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Research Article

Mediterranean Diet and Metabolic Syndrome in Adult Moroccan Women

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Abstract

The objective was to assess the relationship between adherence to Mediterranean dietary pattern (MDP) and the prevalence of metabolic syndrome (MS) in urban Moroccan adult women, living in an agricultural Mediterranean province; El Jadida. A random sample (n=182) of Moroccan women (18-55 years old) was interviewed; anthropometrical measures and fasting blood sample were collected. The prevalence of MS was determined using the NCEP-ATPIII criteria. A general questionnaire on socio-economic status and lifestyle factors was used. Dietary habits were assessed using three 24hours recalls and a semi-quantitative food frequency questionnaire. Adherence to the Mediterranean diet (MD) was defined according to a score constructed considering the consumption of major MD components. The overall prevalence of MS was 20.9 %; MS was prevalent in 20 % among the overweight and 37.8% among the obese women. Eight point eight of women had no risk factors while 41.2% had one risk factor and 29.1% had two risk factors. Low-HDL cholesterol was found among 82.4 %, Hypertension in 36.8 and abdominal obesity among 25.8 % women with MS. The mean adherence to Mediterranean Diet (MD) was 62.84 % (± 12.7). Once adjusted for age, socioeconomic and lifestyle variables, MD adherence was not related to metabolic syndrome but some MD components, such as Cereals and mono-unsaturated to saturated fatty acids ratio, showed a protective effect on triglyceridemia and glycemia criteria, respectively. The study data show that MS is prevalent among the population sample, especially among obese women. Some components of the MD have a protective effect on MS and on its components. However, no association was found between MS and adherence to MD. High education level and availability of family environment were also related to a better adherence to MD pattern.

Keywords: Mediterranean diet - Metabolic syndrome – Obesity - Moroccan women.

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Introduction

The beneficial effect of diet is among several factors related to lifestyle that can influence cardiovascular risks (WHO, 2003; Wood et al., 2001) and there is also evidence that Metabolic Syndrome (MS) etiology includes genetic, metabolic and environmental factors (Mirmiran et al., 2008). Understanding the nature of predictive factors of MS and how these risk factors are distributed and interrelated within different populations is important to identify and target populations at risk which can contribute to the development and implementation of public health interventions. Among environmental factors, the diet is one of the main aspects related to the increase in MS in the population (Buckland et al., 2008). The MS refers to the clustering of cardiovascular risk factors that include dyslipidemia, abdominal obesity, systemic arterial hypertension and impaired fasting glycemia (Takahashi et al., 2011).

From another perspective, there is an increasing scientific evidence during the last decades, that Mediterranean diet (MD) has protective health effects. The Mediterranean food pattern has indeed acquired an emerging role in cardiovascular epidemiology (Trichopoulou et al., 1994; Sofi et al., 2008) as well as beneficial effects on obesity and type 2 diabetes (Willett et al., 1994; Giugliano et al., 2008). The MD as a dietary pattern is rich in plant foods [cereals, fruits, vegetables, legumes, tree nuts, seeds and olives], with olive oil as the principal source of added fat, along with high to moderate intakes of fish and seafood, moderate consumption of eggs, poultry and dairy products (cheese and yoghurt), low consumption of red meat and a moderate intake of alcohol (mainly wine during meals) (Bach-Faig et al., 2011).

Metabolic syndrome constitutes now a major public health concern worldwide with a high prevalence in different regions such as Europe, Asia, Australia and North and South America where the prevalence achieved rates between 9.6% and 55.7%. This problem is in continuous and rapid increase in the world in parallel to an increase of both diabetes and obesity (Day et al., 2007). On the other hand, adherence to MD was recently reported to reduce the risk of developing MS with a beneficial effect on its individual components (Kastorini et al., 2011). However, the influence of the MD on the development of the MS concerning Moroccan women has never been extensively studied.

The aim of this work was, therefore, to examine the prevalence of MS and the lifestyle factors in relation with the adherence to Mediterranean dietary pattern in urban adult women, living in an agricultural Mediterranean province, El Jadida, in the northwest of Morocco.

Methods

Selection of Participants, Recruitment and Approval

The study was performed on a total of 182 urban adult women subjects aged between 18–55, volunteers, not pregnant, living in an agricultural province, El Jadida, in the northwest of Morocco. The recruitment was carried out according to the women's age, based on the data of a cross-sectional survey realized before in the region of El Jadida in 1995, on women at childbearing age (15–49 y) and showing that the CVD risk factors were more prevalent in women of around 30 y old (Belahsen et al., 2005).

