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ORIGINAL ARTICLE

SOCIODEMOGRAPHIC, NUTRITIONAL AND HEALTH STATUS FACTORS ASSOCIATED WITH ADHERENCE TO MEDITERRANEAN DIET IN AN AGRICULTURAL MOROCCAN ADULT'S POPULATION

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ABSTRACT

Background. Numerous studies have demonstrated beneficial effects of adherence to the Mediterranean diet (MD) on many chronic diseases, including chronic kidney disease (CKD).

Objective. The aim of this study was to assess the adherence of a rural population to the Mediterranean diet, to identify the sociodemographic and lifestyle determinants and to analyze the association between adherence to MD and CKD.

Material and Methods. In a cross-sectional study, data on sociodemographic, lifestyle factors, clinical, biochemical parameters and diet were collected on a sample of 154 subjects. Adherence to MD was assessed according to a simplified MD score based on the daily frequency of intake of eight food groups (vegetables, legumes, fruits, cereal or potatoes, fish, red meat, dairy products and MUFA/SFA), using the sex specific sample medians as cut-offs. A value of 0 or 1 was assigned to consumption of each component according to its presumed detrimental or beneficial effect on health.

Results. According to the simplified MD score, the study data show that high adherence (44.2%) to MD was characterized by intakes high in vegetables, fruits, fish, cereals, olive oil, and low in meat and moderate in dairy. Furthermore, several factors such as age, marital status, education level, and hypertension status were associated with the adherence to MD in the study population. The majority of subjects with CKD have poor adherence to the MD compared to non-CKD with a statistically insignificant difference.

Conclusions. In Morocco, maintaining the traditional MD pattern play crucial role for public health. More research is needed in this area to precisely measure this association.

Key words: *Mediterranean diet, chronic kidney disease, simplified MD score, Morocco*

INTRODUCTION

The Mediterranean diet (MD), the diet of the populations residing along the Mediterranean Basin, is widely considered a healthy dietary model whose adherence presumed to have a beneficial effect on health and nutritional status of the individual [1, 2, 3] as well as on the environment [4]. The traditional Mediterranean diet is characterized by a high intake of vegetables, fruits, legumes, nuts, wholegrain and unrefined cereals, and a high intake of olive oil as the main source of dietary lipids, a moderate intake of fish and seafood, a low to moderate consumption of dairy products, and finally a low intake of red and processed meat [5, 6].

Numerous epidemiological studies have demonstrated the protective effect of Mediterranean diet against many chronic diseases, particularly diabetes mellitus, kidney disease, cardiovascular disease and metabolic syndrome [7, 8, 9, 10, 11, 12, 13]. In addition, several meta-analyses of cohort studies that examined the effect of MD on non-communicable diseases (NCDs) underlined that people with the highest levels of adherence to MD have decreased risk of developing diabetes by a 13–23% and that of developing cardiovascular disease (CVD) by 19–27% [14,15] compared those with low adherence levels.

Chronic kidney disease (CKD) is recognized as a serious public health problem around the world. It is associated with high cardiovascular morbidity and mortality and low quality of life [16, 17, 18, 19]. These metabolic and cardiovascular disease (CVD) factors, include obesity, diabetes, hypertension, and metabolic

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syndrome and are in continuous increase worldwide and in Morocco [20, 21, 22]. On the other hand, diet is thought to play a major role in the development of these diseases including CKD risks [23] and the adoption of a healthy diet is reported to protect against all forms of malnutrition and as well as NCDs [24]. One of diets recognized as healthy and of sustainable is Mediterranean diet [24].

