

ADHERENCE TO THE MEDITERRANEAN DIET IN TWO MOROCCAN POPULATIONS LIVING AT DIFFERENT DISTANCES FROM THE MEDITERRANEAN SEA

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ABSTRACT

Background. There is growing strong scientific evidence over the past few decades that the Mediterranean diet (MD) has protective effects on cardiometabolic health.

Objective. This study aimed to assess MD adherence and its association with sociodemographic and lifestyle factors among women living in two Moroccan provinces, El Jadida and Tetouan, located at different distances from the Mediterranean Sea.

Material and methods. It is a cross-sectional study involved 355 subjects of which 55.8% reside in the province of El Jadida, and data on socio-demographic characteristics, lifestyle, cardiovascular risks, medical history and of food frequency consumption were collected. Compliance with the MD was assessed with a simplified MD adherence score based on the weekly frequency of consumption of eight food groups.

Results. The overall mean Simplified Mediterranean Diet Score was 4.37 ± 1.47 with inadequate compliance in 55.2% of the sample. No significant association was found between adherence to MD and geographic, socio-demographic, lifestyle or the major cardiovascular risk factors. However, the participants do not comply with half of the recommendations based on the Mediterranean diet pyramid. The lowest level of compliance was observed for olive oil, followed by sweets, eggs, potatoes, fruits, red meat, vegetables, legumes, olives, nuts and seeds. The increased contribution of sugars, dairy products and meat to the overall food intake is significant in the category with high adherence to MD.

Conclusion. The study data indicate that Mediterranean Diet is far from being a global pattern in this Moroccan population. The study draws attention to the need for a promoting intervention to maintain this pattern as the original diet in the region.

Key words: *Mediterranean diet, adherence to Mediterranean diet, Mediterranean diet score, distance to Mediterranean sea, lifestyle factors, women, Morocco*

INTRODUCTION

The Mediterranean diet (MD) is known as a protective dietary pattern against diseases including cardiovascular disease, diabetes, metabolic syndrome, obesity, cancer and other chronic non-communicable diseases [1] in populations living around the Mediterranean basin but also elsewhere. Many studies have attributed this effect to the high consumption of

plant foods and the low consumption of foods of animal origin [2, 3, 4, 5, 6, 7, 8]. However, this dietary model refers to the traditional food habits of the countries populations around the Mediterranean [9], with benefits on health but also on food and nutritional security, on the environment and biodiversity protection [10], making of this model a sustainable diet [11]. It consists of the use of olive oil as the main source of fat; a high consumption of vegetables, legumes, a moderate

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consumption of fish; fruits, cereals, nuts, eggs, dairy products, white meat, wine; and low consumption of red meat, cold cuts, potatoes and sweets, all combined with regular physical activity [12]. There is not a single model but rather several MDs since each country in the Mediterranean area has its own gastronomic customs influenced by particular socio-cultural, religious and economic factors [13]. Indeed, wine, beer and pork are excluded from the diet of Muslim countries, whereas they are widely consumed in European Mediterranean countries [14, 15]. In addition, large variations in intake and a westernization of dietary habits resulting in a decrease in adherence to MD have also been reported in Mediterranean and non-Mediterranean countries [16, 17]. Morocco, a middle-income country in North Africa, is located on the southwest coast of the Mediterranean Sea and is divided into 12 regions with an estimated population of 36 million in 2020. The official languages are Arabic and Berber but French and Spanish are also spoken there because of a previous history occupation. The majority of the population is of the Muslim faith [18, 19]. Like several developing and Mediterranean countries, Morocco is experiencing the different facets of a global transition, including a demographic, epidemiological and nutritional transition [20]. The Moroccan society has experienced remarkable socioeconomic disparities and stable economic growth over the past decades [21]. The lifestyle and dietary habits of the population have also changed [22] as a result of population growth and increasing urbanization with almost 63% of the population living in urban environment [23], economic development, globalization and increased production and food industry. These changes led to a deviation from MD in relationship with the nutritional transition and the increasing adoption of a pattern marked by sedentary behavior and a shift from consumption of traditional foods rich in whole grains, vegetables and fruits and poor in fat, to that of foods high in refined cereals, sugar, fat and animal products [11]. The origin of nutritional transition have been associated to economic development parallel to concomitant lifestyle changes including food, but also socioeconomic and demographic factors that influence the eating habits of Moroccan populations.

The present comparative study therefore aimed to identify the sociodemographic and lifestyle factors, associated with adherence to MD, in Moroccan women living in two provinces El Jadida and Tetouan located at different distances from the Mediterranean Sea.

MATERIAL AND METHODS

Study participants and study area

The cross-sectional study was carried out in 2016 in two provinces, El Jadida and Tetouan, located

at different distances from the Mediterranean Sea. Tetouan is located on the Mediterranean coast and El Jadida is 466 km away from it. The study involved a population of women aged 18 and over. Pregnant and breastfeeding women, as well as physically and mentally handicapped subjects were excluded from the study. The study was conducted in accordance with the Declaration of Helsinki and the study protocol was accepted by the Moroccan dedicated authority of the Ministry of Health. All participants were informed about the study objectives and that they can leave the survey at any time if they wish, they also gave their consent before taking part in the survey.