Anthropometric Measurements

Height (± 0.5cm) and Weight (± 0.5kg) were measured and Body mass index (BMI) was calculated as body weight (kg) divided by the square of height (m), and the WHO cut-off points for overweight (BMI > 25) and obesity (BMI > 30) were used to determine the general obesity (WHO, 1998). The waist circumference (WC) was measured to the nearest mm, using a flexible tape, as reported before (Rguibi & Belahsen, 2004; Belahsen et al., 2005). Waist to Hip ratio was calculated and was used with WC to assess central obesity, specifically as an indicator of intra-abdominal or visceral fat deposition. A

mean of two separate measurements was used in the analysis (Olinto et al., 2003).

Blood pressure was measured in women in a sitting position after rest using a mercury sphygmomanometer after a rest period of at least 10 min. Hypertension was defined according to Adult Treatment Panel III criteria as blood pressure equal to or greater than 130mmHg (systolic)/85mmHg (diastolic) (NCEP., 2001).

General Questionnaire

Data on the socio-demographic characteristics were collected and filled in by experienced interviewers using a questionnaire. Age, marital status was categorized into married women (including divorced and widow) and single women, and education level was classified into: never-attended school, primary school, secondary school and University. Physical activity was assessed in the subjects by completing a questionnaire indicating their activities over the past year. Information on family income was also collected to determine the socioeconomic level.

Dietary Questionnaire

Three non-consecutive 24-hr dietary recalls (one weekend day and 2 weekdays), collected in September and October, and validated semi-quantitative food-frequency questionnaire (SFFQ, 120 food items) were obtained from the participants. To estimate volumes and portion sizes, Standard portion sizes (spoons, cups, bowel, glasses and a ruler) were used for the estimation of consumed quantities, as well as questions on habitual cooking methods. Conversion of food into nutrients was made by BILNUT (S.C.D.A. NUTRISOFT-BILNUT) using a food composition database modified to accommodate the particularities of the Moroccan diet and Intakes were expressed as grams per day.

Determination of Glycemia, Triglycerides, Total Cholesterol, and HDL-Cholesterol

Venous blood samples were collected in the morning, after an overnight fast into vacutainer tubes containing disodium EDTA. Plasma was immediately separated from whole blood by centrifugation (910 x g at 10°C for 10 min), added with proteolysis inhibitors and stored at –90° until measurements.

Plasma glucose was measured by the glucose oxidase method with a Beckman analyzer and Plasma cholesterol (TC), and triglycerides (TG) concentrations were determined by enzymatic procedure with commercial kits (Biomérieux) (] Allain et al., 1974; Fossati et al., 1982). Plasma levels of high-density lipoprotein cholesterol (HDL-C) were measured with commercial kits (direct HDL-cholesterol, Randox) (Sugiuchi et al., 1995; Harris et al., 1996) and concentration of low-density lipoprotein cholesterol (LDL-C) were calculated using the Friedewald formula (Friedewald et al., 1972). Lipid and lipoprotein values were expressed as mmol/l. Hypercholesterolemia was defined as mild for cholesterol values in the range 5.2–6.2 mmol/l and moderate to severe for cholesterol values > 6.2 mmol/l. Hypo-HDL cholesterolemia was defined for values lower than 1.3 mmol/l, and hypertriglyceridemia was defined for values higher than 1.4 mmol/l (ANAES., 2000).

Metabolic Syndrome Definition

Individuals with metabolic syndrome are those with any combination of three or more of the following abnormalities: waist circumference, hypertriglyceridemia, low HDL-cholesterol and hypertension or hyperglycemia (National Institute of Health., 2002).

Mediterranean Dietary Pattern

In this study the definition provided for the Mediterranean dietary pattern (MDP) is based on the score used by other authors (Trichopoulou et al., 1995; Kouris-Blazos et al., 1999; Lasheras et al, 2000), and calculated from the food items indicating the degree of adherence to the traditional Mediterranean diet. These MDP scores are converted in relative percentage of adherence by the earlier reported method of Sanchez-Villegas et al., 2002. Briefly,

from food items provided by the FFQ, we determined energy adjusted values for the daily consumption of legumes, fruit (including nuts), cereals (including bread and potatoes), vegetables, meat (and meat products), fish, and whole milk (including dairy products). For religious reasons, the consumption of alcohol in women was considered null.

A Z score value, considered as a proportion of the SD of the reference population ((observed intake - mean intake)/SD), is generated from all these values by calculating the difference between each value and the mean of the study population (considered as the value of the reference population). According to the authors methods cited above we calculate the total MDP score by adding up the Z scores obtained for the favorable Mediterranean dietary components (legumes, vegetables, cereals, fruit, fish and MUFA:SFA ratio) and by subtracting the Z value obtained from the consumption of whole milk (mainly high in fat) and meat as shown below:

$$\sum z_i = z_{\text{cereals}} + z_{\text{legumes}} + z_{\text{vegetables}} + z_{\text{fruit}} + z_{fish} + z_{MUFA:SFA} - z_{\text{whole milk}} - z_{\text{meat}} - z_{\text{alcool}}$$

The conversion of the MDP scores to a relative percentage of adherences is made using the equation below where ($\sum z_{min}$ and $\sum z_{max}$) is the range values of the sample. Then, the variables likely to determine a higher or lower adherence were assessed. The calculated percentage varies from 100 to 0 representing the maximum and the minimum adherence respectively.

$$Adherence(percentage_i) = \frac{(\sum z_i - \sum z_{min}) \times 100}{(\sum z_{max} - \sum z_{min})}$$

Statistics

The statistical analyses were made using the Statistical Package for the Social Sciences (SPSS) version 17 (SPSS Inc., Chicago, Illinois, USA). Differences between group means were tested using ANOVA (Tukey's test). Associations between different variables were assessed by Pearson correlation.