The Mediterranean diet is indeed, a traditional reference model of healthy and balanced diet [3, 6, 25]. However, Morocco, like several other developing and Mediterranean countries, is undergoing a demographic, epidemiological and nutritional transition and therefore a deviation from MD model switching to westernized diet [26, 27]. The nutrition transition linked to the profound and rapid changes in eating habits is associated to increased urbanization, improvement of the economy and development of the food industry associated with globalization [28]. Several indexes or scores have been developed to evaluate adherence to MD. Among these, the Mediterranean diet score (MDS) is the most frequently used score to assess the degree of adherence to the traditional Mediterranean diet. It was first defined by *Trichopoulou* et al [3, 29], then expanded and updated later in 2003 with the addition of the fish component [30]. It is also a diet quality score based on heritage recommendations related to the traditional Mediterranean diet. The food components of this score include cereals, vegetables, fruits and nuts, pulses, milk and dairy products, meat and meat products, fish, and the ratio of monounsaturated fats to saturated fats. A high consumption of Mediterranean foods (favourable foods): cereals, legumes, fruits and nuts, vegetables, olive oil and fish was marked by a positive value «1» and a high consumption of non-Mediterranean foods (unfavourable foods): milk and dairy products and meat was marked with a negative or nul value «0». The total score varies therefore, from 0 (minimum adherence to MD) to 8 (maximum adherence to MD) and subjects with a higher score are considered more compliant with the traditional Mediterranean diet [3].

To our knowledge, no study has examined the relationship between compliance with MD and chronic kidney disease. The objective of the present study was therefore, on the one hand to examine the relationship between adherence to MD with sociodemographic and socioeconomic status and other lifestyle parameters, and on the other hand to evaluate the association of MD and CKD membership in a sample of the Moroccan adult population.

MATERIAL AND METHODS

Sample

The current study was carried out between January and December 2017 on a sample of 210 subjects aged 18 years and over, living in the agricultural province of Sidi Bennour in Morocco, and randomly selected from primary health care. The study was supported by the Moroccan ministry of higher education and research and the ministry of health of Morocco. Only people aged 18 years and older, with normal mental health were included. Pregnant women, patients with paralysis and persons with antecedent of kidney disease were excluded from this investigation.

Data collection

A questionnaire was used to collect data on sociodemographic and socioeconomic status (age, sex, marital status, area of residence, profession, monthly income and education level), personal and family health history (hypertension, diabetes and kidney disease) and lifestyle indicators (smoking, alcohol consumption, physical activity) and dietary habits. Blood pressure and anthropometric parameters (weight, height, waist and hip circumferences) were likewise carefully measured. All anthropometric and clinical measurements were performed by the same well-trained nurse in order to reduce subjective errors.

Anthropometric measurement

Weight was measured in light clothing and without shoes to the nearest 0.1 kg on a mechanical scale, and height was recorded to the nearest of 0.1 cm with a stadiometer with the subjects in a standing position, not wearing shoes and with shoulders in normal position. Body Mass Index (BMI) was calculated by dividing weight (kg) by the square of height (m^2), according to the World Health Organization (WHO) criteria, normal weight was defined as $18 \leq BMI < 25$ Kg/m^2, overweight as $25 \leq BMI < 30$ Kg/m^2 and overall obesity was defined as $BMI \geq 30$ Kg/m^2. Waist circumference (WC) in (cm) was measured at midway between the lowest rib and the iliac crest and the hip circumference (HC) at the level of the greater trochanter using a flexible tape and expressed in (cm) and the waist to hip ratio (WHR) was calculated as WC divided by HC. WC is a marker for central obesity and WHR for body fat distribution. According to the NCEP-ATP III reference, WC values larger than 88 cm for females and 102 cm for males are considered to be high and indicate abdominal obesity.

Laboratory measurements

Blood samples were collected by venipuncture after an overnight fast of at least 12 hr and all analyses were made on the day of blood collection. Serum creatinine

was measured according to the standard colorimetric Jaffe-Kinetic reaction method.

Chronic kidney disease

Estimated glomerular filtration rate (eGFR) was calculated using the Modification of diet in renal disease (MDRD) formula as follows [31–33]:

$$eGFR = 186 \times (\text{serum creatinine})^{-1.154} \times (\text{age})^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if African-American})$$

According to the national kidney foundation guidelines, the subjects were classified based on their eGFR levels, as without CKD when eGFR≥60 ml/min/1.73 m² and with CKD if eGFR<60 ml/min/1.73 m².