The province of El Jadida, included in the greater Casablanca-Settat Region and located on the Moroccan Atlantic coast, is one of the richest regions, due to its climate diversity, its geographical position and its agricultural activity (Figure 1). According to the General Population Census of 2014 [24], the total population of the province of El Jadida is 786,716, 40% in urban and 60% in rural areas.



Figure 1. MAP showing the geographical location of provinces El Jadida and Tetouan

The province of Tetouan, part of the Greater Region of Tangier-Tetouan, is located in the extreme northwest of the Kingdom, in the eastern part of the Tingitan peninsula and the Rif mountains. Located at the junction of two seas (the Mediterranean and the Atlantic Ocean) and only at 14 kilometers from the European continent, the province is bounded by the Strait of Gibraltar and the Mediterranean Sea to the north and by the Atlantic Ocean to the west. Its position on two coastal facades and the presence of large reliefs and medium heights, the biogeographical context

of the Tangier-Tetouan Region gives it a temperate Mediterranean climate with oceanic influence. The region is one of the most fertile areas of Morocco, with a rainfall rate between 1000 and 1800 mm/year and high biodiversity. The total population of the province of Tetouan is 549,769 inhabitants, with 72% in urban and 28% in rural areas [25].

Data on medical history sociodemographic characteristics and lifestyle factors

Data were collected using a validated questionnaire completed face-to-face by trained interviewers. The information collected concerned medical history (hypertension, diabetes, etc.), socio-demographic characteristics (age, place of residence (urban or rural), level of education, marital status, profession, housing category, monthly family income) and household characteristics (type of dwelling, and household size). Age was recorded and classified into three categories (<35; 35-47 and \geq 47) based on the distribution of the sample in tertiles. Educational attainment was classified into three categories: illiterate (0 years), \leq 6 years of schooling or informal education and >6 years of schooling (secondary, university). Marital status was divided into two classes: married and unmarried (single or divorced and widowed), the profession in two groups: with employment (active or student) and without paid employment (unemployed and housewife). Housing has been grouped into 4 classes: traditional housing (working-class district), luxurious (villa), modern (apartment) and poor housing (including slums, bedrooms), the family in composite or nuclear type, the family income was classified according to the categories established by HCP in low income (< 3000 MAD) corresponding to the minimum wage in Morocco (International Labor Organization, 2020), Medium (3000 to 4999 MAD) and High ($5000 \geq$ MAD), the equivalent exchange rate is: 1 MAD = 0.095 Euro).

Data on lifestyle were collected; they included the tobacco consumption and the level of physical activity. Tobacco use is categorized into “smokers” (current daily and occasional smokers), “ex-smokers” (if they have quit smoking for more than 3 months at the time of the survey) and “Never” (they had never smoked in their life). Physical activity assessed by a questionnaire included moderate and vigorous activities performed at work and in leisure during a usual week of the previous month. Physical activity was then defined according to WHO guidelines recommending the practice of at least 30 minutes of regular, moderate or vigorous physical activity on most days (including household activities) [26].

Anthropometric measurements

All anthropometric data was recorded. Height (\pm 0.5 cm) and weight (\pm 0.5 kg) were measured and the body mass index (BMI) is calculated by dividing the body weight (in kg) by the square of the height (in m) and the WHO thresholds for overweight (BMI \geq 25) and obesity (BMI \geq 30) were used to define general obesity (World Health Organization, 2000).

Blood pressure was measured in women in a seated position using a mercury sphygmomanometer after a rest period of at least 10 min. Two groups of women are established according to their BP, the group with and the group without high BP. Elevated BP is defined by the Adult Treatment Panel III criteria as systolic blood pressure \geq 130 mmHg and/or diastolic BP \geq 85 mm Hg or on medication for hypertension [27].

Simplified Mediterranean dietary score

In this study, the evaluation of the degree of adherence to MD was carried out using a simplified Mediterranean diet score (MDS) [28], constructed following an adaptation of the MDS, proposed by *Trichopoulou* et al. [8, 29]. The score calculation is based on the self-reported frequency of weekly intake of each food group, with the exception of fruit, where the total weekly intake was calculated by multiplying the number of days of intake per week by the number of servings consumed per day, this score includes eight components (vegetables, legumes, fruits, cereals, olive oil, fish, meat and dairy products). To calculate the total frequency of each component, the frequency of the elements that belong to it was added, dairy products (milk, yogurt and cheese), cereals (bread, cereals, potatoes, rice, pasta and couscous) and meat (red meat, white meat and processed meat). As the ratio of monounsaturated to saturated fatty acids could not be calculated for fat intake, the olive oil intake was considered as the main dietary source of monounsaturated fatty acids in Morocco, in the absence of pork consumption for religious reasons [28]. A value of 0 or 1 was assigned to each of the components using the gender-specific median of the sample as the threshold. For beneficial components (vegetables, legumes, fruits, grains, and fish), people with intakes below the median were assigned a value of 0, and people with intakes at or above the median were assigned a value of 1. People who consumed the olive oil for seasoning or for cooking were given a value of 1 and non-consumers are given value of 0. For the presumed harmful components (meat and dairy), people with consumption below the median were assigned a value of 1, and people with consumption at or above the median were assigned a value of 0. Thus, people who consumed olive oil for seasoning or cooking were given a value of 1 and 0 for non-consumers.