According to the quartile values calculated from the adherence to the Mediterranean diet, the adherence percentage below the lower quartile value corresponds to the population having the lowest adherence, while the percentage of adherence above the upper quartile value corresponds to the group with the highest adherence. We also analyzed if the sociodemographic and life style are determining factors of the adherence level. The odds ratio for each of the three upper quartiles of adherence to the MD (compared with the lowest quartile) and the prevalence of metabolic syndrome or its components are assessed using multiple logistic regressions. The multivariate logistic regression was adjusted for age, education level, socioeconomic status, marital status and physical activity level. Multiple logistic regression models with polynomial contrast were used. We set the level of significance at p values < 0.05.

Ethics

The study protocol has been accepted by the dedicated Moroccan authority of ministry of health. Each participant gave a written consent.

Results

Table1: Characteristics of the participants (n=182)

	Mean (± SE)	Median
Age (years)	39.9 ± 0.66	43
BMI (kg/m^2)	26.7 ± 0.35	26.6
WC (cm)	82.2 ± 0.79	81
HC (cm)	102.3 ± 0.77	102
WHR	0.80 ± 0.005	0.79
Fasting glycaemia level(mM)	0.9 ± 0.03	0.83
TG (mmol/l)	0.9 ± 0.03	0.81
T-C (mmol/l)	4.04 ± 0.05	3.95
HDL-C (mmol/l)	0.9 ± 0.01	0.93
LDL-C (mmol/l)	2.7 ± 0.05	2.5
SBP (mmHg)	123.1 ± 1.05	120
DBP (mmHg)	73.5 ± 0.62	80
Educational level (%)		
None	25.8	
Primary School	50.5	
Secondary School	13.2	
University	10.4	
Family income (%)		
Low	39.0	
Medium	59.9	
High	0.5	
Physical activity level (%)		
Sedentary	94.5	
Active	5.5	
Marital status (%)		
Single	24.2	
Married	58.8	
Separated	14.3	
Widowed	2.7	
Children (%)		
Yes	65.4	
no	34.6	

Abbreviations: BMI, body mass index; WC, waist circumference; HC, hip circumference; WHR, waist-to-hip ratio; TG, triglyceride level; HDL-c, high-density lipoprotein cholesterol level; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 2: Distribution of the consumption (g/d) of the Mediterranean diet (MD) components according to adherence to the MD (mean values and standard deviations) and Spearman correlation (r) with adherence to Mediterranean diet.

	Low adherence to the MD* (n=45)		High adherence to the MD** (n=45)			Adherence to MDP	
	Mean	SD	Mean	SD	P-value	r	p
Cereals	712.7	424.6	1031.7	582.5	0.001	0.305	<0.01
Vegetables	56.8	39.9	167.5	77.2	0.000	0.606	<0.01
Fruits	135.0	89.2	258.0	174.0	0.000	0.395	<0.01
Legumes	13.7	20.0	57.6	38.3	0.000	0.494	<0.01
Fish	49.3	53.4	75.4	102.7	0.251	0.196	<0.01
Red meat	117.1	106.1	86.9	39.1	0.113	- 0.197	<0.01
Whole milk	165.3	165.7	138.4	122.7	0.263	-0.185	<0.05
and products	0.8	0.2	1.1	0.4	0.000	0.339	<0.01
MUFA : SFA	-	-	-	-	-	-	-
Alcohol							
* Lower quartile (<55.51 % adherence to the MD). ** Upper quartile (≥69.72 % adherence to the MD).							

Table 1 shows the study participants characteristics. The mean adherence to the MD was 62.84 % (± 12.7) and the median adherence was 61.16%. Half of the women studied were above the median value.

In Table 2 the consumption of Mediterranean diet components (g/d) are presented according to the adherence to Mediterranean diet. The consumption of the most Mediterranean diet items (fruit, cereals, legumes, vegetables and MUFA: SFA ratio) was higher in women with high adherence to the MDP compared to those with low adherence.

Using Pearson correlation coefficients, the MD components present a positive correlation (P<0.01); red Meat, Whole milk and products were negatively correlated with Adherence to MDP. For religious reasons, the consummation of alcohol was absent in the study population.

