

Individual and food environment determinants of Mediterranean diet adherence among Lebanese adults: a cross-sectional study

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Abstract

Background: Many studies revealed positive health impacts of the Mediterranean diet (MD) especially on metabolic disorders. Conversely, information about determinants of adherence to the MD are limited. This study aims to examine the individual and environmental determinants of MD adherence among adults in Lebanon.

Methods: A cross-sectional study was carried out during July 2021 among a convenient sample of 326 Lebanese adults. Data from participants were collected via an online survey developed by study researchers, that is composed of 3 well-structured questionnaires: a) background questionnaire; b) Perceived Nutrition Environment Measures Survey in the Mediterranean Context (NEMS-P-MED), and c) 14-item Mediterranean Diet Adherence Screener (14-MEDAS).

Results: Mean MD score in the total sample was 7.59 ± 2.22 , reflecting moderate-to-fair MD adherence. Older age and having a regular routine of physical activity emerged as significant independent determinants of better MD adherence. Equally, availability of whole wheat pasta, rice or flour and fish at home and perceived importance of availability of easy to cook foods at food stores showed significant positive association, while healthy food availability, and in-store characteristics had no association with MD adherence score.

Conclusion: Future public health interventions aiming at promoting MD adherence among young adults in Lebanon shall take account of availability of healthy food at home alongside individual factors such as meal preparation skills and regular physical activity.

Background

The Mediterranean diet (MD) is the traditional dietary pattern commonly embraced by the populations bordering the Mediterranean Sea [1]. The MD is characterized by high consumption of carbohydrates (plant foods, cereals and legumes) with low glycemic index, olive oil, a moderate intake of fish, poultry and red wine, and a low intake of red and processed meats. Adherence to the MD has been associated with numerous health benefits including reduced risk of cognitive decline [2], reduced incidence of obesity [3], and prevention of cardiovascular diseases [4, 5], and diabetes mellitus (DM) [5, 6]. Lebanon, among other Mediterranean countries in the Middle East and North Africa (MENA) region, has been experiencing a gradual shift from the traditional Lebanese Mediterranean dietary pattern to the Western dietary pattern, characterized by increased intake of animal-based foods accompanied by a higher prevalence of diet-related diseases [7–9].

Several studies reported low-to-moderate adherence to the traditional MD among Lebanese adults. Only 13% among a nationally representative sample of 2,610 Lebanese adults had higher adherence level to the MD as per the Lebanese Mediterranean Diet (LMD) score (LMD) [10]. Similar results were reported in

another cross-sectional study [11]. While previous research studied the relationship between individual factors and MD adherence level [12], the role of the food environment in determining the level of MD adherence has not been examined among Lebanese adults. We presume that individuals' adherence to the MD is influenced by both individual and food environment factors. Examining the independent associations between individual and food environment factors and MD adherence level would help identify the most important determinants of MD adherence and design effective public health intervention campaigns towards better lifestyle habits. This study aims to assess the independent associations of several individual, home and in-store food environment factors with MD adherence level among Lebanese adults prior to the COVID-19 pandemic and economic crises that have hit Lebanon since February 2020.

Methods

Sampling

A cross-sectional study was carried out during July 2021 among a convenient sample of 326 subjects of recruited from urban Lebanese governorates. The study was approved by the Institutional Review Board of Notre Dame University-Lebanon and performed in accordance with the Declaration of Helsinki. Potential study subjects were invited to participate via an e-flyer. Inclusion criteria included: being a healthy Lebanese adult aged 18–65 years and responsible for most or all household food and grocery shopping. Exclusion criteria included: being pregnant or/and lactating and having chronic diseases (diabetes, kidney disease, cancer) that require dietary modifications. Those interested and eligible to participate were invited to sign an electronic consent form and complete an online self-administered survey.

Data Collection

Data from participants were collected via an online survey developed by study researchers composed of 3 questionnaires: a) background questionnaire; b) Perceived Nutrition Environment Measures Survey in the Mediterranean Context (NEMS-P-MED), and c) 14-item Mediterranean Diet Adherence Screener (14-MEDAS). All questionnaires were translated from English to Arabic by a professional translator, pre-tested on a pilot sample of 10 participants, selected in the same way as participants in the actual study, and amended for clarity and consistency before use in the actual study.

Background information: Socio-Demographic, Lifestyle and Anthropometric Factors

Data on socio-demographic factors included age, gender, having children, area of residence (within Lebanon), marital status, educational status, specialty in a health-related major, and employment status.

Data on lifestyle factors included eating habits such as frequency of meals/day, frequency of main meals/week, frequency of breakfast intake/week, frequency of eating out/week, smoking status, and

physical activity status. Anthropometrics included self-reported weight (kg) and height (cm) measurements for determination of body mass index (BMI), a main indicator of obesity. BMI (kg/m^2) was calculated by dividing the weight (kg) by the height squared (m^2) and classified according to the Center for Disease Control and Prevention (CDC) where participants with a $\text{BMI} \geq 30 \text{ kg}/\text{m}^2$ were classified as obese and those with a BMI less than $30 \text{ kg}/\text{m}^2$ were considered to be non-obese [13]. Moreover, perceived overall sleep quality and health status were measured.

