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ORIGINAL ARTICLE

A Mediterranean diet pattern with low consumption of liquid sweets and refined cereals is negatively associated with adiposity in adults from rural Lebanon

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Background: The beneficial impact of the traditional Mediterranean diet pattern on adiposity is still under debate, and this has never been assessed in a developing Mediterranean country.
Objectives: To assess the relationships between adherence to a traditional Mediterranean diet and adiposity indexes, that is, body mass index (BMI) and waist circumference (WC), in a sample from rural Lebanon.
Design: A sample of 798 adults, aged 40–60 years, was selected in continental rural areas of Lebanon for a cross-sectional study. The questionnaire included socio-demographic, anthropometric and dietary sections. The daily consumption frequencies of selected food groups, categorized as positive or negative components, were calculated based on a food frequency questionnaire. Adherence to the Mediterranean diet was assessed using six *a priori* scores; including the widely used Mediterranean diet score (MDS). Associations between diet scores and BMI and WC were assessed.
Results: Overall, the diet of the study sample only partially matched the traditional Mediterranean diet. A total of 17.0% of men and 33.7% women were obese. The MDS was negatively associated ($P<0.05$) with WC, but not BMI, in men and women. The constructed composite Mediterranean score combining positive components of the diet (whole cereals, vegetables, legumes and fruit, olive oil and fish) and negative components adapted to this sample (refined cereals and pastries, and liquid sweets) was consistently and negatively associated with both BMI and WC for men and women in multivariate models. A 2-point increase in that score was associated with a decrease in BMI of 0.51 and 0.78 $kg\,m^{-2}$ and a decrease in WC of 2.77 and 4.76 cm in men and women, respectively.
Conclusion: The results demonstrate that a Mediterranean diet is negatively associated with obesity and visceral adiposity in a rural population of a developing Mediterranean country.
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Keywords: nutrition; developing country; body mass index; waist circumference; scores; Mediterranean diet

Introduction

Today, more than 1.1 billion adults are overweight and 312 million are obese.[1] Although the increased health burden due to excess adiposity is well-known in industrialized countries, over the past 20 years it is noteworthy that the prevalence of obesity has tripled in more westernized developing countries, where there has been a marked increase in cheap energy-dense food and gradual decline in physical activity. The Middle East, in particular, is facing the greatest threat in terms of the escalating obesity epidemic.[1]

Adults in Mediterranean countries are at high risk of obesity, especially in southern European countries (median = 23.7%), as reported in a meta-analysis on obesity in the Mediterranean region.[2] The high prevalence of adult obesity in southern Europe has more recently been confirmed by the EPIC study; among countries participating in this study, Greece and Spain had the highest mean body mass index (BMI) and waist circumference (WC).[3]

During the last several decades, the food habits in Mediterranean countries have largely evolved from

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a plant-based diet to an animal-based one,[4] indicating a westernization of food habits and a move away from a traditional Mediterranean diet.[5,6] Given its reported overall protective effect on health outcomes,[7,8] the decreased adherence to a Mediterranean diet is expected to have detrimental health effects for Mediterranean populations.

Following a traditional Mediterranean diet might be associated with a lower risk of adiposity. A recent review of the topic[9] reported a trend toward a beneficial effect of the Mediterranean diet on obesity. Whereas some studies found no such relationships,[10,11] other observational studies in industrialized countries suggested a protective effect of the Mediterranean diet on obesity,[12,13] abdominal fat[3,14] and weight gain.[15,16]

In Lebanon, a middle-income developing country of the Eastern Mediterranean basin, the prevalence of overweight and obesity has attained alarming rates in children,[17,18] adolescents[19] and adults,[17] largely in urban areas. These high rates may be the consequence of important changes associated with both reduced physical activity of modern lifestyles[20] and eating habits characterized by energy dense diets that are low in fiber, fruit and vegetables, and high in fats and sugars.[21] Although the above changes are apparent mainly in urban settings, rural areas around Lebanon also appear to be experiencing a nutrition transition.[22]

Using data from a recent survey conducted in interior areas of Lebanon,[22] we aimed to test the hypothesis that adherence to a traditional Mediterranean diet is associated with lower adiposity in people living in rural areas of Lebanon. Subjects' adherence to the traditional Mediterranean diet pattern was assessed by predefined diet quality scores.[23] We tested the widely used Mediterranean diet score (MDS) as defined by Trichopoulou *et al*.[24] (with some modifications) and a more adapted composite Mediterranean (MED) score taking into account the specific food habits of individuals in the sample. Moreover, and similar to a recent study conducted in Greece on mortality,[25] the study investigated the relative importance of the individual food components of the Mediterranean diet on adiposity. More specifically, the relative impact of *a priori* positive or negative components of the diet was investigated by developing four partial scores. We examined the associations of these six diet scores with adiposity markers, namely BMI and WC.