Table3: Prevalence of metabolic syndrome components among the study women according to weight status and MD adherence

	N	High FG	High TG	Low HDL-C	Abdominal obesity (WC)	Hyperte-nsion	*MS
Total	182	15.9	6.6	82.4	25.8	36.8	20.9
BMI status							
Normal weight	67	13.7	3	83.3	3	21.2	9.1
Overweight	69	17.7	8.8	77.9	17.6	45.6	20.6
Obesity	46	17.8	8.9	88.9	71.1***	46.7**	37.8***
Adherence to MD (%)							
Q1	45	15.5	4.4	82.2	26.7	31.1	15.6
Q2	46	17.1	4.3	87.0	28.3	45.7	23.9
Q3	46	19.6	10.9	78.3	19.6	32.6	21.7
	45	11.1	6.7	82.2	28.9	37.8	22.2

Q4							

FG, fasting glycaemia; TG, triglyceride level; WC, waist circumference; *MS, Metabolic Syndrome prevalence; MD, Mediterranean diet; Q, quartiles. Significance levels: *P < 0.05; **P < 0.01; ***P < 001.

Table 3 shows the prevalence of metabolic syndrome components among women (High fasting Glycaemia, High triglyceridemia, Low HDL-cholesterol level, abdominal obesity and hypertension) according to BMI and adherence to the MD. The overall prevalence of metabolic syndrome was about 21%. Low HDL-cholesterol level was the most commonly observed component of metabolic syndrome (82.4%) followed by Hypertension (36.8), while high triglyceridemia was the least common (6.6%). In this population, 41.2% had one component of metabolic syndrome, 29.1% had 2 risk factors, 15.9% had 3 risk factors and 4.4% had 4 risk factors. It is also noted that 8.8% had no risk factor and that one subject (0.5%) had all risk factors (data not shown).

Related to BMI, the criteria for metabolic syndrome were met by 37.8% of obese, by 20.6% of overweight women and by 9.1% of normal weight women. The prevalence of metabolic syndrome components was not significantly different on both sides of the median of the MDP.

Table4: Anthropometric variables of Anthropometric measurements and cardiovascular disease risk factors values in women with or without a diagnosis of metabolic syndrome.

	Without MS (n = 144)		With MS (n = 38)		P-value
	Mean	SD	Mean	SD	
Weight (kg)	65.9	10.5	74.9	12.3	0.000
Height (cm)	159.0	5.7	158.9	6.1	0.381
BMI (kg/m^2)	25.8	4.5	29.6	4.7	
Waist circumference (cm))	79.2	09.1	91.5	10.2	0.000
Hip circumference (cm)	100.75	09.6	107.7	10.5	0.000
WHR	0.78	0.07	0.84	O.05	0.000
Skinfold thickness (mm)					0.000
Triceps	21.5	6.9	24.2	6.8	
Biceps	13.6	6.1	15.7	5.6	0.000
Subscapular	21.9	7.8	27.5	6.7	0.001
Supra-iliac	18.4	6.3	19.6	5.6	0.000
Sum of all skinfold thicknesses (mm)	75.5	22.9	87.1	20.4	0.01
Sum of trunk skinfold thicknesses (mm)	40.4	12.5	47.2	10.9	0.000
					0.000
Cardiovascular disease risk factors (%)	7.6		47.4		0.000
	2.1		23.7		0.000
High fasting glycaemia	79.9		92.1		0.057
High TG	13.9		71.1		0.000

Low HDL-C	22.2		92.1		0.000
Abdominal obesity (WC)	22.2		92.1		0.000
Hypertension	0.7		5.3		0.100
Elevated SBP	62.4		64.50		0.348
Elevated DBP					
MD adherence (%)					

MS, metabolic syndrome; BMI, body mass index; WHR, waist-to-hip ratio.
Data are expressed as mean (sd); statistical analysis was performed by ANOVA, trend analysis, adjusted by age, educational level, socioeconomic status, Marital status and physical activity level.

The association of anthropometric variables with metabolic syndrome was also evaluated (table 4), except for height, subjects having metabolic syndrome showed greater and more statistically significant values for all anthropometric variables evaluated after adjustment for age, education level, socioeconomic status, marital status and physical activity level.

Despite that they are commonly associated with metabolic syndrome, the most associated cardiovascular disease risk factor components are Hypertension, Low HDL-cholesterol level (92.1% for both) and abdominal obesity (71.1%). However, no association with adherence to MD was observed (data not shown).