Food Environment Assessment

Perception of food environment in two different settings, home and stores, was assessed using an adapted version of the NEMS-P-MED questionnaire composed of 5 main sections: (1) Home Food Environment, (2) Perceived Food Environment in Stores, (3) Perceived Food Environment in Restaurants, (4) Your Food Habits and Thoughts About Food, and (5) General/Background Information Questions [14]. To adapt the NEMS-P-MED to the Lebanese context, the questionnaire was translated from Spanish to Arabic by a professional translator and some sections were modified. Specifically, we added 2 questions to Section 1 “How often did you share mealtimes with your household members?” and “How often did your parents/siblings encourage you to have healthy food choices when you were tempted to eat junk foods?”. We also revised responses to 3 questions related to type of food stores, transportation to food stores and in-store characteristics, in Section 2, and added 1 question “Why did you read nutrition labels?” to this section. Two questions were removed from Section 4: one was unrelated to any of our study objectives (on factors affecting eating out at restaurants and ordering take-out) and the other was a question in the 14-MEDAS tool “How often do you eat fruits and vegetables?”. We eliminated Sections 3 and 5 in the original NEMS-P-MED because they probe the consumer’s experience in restaurants (unrelated to any of our study objectives) and participants’ sociodemographic and lifestyle factors (covered in the background questionnaire), respectively.

The final adapted questionnaire (NEMS-P-MED) was, therefore, composed of 3 sections (Home Food Environment, Perceived Food Environment in Stores, and Your Food Habits and Thoughts About Food) that include a total of 13 questions. The questions had different types of responses: dichotomous (yes/no), ordinal with a Likert-type scale ranging between 3 and 5 options (degree of agreement, importance or frequency). The complete adapted NEMS-P-MED questionnaire is available in Additional file 1.

MD Adherence Score

To determine participants’ MD adherence level, we used the 14-MEDAS tool, a 14-item questionnaire developed in the context of the PREDIMED study [15], which has been validated in several Mediterranean (Greece, Cyprus, Italy, Spain, Portugal) and non-Mediterranean (Germany, USA, UK, Korea) populations [16–19]. The 14-MEDAS assesses the consumption frequency of 12 main components of the MD and 2 MD-related food habits [15]. Each of the 14 items is scored 1 (adherence to a MD component) or 0 (non-adherence to a MD component). The MD adherence scores were summed and the resulting score ranged from 0 to 14 with higher scores indicating greater MD adherence. MD adherence was characterized

according to the following criteria: “low adherence”, ≤ 5 ; “moderate to fair adherence”, 6–9; “good or very good adherence” ≥ 10 [20].

Statistical Analyses

Analysis of data was carried out using the Statistical Package for the Social Science (SPSS) software version 22 for Windows. Descriptive statistical analyses were performed to determine means and standard deviations (SD) for continuous variables, and frequencies and percentages for categorical ones. Chi square test/Fisher’s Exact test was used to explore relationships between categorical variables. Group differences on continuous variables were tested using one-way ANOVA when there were more than two groups to be compared. Multiple linear regression analyses were used to assess the individual and environmental determinants (home and food store) of MD adherence after controlling for the effects of confounders. In one regression analysis, the effects of individual characteristics on MD adherence was evaluated in Model 1. These effects were then re-evaluated after the introduction of home and store food environment variables into Model 2 and Model 3, respectively. In another regression analysis, the effects of home food environment variables on MD adherence were evaluated in Model 1. These effects were then re-evaluated after the introduction of individual characteristics in Model 2. In the third regression analysis, the effects of store food environment variables on MD adherence were evaluated in Model 1. These effects were then re-evaluated after the introduction of individual characteristics (Model 2). A p-value < 0.05 was considered to be indicative of statistical significance. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity and homoscedasticity.

Results

Socio-Demographic, Anthropometric and Lifestyle Sample Characteristics

The socio-demographic, anthropometrics and lifestyle characteristics of study participants are presented in additional file 3. Overall, the sample consisted of 326 individuals (~ 79% females) with a mean age of 37.14 ± 11.84 years. Most of the study participants lived in Mount Lebanon (~ 79%), were married (~ 54%), had children (~ 88%), were holders of a university degree (~ 80%) and majored in non-health-related majors (~ 70%). In general, the study participants had normal body weight (~ 58%) and reported 3 or more meals per day (~ 86%), around 6–7 days per week (54%). They take breakfast almost daily (~ 54%), perceive their sleep quality to be good/very good (~ 81%), perceive their health status to be good/excellent (~ 84%) and eat out at a restaurant 0–2 days per week (~ 83%). The majority of the study participants reported to read/understand food labels (~ 56%, 61%, respectively) in order to help them make healthy food choices (58.6%). In the total sample, the mean MD adherence score was 7.59 ± 2.22 . The majority of the study participants (~ 83%) had a good to fair adherence level (MD score ≥ 6) and only about 17% had a low adherence level (MD score ≤ 5).