Methods

Study sample

Data were available from a survey conducted during the period from June to August 2005 in a sample of 798 adults, aged 40–60 years, in selected rural areas of the Bekaa and Mount Lebanon.[22] The sample was selected randomly using municipal lists in three villages; the participation rate was above 85%. The sample is representative of the population in three non-coastal villages at varying levels of economic development in the country with a voluntary bias toward more traditional and poorer sections of the Lebanese population. The sample was not representative of the Lebanese population at large, because the project was concentrated in rural areas.[22]

After excluding outliers, data from 787 participants (48% women; 52% men) were available for analysis. Ethical approval was obtained from the American University of Beirut Institutional Review Board. The questionnaire used was divided into socio-demographic, anthropometric and dietary sections.

Socio-demographic and behavioral variables

In the socio-demographic section, questions about age, occupation, education level, smoking, level of sedentary occupation and physical activity were included. Age was considered to be a linear variable. Income per person was divided into three categories (according to tertiles) and was calculated by dividing household income by the number of persons in the household. Education level was divided into four categories. The study sample was divided into smokers, previous smokers and non-smokers. Hours of sedentary occupation was calculated by adding up hours spent in front of the television and personal computer. Frequency and duration of occupational and leisure time physical activities were also assessed in the questionnaire after validation in a previous study.[26] Time spent (less than 30 min, 30–60 min, 1–1.5 h and more than 1.5 h) on each activity (walking/hiking, jogging/running, housework, gardening/farm work, group sports/football/basketball, individual exercise) was multiplied by the MET value[27] (that is, metabolic equivalent of task) of the activity. The resulting MET-min products were summed to produce an index of daily physical activity, expressing the amount of energy per kg body weight expended during the week.[28]

Anthropometrics

Anthropometrics included weight (in kg), height (in m) and waist circumference (in cm). Body weight, height and WC were measured by trained interviewers according to the procedures described by Lee & Nieman.[29] The BMI ($kg\,m^{-2}$) was calculated by dividing weight in kilograms by height in meters squared. WC was measured by placing a measuring tape around the abdomen.[29] BMI was categorized into three classes and were the same for both genders; normal weight ($BMI < 25\,kg\,m^{-2}$), overweight ($25\,kg\,m^{-2} \leqslant BMI < 30\,kg\,m^{-2}$) and obese ($BMI \geqslant 30\,kg\,m^{-2}$). WC was categorized into two classes; lower risk of metabolic diseases ($WC \leqslant 102\,cm$ for men, $WC \leqslant 88\,cm$ for women) and higher risk of metabolic diseases ($WC > 102\,cm$ for men, $WC > 88\,cm$ for women) according to gender.[29]

Dietary data

The dietary evaluation included a non-quantitative Food Frequency Questionnaire (FFQ) and a 24-h recall.

Questionnaires were finalized and validated as follows. One mixed-gender focus group was held in each community, with an average of six participants. On the basis of FFQ from the literature,[30] a nutritionist and a dietitian explained this dietary method to the participants and a list of food items was drawn. The FFQ was then administered with the 24-h recall to a sub-sample of 20 individuals in every community. If a food was mentioned in any one of the 24-h recalls, but not in the FFQ, it was added into the FFQ. In the reverse situation, items were reviewed by the investigators and a decision was made whether to keep them or not. No further validation (that is, using biological markers) was possible.

Both questionnaires were administered face-to-face by trained individuals under the supervision of a dietitian field coordinator. The FFQ contained 78 items aggregated into 11 food groups. All participants were questioned about usual frequency of intake for different food items during the last year and were asked to report the frequency of these intakes in terms of day, week, month or year. The frequency of daily consumption (FDC) of each food item was then calculated by occasions/day. The sum of the FDC of all food items belonging to the same food group was calculated. Distributions of food group FDC were obtained as well as the corresponding FDC medians. No significantly different figures were observed between genders. The 24-h recalls were used to further confirm the exceptionally high or low FDC found for some food groups in the FFQs.