Table 5: Percentage of MD adherence and the risk of low MD adherence (odds ratio, 95% confidence interval) according to socio-demographic and lifestyle variables (mean values and standard deviations)

	Percentage of Adherence		**Risk of low adherence***		
	Mean	**SD**	**Age adjusted OR**	**95% CI**	**P-value**
Age group (years)					
< 25	60.2	16.6	1.0 (ref)		
25-30	64.2	11.3	0.46	0.15 – 1.36	0.159
> 35	62.9	9.8	0.50	0.17 - 1.53	0.227
Educational level (%)					
None	63.9	11.2	1.0 (ref)		
Primary School	65.7	10.2	0.68	0.31 – 1.49	0.128
Secondary School	55.8	7.1	0.57	0.28 – 1.17	0.007
University	55.1	19.7	0.27	0.10 – 0.75	0.025
Family income (%)					
low	63.4	12.2	1.0 (ref)		
medium	62.9	10.6	0.97	0.37 – 2.56	0.936
high	69.3	0.0	1.22	1.22 – 1.22	0.998
Physical activity level (%)	55.1	27.3	1.0 (ref)		
Sedentary	63.3	10.6	0.59	0.09 – 3.56	0.568
Active					
Marital status (%)	57.5	13.9	1.0 (ref)		
Single	64.9	11.1	0.37	0.16 – 0.85	0.02
Married	58.3	4.8	0.60	0.20 – 1.75	0.35
Separated	64.12	11.3	0.72	0.10 – 5.23	0.74
Widowed					
Children (%)	64.7	10.9	1.0 (ref)		
Yes	59.3	13.6	3.52	1.20 – 10.25	0.021
no					

* Multiple logistic regression analysis adjusting for age. Low adherence was defined as a percentage of MD adherences below the lower quartile (55.51 %); high adherence to MD was defined as a percentage of adherences above the upper quartile (69.72 %).

Means and standard deviations of the percentage of adherence to the MDP according to socio-demographic and lifestyle factors are shown in table 5, together with age-adjusted OR for a low adherence, to find the factors with high risk of low adherence to the MDP. Age and Family income did not influence the women adherence to the MDP. An inverse relationship can be observed between Physical activity and low adherence to the MDP, although this difference is not statistically significant. To be married, to have children or to have a high educational level was associated with a low prevalence of low adherence to MDP (the risk is less three times, three and a half times, and four times as those of single marital status, no children and none educational level, respectively) ($p< 0.05$).

Table 6: Metabolic syndrome components risk (odds ratio, 95% confidence interval) by quartiles of adherence to Mediterranean diet in women (n = 182)

	Q1*	Q2	Q3	Q4	P for trend
N					
Metabolic syndrome criteria					
High fasting glycaemia	1	0.76 (1.15 – 3.71)	0.45 (0.09 – 2.28)	0.27 (0.05 – 1.49)	0.431
High TG	1	0.50 (0.03 – 7.58)	1.78 (0.20 – 15.61)	0.47 (0.04 – 4.94)	0.614
Low HDL-C	1	1.03 (0.05 – 18.80)	1.17 (0.06 – 21.12)	0.29 (0.02 – 3.02)	0.506
Abdominal obesity (WC)	1	0.86 (0.19 – 3.76)	0.17 (0.03 – 0.90)	0.54 (0.13 – 2.27)	0.130
Hypertension	1	1.13 (0.28 – 4.51)	0.23 (0.05 – 1.08)	0.77 (0.19 – 3.15)	0.133

*Quartiles of adherence to the MD. The multivariate logistic regression was adjusted for age, educational level, socioeconomic status, Marital status, children, and physical activity level. Multiple logistic regressions were used to assess the association between MD quartiles (dependent variables) and each of the MS components (dependent variables). Multiple logistic regression models with polynomial contrast were used to generate P for trend.

Table 6 shows the relationship between metabolic syndrome criteria and adherence to MD. In order to consider all the influential variables, a multivariable regression model was developed. Once adjusted, MD adherence was not related to metabolic syndrome, with an OR (95 % CI) 2.06 (0.3-13.8) for subjects in the second quartile of adherence and an OR 2.79 (0.39-19.80) for subjects in the third quartile,

with respect to the first quartile. Individual criteria of metabolic syndrome were also considered, Analysis showed that metabolic syndrome criteria were not significantly associated with the adherence.

Table 7: MS components risk (odds ratio, 95% confidence interval) by tertile of intake of the Mediterranean diet (MD) pattern food groups in the study sample (n = 182)