Adherence to the Mediterranean Diet

Additional file 2 shows the percentage of study participants who met the recommended consumption frequency of the 12 main components of the MD and reported to have two food habits related to the MD. The majority of the study participants (> 50%) met the recommended consumption frequency of nine out of the twelve main components of the MD (seasonings with tomato, onion, garlic and olive oil (81.6%); legumes (74.8%); commercial baked goods (70.6%); vegetables (66%); red/processed meat (55.5%); fruits (54.6%); olive oil (54.3%); sugar-sweetened beverages (51.8%) and butter, margarine or full-fat cream (50.6%). In addition, most of the participants endorsed the two food habits related to the MD; specifically: about 60% reported using olive oil as the main culinary fat and consuming chicken or turkey rather than beef/pork/sausage. Less than half of the participants; however, met the recommended consumption of unsalted nuts (48.2%), fish or seafood (23%) and wine (8.6%).

Description of the Food Environment

Home Food Environment

A description of the home food environment is presented in additional file 4. Most of the study participants reported availability of certain healthy foods at home. These foods included fruits (~ 97%), vegetables (~ 99%), legumes (~ 95%) whole-grain or brown bread (~ 70%), fresh/frozen fish (~ 56%) and diet soft drinks (~ 53%). However, less than half of the individuals included in the study reported availability of other healthy foods at home - specifically, low-fat or non-fat milk (~ 47%), whole wheat pasta, rice or flour/low-fat or non-fat dairy (~ 41%). At least two-thirds of the study participants reported frequent easy access to fruits and vegetables. On the other hand, a high percentage ($\geq 2/3$) of the study participants also reported availability of certain unhealthy foods at home such as refined pasta rice/flour (~ 97%), meat products (92%), sweets and pastries (~ 85%), cold cuts and charcuterie (~ 79%), white bread (~ 77%), chips and snacks (~ 73%), full-fat dairy (~ 74%) and full-fat milk (~ 65%). In addition, half of the participants reported availability of regular soft drinks at home. It is worth mentioning; however, that about 50% of the study participants reported infrequent easy access (sometimes/rarely, never) to sweets and pastries (sweets and pastries on the kitchen counter). As for family-level factors that affect dietary habits, 54% reported having meals with the family all the time and ~ 63% reported having consistently parental and sibling support to make healthy dietary choices.

Food Environment In Stores

A description of the food environment in stores is presented in additional file 5. The majority of the study participants reported going to supermarkets for food shopping (81.6%) while an equal percentage of the remaining participants reported going to minimarkets (35.3%) or small grocery stores (34.4%). Reasons for selecting a certain food shopping place include, in decreasing order: quality (92%), price (~ 88%) and variety (~ 84%) of food available at a food store, proximity of the food store to the participant's house (~ 78%)/other places the participant goes to (~ 76%), and same shopping store as that of friends/family (~ 33%). The majority of the study participants (~ 68%) indicated that the prices of fresh fruits and vegetables at the food store where they buy their food were not expensive as compared to those in other

food stores. Furthermore, at least 70% of the participants agreed that healthy, unhealthy and a variety of food products are easy to buy at the food store where they buy their food (healthy (68–76%): fruits, vegetables, lean meats, low-fat products; unhealthy (71–80%): sweets, snacks and sodas or sugary drinks; a variety of food products: 85.9%). The majority of the study participants reported that they use their own car (~ 87%) to visit food stores. Other methods of transportation include walking (~ 18%), use delivery services (17.2%), or ride with a neighbor (5.5%).

As for food placement and promotions in stores where participants buy most of the food, only about 22% agreed that unhealthy foods were placed at one of the ends of the aisles, whereas 32% agreed that they bought food items placed at eye-level on shelves. While about 51% agreed that food items placed next to cash registers were usually unhealthy, only about 18% agreed that they bought food items placed next to the cash registers. Moreover, about 43% participants reported that they see signs that encourage the customer to buy healthy food compared to only 34% for unhealthy food. Approximately 62% of the study participants were aware of nutrition facts labels' presence on most pre-packed food products. The proportion of participants indicating each of the suggested characteristics of food as important when considering purchase of a particular food was as follows: food taste: ~98%; healthy food: ~94%; price: ~91%; convenience/easy to cook: 88%, and weight control: ~82%. Furthermore, most of the participants reported use of a shopping list to buy their groceries (sometimes: ~43%; always: ~33%).

Determinants of MD Adherence

Individual Determinants

Associations of socio-demographic, anthropometric, and lifestyle characteristics with MD adherence level are presented in Table 1. In the total sample, older age, having children, having a health-related major, and having a regular routine of physical exercise were associated with higher MD adherence level.