Diet scores

Six different diet scores (Table 1), based on food groups were derived from the FFQ, namely MDS, positive MDS, negative MDS, positive MED, negative MED and composite MED. This corresponded with the logic behind previous scoring strategies used for the traditional Mediterranean diet.[31] The MDS was based on the previously described and widely used Mediterranean diet score.[24] This MDS, which includes *a priori* positive and negative components was first calculated. This score was further decomposed into the positive MDS and negative MDS scores to separately identify the specific roles of its positive and negative components. To take into account the specific food intakes within the sample (further confirmed by the 24-h recalls) more effectively,[5] and to comply with the traditional Mediterranean diet, refined cereals and pastries were removed from the positive MDS to obtain the positive MED score. Wholemeal cereals were included as a separate component of the positive MED score along with the other positive components included in the MDS. In addition, foods with a low nutrient density (that is, refined cereals and pastries, and liquid sweets including sugar-sweetened tea and coffee) were included in the negative MED score. Combination of the positive MED and negative MED scores components resulted in a composite MED score better reflecting the dietary habits of our study sample.

The MDS calculated in this study underwent some modifications compared to the Mediterranean diet score initially developed by Trichopoulou *et al*.[24] First, because the FFQ used in this study was non-quantitative, the MDS was based on medians of frequency of daily intake (FDC) instead of median intake in grams. Second, nuts were not included in the MDS because they were most often consumed salted and oil roasted in the study sample (further confirmed by the 24-h recalls). Third, for fat intake, we used the ratio of olive oil to saturated fat sources (butter + Ghee + coconut margarine) instead of monounsaturated lipids to saturated lipids. Finally, ethanol consumption was not accounted for in this study as it is believed that alcohol would be, if consumed, largely underreported because of religious prohibitions against consumption.

Table 1 Medians of the frequency of daily consumption (FDC) and construction of the six different diet scores based on the food groups consumed in the studied population sample

Food groups	*FDC median*[a]	*MDS*[b]	*Positive MDS*[c]	*Negative MDS*	*Positive MED*	*Negative MED*	*Composite MED*
Cereal and grain products:	3.6	+	+				
Wholemeal[d]	0.35				+		+
Refined cereals and pastries[e]	3.1					–	–
Fruit	5.1	+	+		+		+
Vegetables (excluding potatoes)	6.0	+	+		+		+
Legumes	0.43	+	+		+		+
Fish and Seafood	0.033	+	+		+		+
Olive oil/saturated fats ratio[f]	1.0	+	+		+		+
Red meat and poultry[g]	0.57	–		–			
Whole milk and dairy products[h]	2.7	–		–			
Liquid sweets[i]	4.6					–	–
Maximum score		8 points	6 points	2 points	6 points	2 points	8 points

[a]FDC: frequency of daily consumption, occasion/day. [b]MDS is the Mediterranean diet score as defined by Trichopoulou *et al*.[24] (NEJM 2003) with few modifications imposed by the study context. [c]The four other partial scores and the composite MED score have been defined and calculated during this study (for score details see the Methods section). [d]Bread (wholemeal)+bulgur (cracked wheat)+cooked wheat+corn. [e]Pastries = oriental pastries+western style pastries. [f]Saturated fats = butter+ghee+coconut margarine. [g]Including organ meats and birds. [h]Including dairy desserts. [i]Fruit juices, carbonated beverages, sweetened tea, herbal teas and coffee.

As previously described,[24] people who consumed less than the median of beneficial components (total cereals, whole grains, fruit, vegetables, legumes, fish and seafoods, olive oil/ saturated fats ratio) were assigned a value of 0, and people who consumed at or above the median were assigned a value of 1. For components presumed to be detrimental (meat and poultry, dairy products, which are rarely non-fat or low-fat in our sample, and liquid sweets), an inverse score was assigned. People who consumed below the median were assigned a value of 1, and people who consumed at or above the median were assigned a value of 0. Refined cereals and pastries were considered beneficial in the MDS (as a component of the cereal group), but detrimental in the negative MED and composite MED scores.