	Hypertension	High fasting glycaemia	High TG	Low HDL-C	Abdominal obesity (WC)
Cereals and roots					
T1 (ref)	1.00	1.00	1.00	1.00	1.00
T2	1.37(0.31-5.97)	1.32(0.25-6.86)	0.08(0.01-0.78)*	0.78(0.03-6.04)	0.50(0.08-2.92)
T3	2.67(0.62-5.54)	1.93(0.3-6.01)	0.04(0.004-0.48)*	0.22(0.01-2.76)	0.44(0.07-2.77)
Vegetables					
T1 (ref)	1.00	1.00	1.00	1.00	1.00
T2	0.78(0.21-2.85)	0.73(0.15-3.45)	1.41(0.07-5.6)	0.69(0.09-5.05)	0.47(0.09-2.47)
T3	0.77(0.19-3.01)	0.67(0.15-2.84)	2.60(0.45-6.81)	1.23(0.11-5.84)	0.39(0.07-2.06)
Fruits					
T1 (ref)	1.00	1.00	1.00	1.00	1.00
T2	0.65(0.19-2.23)	0.77(0.19-2.98)	1.17(0.01-2.12)	0.66(0.08-5.39)	0.60(0.11-3.06)
T3	0.54(0.11-2.50)	0.33(0.06-1.77)	1.24(0.16-5.41)	1.20(0.09-4.82)	3.88(0.66-5.9)
Legumes					
T1 (ref)	1.00	1.00	1.00	1.00	1.00
T2	0.96(0.25-3.64)	1.36(0.29-5.37)	1.65(0.16-5.30)		1.15(0.22-5.04)
T3	1.02(0.27-3.89)	2.03(0.4-5.06)	1.93(0.27-4.51)	0.72(0.10-5.02)	0.80(0.15-4.23)
Fish					
T1(ref)	1.00	1.00	1.00	1.00	1.00
T2	1.20(0.32-4.37)	3.77(1.45-5.48)	0.57(0.06-5.11)	0.22(0.02-1.79)	1.34(0.24-5.21)
T3	0.94(0.23-3.73)	1.29(0.84-5.73)	0.79(0.02-5.32)	1.35(0.08-5.98)	0.84(0.15-4.70)
Meat					
T1 (ref)	1.00	1.00	1.00	1.00	1.00
T2	0.65(0.17-2.49)	0.57(1.12-2.66)	2.44(0.80-5.73)	2.65(0.35-5.05)	0.61(0.11-3.30)
	0.76(0.18-3.09)	1.27(0.29-5.51)	0.65(0.04-5.70)	0.73(0.09-5.50)	1.27(0.23-5.85)
T3					
Whole milk and products	1.00	1.00	1.00	1.00	1.00
	0.44(0.11-1.76)	0.49(0.11-2.13)	0.35(0.04-2.98)	1.63(0.07-5.65)	2.34(0.47-5.60)
T1 (ref)	2.12(0.53-5.51)	1.22(0.23-5.34)	1.19(0.12-5.77)	0.14(0.01-1.77)	4.19(0.74-5.61)
T2	1.00	1.00	1.00	1.00	1.00
T3	0.82(0.21-3.16)	0.10(0.02-0.50)**	1.27(0.12-5.38)	0.24(0.02-2.64)	0.27(0.05-1.35)
MUFA : SFA	0.66(0.17-2.55)	0.16(0.03-0.77)*	3.23(0.34-5.57)	1.98(0.10-5.08)	0.36(0.07-1.85)
T1 (ref)					
T2					
T3					

T1, first tertile; T2, second tertile; T3, third tertile; MUFA/SFA, monounsaturated to saturated fatty acids ratio. Adjusted by, age, BMI, educational level, physical activity level Marital status, Children, Family income, energy intake and intake of rest of food groups included in the MD adherence. *P <0.05; **P<0.01.

The association of the food items of the MD pattern with the five metabolic syndrome criteria prevalence was considered separately (table 7). Cereals intake and high mono-unsaturated to saturated fatty acids showed a protective effect on triglycerides criterion (p = 0.002) and on glycemia criterion (p = 0.02). No noticeable association was observed for the other metabolic syndrome criteria.

Discussion

The objective of the study was to assess the prevalence of MS in women population of Morocco, a Mediterranean country, in relationship with the adherence to Mediterranean diet. To the best of our knowledge, this study is the first one focusing on the possible relationship between the traditional Mediterranean diet (MD) and metabolic syndrome in the region. To better know the determinants of adherence of the women sample to the MD, the effect of the MD specific components is also discussed in this paper.

In Morocco, a developing country that is also experiencing demographic, health and nutrition transitions, few epidemiological studies have been conducted to characterize the magnitude of the prevalence of MS particularly in women; the importance of identifying women who are at risk of developing MS cannot be underestimated.

It is important to note that comparison of the prevalence of MS between studies is difficult, as different criteria are used and, most importantly, sex and age standardization is indispensable, that makes the comparison is not easy to make between published studies.

Although the prevalence of MS differs according to the criteria used to define it, it seems to affect around 25% of the population in developed countries (Alvarez Leon et al., 2003; Athyros et al., 2005). In this study, we used the National Cholesterol Education Program Adult Treatment Panel description of MS which is considered to be the most applicable tool for clinical and epidemiological practices (Isomaa et al., 2003).