Specifically, individuals with good MD adherence levels were older (Good: 40.55 ± 11.88 vs. Low: 34.52 ± 11.33 , $p = 0.016$). In addition, a significantly higher percentage of individuals who reported having children and majored in health-related fields had good MD adherence levels compared to their counterparts (Children: Yes: 24% vs. No: 4.8%, $p = 0.023$; health-related fields: Yes: 29.5% vs. No: 14.8%, $p = 0.020$). Lastly, a significantly higher percentage of the study participants who reported following a regular routine of physical exercise was found to have good/moderate MD adherence levels compared to those who reported not to follow a regular routine of physical exercise (Yes: ~93% vs. No: ~78%, $p = 0.001$).

Table 1

Associations of socio-demographic, anthropometric, and lifestyle characteristics with MD adherence level.

	Total (n = 326)			
	MD Adherence Mean \pm SD or n (%)			
	Good	Moderate to fair	Low	P value*
Age (years)	40.55 \pm 11.88	36.77 \pm 11.77	34.52 \pm 11.33	0.016
Gender				0.778
Male	13 (19.4)	41 (61.2)	13 (19.4)	
Female	51 (19.7)	167 (64.5)	41 (15.8)	
Living area				0.596
Beirut	6 (15.8)	24 (63.2)	8 (21.1)	
Mount Lebanon	49 (18.9)	169 (65.3)	41 (15.8)	
South Lebanon	1 (14.3)	4 (57.1)	2 (28.6)	
North Lebanon	4 (33.3)	6 (50)	2 (16.7)	
Bekaa	4 (40)	5 (50)	1 (10)	
Marital status				0.252
Single	22 (15.9)	93 (67.4)	23 (16.7)	
Married	39 (22)	109 (61.6)	29 (16.4)	
Separated/divorced	2 (28.6)	5 (71.4)	0 (0)	
Widowed	1 (25)	1 (25)	2 (50)	
Children				0.023
Yes	41 (24.6)	102 (61.1)	24 (14.4)	
No	1 (4.8)	13 (61.9)	7 (33.3)	
Education level				0.238

* Significant at P < 0.05

	Total (n = 326)			
Pre-high school or its equivalent	2 (20)	5 (50)	3 (30)	
High school or its equivalent	12 (21.8)	30 (54.5)	13 (23.6)	
University or its equivalent	50 (19.2)	173 (66.3)	38 (14.6)	
Health-related major				0.020
Yes	23 (29.5)	44 (56.4)	11 (14.1)	
No	27 (14.8)	129 (70.5)	27 (14.8)	
Employment status				0.273
Full-time employee	33 (17.5)	129 (68.3)	27 (14.3)	
Part-time employee	10 (25.6)	21 (53.8)	8 (20.5)	
Unemployed, actively seeking employment	6 (17.6)	24 (70.6)	4 (11.8)	
Unemployed, not seeking employment (student, housewife, retired, disabled etc.)	15 (23.4)	34 (53.1)	15 (23.4)	
BMI				0.686
Underweight (< 18.5kg/m ²)	1 (10)	7 (70)	2 (20)	
Normal weight (18.5–24.9 kg/m ²)	33 (17.4)	126 (66.3)	31 (16.3)	
Overweight (25–29.9 kg/m ²)	21 (25.6)	46 (56.1)	15 (18.3)	
Obese	9 (20.5)	29 (65.9)	6 (13.6)	
Meals per day				0.781
One	0 (0)	2 (100)	0 (0)	
Two	10 (22.7)	29 (65.9)	5 (11.4)	
Three	29 (19.9)	88 (60.3)	29 (19.9)	
Four or more	25 (18.7)	89 (66.4)	20 (14.9)	
* Significant at P < 0.05				

	Total (n = 326)			
Frequency of breakfast consumption				0.918
0–2 days per week	16 (19.3)	52 (62.7)	15 (18.1)	
3–5 days per week	12 (17.6)	43 (63.2)	13 (19.1)	
6–7 days per week	36 (20.6)	113 (64.6)	26 (14.9)	
Frequency of main meals				0.967
0–2 days per week	11 (20.4)	35 (64.8)	8 (14.8)	
3–5 days per week	19 (19.8)	59 (61.5)	18 (18.8)	
6–7 days per week	34 (19.3)	114 (64.8)	28 (15.9)	
Frequency of eating out at a restaurant				0.951
0–2 days per week	54 (19.9)	170 (62.7)	47 (17.3)	
3–5 days per week	8 (18.6)	29 (67.4)	6 (14)	
6–7 days per week	2 (16.7)	9 (75)	1(8.3)	
Smoking				0.124
Yes	16 (13.7)	81 (69.2)	20 (17.1)	
No	48 (23)	127 (60.8)	34 (16.3)	
Physical activity				0.001
Yes	30 (25.4)	80 (67.8)	8 (6.8)	
No	34 (16.3)	128 (61.5)	46 (22.1)	
Perceived sleep quality				0.466
Fairly good/very good	55 (20.9)	166 (63.1)	42 (16)	
Fairly bad/very bad	9 (14.3)	42 (66.7)	12 (19)	
* Significant at P < 0.05				