Given that alcohol consumption is prohibited for religious reasons, and therefore not usual or probably under-reported in the Moroccan population, in particular women, this component was not taken into account in the calculation of the simplified MD score. Thus, the simplified total score of the MD ranging from 0 (minimum adhesion) to 8 (maximum adhesion), makes it possible to classify the participants into two groups according to the level of their adhesion to the MD, “low” adhesion to the MD (0 to 4 points), and “high” adherence to the MD (5 to 8 points).

Statistical analysis

Food frequency consumption and sociodemographic characteristics of the sample were described according to high (simplified MeDi score 5–8) vs low (simplified MeDi score 0–4) MeDi adherence. A descriptive analysis was conducted to compute medians and means with standard deviation (SD) for quantitative variables and frequencies (%) for qualitative variables. Student’s t-test was used for comparison of the means and the chi-square tests for comparison of proportions between the two groups. The level of significance was established at $p < 0.05$. All analyses were performed with the use of Statistical Package for the Social Sciences SPSS (version 23).

RESULTS

A number of 355 out of 500 women recruited in the two provinces studied, participated in the survey. Individuals not included did not complete all of the survey data. The final sample with complete food data included thus 198 (55.8%) women from El Jadida and 157 (44.2%) from Tetouan. The women average age was 41.57 ± 12.91 years with a difference between the two provinces ($43.75 \text{ years} \pm 13.09$ in El Jadida against $38.8 \text{ years} \pm 12.16$ in Tetouan).

In the overall sample, the prevalence of obesity was 32.1%, that of diabetes 12.1% and that of hypertension was 41.1% with higher prevalence in El Jadida than in Tetouan respectively for obesity (43.4% vs 17.8%; $p < 0.001$) and diabetes (17.7% vs 5.1%; $p < 0.001$).

Table 1 presents data on the socio-demographic and lifestyle characteristics according to the region of the population under study. The table shows significant differences between the populations in the two provinces, for household size, number of children, type of dwelling, physical activity, age groups, income average and occupation of the head of household, place of residence and for the type of family.

Table 1. The population sociodemographic and lifestyle characteristics according to the region

	Total % (n=355)	El Jadida (n = 198)	Tetouan (n = 157)	P-value
Area of residence				
Urban	38.3 (136)	29.8 (59)	49 (77)	0.000
Rural	61.7 (219)	70.2 (139)	51 (80)	
Age groups (years)				
≤35	32.1 (114)	26.3 (52)	39.5 (62)	0.006
35–47	31.5 (112)	30.8 (61)	32.5 (51)	
≥47	36.3 (129)	42.9 (85)	28 (44)	
Marital status				
Married	81.7 (290)	79.8 (158)	84.1 (132)	0.185
Not Married	18.3 (65)	20.2 (40)	15.9 (25)	
Education				
Illiterate	44.5 (158)	48.5 (96)	39.5 (62)	0.1
< 6 years	30.7 (109)	30.8 (61)	30.6 (48)	
≥ 6 years	24.8 (88)	20.7 (41)	29.9 (47)	
Average income (MAD)				
< 3000 MAD	60.2 (213)	63.6 (126)	55.8 (87)	0.004
3000 - 5000	22.3 (79)	24.7 (49)	19.2 (30)	
≥ 5000	17.5 (62)	11.6 (23)	25 (39)	
Household head occupation				
Unemployed	79.4 (282)	85.4 (169)	72 (113)	0.002
Employed	20.6 (73)	14.6 (29)	28 (44)	

Household size				
<4 peoples	17.5 (62)	17.7 (35)	17.2 (27)	0.04
4 to 6 people	57.2 (203)	52 (103)	63.7 (100)	
>6 peoples	25.4 (90)	30.3(60)	19.1 (30)	
Family type				
Composite	63.9 (227)	55.6 (110)	74.5 (117)	0.000
Nuclear	36.1 (128)	44.4 (88)	25.5 (40)	
Number of children/woman				
No children	13.5 (48)	10.6 (21)	17.2 (27)	0.022
1 to 2 children	30.1 (107)	26.8 (53)	34.4 (54)	
3 and more	56.3 (200)	57 (124)	55.6 (76)	
Housing				
Poor housing	38.3 (136)	42.9 (85)	32.5 (51)	0.031
Modern	11.8 (42)	8.1 (16)	16.6 (26)	
Luxurious	2.8 (10)	3.5 (7)	1.9 (3)	
Traditional housing	47 (167)	45.5 (90)	49 (77)	
Smoking				
Current and ex-smokers	1.7 (6)	2.5 (5)	0.6 (1)	0.171
Never smoke	98.3 (349)	97.5 (193)	99.4 (156)	
Physical activity (≥ 30 min/day)				
Yes	86.8 (308)	90.4 (179)	82.2 (129)	0.017
No	13.82(47)	9.6 (19)	17.8 (28)	

Chi² test (percent (number)), statistically significant differences are defined as $P < 0.05$.