Our findings on the prevalence of MS are quite similar to those previously reported in developed countries, indeed, one in every fifth adults presented MS in this population. This prevalence confirms the results of a cross-sectional survey conducted in 1995 in the same population about the magnitude of the prevalence of MS and association of BMI and WC with risk factors for cardiovascular diseases (Belahsen et al., 2005). This prevalence was also greater than that encountered by another study conducted in another region, the south of Morocco (Rguibi et al., 2004). Compared to the North Africa, MS is less prevalent than that observed in Tunisian women (Allal-Elasmi et al., 2010) or Algerian women (Biad et al., 2010) with significantly higher prevalence in women (37.3% and 27,1%) than in men(23.9% and 14,9%) (Bouguerra et al., 2007). It is also the case of the countries in Middle East where MS is among the major health problems testified by the abundant published literature. In Turkey, for instance, the prevalence of MS was estimated as 33.9% more marked in among women [39.6%] than men 28% (Kozan et al., 2007). In Saudi Arabia a prevalence of 13.6% comparable to that found in the present study was reported in adult females (Motlagh et al., 2009). In Oman, another country of the same region, the MS prevalence was estimated as 21.0%. In the same way, the prevalence of MS using the ATP III definition was reported to be 36.3% in a population of the Northern Jordan with higher rates in women than in men.

In this study, all anthropometric indices (BMI, WHR, Skinfold thickness and WC) provided useful information on metabolic risks. Comparative findings about the mean values of anthropometric variables of groups with and without MS can be explained by the recognized association between weight excess and body fat, and metabolic alterations (Oliveira et al., 2009). The proportion of women with ≥ 1 MS abnormalities (91.2%) suggests that each MS component worsens with obesity

among women, and is in accordance with previous studies (Mar Bibiloni et al., 2011; Hillier et al., 2006). Low HDL-cholesterol level was the most commonly observed component of MS (82.4%) followed by Hypertension (36.8%), while high triglyceridemia was the least common (6.6%). The prevalence of MS factors in our population follows in part the pattern in developed countries when we stratified by the presence or absence of metabolic syndrome. There are discrepancies in literature about the prevalence of MS components. In developed countries, low HDL-cholesterol levels, and high triglyceridaemia and hypertension were the most common MS factors, whereas high fasting glycaemia was the least common (Do Carmo et al., 2008). In developing countries, high fasting triglyceridaemia was the most common MS factor, whereas low HDL-cholesterol level was the least common (Ebrahimpour et al., 2006).

Diet may also be one of the most important factors determinants of MS. The average adherence to the MDP was 62.84 % (± 12.7). The present study shows a low variability of the percentage of adherence to Mediterranean diet as reflected by the SD values.

There was no association between the adherence to MD and the risk of metabolic syndrome, indicating that there is no protective effect of MD on the prevalence of MS in our study population. Several epidemiological studies have evaluated the role of the MD on the development or progression of the metabolic syndrome; and the association of the adherence to the MD with a beneficial effect on the MS was largely reported (Rumawas et al., 2009; Paletas et al., 2010), In the opposite, other studies in adults (Panagiotakos et al., 2004; Thanopoulou et al., 2006) found contradictory results or do not present a clear benefit of high adherence to MD in lowering prevalence of metabolic syndrome.

In the same way, this study shows that MS components were not significantly associated with adherence to the MDP, while several recent clinical trials demonstrated that adhering to MD has a beneficial effect on abdominal obesity (Romaguera et al., 2009), lipids levels (Tzima et al., 2007), glucose metabolism (Panagiotakos et al., 2007), and blood pressure levels (Estruch et al., 2006) and all the components of the MS, that are also risk factors for the development of cardiovascular disease, insulin resistance, and diabetes.

The multiple beneficial effects of the MD on the parameters of MS are also closely associated with its individual dietary components; in this context, the MS components risk was also evaluated by the MD pattern food groups. In our study, the food items associated with MD protective effect were higher MUFA /SFA for glycemia and higher cereals and roots for triglycerides.

The primary source of MUFA is olive oil; it's one of the most representative and central food of traditional MD. In the study subjects; this food represents 17.6 % of the fats and oils food group which explains the ratio MUFA/SFA of 1.02 ± 0.35. In Morocco; olive oil is used abundantly as a culinary fat. A recent review demonstrated its beneficial effects of MD on lowering blood pressure, reducing plasma glucose, and improving the cholesterol/HDL ratio and endothelial function (Lopez-Miranda et al., 2010). It is also to be noted that in our study, even not significant, high intakes of MUFA/SFA, Fruits, Vegetables and Fish were associated with lower risk of blood pressure criterion. Polyphenols and flavonoids present in fruits and vegetables, Intake of fish oil N-3 fatty acids have also been shown to decrease plasma triglycerides and blood pressure (Perez-Vizcaino et al., 2009; Duda et al., 2009).

