-Tovar ML, Tur JA, Olea-Serrano F. Proposal of a Mediterranean diet serving score. PLoS One 2015;10:e0128594.
48. Zaragoza-Martí A, Cabañero-Martínez MJ, Hurtado-Sánchez JA, Laguna-Pérez A, Ferrer-Cascales R. Evaluation of Mediterranean diet adherence scores: a systematic review. BMJ Open 2018;8:e019033.
49. Naja F, Hwalla N, Itani L, Baalbaki S, Sibai A, Nasreddine L. A novel Mediterranean diet index from Lebanon: comparison with Europe. Eur J Nutr 2015;54:1229-43.