The distribution according to place of residence reveals that globally the female population was predominantly rural (61.7%) representing 70.2% in El Jadida against 51% in Tetouan. The proportion of women in the youngest age group was higher (39.5%) in the province of Tetouan and that of the oldest age group was the most present in El Jadida (42.9%).

In addition, the population as a whole (60.2%) had the lowest monthly income, the majority of which (63.6%) was in El Jadida. Furthermore, 85.3% of the sample lived in popular or precarious housing. The proportion of people considered to be physically active was 86.8%, women who were non-smokers or did not consume tobacco were the most represented (98.3%) and 63.9% of women belonged to composite families, mainly in the province of Tetouan with 56.3% including 3 or more children.

Consumption of major foods and food groups by region is shown in Table 2. The data in the table reveals significant differences in dietary intakes of different food groups. The women of El Jadida had a higher frequency of weekly consumption of meat (red, white and processed meat), potatoes (mean = 5.44 frequency), vegetables (mean = 6.96 frequency), cereals (mean = 5.05 daily frequency), herbs, spices, garlic and onions (mean = 6.67 frequency) and drinks (mean = 5.43 daily frequency) than those in Tetouan. On the other hand, women in Tetouan consumed more

legumes (mean = 3.59 weekly frequency), eggs (mean = 3.29 weekly frequency) and more olive oil ((mean = 3.29 weekly frequency)= 0.90 daily frequency). Olive oil was the main source of fat for cooking or seasoning (86.2%). However, no difference was found for other foods (dairy products, sweets, fruits, olives, nuts, seeds and fish).

Compliance with the guide or the Mediterranean diet pyramid' recommendations, shows that the diet of the study women was not compliant for all types of food groups and that, the diet of at least half of these women, was inconsistent for red meat, legumes, potatoes, eggs, sweets, olives, nuts and seeds, vegetables, fruits, and olive oil.

Figure 2 presents the distribution of the studied women sample, according to adherence to the MD and Figure 3 shows the distribution of the scores of adherence to this diet. In both provinces, more than half of the women (55.2%) had high adherence to MD (against 44.8% with low adherence) (Figure 2), but no significant difference is reported between the two regions. The results also show a bell-shaped distribution of the different adhesion scores between 0 and 8, as illustrated in Figure 3.

The study sample sociodemographic and lifestyle characteristics are presented in Table 3. The results show that there is no significant association of sociodemographic characteristics, neither lifestyle

Table 2. The mean values of usual consumption of major foods or food groups according to the region among the population studied

Dietary variable	Servings*	Total (N)	Consumption (%)	Recommendation (%)	EL JADIDA	TETOUAN	P-value
Weekly							
Red meat	<2	3.64 ± 2.73	95.8	32.1	4.31 ± 2.99	2.79 ± 2.08	0.000
White meat	2	2.94 ± 2.69	92.4	52.7	3.71 ± 3.02	2.97 ± 1.79	0.000
Processed meat	≤1	0.66 ± 0.07	77.2	82.8	0.86 ± 0.1	0.42 ± 0.08	0.002
Legumes	≥2	2.7 ± 0.22	94.4	48.7	1.99 ± 0.1	3.59 ± 0.47	0.000
Potatoes	≤3	5.11 ± 3.26	92.4	29.3	5.44 ± 3.52	4.70 ± 2.85	0.034
Fish	≥2	3.04 ± 2.78	95.8	56.1	3.07 ± 2.66	3.01 ± 2.94	0.838
Eggs	2-4	2.8 ± 2.74	82.8	23.3	2.68 ± 2.66	3.29 ± 2.82	0.035
Sweets	≤2	17.27 ± 11.85	94.9	7.0	17.97 ± 12.38	16.38 ± 11.13	0.211
Daily							
Dairy products	2	1.8 ± 1.32	94.6	62.8	1.68 ± 1.33	1.94 ± 1.31	0.076
Olives, nuts, seeds	1-2	1.03 ± 0.83	94.6	36.4	0.97 ± 0.71	1.12 ± 0.96	0.099
Herbs, spices, garlic, onions	-	6.09 ± 5.81	97.2	-	6.67 ± 5.42	5.35 ± 2.49	0.033
Water and herbal infusions	-	4.78 ± 3.87	94.6	-	5.43 ± 4.16	3.95 ± 3.32	0.000
Every Main Meal							
Vegetables	≥2	6.39 ± 2.39	97.2	44.8	6.96 ± 2.97	5.67 ± 2.81	0.000
Fruits	1-2	4.15 ± 3.37	97.2	29.5	3.84 ± 3.03	4.53 ± 3.73	0.056
Cereals	1-2	4.65 ± 1.74	98	64.2	5.05 ± 1.6	4.15 ± 1.78	0.000
Olive oil	1	0.77 ± 0.62	86.2	2.0	0.67 ± 0.52	0.90 ± 0.71	0.000

Recommendations based on the Mediterranean diet pyramid and other studies (Bach-Faig et al., 2011b; Sofi et al., 2013). EMM: Every Main Meal. Dairy products (milk, yogurt, and cheese), cereals (bread, cereals, rice, pasta, and couscous), Potatoes (potato, sweet potato), sweets (Sugar, jelly, candies, pastries, and sweetened fruit juices), white meat (poultry and turkeys) and red meat (veal, lamb, camel, and goat). Variables are presented as mean (standard deviation). Statistically significant differences are *defined as $P < 0.05$.