The protective effect of the MD on triglycerides was mediated by higher cereals and roots food items and their known beneficial effect on lipid metabolism due to their water-soluble fiber content (Brown et al., 1999). In our study population, there's a large intake of cereals and roots (696.4 g day^{-1}); The effect of fiber on plasma triacylglycerol is mainly from such gel-forming fiber which influences the

functional properties of the intestinal mucosa by slowing upper intestinal transit, as a result, the intestinal absorption of dietary lipids may impair (Topping et al., 1988).
The study reports also no protective effect of cereals intake on glycemia. Some studies have reported an association of high cereal intake with a lower prevalence of the glycaemic and even insulin resistance criterion. In this study, subjects with cereal intake >150 g day^{-1} presented half the risk of hyperinsulinemia than subjects with lower intakes. This effect could be explained in part by those foods fiber content, resulting in a lower rate of gastric emptying and an increased satiation (Delzenne et al., 2005).

The results of our analysis showed an association between some life-style characteristics and the adherence to a global MDP. Many studies have associated socioeconomic characteristics and life-styles with the adherence to several population dietary patterns (Sanchez-Villegas et al., 2002; Whichelow et al., 1996; Martinez et al., 2010) but to our knowledge this is the first time that the factors associated with the adherence to MDP have been analyzed in this population. Our subjects belong to a population stratum with a medium education level (half of the population has a primary school education level); there was a direct association between adherence to the MDP and women education level. The latter was reported to have marked effect on family lifestyles and dietary habits (Do Carmo et al., 2008). Nowadays, mothers are still in charge of the home dieting in the Moroccan population, and the mother education level is one of the best predictors of the family diet quality. The present results are also in agreement with previous studies carried out in Spanish adults (Moreno et al., 2002; Tur et al., 2004) suggesting a direct association between low education level and low fruits and vegetables' consumption..

On average, higher socioeconomic level, defined by education level, has been associated with the adherence to a healthier dietary pattern (Fraser et al., 2000); however, Family income, another direct indicator of socioeconomic level, was not significantly linked to greater or lower adherence to the MD in the present study; this reinforces again the influence of education level especially in terms of food intake behaviour.

Contrary to other investigations, we have not been able to determine the number of women smokers because they do not want to respond to this issue probably for social and culture considerations. It was reported that smoking is positively associated with unhealthy dietary habits (lloveras et al., 2001) and negatively associated with high adherence to the traditional MDP (Martinez-Gonzalez et al., 1997).

We have also considered that Mediterranean lifestyle includes the regular practice of physical activity. In our study, despite a high rate of physical inactivity (94%), an inverse relation can be observed between physical activity during leisure-time and low adherence to the MD, although this difference is not statistically significant; the beneficial effect attributed to the MD against CHD and other related diseases could not be a result of diet only, but also in part to a more active life-style during leisure time of those who adhere to the traditional Mediterranean diet, this association has also been observed in previous studies (Sanchez-Villegas et al., 2002; Martinez et al., 2010; Mariscal-Arcas et al., 2007). Besides, epidemiological evidence supports a detrimental role of sedentary lifestyles on increasing obesity epidemic in Mediterranean countries (Martınez-Gonzalez et al., 2001).

Having children, marital status represents another social dimension, as dietary habits could be influenced by living arrangement. Women not living with spouse tend to have nutritional deficiency of iron, vitamin D and lower consumption of vegetables and fish. It is possible that they pay less attention to meal preparation. Other possible explanations are the low income, or lower education level in these women. Numerous studies have shown that married persons have lower risk of mortality, and enjoy better physical and mental health than

their unmarried counterparts (Hu et al., 1990). Moreover, marital termination by death or divorce has been prospectively linked to decline in health and increased mortality risk, with more pronounced effects among men (Ebrahim et al., 1995; Stroebe et al., 1983).

To sum up, MS is prevalent among the study population, especially among obese women. These findings demonstrate an emerging health problem in Morocco because of the number of overweight and obese women that are likely to develop MS. Some components of the MD showed a protective effect on some MS components; however, no association was found between MS and adherence to MD. High education level, increased physical activity level and availability of family environment were also related to a better adherence to MD pattern.

Study Limitations

The key limitations of this study are the small sample size of this work. Furthermore, adherence to the MD was relatively uniform with low variability among the subjects, since the diets of the subjects are not largely different and remained relatively similar. Another concern is that adherence to the MD was determined only from dietary data collected over a few months (between September and December); it is possible that some subjects changed their diet over the many years required for MS to develop. It's for this reason that we chose subjects who are not taking medication or recently changed their diet on the recommendation of their physician because of the detection of abnormalities (e.g., hypertension) linked to MS.

Conclusion

The present study demonstrates that despite the uniformity of the adhesion of the population to the MD that is the original Moroccan diet, there is an absence of its effect on the MS. The effect is still present in some components of MD, which shows an increasing abandonment of this diet that it is replaced by the nutrition transition that crosses Morocco. MD is often lost regardless of age and income, especially among people with low education and physical activity, living alone and having no children. These groups should be targeted for intervention strategies to deviate the development of detrimental mechanisms involved in the genesis of the synergistic effects of MS components, and to slow down the effects of nutrition transition that is the major source of alteration of the traditional MD pattern considered as the original diet in Morocco.

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