Total (n = 326)			
Perceived health status			0.129
Excellent	14 (30.4)	29 (63)	3 (6.5)
Good/very good	43 (18.8)	145 (63.3)	41 (17.9)
Fair/poor	7 (13.7)	34 (66.7)	10 (19.6)
Read food labels			0.521
Disagree	10 (14.3)	48 (68.6)	12 (17.1)
Neither agree nor disagree	12 (16.7)	46 (63.9)	14 (19.4)
Agree	42 (22.8)	114 (62)	28 (15.2)
Understand food labels			0.627
Disagree	13 (26)	28 (56)	9 (18)
Neither agree nor disagree	12 (15.4)	52 (66.7)	14 (17.9)
Agree	39 (19.7)	128 (64.6)	31 (15.7)
Reason for reading food labels			0.120
Helps make healthy food choices	33 (22)	95 (63.3)	22 (14.7)
Medical doctor/dietitian recommendation	4 (44.4)	4 (44.4)	1 (11.1)
Lose/control weight	11 (23.9)	30 (65.2)	5 (10.9)
Curiosity (compare different food products)	6 (11.8)	31 (60.8)	14 (27.5)
* Significant at P < 0.05			

Home Food Environment Determinants

Associations of home food environment and MD adherence levels are presented in Table 2. A significantly higher percentage of participants who reported to have healthy foods available at home such as whole wheat pasta, rice or flour (Good: 25% vs. Moderate: 63.6% vs. Low: 11.4%, $p = 0.032$), wholegrain or brown bread (Good: 21% vs. Moderate: 68.1% vs. Low: 10.9%, $p = 0.000$), fresh/frozen fish

(Good: 25.7% vs. Moderate: 65% vs. Low: 9.3%, $p = 0.000$), and low-fat or non-fat dairy (Good: ~22.7% vs. Moderate: ~66.7% vs. Low: ~10.6%, $p = 0.047$) were found to have good/moderate-fair MD adherence level. Similarly, a significantly higher percentage of participants who didn't report availability of unhealthy foods at home such as sweets and pastries (Good: 33.3% vs. Moderate: 52.1% vs. Low: ~14.6%, $p = 0.035$), chips and snacks (Good: 28.7%, vs. Moderate: 55.2%, Low: 16.1%, $p = 0.041$) and regular soft drinks (Good: 24.5% vs. Moderate: 64.4% vs. Low: 11%, $p = 0.007$) were found to have good/moderate-fair MD adherence level. Moreover, a significantly higher percentage of participants who reported infrequent access to sweet and pastries was found to have good MD adherence level (sweet and pastries on the kitchen counter: never/rarely: 35.7% vs. always: 24.1% vs often: 10.1% vs. sometimes: 16.9%, $p = 0.006$).

Table 2
Association of home food environment with MD adherence level.

	Total (n = 326)			P value*
	MD Adherence n (%)			
	Good	Moderate to fair	Low	
Availability of healthy foods				
Fruits				0.480
Yes	63 (19.9)	203 (64)	51 (16.1)	
No	1 (11.1)	5 (55.6)	3 (33.3)	
Vegetables				1
Yes	63 (19.6)	205 (63.9)	53 (16.5)	
No	1 (20)	3 (60)	1 (20)	
Diet soft drinks				0.265
Yes	31 (17.8)	118 (67.8)	25 (14.4)	
No	33 (21.7)	90 (59.2)	29 (19.1)	
Whole wheat pasta, rice or flour				0.032
Yes	33 (25)	84 (63.6)	15 (11.4)	
No	31 (16)	124 (63.9)	39 (20.1)	
Wholegrain or brown bread				0.000
Yes	48 (21)	156 (68.1)	25 (10.9)	
No	16 (16.5)	52 (53.6)	29 (29.9)	
Legumes				1
Yes	61 (19.7)	197 (63.8)	51 (16.5)	
No	3 (17.6)	11 (64.7)	3 (17.6)	
Fresh/frozen fish				0.000
Yes	47 (25.7)	119 (65)	17 (9.3)	
No	17 (11.9)	89 (62.2)	37 (25.9)	
Low-fat or non-fat milk				0.262
Yes	30 (19.6)	103 (67.3)	20 (13.1)	