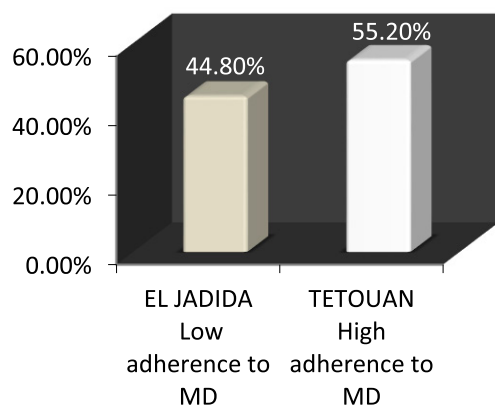


Figure2. Distribution of adherence to Mediterranean Diet

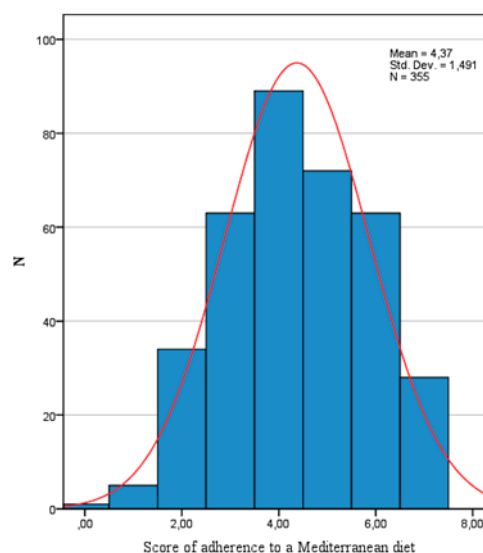


Figure3. Levels of adherence to a Mediterranean Diet

Table 3. The sociodemographic and lifestyle characteristics and cardiovascular risk factors according to the adherence to MD

	Total (n = 355)	Low 1–4 (n = 196)	High 5–8 (n = 159)	P-value
Area of residence				
Urban	38.3 (136)	37.8 (74)	39 (62)	0.448
Rural	61.7 (219)	62.2 (122)	61 (97)	
Age groups (years)				
≤35	32.1 (114)	32.7 (64)	31.4 (50)	
35–47	31.5 (112)	29.6 (58)	34 (54)	0.666
≥47	36.3 (129)	37.8 (74)	34.6 (55)	
Marital status				
Married	81.7 (290)	78.6 (154)	85.5 (136)	0.06
Not Married	18.3 (65)	21.4 (42)	14.5 (23)	
Education				
Illiterate	44.5 (158)	43.9 (86)	45.3 (72)	0.915
< 6 years	30.7 (109)	31.6 (62)	29.6 (47)	
≥ 6 years	24.8 (88)	24.5 (48)	25.2 (40)	
Average family income (MAD)				
< 3000 MAD	60.2 (213)	64.3 (126)	55.1 (87)	0.176
3000 - 4999	22.3 (79)	20.9 (41)	24.1 (38)	
≥ 5000	17.5 (62)	14.8 (29)	20.9 (33)	
Household head occupation				
Unemployed	79.4 (282)	82.1 (161)	76.1 (121)	0.102
Employed	20.6 (73)	17.9 (35)	24.3 (38)	
Household size				
<4 people	17.5 (62)	<ee	15.7 (25)	0.534
4 to 6 people	57.2 (203)	54.6 (107)	60.4 (96)	
>6 people	25.4 (90)	26.5 (52)	23.9 (38)	
Family type				
Composite family	63.9 (227)	61.2 (120)	67.3 (107)	0.141
Nuclear family	36.1 (128)	38.8 (76)	32.7 (52)	

