

ADHERENCE TO MEDITERRANEAN DIET IN MOROCCAN SCHOOL-AGE ADOLESCENTS: SOCIODEMOGRAPHIC, SOCIOECONOMIC AND LIFESTYLE DETERMINANTS

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ABSTRACT

Background. Despite its benefits, the Mediterranean diet (MD) is abandoned or not adopted by the younger generations in most Mediterranean countries.

Objective. The aim here was to examine some factors determining adherence to MD in Moroccan school-age adolescents.

Material and Methods. A cross-sectional survey was conducted in a school setting among 386 students (148 boys and 238 girls), aged 14 to 18 years, randomly selected and from different socioeconomic strata. A structured questionnaire was used to collect sociodemographic, socioeconomic and lifestyle data. Physical activity was assessed using the short French version of the IPAQ questionnaire. The KIDMED test was used to assess adherence to the Mediterranean diet. Weight, height and waist circumference were measured according to WHO standards. Body mass index (BMI) and waist-to-height ratio (WHtR) were calculated. Statistical ANOVA test was used for to compare multiple means, Student's t-test for independent samples, Chi^2 test for categorical variables and multinomial logistic regression analysis to identify factors associated with adherence to the MD amongst adolescents sample.

Results. Adherence to the MD in this population was very low, with nearly 53% having poor adherence and only 7.7% reporting optimal adherence. Multinomial regression analyses showed that poor adherence is correlated with female gender ($p=0.042$), low paternal education ($p=0.004$), limited number of meals ($p=0.006$), advanced age ($p=0.005$) and inadequate sleep duration ($p=0.027$). In contrast, better adherence appears to be correlated with a high number of meals per day ($p<0.001$) and a better socio-professional class of the father ($p<0.001$).

Conclusion. This study revealed a low prevalence of good adherence to MD confirming a transition of the study adolescents towards a Westernized diet. Targeted nutritional intervention programs should be implemented to improve adherence to the MD among Moroccan adolescents, by promoting healthy eating habits.

Key words: Mediterranean diet, sociodemographic, socioeconomic, lifestyle characteristics, school-age adolescents, Morocco

INTRODUCTION

The Mediterranean diet, recognized by UNESCO in 2010 as an intangible cultural heritage of humanity, is the traditional dietary pattern that characterizes the eating habits of populations living along the Mediterranean basin including Morocco, Greece, Spain and southern Italy [1]. This quasi-vegetarian diet is characterized by abundant consumption of plant-based foods (fruits, vegetables, legumes, unrefined natural cereals, nuts), moderate consumption of eggs, fish, dairy products and alcohol, and reduced consumption in quantity and frequency of saturated

fats, sweets and red and processed meat. The main source of unsaturated fat is olive oil [2, 3]. In addition, the MD involves the consumption of traditional, local, seasonal products, minimally processed food products that promote biodiversity [4], and are environmentally friendly [5]. These elements qualify this model as much as a sustainable diet [6]. The MD richness is also related to social, cultural and life habits qualitative criteria, such as conviviality, culinary activities, frugality and sobriety [7]. All combined with regular physical activity and adequate rest [3, 8]. The Mediterranean diet is associated with a lower prevalence of several diseases, such as type

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2 diabetes, hypertension, cardiovascular diseases and some cancers among others, that are all associated with overweight [9, 10]. Indeed, the Mediterranean diet is low in calories and rich in vitamins and minerals derived from vegetables and fruits, whole grains, nuts, virgin olive oil and fish, which guarantees sufficient intakes of micronutrients [11]. This explains also the absence of B type vitamin deficiency (B₁, B₂, niacin, B₆, folates or B₁₂) in the Mediterranean basin and the high intakes of antioxidant vitamins (vitamins E and C) and carotenes [12, 13]. All of these characteristics made WHO considering MD as a healthy diet [14]. However, despite the health benefits of the Mediterranean diet, there has been a gradual abandonment of this dietary pattern in the recent decades by the inhabitants of the Mediterranean basin and the adoption of a more Westernized dietary pattern, particularly by the younger generations [15, 16]. Indeed, during this period, many factors have influenced their eating habits [17]. This has been partly attributed to the process of globalization through the widespread diffusion of Western-type dietary patterns [18]. Furthermore, it is suggested that sociodemographic, socioeconomic and lifestyle characteristics significantly affect adherence to the Mediterranean diet among adolescents [16]. Previous studies have found that optimal adherence to the Mediterranean diet is associated with younger age [16], regular physical activity [15], and high paternal education [19], while other researchers have correlated adherence to the MD with maternal education [16]. On the other hand, the HELENA study [20], has reported an inverse association between adherence to the Mediterranean diet and sedentary behaviors related to screen time, similar results were found in the literature. In addition, better adherence to Mediterranean diet is correlated with optimal sleep duration [16]. It was indeed, reported that the lack of sleep appears to contribute to eating disorders such as anorexia, bulimia, and binge eating disorder and that, inadequate sleep duration is in addition, associated with low intake of minimally processed foods and high intake of ultra-processed foods [21]. Morocco, among other Mediterranean countries, has been facing, in recent years, a change in lifestyle including a nutrition transition and a shift from an active to a sedentary lifestyle [22]. This dietary transition is characterized by a shift from a traditional diet based on cereals and legumes to a diet composed of more animal products and tending to be excessive in relation to the energy needs of a sedentary life [23]. This phenomenon has led to a gradual decrease in malnutrition in young children but is also one of the actors involved in the high prevalence of excess weight in countries that are supposed to adopt a traditional Mediterranean diet [23].