Mediterranean diet score

The food frequency questionnaire (FFQ) was completed for a sub sample of 154 participants in a face-to-face interview. The MDS is used to assess the degree of adherence to the MD. The calculation of this score was based on the frequency of the daily intake of each food group; the score is made up of eight components or food groups (vegetables, legumes, fruits, cereals, fish, meat and dairy products). To calculate the total frequency of each component, the frequency of the food items that belong to it is added, dairy products (milk, yogurt and cheese), cereals (bread, cereals, potatoes, rice, pasta and couscous) meats (meat red, white meat and processed meat), and the monounsaturated fatty acid to the saturated fatty acid ratio is computed for a fat intake. A value of 0 or 1 was contributed for each of the components with the use of the sex-specific median as the cut-off. For the beneficial components (vegetables, legumes, fruits, cereals, and fish), persons whose consumption was below the median were assigned a value of 0, and those with a consumption at or above the median were assigned a value of 1. For components presumed to be detrimental (meat and dairy products), persons that have a consumption below the median were assigned a value of 1, and those having a consumption at or above the median were assigned a value of 0. Thus, the total simplified MD score ranged from 0 (minimal adherence) to 8 (maximal adherence). This index is then used to classify subjects into two groups according to their adherence to the MD, "low" adherence to the MD (0 to 4 points), and "high" adherence to the MD (5 to 8 points) [26, 34].

Ethical consideration

The authorities were previously informed by the delegation of the Ministry of Health about the realization of the study, its objectives and terms. Also, the procedures and objectives of the study were clearly explained to the participants who provided written informed consent.

Statistical analyses

All calculations were performed using the SPSS statistics program version 24.0. Continuous variables were expressed by mean ± SD and categorical variables were reported by frequency and proportions. Student's t-test was used to compare differences in means and *Chi*-square test was used to compare differences in proportions. Analysis of variance (ANOVA) was used to determine the relationship between MDS categories and quantitative variables. In all statistical tests, p-value less than 0.05 is considered statistically significant.

RESULTS

Table 1 shows the mean values of the MDS according to the participants' characteristics. The mean MDS was 4.44 ± 1.56 with an interval of 1 to 8. The comparison of the mean MDS values according to the gender, area of residence, SES, anthropometrical status and prevalence of CKD did not show any significant difference. On the other hand, the comparison of this score according to the age groups, level of education and the incidence of hypertension indicated statistically significant differences.

Table 2 shows the association between all the sociodemographic and clinical characteristics of the population with the degree of adherence to Mediterranean diet. The table shows no significant difference in the degree of adherence to the MD between categories of gender, area of residence, SES, anthropometrical status, and prevalence of CKD. On the other hand, this adherence was significantly associated with age, marital status, level of education and the incidence of hypertension, and a negative correlation between MDS and hypertension has been noted (r =-0.268; p=0.001).

The consumption of food groups by gender is described in Table 3. Our results showed that the differences of medians of food groups consumption between the two gender were statistically significant except for meats and the MUFA/SFA fat ratio which were more frequently consumed by women. Otherwise, in our population 44.2% had high MDS while 55.8% had low MDS. The prevalence of adherence to the MD is relatively higher in men compared to women 47.7% vs. 42.7%.

Food groups' consumption according to the categories of adherence to the Mediterranean Diet is shown in the Table 4. According to table results, high adherence to the MD was characterized by high intakes of vegetables, fruits, legumes, fish, cereals, olive oil, and low meat and dairy consumption, whereas, a low

Table 1. Comparison of MDS values according to the study participants' characteristics