Number of children				
No children	13.5 (48)	15.3 (30)	11.3 (18)	0.498
1 to 2 children	30.1 (107)	28.6 (56)	32.1 (51)	
3 and more	56.3 (200)	56.1 (110)	56.6 (90)	
Housing				
Poor housing	38.3 (136)	34.7 (68)	42.8 (68)	
Modern	11.8 (42)	13.8 (27)	9.4 (15)	0.278
Luxurious	2.8 (10)	3.6 (7)	1.9 (3)	
Traditional housing	47 (167)	48 (94)	45.9 (73)	
Smoking				
Current and ex-smokers	1.7 (6)	2.6 (5)	0.6 (1)	0.164
Never smoker	98.3 (349)	97.4 (191)	99.4 (158)	
Physical activity (≥ 30 min/day)				
Yes	86.8 (308)	87.8 (172)	85.5 (136)	0.323
No	13.2(47)	12.2 (24)	14.5 (23)	
Class BMI (Kg/m ²)				
< 25	26.8 (95)	27.6 (54)	25.8 (41)	
25 – 29.9	41.1 (146)	44.9 (88)	36.5 (58)	0.108
≥ 30	32.1 (114)	27.6 (54)	37.7 (60)	
Hypertension				
No	58.9 (209)	56.6 (111)	61.6 (98)	
Yes	41.1 (146)	43.4 (85)	38.4 (61)	0.199
Diabetes				
No	87.9 (312)	86.7 (170)	89.3 (142)	0.284
Yes	12.1 (43)	13.3 (26)	10.7 (17)	

BMI: body mass Index. χ^2 test (percent (number)), statistically significant differences are defined as $P < 0.05$

nor the other cardiovascular risk factors studied with the adhesion to MD. Comparative analysis showed no statistically significant difference of major cardiovascular risk factors, including obesity, overweight ($p=0.108$), diastolic and systolic hypertension ($p=0.199$), and diabetes ($p=0.284$) between the two population groups with inadequate or adequate levels of adherence to the Mediterranean diet; while a difference but not statistically significant was found for heart rate. The same result is found for both regions analyzed independently.

Table 4 presents the results concerning the distribution of the simplified MD score according to compliance with adherence to the Mediterranean diet (low or high compliance). The simplified Mediterranean diet score value was on average 4.37 ± 1.49 in the general study population, with no significant difference between the two regions. However, a significant difference between both low and high compliance groups was found at the level of each region ($P < 0.000$). In accordance with the objective, the consumption of vegetables, cereals, fruits, legumes, fish and olive oil were significantly increased with the increased adherence to the MD

and were lower with lower adherence to MD in both regions ($P < 0.0001$). However, the consumption of dairy products and meat were not significantly different among the women of the two categories of adherence to the DM or between the two regions of residence ($P = 0.091$ and $P = 0.928$ successively). This relationship of food groups to categories of adherence to the MD remains the same in the whole population for the dairy products ($P = 0.1$) and meat ($P = 0.136$) consumption.

DISCUSSION

This work examined the influence of the geographical situation on the degree of adherence to Mediterranean diet, in women from two Moroccan regions at different distances to the Mediterranean basin. The study women population were from two provinces, Tetouan in the Tangier-Tetouan-Al Hoceima Region to the north near the Mediterranean Sea and El Jadida in the Casablanca-Settat region, located in the center on the Atlantic coast, both distant of 486 Km. To meet the targeted objectives, food intake and adherence to MD as well as compliance

Table 4. Distribution of Simplified Mediterranean Dietary Score (SMDS) and dietary intake of food groups according to the categories of adherence to Mediterranean diet and region of residence, n = 355

	EL JADIDA (n = 198)				TETOUAN (n = 157)			
	All	Low adherence 1-4 (n = 97)	High adherence 5-8 (n = 101)	P-value	All	Low adherence 1-4 (n = 81)	High adherence 5-8 (n = 76)	P-value
SMDS	4.37 ± 1.47	3.33 ± 0.97	5.68 ± 0.79	0.000	4.36 ± 1.51	3.22 ± 0.87	5.74 ± 0.8	0.000
Food groups								
Dairy products ^(a)	1.68 ± 1.33	1.58 ± 1.21	1.81 ± 1.46	0.220	1.94 ± 1.31	1.77 ± 1.16	2.13 ± 1.45	0.091
Vegetables ^(a)	6.96 ± 2.97	5.74 ± 2.27	8.48 ± 3.05	0.000	5.67 ± 2.81	4.37 ± 2.55	7.24 ± 2.27	0.000
Cereals ^(a)	5.05 ± 1.6	4.5 ± 1.64	5.73 ± 1.26	0.000	4.15 ± 1.78	3.63 ± 1.83	4.78 ± 1.51	0.000
Fruits ^(a)	3.84 ± 3.03	2.95 ± 2.65	4.98 ± 3.13	0.000	4.53 ± 3.73	3.03 ± 2.66	6.35 ± 4.04	0.000
Meat ^(b)	8.89 ± 5.32	8.25 ± 4.82	9.69 ± 5.82	0.059	5.19 ± 3.63	5.16 ± 3.87	5.22 ± 3.35	0.928
Legume ^(b)	1.99 ± 1.48	1.5 ± 1.37	2.61 ± 1.39	0.000	3.59 ± 0.47	2.45 ± 0.32	4.98 ± 0.96	0.008
Fish ^(b)	3.07 ± 2.66	2.05 ± 1.79	4.34 ± 3.01	0.000	3.01 ± 2.94	1.79 ± 1.62	4.48 ± 3.33	0.000
Olive oil (%)	86.9	82.2	92.3	0.029	85.4	71.9	100	0.000

(a) Frequency of consumption per day. (b) Frequency of consumption per week. Dairy products (milk, yogurt, and cheese), cereals (bread, cereals, rice, pasta, and couscous), meat (red meat, white meat, and processed meat), Legumes (Split Peas, Dry Beans, Lentils, Chickpeas) and Vegetables (excludes potatoes) Variables are presented as mean (standard deviation). Statistic significant differences are defined as $P < 0.05$ for t-test for Equality of means or for the Chi2 test according to categories of adherence to Mediterranean diet.

with the recommendations of the Mediterranean dietary pyramid were initially evaluated. This analysis included the study of the dietary intake from food groups according to the categories of adherence to the Mediterranean diet and to the region of residence. In a second step, the relationship of adherence to MD with the populations' socio-demographic and the lifestyle factors in both regions was also analyzed.