Overweight and obesity, generally considered as risk factors for noncommunicable diseases (NCDs), also represent a public health problem in Mediterranean countries. This is the case in Morocco where excess weight affects both children and adults nationwide [24]. Thus, according to data from the latest 2018 National Survey on Population and Family Health, 10.8% of children under 5 years of age are overweight, of whom 2.9% are obese. In comparison with these data, a proportion of 10.4% was recorded in 2003-2004 against 10.7% in 2011 of overweight children [25]. On the other hand, the World Health Organization (WHO) reported that one in ten Moroccan children and adolescents, or 10.3% of boys and 9.9% of girls aged 5 to 19 years, are obese [24].

According to WHO, adolescence is a period of rapid growth, beginning with puberty and ending in adulthood [26]. This critical transition phase in life is marked by a constellation of developmental and behavioral changes, including a decline in healthy eating habits [27]. Given the psychological and behavioral complexity and particularities that accompany this stage of life, an individualized approach is required in many areas, mainly nutrition and nutritional needs [28]. The search for autonomy among young people, the nutritional transition and the lack of nutritional education are factors that disrupt eating habits with effects on health [29]. In Morocco, few studies have been conducted on the adherence of school adolescents to the Mediterranean diet. This lack of data is among the motivations for undertaking this work.

This study aims to assess the level of MD adherence using the KIDMED test in a sample of Moroccan adolescents attending school and to determine the association between sociodemographic, socioeconomic and lifestyle factors and adherence to the Mediterranean diet among school-age adolescents in Morocco.

MATERIAL AND METHODS

Study population

After the exclusion of 23 respondents, 386 adolescents enrolled in a public secondary school in the city of Azemmour, in the province of El-Jadida in the Casablanca-Settat region (Morocco), were recruited to participate in this cross-sectional study during the 2022/2023 and 2023/2024 school years.

The study included the schoolers aged 14-18 years enrolled in a public secondary school in the city of Azemmour who agreed to participate, those suffering from physical disabilities or who were absent on the days of the data collection were excluded from the study.

Among the total of 23 respondents excluded from the study, 12 did not complete their questionnaires, 6 participants were absent during the anthropometric measurement sessions and 5 adolescents voluntarily withdrew.

Data collection

A questionnaire was used to collect the various information. It is inspired by published sources, was translated into Arabic and adapted to the particularities of the Moroccan population.

Socioeconomic and sociodemographic characteristics

The sociodemographic variables collected in this study are gender, age, parents' level of education (illiterate, primary, secondary or university), place of residence (urban or rural), household size, family structure (nuclear or composite) and marital status of parents (married, divorced, father or mother deceased). The information concerning socioeconomic characteristics included the socio-professional class (SPC) of parents classified into four categories according to the definition of Urban-Seghebarth and collaborators [30]. The first category SPC1 corresponds to large traders and liberal professions; SPC2 to civil servants and executives; SPC3 to craftsmen, employees, workers, farmers, drivers and shop assistants; and finally, the SPC4 category was that of people without any paid profession.

The other information collected is the household income which is classified into three categories: 1 – low (<300 €), 2 – medium (≥ 300 and <500 €) and 3 – high (≥ 500 €). Finally, the type of housing is categorized into owner or tenant.

Assessment of adherence to the Mediterranean diet

The KIDMED index developed by Serra-Majem et al., in 2004 has been extensively used to assess adherence to the Mediterranean diet and general dietary habits including skipping breakfast and fast-food consumption in different areas of the world.

This tool has proven good validity and reliability for evaluating adherence to MD among young populations in the Mediterranean region [31, 32]. It has demonstrated suitable psychometric properties for assessing adherence to the MD in schoolchildren [33].

The index consists of sixteen questions answered yes or no with a total score ranging from -4 to +12 [34]. The questions with negative connotations are: skipping breakfast, eating in a fast-food restaurant more than once a week, eating industrial pastries for breakfast and, eating sweets or candies several times a day received a score of -1, while the others received a score of +1. The total score was classified into three categories indicating an optimal adherence when

the score is ≥ 8 , a need for improvements to achieve optimal adherence if the score is between 4 and 7, and finally indicating very poor dietary quality if the score is ≤ 3 [34]. In addition to the KIDMED index, the participants were also requested to answer questions on the number of meals consumed daily.

Anthropometric measurements

Anthropometric variables were measured on each adolescent according to the World Health Organization standards [35]. Weight was recorded on each participant with light clothing and without shoes, using a TANITA BC-313 digital scale (150 ± 0.05 kg).

Height was assessed to the nearest 0.1 cm, using a height rod. The respondent stood without shoes, legs straight, arms hanging and relaxed and heels together, with head and buttocks in contact with the wall. Adolescents' waist circumference (WC) was measured in a standing position with the feet 2.5 cm apart, using a tape measure placed without compression midway between the lower costal margin and the anterior superior iliac crest on the mid-axillary line, at the end of a normal expiration and without exerting pressure on the skin.

Waist-to-height ratio (WHtR) was calculated and a value of 0.5 was used to define the presence or absence of abdominal obesity in boys and girls [36].

Body mass index (BMI), or Quetelet index, was used as an indicator of general obesity and calculated by dividing weight in kg by the square of height in meters (kg/m^2). The reference standards established by WHO in 2007 are used to calculate z-score values for BMI/age using the WHO software, AnthroPlus (version 1.0.4, 2010) used to assess growth in children and adolescents worldwide [37]. Four categories are defined to classify the adolescents according to these values. They are underweight when z-score $\leq -2\text{SD}$, normal weight if $-2\text{SD} < \text{z-scores} < +1\text{SD}$, overweight if z-score $\geq +1\text{SD}$ and obese when z-score $\geq +2\text{SD}$.