Characteristics	n (%)	MDS (mean ± SD)	P-value
Gender			
Male	44 (28.6)	4.43 ± 1.45	0.987
Female	110 (71.4)	4.44 ± 1.61	
Age categories (years)			
[18-29]	10 (6.5)	4.40 ± 1.83	**0.011**
[30-59]	86 (55.8)	4.76 ± 1.45	
≥60	58 (37.7)	3.97 ± 1.58	
Area of residence			
Urban	47 (30.5)	4.49 ± 1.33	0.777
Rural	107 (69.5)	4.41 ± 1.66	
Socio economic status			
Low	91 (59.1)	4.43 ± 1.52	0.777
Medium	45 (29.2)	4.36 ± 1.59	
High	18 (11.7)	4.67 ± 1.78	
Level of education			
Never attended	118 (76.6)	4.26 ± 1.53	**0.013**
Attended School	36 (23.4)	5.00 ± 1.54	
BMI categories			
Underweight	3 (1.9)	3.00 ± 1.00	0.298
Normal weight	39 (25.3)	4.26 ± 1.71	
Overweight	52 (33.8)	4.46 ± 1.48	
Obesity	60 (39.0)	4.60 ± 1.56	
Chronic kidney disease			
With CKD	6 (4.0)	3.67 ± 1.63	0.211
Without CKD	143 (96.0)	4.49 ± 1.56	
HTA			
Yes	48 (31.2)	3.81 ± 1.62	**0.001**
No	106 (68.8)	4.72 ± 1.46	

HTA: hypertension; MDS: Mediterranean diet score; CKD: Chronic kidney disease
The t test and 1-way ANOVA were used to compare the means of the MDS score according to the classes of the different characteristics studied.

Table 2. Characteristics of the population according to the degree of adherence to the Mediterranean diet

Charactetristics	Low MDS (1-4) n=86 (55.8%)	High MDS (5-8) n=68 (44.2%)	p-value
Gender			
Male	23 (52.3)	21 (47.7)	0.572
Female	63 (57.3)	47 (42.7)	
Age groups (years)			
18-29	6 (60.0)	4 (40.0)	**0.028**
30-59	40 (46.5)	46 (53.5)	
≥60	40 (69)	18 (31.0)	
Marital status			
Married	51 (51.0)	49 (49.0)	**0.099**
Not married	35 (64.8)	19 (35.2)	
Area of residence			
Urban	28 (59.6)	19 (40.4)	0.537
Rural	58 (54.2)	49 (45.8)	
SES			
Low	52 (57.1)	39 (42.9)	0.915
Medium	24 (53.3)	21 (46.7)	
High	10 (55.6)	8 (44.4)	
Education attainment			
Never attended	72 (61.0)	46 (39.0)	**0.019**
Attended school	14 (38.9)	22 (61.1)	

BMI categories			
Underweight	3 (100)	0 (0.0)	
Normal weight	22 (56.4)	17 (43.6)	0.470
Overweight	29 (55.8)	23 (44.2)	
Obesity	32 (53.3)	28 (46.7)	
CKD			
Yes	5 (83.3)	1 (16.7)	0.164
No	78 (54.5)	65 (45.5)	
HTA			
Yes	34 (70.8)	14 (29.2)	**0.012**
No	52 (49.1)	54 (50.9)	

The results are presented as n (%).
Chi^2 test was used to compare the distribution of the degree of adherence to the Mediterranean diet according to the different characteristics studied.

Table 3. Distribution of the daily consumption of the different food groups according to the degree of MD adherence (MDS)