Thus, the MDS and the newly constructed composite MED score ranged from 0 (minimal adherence to the traditional Mediterranean diet) to 8 (maximal adherence) (Table 1). The positive MDS and positive MED scores ranged from 0 to 6 whereas the negative MDS and negative MED scores ranged from 0 to 2. For food groups included in the positive scores, a high score reflected a high frequency of intake. Inversely, for food groups included in the negative scores, a higher score reflected a low frequency of intake.

Statistical analysis

Completed questionnaires were entered and analyzed in SPSS (version 12, Chicago, IL, USA), and used for statistical analysis. All continuous variables were tested for normality. Univariate and multivariate linear regressions were performed with BMI and WC as dependent variables and the six different scores as independent variables in separate models. The analyses were stratified by gender. In multivariate analysis, age, education level, income per person, smoking, television and personal computer hours and MET-min/week were entered as potential confounding variables. A P-value of less than 0.05 was considered significant.

Table 2 Baseline characteristics of the study sample by gender

	Men	*Women* % (n)	*Total*
Sample size	52.1 (410)	47.9 (377)	100 (787)
Age			
Years, mean (s.d.)	49.4 (6.28)	46.9 (6.45)	48.2 (6.5)
Body mass index			
BMI $<25\,kg/m^2$	39.8 (162)	29.9 (112)	35.1 (274)
$25\,kg/m^2 \leqslant$ BMI $<30\,kg/m^2$	43.2 (176)	36.4 (136)	39.9 (312)
BMI $\geqslant 30\,kg/m^2$	17.0 (69)	33.7 (126)	25.0 (195)
Waist circumference			
WC $\leqslant$ 102 cm (M); WC $\leqslant$ 88 cm (W)	73.5 (285)	32.6 (115)	54.0 (400)
WC $>$ 102 cm (M); WC $>$ 88 cm (W)	26.5 (103)	67.4 (238)	46.0 (341)
Occupation			
Farmer/blue collar	24.2 (99)	0.8 (3)	13 (102)
Homemaker	0	89.8 (335)	42.8 (335)
Education level			
Elementary	49.5 (201)	59.3 (216)	54.2 (417)
Intermediate	31.5 (128)	28.0 (102)	29.9 (230)
High School	8.6 (35)	7.7 (28)	8.2 (63)
College	10.3 (42)	4.9 (18)	7.8 (60)
Monthly income per person (MIP) in US$[a]			
MIP $\leqslant$ 67 US$	35.6 (144)	36.9 (138)	36.2 (282)
67 $<$ MIP $<$ 132	26.0 (105)	27.3 (102)	26.6 (207)
MIP $\geqslant$ 132	38.4 (155)	35.8 (134)	37.1 (289)
Smoking			
Previous smoker	6.4 (26)	2.4 (9)	4.5 (35)
Non-smoker	47.2 (193)	75.7 (283)	60.8 (476)
Current smoker	46.5 (190)	21.9 (82)	34.7 (272)
Daily sedentary occupations			
TV and PC hours >2	21.7 (86)	13.7 (50)	17.8 (136)
Physical activity			
MET-min/week, median (IQR)[b]	892 (2414)	1837 (1950)	1119 (2100)

[a]After conversion (1 US$ = 1500 LBP); data from 2004–2005 show that 28.5% of Lebanese households are poor (equivalent to US$ 120 per capita per month). Most of the communities involved in our study are therefore poor ones by Lebanese standards, some exceeding 50% poverty. [b]Inter-quartile ratio.

Results

The baseline characteristics of the study sample are presented in Table 2 for the whole sample ($n = 787$) and separately for men and women. The study sample ranged in age between 40 and 60 years, with a mean age of 49.4 for men and 46.9 for women. A total of 17.0% men and 33.7% women were obese (that is, BMI $\geqslant 30\,kg\,m^{-2}$) while 26.5% men and 67.4% women had an abnormally high WC. More than half of the sample (54.2%) had elementary education and only 10.3% of men and 4.9% of women had college education. Almost two-thirds of the sample had a monthly income lower than 200 000 L.P (that is, 130 US dollars). There was a higher proportion of men (46.5%) than women (21.9%) who smoked, and a higher proportion of men (21.7%) than women (13.7%) who spent more than 2 h per day watching television and/or using a personal computer. The median MET-min/week was 892 for men and 1837 for women.