Analysis of the data on food intake indicates that women in El Jadida, which belongs to the Casablanca-Settat region, have a higher weekly consumption of meat (red, white, processed), vegetables, cereals, potatoes and a daily consumption of herbs, spices, garlic, onions, water and infusions than the Tetouan region. This result can be due, mainly, to the geographical nature made of vast fertile fields and to a strong agricultural activity in El Jadida region compared to that of Tetouan which is located in the mountain range of the Rif. The red meat production in the Casablanca-Settat region represents indeed, 11% of national production, with a processing and processing capacity of 150,000 tons/year (Ministry of Agriculture, Fisheries, Rural Development, n.d.). The region that includes the Tetouan province, located in the north of the country close to the Mediterranean coast, is an important basin of olive groves and productions of legumes, olives, nuts and seeds, given the climatic conditions particularly rainfall, improved irrigation facilities and production methods. The yields of olive oil production vary from 1.6 to 3 tons/Ha and contribute up to 16% to the deficit in edible oils (50,000 tons) [30, 31].

Many rating systems expressed as indices or scores have been used to measure adherence to the Mediterranean diet. However, the different definition of the maximum and minimum possible values as well as the definition of compliance levels (low, medium and high), make inter-study comparison difficult [32, 33]. In this study, the score used is the Simplified Mediterranean Food Score [28] adapted from the Mediterranean Food Score (MDS) [8]. Although the latter is the first most used score developed for Mediterranean countries, the MDS cannot faithfully reflect the respect of traditional eating habits specific to the Moroccan study population, mainly those related to religion, such as abstinence from alcohol.

Our data showed that the simplified Mediterranean dietary score is below that reported in other Moroccan studies [28, 34] as only 2 out of 5 participating women had their eating habits compliant with at least 40% of the MD characteristics. The same proportion of adherence was found before, in the same region of El Jadida in 2015 but using another Mediterranean score [35]. Although the majority of the study population consumes most of the food groups concerned, this study shows that the present women population

does not fully follow the recommendations of the Mediterranean diet pyramid. The most concrete examples are those of the consumption of olive oil and red meat which are 86.2% and 95.8% respectively in the whole population studied while only 2 % and 32.1% have respectively this consumption consistent with the Mediterranean diet pyramid norms. This low compliance with the recommendations of the Mediterranean diet pyramid has been registered in other studies.

These results are in agreement with other studies carried out in other provinces such as Casablanca with regard to the consumption of fish, potatoes and olive oil, but not for the consumption of red meat, dairy products and sweets [34]. The comparable fish consumption is probably linked to the position of these towns on the coast, with greater accessibility to seafood products. The consumption of white meat, processed meat, vegetables and eggs in Casablanca than in the study population, would be due to the fact that the former is the economic capital with largest agglomeration in the country [24], where most people eat out of home or on their workplace. On the other hand, in comparison with the population of Fez [28], the province of Tetouan has similarities in terms of geographical proximity. El Jadida is also comparable with the province of Fez for all food groups except legumes and olives.

The present data show that in general, the high adherence to the Mediterranean diet found among women in the two regions studied, is characterized by a high consumption of vegetables, fresh fruits, legumes, cereals, fish, olive oil and low meat consumption (non-significant decrease). However, the consumption of dairy products which is supposed to be lower does not show a significant difference. This is certainly attributed to the non-compliance on the part of the subjects studied of nearly 60% of the recommendations of the Mediterranean diet, which largely explains the low distribution of adherence to the DM which is 44.8%.

The food profile studied shows a marked deviation from the traditional Mediterranean diet, particularly in terms of consumption of animal products (meat and dairy products), sweets, sugar and olive oil. The most surprising low consumption of the latter is probably due to its limited affordability, which could constitute an obstacle to a healthy diet [36, 37, 38, 39] not only in the two regions of study, but also in most Mediterranean countries [40, 41]. These eating habits changes, through the adoption of cheaper and unhealthy foods, will switch to a cheap and westernized diet high in empty calories as part of a nutritional transition expressed in parallel to an increase in the production of food industry, increasing urbanization, economic development and the effect of globalization [11, 12,

20]. On the other hand, the correlations studied of the DM adherence are different from those observed in other Mediterranean countries. Generally, the analysis results do not indicate any detected significant impact of socio-demographic or lifestyle factors on the level of adherence to the Mediterranean diet.