Physical activities and sedentary behavior

Physical activity (PA) was assessed using the validated French short version of the modified International Physical Activity Questionnaire (IPAQ) for adolescents [38], according to which the respondent indicated the level of (PA) performed during the 7 days preceding the administration of the questionnaire. The frequency (number of days per week) and duration (minutes/day) of practice of three types of physical activity: vigorous, moderate and walking were recorded for each participant.

A mean "Metabolic Equivalent of Task" (MET) score, expressed as metabolic equivalent of task relative to rest, was derived for each type of activity: 3.3 for walking, 4.0 for moderate activity and 8.0 for vigorous activity [38]. The MET-minute score was

then calculated by multiplying the MET score by the minutes performed, giving the energy expenditure (in metabolic equivalent of task: MET-minutes per week) for each type of activity.

Sedentary behavior and specifically screen time was assessed by asking the respondents to estimate the average time in hours per day that they spent in front of a screen (watching TV, playing computer games and using a mobile phone), a screen time of 2 hours per day was considered sufficient [39].

Mean sleep duration in hours per night was calculated as the difference between the reported bedtime in the evening and the wake-up time in the morning, with sleep duration classified as inadequate if less than 8 hours per night and adequate if greater than or equal to 8 hours per night [40].

Statistical analysis

Data analysis was performed using *zmieni* na: IBM SPSS Statistics for Windows version 26.0 (IBM Corp., Armonk, NY, United States). Quantitative variables are presented as means \pm standard deviations (SD) or as means \pm standard error (SE), while qualitative variables are presented as frequencies and percentages. Adherence to the Mediterranean diet is classified into three categories based on established reference standards. Analysis of variance (ANOVA) was used to compare multiple means, Student's *t*-test was used for independent samples and the *Chi*² test was used to compare categorical variables. In addition, multinomial logistic regression analysis was performed to identify factors associated with adherence to the Mediterranean diet among Moroccan school-going adolescents. Differences were considered statistically significant for *p*-values less than 0.05.

Ethical considerations

The survey was conducted after obtaining authorizations (N° 0483/2022 and N° 2015/2023) from the provincial education directorate of the Casablanca-Settat region, Morocco. Subjects were informed of the objectives and methodology of the research, as well as the possibility of withdrawing from the study at any time if they wished. All participants and their parents gave their consent before the start of the survey.

RESULTS

Sociodemographic and socioeconomic characteristics of the study population

Table 1 shows the data on the sociodemographic and socioeconomic characteristics of the study population. A total of 386 school-going adolescents were recruited in this cross-sectional study, of which 61.6% were female. The mean age of the respondents was 15.5 \pm 0.9 years, with the majority of the adolescents (59%) falling

into the 14-15 age group. The data also show that the majority (76.68%) of the adolescents resided in urban areas, while 23.32% resided in rural areas, and most of the subjects (88.86%) belonged to nuclear families. Regarding the education level of the respondents' parents, a proportion of 44.56% of the fathers had a low education level and 24.61% a higher education level. On the other hand, more than half of the mothers (56.74%) were with low level of education and only

Table 1. Sociodemographic and socioeconomic characteristics of the study population

Characteristics		N (%) or M \pm SD
Sociodemographic characteristics		
Mean age		15.5 \pm 0.9
Age categories (years)	14-15	228 (59.07%)
	16	99 (25.65%)
	17-18	59 (15.28%)
Sex	Boys	148 (38.34%)
	Girls	238 (61.6%)
Area of residence	Urban	296 (76.68%)
	Rural	90 (23.32%)
Father education level	None	67 (17.36%)
	Primary	105 (27.20%)
	Secondary	119 (30.83%)
	University	95 (24.61%)
Mothers education level	None	140 (36.27%)
	Primary	79 (20.47%)
	Secondary	110 (28.50%)
	University	57 (14.77%)
Parents civil status	Married	349 (90.41%)
	Divorced	16 (4.15%)
	Widow or widower	21 (5.44%)
Type of family	Nuclear	343 (88.86%)
	Composite	43 (11.14%)
Socioeconomic characteristics		
Fathers SPC	SPC 2	127 (32.90%)
	SPC 3	245 (63.47%)
	SPC 4	14 (3.63%)
Mothers SPC	SPC 2	26 (6.74%)
	SPC 3	46 (11.92%)
	SPC 4	314 (81.35%)
Monthly household income	Low <300 €	152 (39.38%)
	Middle \geq 300 and <500 €	112 (29.02%)
	High \geq 500 €	122 (31.61%)
Type of habitat	Owner	319 (82.64%)
	Tenant	67 (17.36%)

N (%) – number (percentage); M \pm SD – mean \pm standard deviation; SPC – socio-professional class; € – Euro

14.77% had a high education level. The results on the professional situation of the adolescents' parents show that 63.47% belonged to the class of employees, workers, craftsmen, farmers and traders (SPC3) while the majority of the mothers of these adolescents (81.35%) were without paid profession. Also, nearly 39% of the participants came from families with low monthly income. In addition, the marital status of the parents shows that the majority (90.41%) were married.

Anthropometric characteristics of the population studied by sex

Table 2 represents the anthropometric parameters of the study population by sex. The adolescents studied had on average 1.65±0.08 m and weighed approximately 58.35±10.39 kg, their BMI was on average of 21.39±3.51, the majority of them (79%) had a normal weight and their WHtR was on average 0.43±0.05. Abdominal adiposity was present in

(11.92%) of the study population, with a very high prevalence in girls (p<0.001). Thus, overweight including obesity affects 18.4% of the adolescents' sample, 23.5% in girls against 10% in boys.