Table 1 shows the partial score points attributed to the different food groups based on the FDC. The FDC of all food groups (except for whole cereals that showed four peaks) followed a normal distribution (data not shown) in the study sample.

Table 1 also shows the median values of the FDC of the 11 food groups included in the six different score versions. In the study sample, refined cereals and pastries, fruit, vegetables, dairy products and liquid sweets were consumed more than one time per day (median FDC $\geqslant 1$) whereas the consumption of wholemeal cereals, legumes, fish and sea foods, red meat and poultry was lower. The median FDC of olive oil was 0.43 and the ratio of olive oil/saturated fat was 1.0.

Table 3 Univariate and multivariate linear regressions of the associations between each anthropometric variable (that is, BMI or WC as the dependent variable) and each of the six dietary scores (independent variable)

Score	Men				Women			
	B^a	P-value	B^b	P-value^c	B^a	P-value	B^b	P-value^c
MDS								
BMI	−0.085	0.497	−0.131	0.334	−0.338	0.074	−0.156	0.452
WC	−0.840	0.075	**−1.208**	**0.018**	**−1.984**	**0.001**	**−2.077**	**0.001**
Positive MDS								
BMI	−0.024	0.844	−0.066	0.619	−0.346	0.069	−0.218	0.285
WC	−0.782	0.088	**−1.169**	**0.017**	**−2.411**	**<0.001**	**−2.349**	**<0.001**
Negative MDS								
BMI	−0.280	0.300	−0.300	0.316	0.018	0.963	0.300	0.485
WC	−0.047	0.963	0.130	0.906	1.781	0.147	1.546	0.241
Positive MED								
BMI	−0.184	0.133	−0.245	0.065	**−0.485**	**0.006**	−0.355	0.072
WC	−0.894	0.053	**−1.268**	**0.011**	**−2.441**	**<0.001**	**−2.399**	**<0.001**
Negative MED								
BMI	**−0.467**	**0.044**	**−0.600**	**0.016**	**−1.023**	**0.003**	**−0.894**	**0.017**
WC	**−2.937**	**0.001**	**−3.332**	**0.001**	**−4.420**	**<0.001**	**−4.645**	**<0.001**
Composite MED								
BMI	**−0.194**	**0.044**	**−0.255**	**0.014**	**−0.479**	**0.001**	**−0.392**	**0.014**
WC	**−1.070**	**0.003**	**−1.384**	**0.001**	**−2.271**	**<0.001**	**−2.382**	**<0.001**

[a]Non-standardized coefficient; univariate analysis. [b]Non-standardized coefficient; multivariate analysis: adjustments were made for age, education level, income, smoking, sedentary occupation and physical activity. [c]Bold lettering highlights significant differences ($P<0.05$). For food groups included in the positive scores, a high score reflected a high consumption. Inversely, for food groups included in the negative scores, a higher score was attributed to a lower frequency of intake.

Associations between the six different scores and the dependent variables (BMI and WC) are presented for men and women separately (Table 3). The tested hypothesis was the inverse association between each score and adiposity markers. In the univariate analysis, no associations were found between the MDS score and BMI in the two genders. The MDS score was negatively and significantly associated with WC in women only. The same pattern was observed with the partial positive MDS, but no significant association was found for BMI, or WC and the partial negative MDS in both genders. Significant inverse associations were found between the composite MED score and BMI in both men and women as well as with WC in men and women. The same associations were found with the negative MED score in both genders, whereas the positive MED score was negatively associated with BMI in women and with WC in both genders (borderline P-value for men).

The above described univariate associations between each of the six scores and BMI or WC generally persisted after adjustments were made for confounding variables (that is, age, education level, income, smoking, sedentary occupation and physical activity) in multivariate analysis (Table 3). The MDS was not significantly associated with BMI in the two genders, but was negatively associated with WC in both men ($P=0.018$) and women ($P=0.001$). These associations with WC were also found with the positive MDS, but not with the negative MDS. The composite MED score was negatively and consistently associated with BMI ($P=0.014$) and with WC ($P\leqslant0.001$) in both men and women. Similar significant associations were found with the negative MED score (all $P\leqslant0.001$) and the positive MED score with WC in both men ($P=0.011$) and women ($P<0.001$).