While age was a predictor of adherence to the Mediterranean diet in most Mediterranean areas [32, 41, 42, 4, 44, 45, 46], no association was revealed in the present study, between age groups and adherence to MD. This result corroborates with those of a study previously carried out in the country [28]. In Mediterranean countries, especially those experiencing a nutritional transition, young people are more adopting the Western dietary pattern [45, 47] characterized by, modern, fast and off-home food, while older peoples stick to the traditional lifestyle and eating habits they grew up with and avoid modern dishes and fast foods. However, the present study data do not support this hypothesis, probably because Morocco is in an earlier stage of the nutritional transition in Morocco [20] and to cultural and traditional lifestyle differences between Moroccans and other populations of the Mediterranean Basin. Furthermore, the study sample does not include young aged people (children and adolescents) under the age of 18.

Similarly, no significant differences of the adherence to the Mediterranean diet were revealed according to average family income or education. These results are consistent with those found in other national population studies [28, 34], and could be explained by the characteristics of the study population that is mostly illiterate or poorly educated and of low income. Nevertheless, it is important to emphasize that a good family income regardless of the level of education does not automatically guarantee good nutritional status. Indeed, traditional food, which is rather less expensive and within reach of poor households, was traditionally more plant-based, diversified and healthy. Therefore, the deviation from the traditional MD is mainly linked to changes in eating habits associated with factors related to the overall transition underway in the country. It is rather a lack of nutritional education, associated with the economic and political transition following a set of mutations and changes that the country has experienced and which have given rise to great socio-economic disparities and social categories with contradictory characteristics. These are accompanied by an improvement in the economic level of households associated with the abundance and poor quality of food and living conditions inducing a direct impact on health and nutritional status [11, 48]. Other studies have, conversely, shown a significant association between a healthier diet and higher levels of education and income while, low income affects the type of food products consumers buy in terms of

quality and variety [35, 49, 50]. On the other hand, a low level of education is generally associated with limited nutritional knowledge and low awareness of food-related issues.

Contrary to what is reported in the literature, in the present study being married was not associated with the highest adherence to the Mediterranean diet [50, 51]. This finding may be related to weakening potential family influences and the changing role of women in the family over the past decades. Indeed, traditional meal preparation by housewives has declined and eating outside the home has become more common. Regarding housing classes, no association was found between a healthier diet and living in luxurious housing. This is consistent with the result discussed above showing that adherence to the Mediterranean diet is not significantly associated with higher income or education levels in this study population, and consumers can meet their nutritional needs in terms of food quality and diversity. A contradictory result was reported in the province of Fez in Morocco by [28, 34], which showed that the inhabitants of the old and the new medina (town), still retain their traditional way of life while people living in luxurious dwellings may have lower adherence to the Mediterranean diet or the opposite.

Tobacco use was not widespread among the studied women, who were 98.3% non-smokers. As in such communities, it is difficult to determine the actual number of women smokers given the social and cultural considerations preventing them from answering this question. Smoking has already been reported to be positively associated with unhealthy eating habits [52] but also negatively associated with adherence to the traditional Mediterranean diet [53, 54].

The Mediterranean lifestyle also includes regular physical activity. In this study, no relationship was observed between physical activity at work and during leisure time with MD adherence, although the majority of the study population (86.8%) practiced physical activity. The beneficial health effect attributed to MD against coronary artery disease and other related diseases, is not the result of diet alone, but also includes in part a more active leisure lifestyle of those who adhere to the traditional Mediterranean diet. This association has also been confirmed by previous studies [47, 55]. Furthermore, the present study did not reveal any significant impact of medical history or cardiovascular risk factors on the level of adherence to MD. The only noticeable effect was on heart rate which was, on average, slightly lower in participants with high MD adherence scores compared to those with lower ones; this difference was however, not statistically significant. Nevertheless, the cross-sectional design of the present study does not make

it possible to establish the causality between these cardiovascular risk factors and adherence to DM. The high prevalence of these risk factors in previous Moroccan data [56, 57, 58] could partly be explained by the abandonment of the traditional MD, which constitutes a culinary heritage of Morocco and other Mediterranean countries.

CONCLUSIONS

The data from this study show that adherence to the Mediterranean diet is comparable in the two provinces studied regardless of their geographical proximity to the Mediterranean. These results do not reveal any significant association between socio-demographic factors, lifestyle or medical history with MD adherence, regardless of the location or distance of residence from the Mediterranean. The adherence rate to the MD obtained in this work, comparable result and in agreement with that previously reported in the same population and of El Jadida province studied using an adapted score [35] constructed on the first score developed by underlines the validity of the simplified score of the MD used in this study. Furthermore, the data from this work underline a comparable deviation from the traditional Mediterranean diet in the two provinces.

The shift away from MD model observed in the two populations suggests a change in adopted eating habits associated to a loss of culinary traditions and the introduction of fast and modern food. Hence, there is an urgent need for education about healthy properties and benefits of the MD diet through public awareness in order to re-establish the Mediterranean model of diet and lifestyle.

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Conflicts of interest

The authors declare that they have no competing interest.

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