	Total (n = 326)			
	MD Adherence n (%)			
No	34 (19.7)	105 (60.7)	34 (19.7)	
Low-fat or non-fat dairy				0.047
Yes	30 (22.7)	88 (66.7)	14 (10.6)	
No	34 (17.5)	120 (61.9)	40 (20.6)	
Availability of unhealthy foods				
Sweets and pastries				0.035
Yes	48 (17.3)	183 (65.8)	47 (16.9)	
No	16 (33.3)	25 (52.1)	7 (14.6)	
Chips and snacks				0.041
Yes	39 (16.3)	160 (66.9)	40 (16.7)	
No	25 (28.7)	48 (55.2)	14 (16.1)	
Cold cuts and charcuterie				0.204
Yes	46 (17.9)	170 (66.1)	41 (16)	
No	18 (26.1)	38 (55.1)	13 (18.8)	
Regular soft drinks				0.007
Yes	24 (14.7)	103 (63.2)	36 (22.1)	
No	40 (24.5)	105 (64.4)	18 (11)	
Refined pasta, rice, or flour				0.396
Yes	62 (19.7)	199 (63.2)	54 (17.1)	
No	2 (18.2)	9 (81.8)	0 (0)	
White bread				0.679
Yes	50 (19.8)	158 (62.7)	44 (17.5)	
No	14 (18.9)	50 (67.6)	10 (13.5)	
Meat (chicken, beef...)				0.582
Yes	61 (20.3)	190 (63.8)	49 (16.3)	
No	3 (11.5)	18 (69.2)	5 (19.2)	
Full-fat milk				0.791

	Total (n = 326)			
	MD Adherence n (%)			
Yes	40 (18.8)	136 (63.8)	37 (17.4)	
No	24 (21.2)	72 (63.7)	17 (15)	
Full-fat dairy				0.217
Yes	47 (19.5)	149 (61.8)	45 (18.7)	
No	17 (20)	59 (69.4)	9 (10.6)	
Accessibility of foods				0.242
Fruits and vegetables in fridge				
Always	48 (21.6)	138 (62.2)	36 (16.2)	
Often	12 (16.2)	49 (66.2)	13 (17.6)	
Sometimes	1 (4.3)	17 (73.9)	5 (21.7)	
Never or rarely	3 (42.9)	4 (57.1)	0 (0)	
Fruits and vegetables on kitchen counter				0.244
Always	37 (25.3)	90 (61.6)	19 (13)	
Often	8 (11.3)	49 (69)	14 (19.7)	
Sometimes	12 (17.6)	42 (61.8)	14 (20.6)	
Never or rarely	7 (17.1)	27 (65.9)	7 (17.1)	
Sweets, pastries on kitchen counter				0.006
Always	21 (24.1)	56 (64.4)	10 (11.5)	
Often	8 (10.1)	51 (64.6)	20 (25.3)	
Sometimes	20 (16.9)	81 (68.6)	17 (14.4)	
Never or rarely	15 (35.7)	20 (47.6)	7 (16.7)	
Sharing meals with family				0.819
Always	31 (17.6)	113 (64.2)	32 (18.2)	
Sometimes	31 (21.8)	90 (63.4)	21 (14.8)	
Never or rarely	2 (25)	5 (62.5)	1 (12.5)	
Family support to make healthy food choices				0.374
Always	42 (20.6)	134 (65.7)	28 (13.7)	

	Total (n = 326)		
	MD Adherence n (%)		
Sometimes	17 (17.7)	60 (62.5)	19 (19.8)
Never or rarely	5 (19.2)	14 (53.8)	7 (26.9)

*Significant at $P < 0.05$

Food Store Environment Determinants

Associations of food environment in stores with MD adherence level are presented in Table 3. A significantly higher percentage of participants who select a food store based on perceived proximity, food quality, and convenience were found to have low MD adherence level than those who did not perceive these factors as important (food store proximity: not important 6.9% vs. important 19.3%, $p = 0.002$; food quality: not important 7.7% vs. important 17.3%, $p = 0.045$; convenience: not important 7.7% vs. important 17.8%, $p = 0.039$). In addition, a significantly higher percentage of participants who found it easy to buy canned fruits and vegetables in stores were found to have low MD adherence level compared to those who disagreed (disagreed: 6.1% vs. agreed: 14.8%, $p = 0.003$). Associations between other in-store food environment characteristics and MD adherence level were of borderline statistical significance. Specifically, 7.8% of participants who perceived food variety in selecting place of food shopping as important vs. 18% of those who did not perceive this factor as important had low MD adherence level ($p = 0.057$). Moreover, 38.9% of participants who go to the food store with their neighbor vs. 15.3% of those who do not, have low MD adherence levels ($p = 0.051$).

Table 3
Association of food environment in stores with MD adherence level.