In the case of the composite MED score, the only other statistically significant variables, in addition to the score, were: income for WC in men (positive relation, $P=0.003$), income for BMI in men (positive relation, $P=0.029$) and education for BMI in women (negative relation, $P=0.027$) (data not shown).

As presented in Table 3, the data demonstrates that a 2-point increase (over a total of eight) in the composite MED score was associated with a decrease in BMI of 0.510 $kg\,m^{-2}$ in men and 0.784 $kg\,m^{-2}$ in women. Moreover, a 2-point increase in the composite MED score was found to be associated with a decrease in WC of 2.77 cm in men and 4.76 cm in women.

Discussion

In this study, we questioned the possible association between adherence to a traditional Mediterranean diet and adiposity in a sample of adults in rural Lebanon. A high prevalence of obesity and a low adherence to a Mediterranean diet pattern were observed in the study sample even though it was a sample of a rural, poor and aged population. By using the well-known MDS as a reference,[24] or constructing various scores tailored to this sample, we found that the relationship between diet and adiposity was more effectively shown using the composite MED score, combining positive components of the diet with the most relevant negative components to this sample. Moreover, the partial negative MED score, and to a lesser degree, the partial positive MED score showed consistent associations. Adherence to the Mediterranean dietary pattern was negatively associated with BMI and WC in both men and women. This was not found with the negative MDS or observed with WC alone with the positive MDS and the MDS (used with some modifications imposed by the study sample and study design).

The Lebanese rural sample studied had overall low income, limited academic education and moderate to low physical activity. Our findings indicate that there were slightly more overweight men (43.2%) than women (36.4%), but almost half as many obese women than men (33.7 and 17.0%). Obesity prevalence in this rural sample is similar to those reported in several member states of the European Union (range, 8–40%; mean, 32%)[32] and the United States (27%).[33] It is also comparable to observations of the same age group in a study performed at the national level in Lebanon in

1997.[17] These studies reported 19.4% (40–49 years) and 19.7% (50–59 years) for obese men and 20.4% (40–49 years) and 39.3% (50–59 years) for obese women. Our figures are also consistent with findings in Morocco showing a high prevalence of overweight and obesity in both urban and rural areas,[34] especially for women.[35] High prevalence of obesity in women has also been reported in Tunisia,[36] Egypt,[37] Jordan[38] and Saudi Arabia.[39] The common underlying factors of this exceptionally high prevalence of obese women in our sample and in the Southern/Eastern countries of the Mediterranean region is not well understood and might warrant further investigation in the areas of occupation, energy expenditure and social acceptability of large body shapes, especially as it relates to rural women. Given the well-known association between obesity and development of type 2 diabetes and cardiovascular diseases as well as total mortality,[40] such a high prevalence of adiposity represents a burden likely to challenge public health in these countries in the coming decades.

The contribution of changes in lifestyle and especially dietary patterns in the development of obesity has been widely studied and discussed.[40] Rather than evaluating single nutrients, whose specific role in adiposity development is controversial, investigating impacts of global dietary patterns could be very informative and relevant.[23,41] This study's rural sample exhibited a dietary pattern with frequent intakes of vegetables, fruit, dairy products, refined cereals, liquid sweets, fats and oils, whereas other foods were much less frequently consumed (that is, wholemeal cereals, legumes, olive oil, fish, red meat and poultry). This may be the result of the sample's specific location and traits (that is, to fish and sea foods not readily available and expensive in rural areas relatively remote from the coast, and to expensive olive oil), but also the result of the recent increase in intakes of fat, sweets and dairy products observed in the Lebanese youth and adult population[42] as well as in other Southern Mediterranean countries.[4,43] This change is likely to lead to higher intakes of saturated fats and refined carbohydrates and sugars, and a lower intake of fiber possibly explaining the increased adiposity.[40] Hence, the recent shift from a traditional Mediterranean diet to a more westernized diet could explain, along with increased sedentary occupations, the observed trends in obesity and related metabolic disorders reported in this region,[43] and specifically in the study sample.