BMI was significantly higher (p<0.001) in girls compared to boys, while height was significantly higher in boys (p<0.001).

Lifestyle characteristics by gender of the study population

Table 3 illustrates the lifestyle characteristics of school-aged adolescents by gender. The table data show that the studied adolescents devoted significantly more time to vigorous physical activity (1637.96±90.75 MET-min/week) and walking (1610.11±64.28 MET-min/week) compared to moderate physical activity (1019.59±54.28 MET-min/week). The comparison by gender shows that boys spent 591.55 MET-min/week more than girls on vigorous physical activity

Table 2. Anthropometric characteristics of the study population by sex

Variables		Total N (%) or M±SD	Girls N (%) or M±SD	Boys N (%) or M±SD	p-value
Weight (kg)		58.35±10.39	57.72±10.36	59.37±10.41	0.129
Height (m)		1.65±0.08	1.61±0.06	1.71±0.07	<0.001
BMI (kg/m ²)		21.39±3.51	22.21±3.48	20.08±3.15	<0.001
WC (cm)		71.97±8.11	72.12±8.86	71.74±6.75	0.640
WHtR		0.43±0.05	0.44±0.05	0.41±0.03	<0.001
BMI z-score categories	Underweight	9 (2.33%)	3 (1.30%)	6 (4.10%)	0.004
	Normal weight	306 (79.27%)	179 (75.20%)	127 (85.80%)	
	Overweight	55 (14.25%)	44 (18.5%)	11 (7.40%)	
	Obesity	16 (4.15%)	12 (5.00%)	4 (2.70%)	
WHtR categories	Without AO	340 (88.08%)	197 (8.80%)	143 (96.60%)	<0.001
	With AO	46 (11.92%)	41 (17.20%)	5 (3.40%)	

N (%) – number (percentage); M±SD – mean ± standard deviation; WC – waist circumference; WHtR – waist-to-height ratio; AO – abdominal obesity; *Chi*² test, t-test for independent samples: p<0.05

Table 3. Lifestyle characteristics in the study population by sex

Variables		Total N (%) or M±SE	Girls N (%) or M±SE	Boys N (%) or M±SE	p-value
Physical activity	Intense PA	1637.96±90.75	1411.15±88.78	2002.7±185.37	<0.001
	Moderate PA	1019.59±54.28	894.3±61.41	1221.08±99.5	0.001
	Walking	1610.11±64.28	1453.3±63.37	1862.27±131.81	0.023
Sleep duration /night	<8 h	195 (50.5%)	117 (49.2%)	78 (52.7%)	0.458
	≥8 h	191 (49.5%)	121 (50.8%)	70 (47.3%)	
Time spent in front of screens/day	≤2 h	74 (19.2%)	54 (22.7%)	20 (13.5%)	0.026
	>2 h	312 (80.8%)	184 (77.3%)	128 (86.5%)	
Number of meals/day	1-2	27 (6.99%)	20 (8.40%)	7 (4.70%)	0.004
	3	193 (50.00%)	131 (55.00%)	62 (41.90%)	
	4 or more	166 (43.01%)	87 (36.60%)	79 (53.40%)	

N (%) – number (percentage); M±SE – mean ± standard error; PA – physical activity; h – hours; *Chi*² test, ANOVA one-way: p<0.05

($p < 0.001$), 302.43 MET-min/week more on walking ($p = 0.023$) and 326.78 MET-min/week more on moderate physical activity ($p < 0.001$). Regarding the duration of nighttime sleep, the majority of adolescents do not meet WHO recommendations on sleep, with no significant difference between the two sexes. In addition, 80.8% of the teenagers studied spent more than 2 hours a day in front of a screen, with a significantly higher proportion of boys than girls exceeding WHO sleep recommendations ($p = 0.026$).

Regarding the number of meals per day, a significantly higher proportion of boys (53.40%) consumed 4 or more meals per day compared to girls ($p = 0.004$) while girls are more likely to eat 3 meals per day (55.00%).

Data on the adherence of the study population to the Mediterranean diet

The results regarding the proportion of positive responses of the adolescents in the study to the KIDMED test according to gender are presented in Table 4. These data show that fruits and fruit juices were consumed daily by less than half of the participants (47%) with only 11% of them taking a second portion

each day. In addition, a large proportion (94%) of these students ate vegetables every day with 37% consuming them more than once a day. An almost daily consumption of pasta or rice was also observed in 59% of the respondents. Regarding protein-based foods, more than a quarter of this group (27%) regularly ate fish and three out of four adolescents (74%) consumed legumes more than once a week. Furthermore, as expected in a Mediterranean country, over 84% of people consumed olive oil regularly and nearly 59% regularly consumed dried fruits. On the other hand, regular breakfast consumption was reported by more than half of the students (54%), of whom 85% consumed cereals, 54% milk or dairy products and 32% commercially available bakery or pastries for breakfast. Furthermore, a few adolescents said they ate two yogurts and/or 40 g of cheese per day. The data show that, on the other hand, 66% of the sample frequented fast food restaurants more than once a week and around one out of two ate sweets and/or candies several times a day. Data analyses also show significant differences between the individual components of the KIDMED score and gender. Furthermore, the mean KIDMED score was significantly different between

Table 4. Percentages of positive responses of adolescents to KIDMED test according to gender