Food variables	Total	Men n=44		p-value	Total	Women n=110		p-value
		Low MDS n=23 (52.3)	High MDS n=21 (47.7)			Low MDS n=63 (57.3)	High MDS n=47 (42.7)	
Vegetables								
Median	10.11			**0.007**	10.01			**0.000**
≥ Median		7 (30.4)	15 (71.4)			16 (25.4)	39 (83.0)	
< Median		16 (69.6)	6 (28.6)			47 (74.6)	8 (17.0)	
Legumes								
Median	0.31			**0.000**	0.17			**0.000**
≥ Median		5 (21.7)	18 (85.7)			18 (28.6)	41 (87.2)	
< Median		18 (78.3)	3 (14.3)			45 (71.4)	6 (12.8)	
Fruits								
Median	5.35			**0.007**	4.84			**0.000**
≥ Median		7 (30.4)	15 (71.4)			15 (23.8)	40 (85.1)	
< Median		16 (69.6)	6 (28.6)			48 (76.2)	7 (14.9)	
Fish								
Median	0.19			**0.000**	0.17			**0.000**
≥ Median		5 (21.7)	18 (85.7)			23 (36.5)	37 (78.7)	
< Median		18 (78.3)	3 (14.3)			40 (63.5)	10 (21.3)	
Cereals								
Median	4.59			**0.007**	4.40			**0.000**
≥ Median		7 (30.4)	15 (71.4)			21 (33.3)	35 (74.5)	
< Median		16 (69.6)	6 (28.6)			42 (66.7)	12 (25.5)	
MUFA/SFA								
Median	1.44			0.500	1.59			0.112
≥ Median		12 (52.2)	10 (47.6)			29 (46.0)	28 (59.6)	
< Median		11 (47.8)	11 (52.4)			34 (54.0)	19 (40.4)	
Meat								
Median	1.31			0.613	1.17			0.310
≥ Median		11 (47.8)	10 (47.6)			28 (44.4)	24 (51.1)	
< Median		12 (52.2)	11 (52.4)			35 (55.6)	23 (48.9)	
Dairy products								
Median	0.62			0.273	0.70			0.161
≥ Median		13 (56.5)	22 (50.0)			34 (54.0)	20 (42.6)	
< Median		10 (43.5)	22 (50.0)			29 (46.0)	27 (57.4)	

MDS: Mediterranean diet score; MUFA/SFA: Mono Unsaturated Fatty Acid/Saturated Fatty Acid ratio. The results are presented as n (%).
The *Chi*^{2} test was used to compare the distribution of the daily consumption of different food groups according to the degree of adherence to MD for both sexes.

Table 4. Food groups'consumption according to the categories of adherence to the MD

Adherence to MD	Low adherence n=86 (55.8%)	High adherence n=68 (44.2%)	p-value
Food groups			
Vegetables	8.75 (6.94 – 10.26)	11.94 (10.44 – 14.65)	0.000
Meat	1.23 (1.00 – 1.45)	1.17 (0.98 – 1.87)	0.484
Legumes	0.10 (0.00 – 0.18)	0.35 (0.20 – 0.53)	0.000
Fish	0.12 (0.06 – 0.20)	0.31 (0.20 – 0.53)	0.000
Cereals	4.01 (3.47 – 4.62)	4.97 (4.46 – 5.62)	0.000
Milk and dairy products	0.62 (0.23 – 1.24)	0.99 (0.39 – 2.19)	0.004
Fruits	3.60 (2.70 – 5.35)	6.71 (5.38 – 9.24)	0.000
MUFA/SFA	1.47 (1.05 – 1.84)	1.63 (1.25 – 2.16)	0.095

MD: Mediterranean diet; MUFA/SFA: Mono Unsaturated Fatty Acid/Saturated Fatty Acid ratio. The results are presented as the median (percentiles).
The *Mann-Whitney* test was used to compare the median daily consumption frequencies of the different food groups according to the degree of adherence to the Mediterranean diet.

adherence to MD was characterized by low intakes of vegetables, fruits, legumes, fish, cereals, olive oil, and high meat and dairy consumption. There were significant differences in the consumption of each food group according to the categories of adherence to Mediterranean diet (P<0.05), except for meats food group and the MUFA/SFA fat ratio.