In this context, we specifically addressed the question of the possible association between adherence to a traditional Mediterranean diet and adiposity markers such as BMI and WC. For this purpose we chose the widely used MDS.[24] We also elaborated different scores based on previous studies in this field[31] and some specific traits of the study sample. In this study, the MDS was negatively associated with WC only in multivariate analysis in men and women separately (Table 3). This is in line with previous findings in Europe where MDS was associated with WC in one study,[3] but not consistently with BMI.[3,10,12] We obtained comparable data with partial positive MDS, but this association was not found with the negative MDS. This indicates that MDS with reference to its negative components, as used, was not fully adapted to this sample. Indeed, due to religious prohibitions, the alcohol component (1 over 9 in the original MDS) had been removed from the original MDS. This may have weakened the power of MDS.[24,25] In addition, in this largely poor population, the intake of poultry and red meat was low (about 0.5 occasion/day) and the intake of dairy was moderate (2.7 occasions/day), suggesting that these items are not to be considered as negative like they would be in affluent western countries where their intakes are high. Finally, the sizeable intake of refined cereals (and pastries) in this sample suggests that it should not necessarily be considered as a positive item. This prompted us to develop alternative scores by using a partial positive MED score containing only wholemeal cereals in the cereal and grain group, and by creating a partial negative MED score well adapted to the sample and to the traditional Mediterranean diet.[5] This negative MED score was made up of the highly consumed refined cereals (and pastries) and liquid sweets only. Pooling these two partial scores provided a composite MED score. We found that the composite MED score was significantly and negatively associated with BMI and WC in men and women, after adjusting for confounding variables in a multivariate linear regression analysis (Table 3). This was also consistently observed with the partial negative MED score and to a lesser extent the positive MED score, illustrating the relevance of the alterations made to raise these partial scores. This fits well with the traditional Mediterranean diet pattern[5] and the acknowledged beneficial effect of fiber-rich foods,[44–46] as well as the detrimental influence of sugar-sweetened beverages[47,48] on anthropometric measures.

Although a general trend for a negative relationship between adherence to the Mediterranean diet and obesity has been reported in a literature review,[9] results were inconsistent. Such inconsistency was particularly found in some Mediterranean countries from Southern Europe, such as Greece and Spain.[3,10–13] Our findings suggest that the type of negative components included in the scores may help explain these controversies. In particular, in this study, no relationships were found with BMI when using the MDS derived from literature.[24] Indeed, the consumption of items such as red meat and dairy, generally considered as negative markers of the Mediterranean diet, may reflect very different socio-cultural and socio-economic backgrounds depending on the country. In fact, because they are consumed in small or moderate quantities in our poor, rural and older sample, the consumption of these luxury items may be a marker of wealth rather than a marker of unhealthy eating. Consistent with findings in developing countries in transition,[49] including Lebanon,[17] it is noteworthy that some socioeconomic variables (education level in women and income in men) were negatively associated with adiposity in women and positively associated in men, in the study. In this case, the study sample lives in a non-coastal area of Lebanon (a developing country in transition) and did not show overall dietary patterns characteristic of a Mediterranean population. The findings on BMI and WC for both genders, in a rural and moderately physically active Mediterranean sample, add to previous observations from other European countries.[9]

Some limitations of this study are important to mention. First, this study has a cross-sectional design with an inherent potential bias due to the possible inconsistency between the recorded food consumption and past food consumption likely related to the measured adiposity markers. Second, the cut-off points used for BMI and WC were the ones applicable to the American/European population[29] and thus may not be fully adapted to the sample under study. Some research has suggested that lower cut-off points should be used for ethnic Arabs, suggesting that the high rates observed in this sample would get even higher.[50] Third, the FFQ used was only qualitative and therefore hampered the possibility of calculating the MDS as originally elaborated.[24,41] Moreover, only individual food items were included in the FFQ and not composite dishes. This may have led to under-reporting of some foods (that is, whole wheat, fats and vegetable oils) that are consumed as part of composite dishes.[51] The FFQ was administered during the summer season and this could have favored reporting the frequency of intake of some food items over others, although seasonality was not expected to modify the distribution of FDC. Finally, the sample size is limited and can thus limit the statistical power.

In conclusion, the results obtained in a population typical of a Mediterranean developing country are generally consistent with the ones from other studies performed in industrialized countries and thus support the idea that adherence to a Mediterranean-type diet is associated with reduced obesity and abdominal adiposity.

Conflict of interest

The authors declare no conflict of interest.

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