Questions	Total N (%)	Girls N (%)	Boys N (%)	p-value
Eat a fruit or fruit juice every day	183 (47.41%)	114 (29.3%)	69 (17.87%)	0.807
Eat a second fruit every day	45 (11.66%)	19 (4.92%)	26 (6.73%)	0.004
Eat raw vegetables (salad) or cooked once a day	363 (94.04%)	224 (58.03%)	139 (36.01%)	0.936
Eat raw or cooked vegetables more than once a day	146 (37.82%)	82 (21.24%)	64 (16.58%)	0.083
Eat fish regularly (at least 2 to 3 times a week)	105 (27.20%)	63 (16.32%)	42 (10.88%)	0.682
Eat at least once a week in a fast-food restaurant	256 (66.32%)	155 (40.15%)	101 (26.16%)	0.529
Eat dried vegetables (legumes) more than once a week	288 (74.61%)	174 (45.07%)	114 (29.53%)	0.39
Eat pasta or rice at least 5 times a week	152 (39.38%)	95 (24.61%)	57 (14.76%)	0.784
Eat cereals and their derivatives (bread, ...) for breakfast	331 (85.75%)	191 (49.48%)	140 (36.26%)	<0.001
Eat dried fruits regularly (dates, almonds, walnuts, peanuts)	229 (59.33%)	139 (36.01%)	90 (23.31%)	0.64
Eat olive oil in your home regularly	328 (84.97%)	196 (50.77%)	132 (34.19%)	0.068
Skip breakfast	175 (45.34%)	120 (31.08%)	55 (14.24%)	0.011
Eat milk and its derivatives (butter, cheese, yogurt ...) for breakfast	210 (54.40%)	128 (33.16%)	82 (21.24%)	0.755
Eat industrial pastries for breakfast (croissant, biscuit, ...)	127 (32.90%)	87 (22.53%)	40 (10.36%)	0.053
Eat 2 yogurts or 40g of cheese (4 pieces) every day	37 (9.59%)	23 (5.95%)	14 (3.62%)	0.947
Eat sweets, chocolates, candies, several times a day	211 (54.66%)	134 (34.71%)	77 (19.94%)	0.412
KIDMED Index				
Low adherence	207 (53.63%)	141 (59.20%)	66 (44.60%)	0.019
Moderate adherence	149 (38.60%)	81 (34.00%)	68 (45.90%)	
Optimal adherence	30 (7.77%)	16 (6.70%)	14 (9.50%)	
KIDMED Mean Score	4.27±2.2	4±2.27	4.7±2.01	0.002

N (%) – number (percentage); M±SD – mean ± standard deviation; t-test, Chi^2 test: $p < 0.05$

genders, namely 4.7 ± 2.01 in boys versus 4 ± 2.27 in girls ($p=0.002$). In addition, the proportion of boys who ate a second portion of fruit per day was significantly higher than that of girls ($p=0.004$). On the contrary, more girls consumed significantly cereals and their derivatives at breakfast than boys (49% versus 36.26% respectively; $p<0.001$) but also, they skipped breakfast more than boys ($p=0.011$). The results of the present study revealed a low percentage of adolescents who

have optimal adherence (7.77%) while nearly (38.60%) of these adolescents had moderate adherence and 53.63% had low adherence. In fact, the group of adolescents with low adherence included a higher percentage of girls (59.20%), while the groups with moderate and high adherence included more boys (45.90% and 9.50%, respectively) than girls (34% and 6.70%, respectively) ($p=0.019$).

Table 5. Factors associated with adherence to the MD in the adolescents studied

Characteristics		Total N (%)	Low adherence N (%)	Moderate adherence N (%)	Optimal adherence N (%)	p-value
Age categories (years)	14-15	228 (59.07%)	106 (51.2%)	100 (67.1%)	22 (73.3%)	0.002
	16	99 (25.65%)	57 (27.5%)	35 (23.5%)	7 (23.3%)	
	17-18	59 (15.28%)	44 (21.3%)	14 (9.4%)	1 (3.3%)	
Sex	Boys	238 (61.66%)	141 (68.1%)	81 (54.4%)	16 (53.3%)	0.019
	Girls	148 (38.34%)	66 (31.9%)	68 (45.6%)	14 (46.7%)	
Area of residence	Urban	90 (23.32%)	50 (24.2%)	36 (24.2%)	4 (13.3%)	0.40
	Rural	296 (76.68%)	157 (75.8%)	113 (75.8%)	26 (86.7%)	
Father education level	None	67 (17.36%)	40 (19.3%)	25 (16.8%)	2 (6.7%)	<0.001
	Primary	105 (27.2%)	72 (34.8%)	28 (18.8%)	5 (16.7%)	
	Secondary	119 (30.83%)	62 (30%)	50 (33.6%)	7 (23.3%)	
	University	95 (24.61%)	33 (15.9%)	46 (30.9%)	16 (53.3%)	
Mother education level	None	140 (36.27%)	83 (40.1%)	51 (34.2%)	6 (20%)	0.01
	Primary	79 (20.47%)	46 (22.2%)	29 (19.5%)	4 (13.3%)	
	Secondary	110 (28.5%)	52 (25.1%)	49 (32.9%)	9 (30%)	
	University	57 (14.77%)	26 (12.6%)	20 (13.4%)	11 (36.7%)	
Parents civil status	Married	16 (4.15%)	11 (5.3%)	4 (2.7%)	1 (3.3%)	0.07
	Divorced	349 (90.41%)	179 (86.5%)	142 (95.3%)	28 (93.3%)	
	Widow or widower	21 (5.44%)	17 (8.2%)	3 (2%)	1 (3.3%)	
Type of family	Nuclear	43 (11.14%)	26 (12.6%)	15 (10.1%)	2 (6.7%)	0.548
	Composite	343 (88.86%)	181 (87.4%)	134 (89.9%)	28 (93.3%)	
Fathers SPC	SPC 2	117 (30.31%)	52 (25.1%)	50 (40.3%)	15 (50%)	0.002
	SPC 3	245 (63.47%)	143 (69.1%)	87 (58.4%)	15 (50%)	
	SPC 4	14 (3.63%)	12 (5.8%)	2 (1.3%)	0 (0%)	
Mothers SPC	SPC 2	26 (6.74%)	12 (5.8%)	9 (6%)	5 (16.7%)	0.009
	SPC 3	46 (11.92%)	34 (16.4%)	11 (7.4%)	1 (3.3%)	
	SPC 4	314 (81.35%)	161 (77.8%)	129 (86.6%)	24 (80%)	
Monthly household income	Low <300 €	152 (39.38%)	101 (48.8%)	44 (29.5%)	7 (23.3%)	<0.001
	Middle ≥ 300 and <500 €	112 (29.02%)	61 (29.5%)	44 (29.5%)	7 (23.3%)	
	High ≥ 500 €	122 (31.61%)	45 (21.7%)	61 (40.9%)	16 (53.3%)	
Type of habitat	Owner	67 (17.36%)	42 (20.3%)	16 (10.7%)	9 (30%)	0.01
	Tenant	319 (82.64%)	165 (79.7%)	133 (89.3%)	21 (70%)	
Household size categories	<5	247 (63.99%)	124 (59.9%)	100 (67.1%)	23 (76.7%)	0.166
	5-7	126 (32.64%)	77 (37.2%)	42 (28.2%)	7 (23.3%)	
	≥ 8	13 (3.37%)	6 (2.9%)	7 (4.7%)	0 (0%)	