DISCUSSION

The diet in Morocco is of the Mediterranean type. This diet has demonstrated a protective effect against the incidence of cardiovascular diseases as well as other chronic diseases such as diabetes, obesity, cancer or other metabolic disorders by numerous studies [7, 8, 14, 34–37]. Adherence to this diet has also been shown to play a key role in preventing several morbid conditions related to NCDs and cognitive health [7, 22, 37, 38–41]. However, the composition of the traditional Moroccan Mediterranean diet has actually undergone some variations over time, linked to a «westernization» of eating habits in addition to a sedentary lifestyle [26]. Few studies reported about the factors of adherence to the MD in the south of mediterranean basin populations. In Morocco, except the study by *El Rhazi* et al. [34], the present study revealed an association between the degree of adherence to the Mediterranean diet with some sociodemographic factors, such as age, the level of education and the marital status in Moroccan population. Indeed, a low adherence to MD was observed much more in the elderly individuals with a high level of education, and in no married persons. This can be explained by the fact that single person and those with a good level of education are more likely to adopt Western dietary patterns characterized by ready to take away and ready-to-eat foods. It reveals also the lack of nutritional education in the population. Whilst contradictory to observations of *Mohtadi* et al. and that of *O'Connor* et al [26, 37], this explanation is in line with that of other studies [34, 42, 43]. This highlights also the influence of the family potential on eating behavior, which is characterized by the preparation and sharing of cooked meals between different family members. However, no significant difference was recorded in this study concerning the other sociodemographic characteristics, namely: marital status, area of residence and socioeconomic status.

On the other hand, adherence to the Mediterranean diet is considered a protective factor against the risk of incidence of chronic kidney disease according to the literature data [7]. In the present study, The majority of subjects with CKD have poor adherence to the MD compared to non-CKD with a statistically insignificant difference (p>0.05). However, the association of MD adherence scores with hypertension, considered a cardiovascular risk factor of CKD in the study population, revealed a statistically significant difference. This result demonstrating that hypertension is inevitably associated with low adherence to the Mediterranean diet, is in agreement with that found by many other studies conducted on the Greek population [30, 44, 45]. Moreover, even if the association between CKD and the MD has not yet been extensively studied and more studies are required in this field, it is demonstrated that the high fiber content in MD improve GFR levels by decreasing nephron workload. Also, the antioxidant components of MD protect kidney function by improving endothelial function and protecting against major risk factors for CKD such as obesity and diabetes mellitus [7].

The findings showed that adherence to MD in the study population, was characterized by high intake of cereals, vegetables, fruits, legumes and fish, moderate

intake of milk and dairy products and low intake of meat. Other Moroccan studies have demonstrated similar results [26, 34]. Comparing the different food groups consumption according to gender and category of adherence to the MD, the results reported here, showed that men were more compliant than women with the MD, this finding was comparable to that obtained by other studies fulfilled in Morocco and Spain [26,42]. However, this finding is different from that obtained by the study of *El Rhazi* et al [34]. Also, in accordance with other studies carried out before on samples of the Moroccan and Italian populations, the analysis of the obtained results showed that there is no statistically significant association between the MDS and the anthropometrical status [26, 34, 46]. Furthermore, regarding the socio with economic status and even if not statistically significant, the present results showed that people belonging to households with a medium and a high socioeconomic status have relatively higher adherence to MD compared to those from disadvantaged households with a low socio-economic status. This result is similar to that found by *El Rhazi* et al and *Tong* et al [34, 47].

This current study has few limitations. Firstly, the dietary data was based on FFQ. Food consumption was not assessed with high accuracy and people might have overestimated the consumption of healthy nutrients and food items like vegetables, fruits or cereals, typical components of the MD and underestimated the consumption of unhealthy nutrients and food items like red meat and some fats. Secondly, like all other cross-sectional studies, we could not determine the causal-effect relationship between adherence to the MD and CKD. Despite these limitations, this seems to be the first study to evaluate the link between adherence to the MD and CKD among this Morroccan population.

CONCLUSIONS

The present study has focused on the Mediterranean diet which constitutes a culinary heritage and original diet of Morocco and other Mediterranean countries ; the diet tends to be abandoned in favor of a modern diet rich in saturated fats, salt and sugar. The study data found that high adherence to MD was characterized by high intakes of vegetables, fruits, fish, cereals, olive oil, low meats, and moderate milk and dairy products according to the used simplified MD score. Higher adherence to the MD in the surveyed adult sample was associated with several factors such as age, education level, and hypertension status. Finaly, although no significant difference was observed in the relationship between MD and the occurrence of CKD, maintaining the traditional MD model plays an essential role for public health and therefore, further research is needed to accurately measure and assess these associations.

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Conflict of interest

The authors declare that there are no conflict of interest regarding the publication of this paper.

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