	MD adherence (%)			P value*
	Good	Moderate to fair	Low	
Type of food store mostly shopped from				
Small grocery store				0.100
Yes	29 (25.9)	64 (57.1)	19 (17)	
No	35 (16.4)	144 (67.3)	35 (16.4)	
Minimarket				0.767
Yes	25 (21.7)	72 (62.6)	18 (15.7)	
No	39 (18.5)	136 (64.5)	36 (17.1)	
Supermarket				0.901
Yes	51 (19.2)	171 (64.3)	44 (16.5)	
No	13 (21.7)	37 (61.7)	10 (16.7)	
Importance to select food store				
Close to my house				0.002
Not important	23 (31.9)	44 (61.1)	5 (6.9)	
Important	41 (16.1)	164 (64.6)	49 (19.3)	
Close to other places I go to				0.554
Not important	19 (23.8)	49 (61.2)	12 (15)	
Important	45 (18.3)	159 (64.6)	42 (17.1)	
My friends and family shop there				0.361
Not important	47 (21.4)	140 (63.6)	33 (15)	

* Significant at $p < 0.05$

	MD adherence (%)			
Important	17 (16)	68 (64.2)	18 (19.8)	
Variety of food offered				0.057
Not important	15 (29.4)	32 (62.7)	4 (7.8)	
Important	49 (17.8)	176 (64)	50 (18.2)	
Quality of food offered				0.045
Not important	10 (38.5)	14 (53.8)	2 (7.7)	
Important	54 (18)	194 (64.7)	52 (17.3)	
Price of food offered				0.151
Not important	12 (30)	24 (60)	4 (10)	
Important	52 (18.2)	184 (64.3)	50 (17.5)	
Fruits & vegetables prices compared to that in other food stores				0.644
Not expensive	44 (19.8)	139 (62.6)	39 (17.6)	
Expensive/ Very expensive	9 (14.8)	43 (70.5)	9 (14.8)	
I don't know	11 (25.6)	26 (60.5)	6 (14)	
Easy to buy healthy foods				
Fresh fruits and vegetables				0.611
Disagree	8 (23.5)	22 (64.7)	4 (11.8)	
Neither agree nor disagree	10 (17.9)	33 (58.9)	13 (23.2)	
Agree	46 (19.5)	153 (64.8)	37 (15.7)	
Canned fruits and vegetables				0.003
* Significant at p < 0.05				

	MD adherence (%)			
Disagree	9 (18.4)	37 (75.5)	3 (6.1)	
Neither agree nor disagree	7 (13)	29 (53.7)	18 (33.3)	
Agree	48 (21.5)	142 (63.7)	33 (14.8)	
Low-fat products				0.497
Disagree	6 (33.3)	10 (55.6)	2 (11.1)	
Neither agree nor disagree	11 (18)	37 (60.7)	13 (21.3)	
Agree	47 (19)	161 (65.2)	39 (15.8)	
Lean meat (chicken, turkey...)				0.360
Disagree	6 (14)	27 (62.8)	10 (23.3)	
Neither agree nor disagree	10 (16.1)	39 (62.9)	13 (21)	
Agree	48 (21.7)	142 (64.3)	31 (14)	
Easy to buy a variety of products				0.879
Disagree	5 (26.3)	12 (63.2)	2 (10.5)	
Neither agree nor disagree	4 (14.8)	18 (66.7)	5 (18.5)	
Agree	55 (19.6)	178 (63.6)	47 (16.8)	
Easy to buy unhealthy foods				
Sweets, pastries etc.				0.240
Disagree	10 (35.7)	16 (57.1)	2 (7.1)	
Neither agree nor disagree	8 (18.2)	28 (63.6)	8 (18.2)	

* Significant at $p < 0.05$

	MD adherence (%)			
Agree	46 (18.1)	164 (64.6)	44 (17.3)	
Potato chips and snacks				0.193
Disagree	13 (28.3)	25 (54.3)	8 (17.4)	
Neither agree nor disagree	5 (10.2)	33 (67.3)	11 (22.4)	
Agree	46 (19.9)	150 (64.9)	35 (15.2)	
Soft drinks and SSBs				0.455
Disagree	8 (32)	14 (56)	3 (12)	
Neither agree nor disagree	7 (17.5)	24 (60)	9 (22.5)	
Agree	49 (18.8)	170 (65.1)	42 (16.1)	
Transportation to food store				
Walking				0.107
Yes	15 (25.9)	30 (51.7)	13 (22.4)	
No	49 (18.3)	178 (66.4)	41 (15.3)	
In my own car				0.499
Yes	53 (18.7)	184 (64.8)	47 (16.5)	
No	11 (26.2)	24 (57.1)	7 (16.7)	
Go with neighbor				0.051
Yes	2 (11.1)	9 (50)	7 (38.9)	
No	62 (20.1)	199 (64.6)	47 (15.3)	
Call and ask for delivery				0.774

* Significant at p < 0.05

	MD adherence (%)			
Yes	10 (17.9)	35 (62.5)	11 (19.6)	
No	54 (20)	173 (64.1)	43 (15.9)	
<i>Perception: placement of foods</i>				
Unhealthy foods were placed at one of the ends of the aisles				0.238
Disagree	35 (21.5)	95 (58.3)	33 (20.2)	
Neither agree nor disagree	16 (17.4)	66 (71.7)	10 (10.9)	
Agree	13 (18.3)	47 (66.2)	11 (15.5)	
Food items placed next to cash registers were usually unhealthy				0.869
Disagree	14 (17.9)	50 (64.1)	14 (17.9)	
Neither agree nor disagree	17 (20.5)	50 (60.2)	16 (19.3)	
Agree	33 (20)	108 (65.5)	24 (14.5)	
Often bought food items placed at eye-level on shelves				0.547
Disagree	34 (23)	88 (59.5)	26 (17.6)	
Neither agree nor disagree	14 (19.2)	47 (64.4)	12 (16.4)	
Agree	16 (15.2)	73 (69.5)	16 (15.2)	
Often bought food items placed next to the cash registers				0.228
Disagree	42 (22.1)	121 (63.7)	27 (14.2)	
Neither agree nor disagree	12 (15.4)	47 (60.3)	19 (24.4)	