N (%) – number (percentage); SPC – socio-professional class; € – Euro; Chi^2 test: $p<0.05$

Table 5 presents the results of the bivariate analysis of factors associated with adherence to the Mediterranean diet in the adolescents studied. Indeed, according to the data of the present study, nearly 51% and 62% of adolescents whose fathers and mothers had a low level of education, respectively, did not adhere to the Mediterranean diet ($p < 0.001$ and $p = 0.01$, respectively). On the other hand, optimal adherence to the Mediterranean diet seems to be associated with younger age, such that 73% of adolescents in the 14-15 age group have better adherence compared to their 17-18-year-old counterparts (3%) ($p = 0.002$). Furthermore, a significantly higher proportion of adolescents whose father and mother belonged to SPC2 had optimal adherence, suggesting that a better socioeconomic situation seems to be associated with good adherence to the Mediterranean diet ($p = 0.002$ and $p = 0.009$, respectively). In addition, good adherence was marked in 53% of children from households with a high monthly income ($p < 0.001$). Contrary to what was expected, 79% of participants whose parents' housing status was home ownership had low adherence. The results obtained here do not show any influence of other parameters studied such as the area of residence, the marital status of the parents, the type of family and the size of the household on adherence to the Mediterranean diet.

The results regarding the association between adherence to the Mediterranean diet and lifestyle characteristics are illustrated in Table 6. According to the results of the table, no association was found between adherence to the Mediterranean diet and the different components of physical or sedentary activity, namely, intense physical activity ($p = 0.281$), moderate physical activity ($p = 0.123$) or walking ($p = 0.689$), nor with screen time ($p = 0.449$). On the other hand, better

adherence to the Mediterranean diet is positively correlated with optimal sleep duration ($p = 0.004$) and the number of meals per day ($p < 0.001$). Indeed, 70% of adolescents who ate four or more meals per day, and those with an efficient sleep duration had a good adherence to the Mediterranean diet compared to their counterparts.

Table 7 presents the results of the logistic regression analysis of factors associated with adherence to the Mediterranean diet. Indeed, to eliminate confounding factors, following the bivariate analysis, and to explore the relationship between adherence to the MD, with moderate adherence as reference modality, and all significant determinants, a multinomial regression analysis was conducted. As shown in Table 7, this analysis showed that the risk of having poor adherence is associated with female gender compared to male gender (OR=1.68; 95% CI: 1.02-2.76). In addition, adolescents whose mothers do not have a profession (OR=0.45; 95% CI: 0.20-0.98) are less likely to have low adherence compared to their counterparts, suggesting that housewives put a lot of time and care into meal preparation. Moreover, a father's secondary or university education is associated with a significantly reduced chance of poor adherence to the MD compared to primary education ($p = 0.017$, OR=0.45; 95% CI: 0.23-0.87 and $p = 0.004$, OR=0.28; 95% CI: 0.12-0.66) respectively. Furthermore, participants in the 17-18 age group were more likely to have low KIDMED scores (OR=2.9; 95% CI: 1.38-6.12). On the other hand, inadequate sleep duration was correlated with a higher likelihood of having low adherence to the diet (OR=1.72; 95% CI: 1.06-2.78). Furthermore, adolescents who ate 1-2 meals per day were 5.25 times more likely to have low adherence (OR=5.25; 95% CI: 1.62-17.04), compared to their peers. In contrast, good

Table 6. Adherence to the Mediterranean diet in the study population according to lifestyle characteristics

Characteristics		Total N (%) or M±SE	Low adherence N (%) or M±SE	Moderate adherence N (%) or M±SE	Optimal adherence N (%) or M±SE	p-value
Physical activity	Intense PA	1637.96±90.75	1632.92±119.97	1702.55±152.08	1352±334.39	0.281
	Moderate PA	1019.59±54.28	934.6±76.93	966.84±68.42	1868±259.84	0.123
	Walking	1610.11±64.58	1728.81±91.58	1441.47±98.95	1628.55±211.69	0.689
Sleep duration/ night	<8 h	195 (50.5%)	119 (57.5%)	67 (45%)	9 (30%)	0.004
	≥8 h	191 (49.5%)	88 (42.5%)	82 (55%)	21 (70%)	
Time spent in front of screen/day	≤2 h	74 (19.2%)	36 (17.4%)	30 (20.1%)	8 (26.7%)	0.449
	>2 h	312 (80.8%)	171 (82.6%)	119 (79.9%)	22 (73,3%)	
Number of meals/ day	1-2	27 (6.99%)	23 (11.1%)	4 (2.7%)	0 (0%)	<0.001
	3	193 (50%)	111 (53.6%)	73 (49%)	9 (30%)	
	4 or more	166 (43.01%)	73 (35.3%)	72 (48.3%)	21 (70%)	

N (%) – number (percentage); M±SE – mean ± standard error; PA – physical activity; h – hours; Chi^2 test, ANOVA one-way: $p < 0.05$

Table 7. Results of the multinomial logistic regression analysis of factors associated with adherence to the Mediterranean diet

Characteristics		Poor adherence		Optimal adherence	
		OR (IC 95%)	p-value	OR (IC 95%)	p-value
Sex	Girls	1.68 (1.02-2.76)	0.042	1.4549 (0.58116-3.642)	0.423
	Boys	Reference			
Father education level	None	0.63 (0.30-1.31)	0.213	0.46 (0.076-2.79)	0.397
	Primary	Reference			
	Secondary	0.45 (0.23-0.87)	0.017	0.78 (0.20-3)	0.714
	University	0.28 (0.12-0.66)	0.004	1.51 (0.32-7.05)	0.602
Mother education level	None	0.67 (0.34-1.32)	0.251	1.14 (0.26-4.98)	0.858
	Primary	Reference			
	Secondary	0.69 (0.34-1.42)	0.32	1.30 (0.32-5.3)	0.711
	University	1.43 (0.57-3.600)	0.448	3.14 (0.68-14.43)	0.141
Fathers SPC	SPC 2	0.92 (0.48-1.76)	0.812	0.70 (0.21-2.33)	0.564
	SPC 3	Reference			
	SPC 4	2.12 (0.43-10.55)	0.358	1.14×10^{-5} (1.14×10^{-5} - 1.14×10^{-5})	<0.001
Mothers SPC	SPC 2	0.5971 (0.16-2.23)	0.443	3.62 (0.28-47.50)	0.326
	SPC 3	Reference			
	SPC 4	0.45 (0.20-0.98)	0.045	2.22 (0.23-20.98)	0.486
Age categories (years)	14-15	Reference			
	16	1.48 (0.82-2.66)	0.193	1.34 (0.45-4)	0.595
	17-18	2.9 (1.38-6.12)	0.005	0.44 (0.05-3.79)	0.452
Sleep duration/night	<8 h	1.72 (1.06-2.78)	0.027	0.54 (0.21-1.39)	0.201
Number of meals/day	1-2	5.25 (1.62-17.04)	0.006	6.86×10^{-7} (6.86×10^{-7} - 6.86×10^{-7})	<0.001
	3	Reference			
	4 or more	0.86 (0.52-1.40)	0.451	2.52 (0.97-6.58)	0.058

OR – odds ratio; SPC – socio-professional class

adherence was correlated with a negligible chance to a limited number of meals per day (OR= 6.86×10^{-7} ; 95% CI: 6.86×10^{-7} - 6.86×10^{-7}). Conversely, a higher number of meals per day seems to be a good predictor of optimal adherence (OR=2.52; 95% CI: 0.97-6.58), although this is not significant (p=0.058). Also, a strong adherence to the Mediterranean diet is correlated with an extremely low probability (almost zero) to the professional occupation of the father SPC4 (OR= 1.14×10^{-5} ; 95% CI: 1.14×10^{-5} - 1.14×10^{-5}) which suggests an association of optimal adherence to the MD with a better socio-professional class.

DISCUSSION

The data from the present cross-sectional study revealed the sociodemographic, socioeconomic and lifestyle factors determining adherence to the traditional Mediterranean diet among the youth population in Morocco verifying positively the formulated research hypothesis. Indeed, the results of

this study, which focused on a sample of 386 Moroccan school-age adolescents, attests that adherence to the MD among this population was extremely poor, with a very low percentage of the adolescents having optimal adherence, while 38% of the participants were moderately adherent to this diet. Also, poor adherence is correlated with female gender, low level of education of the father, limited number of meals per day, advanced age and inadequate sleep duration. On the other hand, better adherence appeared to be correlated with high number of meals per day and a better socio-professional class of the father. It has been previously reported that the degree of adherence to the Mediterranean diet differs between Mediterranean countries and even within the same country [41, 42]. The low rate of optimal adherence revealed by the present study corroborates the results of a previous research conducted on a population of Greek adolescents aged 12-18 years [16]. The present data also show that the poor adherence reported here may be related to a reduced frequency of consumption

of the basic food groups characterizing the traditional MD. Indeed, the results show a majority of adolescents who did not take a second portion of fruit or fruit juice each day (89%), did not consume raw or cooked vegetables more than once a day (63%), did not regularly eat fish (73%) and who ate fast food more than once a week (66%). In addition, the consumption of sweets and/or candies several times a day is recorded in more than half of the participants. Furthermore, a small percentage of the participants of this young population ate two yogurts and/or 40 g of cheese per day.

However, our results contrasted with the study of Azekour et al. (2020) [43] and the DIMENU study [44] which reported that 58% and 61% of their respective participants, had moderate adherence to MD. In the present study sample, girls are more likely to have poor adherence compared to boys. Also, the reported results reveal that the proportion of boys who ate a second portion of fruit per day was significantly higher than that of girls and that more girls skipped breakfast than boys. These results are consistent with those found in the literature [16], while Depboylu and Kaner (2023) [19] found no correlation. These results could be explained by various factors, including social and personal aspects. Indeed, boys tend to participate more in sports and physical activity as judged by the observations reported in this study, and this tendency may be associated with healthier food choices. On the other hand, adolescent girls may face more societal pressures regarding body image than boys, such a situation could lead to a greater emphasis on restrictive diets or alternative eating habits, which could distance them from adopting the Mediterranean diet. This study also revealed that older adolescents presented lower adherence, this finding followed previous studies [16, 19], this result may be explained by the absence of parental control, the increased influence peers, the acquisition of autonomy and financial independence in this age group and could be associated with inadequate nutritional intake and poor nutritional status [45].

Another significant finding of the present study was the association between optimal adherence to the Mediterranean diet and the high level of education of the father, and this has also been suggested by other studies [19, 43]. A weak correlation between a level of parental education and a low level of nutritional knowledge and a limited awareness of nutrition-related issues has in fact already been demonstrated before [19], while other data, namely those of the PASOS study [46] (Physical Activity, Sedentarism, lifestyles and Obesity in Spanish youth) reported that optimal adherence to the Mediterranean diet was associated with the level of income and the highest degree of maternal education [47]. Similar results to the latter

have been reported previously [16, 46]. Certainly, mothers with a high level of education can influence their children's food choices through the availability and accessibility of certain foods, as well as by being a role model for them. However, it is also possible that higher educational status is associated with higher income and, therefore, greater availability of healthy foods [48].

An association of inadequate sleep duration with low adherence to the Mediterranean diet was also revealed by the present results in accordance with other studies [16, 19]. Sleep deprivation is known to contribute to eating disorders such as anorexia, bulimia, and binge eating disorder. In addition, insufficient sleep duration is associated with low consumption of minimally processed foods and high consumption of ultra-processed foods [21].

The present study further reports that a limited number of meals per day is associated with poor adherence to MD. These data are in agreement with those of some authors [49], while others found no correlation [15], moreover, skipping meals was associated with poor compliance with MD [47]. Likewise, skipping meals is correlated with unnecessary snacking, especially unhealthy food choices and energy-dense foods rather than the nutrient-dense items that are part of the MD [15].

Previous research has mentioned an association between a high KIDMED score and regular physical activity and reduced screen time [15, 20, 43], in that sense, some studies have found an association between absence of distractions or leisure (such as television) during mealtimes and higher degree of adherence to a MD. The lack of the latter might enhance family supervision and support the development of healthy eating habits, potentially mitigating the negative impact of television food advertising on the dietary behaviors of children and adolescents [48]. Unexpectedly, and contrary to previous studies, our findings did not find any significant variations in this score according to the levels of this variable.

Strengths and limitations

This study reported interesting and original data on the determinants of adolescents' adherence to MD. However, these results should be considered in light of their strengths and limitations.

To the best of our knowledge, this is the first study to analyze the association between adherence to the Mediterranean diet and sociodemographic, socioeconomic, and lifestyle factors among school-going adolescents in Morocco.

A major strength of this study is that physical activity and adherence to the Mediterranean diet were assessed by internationally validated adolescent questionnaires, such as the IPAQ and KIDMED.

Another strength is that data collection was conducted through face-to-face interviews, which could reduce the bias of self-reported data.

On the other hand, among the limitations of this study is that the cross-sectional design does not allow conclusions on causality. In addition, the validity of the KIDMED questionnaire and its adaptation to the particularities of the Moroccan population have not yet been carried out in Morocco. Also, the number of girls and boys included in the study sample is not balanced.

CONCLUSIONS

The data reported in this study indicate that adherence to the Mediterranean diet in the adolescent population surveyed was very low with more than half of adolescents having worse adherence and a low percentage with high adherence to this diet. These results confirm the progressive nutritional transition underway in this population, diverting its diet from a healthy traditional diet to a Westernized diet as previously described.

Further, the present study results reveal that poor adherence to MD was correlated with female gender, low level of education of the father, limited number of meals, advanced age and inadequate sleep duration. On the other hand, better adherence appears to be correlated with a high number of meals per day and a better father socio-professional class.

Given that adolescence is a critical phase for the adoption and maintenance of healthy habits and that adolescents are the adults of tomorrow and to avoid the onset of health problems early in young adults, interventions targeting Moroccan adolescents should be planned. Also research studies accompanying and evaluating these interventions must also be undertaken to establish adequate strategies. Such interventions should use practical advice to orient adolescents towards the benefits of the Mediterranean diet to improve their adherence to this diet. In addition, nutrition education should include families to ensure an improvement in the quality of their food choices. Finally, policy makers should also consider food cost policies, by lowering the prices of healthy foods or providing financial support to low-income households, especially in times of economic and societal disruptions, when inequalities make people in poverty more vulnerable.

Abbreviations

UNESCO – United Nations Educational, Scientific and Cultural Organization; MD – Mediterranean diet; KIDMED – Mediterranean Diet Quality Index for Children and Adolescents; IPAQ – International Physical Activity Questionnaire; WHO – World Health Organization; BMI – body mass index; WHtR

– waist-to-height ratio; PA – physical activity; MET – Metabolic Equivalent of Task

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Conflicts of Interest

The authors declare no conflicts of interest.

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