* Significant at $p < 0.05$

	MD adherence (%)			
Agree	10 (17.2)	40 (69)	8 (13.8)	
Perception: food promotions				
Used to see signs that encouraged me to buy healthy food				0.502
Disagree	24 (21.1)	75 (65.8)	15 (13.2)	
Neither agree nor disagree	14 (19.2)	49 (67.1)	10 (13.7)	
Agree	26 (18.7)	84 (60.4)	29 (20.9)	
Used to see signs that encouraged me to buy unhealthy food				0.976
Disagree	24 (20.5)	74 (63.2)	19 (16.2)	
Neither agree nor disagree	17 (17.3)	64 (65.3)	17 (17.3)	
Agree	23 (20.7)	70 (63.1)	18 (16.2)	
Most pre-packed foods had a nutrition facts label				0.579
Disagree	9 (22.5)	23 (57.5)	8 (20)	
Neither agree nor disagree	13 (15.7)	59 (71.1)	11 (13.3)	
Agree	42 (20.7)	126 (62.1)	35 (17.2)	
When shopping for food, how important is				
Taste				0.281
Not important	3 (37.5)	5 (62.5)	0 (0)	
Important	61 (19.2)	203 (63.8)	54 (17)	
Nutrition (healthy food)				0.629
Not important	5 (25)	11 (55)	4 (20)	
* Significant at p < 0.05				

	MD adherence (%)			
Important	59 (19.3)	197 (64.4)	50 (16.3)	
Price				0.241
Not important	9 (32.1)	15 (53.6)	4 (14.3)	
Important	55 (18.5)	193 (64.8)	50 (16.8)	
Convenience				0.039
Not important	13 (33.3)	23 (59)	3 (7.7)	
Important	51 (17.8)	185 (64.5)	51 (17.8)	
Weight control				0.229
Not important	10 (17.2)	34 (58.6)	14 (24.1)	
Important	54 (20.1)	174 (64.9)	40 (14.9)	
Use shopping list				0.806
Never	8 (28.6)	15 (53.6)	5 (17.9)	
Occasionally	9 (18.4)	34 (69.4)	6 (12.2)	
Sometimes	28 (20)	87 (62.1)	25 (17.9)	
Usually or always	19 (17.4)	72 (66.1)	18 (16.5)	
* Significant at p < 0.05				

Individual Determinants of MD Adherence as Assessed by Multivariable Linear Regression

Independent associations of individual characteristics with MD score in the study population, as assessed by multivariable linear regression is presented in Table 4. After controlling for gender, having children, educational level, having a degree in health-related disciplines, smoking, and physical exercise, a 1-year increase in age was found to be associated with an increase of 0.042 in the MD score. In addition, lack of a regular routine of physical exercise was associated with a decrease of 0.908 points in the MD

score (Model 1). After controlling for the effects of home food environment variables (availability of whole wheat pasta, rice or flour, whole grain or brown bread, fresh/frozen fish, low-fat or non-fat dairy, sweets and pastries and regular soft drinks) in Model 2, and the effects of store food environment variables (e.g., motivation to select place of food shopping (variety, quality and price) and importance of taste, nutrition, price and convenience when shopping for food) in Model 3, age and regular routine of physical exercise remained to be positively associated with the MD score. Specifically, a 1-year increase in age and lack of a regular routine of physical exercise were found to be associated with an increase of 0.028 and a decrease of 0.775 points in the MD score, respectively (Model 2). Similarly, in Model 3, a 1-year increase in age and lack of a regular routine of physical exercise were found to be associated with an increase of 0.042 and a decrease of 0.990 points in the MD score, respectively.

Table 4

Associations of socio-demographic and lifestyle factors with MD adherence as assessed by multivariable linear regression.

	Unstandardized β	SE	Standardized β	95% CI	
Model 1					
Age	0.042*	0.013	0.222	0.016	0.068
Gender	0.328	0.302	0.060	-0.267	0.922
Children	0.000	0.000	0.057	0.000	0.001
Educational level	0.381	0.742	0.084	-1.080	1.841
Health related-major	-0.001	0.001	-0.154	-0.003	0.001
Smoking	-0.448	0.253	-0.097	-0.945	0.049
Physical activity	-0.908*	0.253	-0.197	-1.405	-0.410
Model 2					
Age	0.028*	0.013	0.148	0.002	0.054
Gender	0.460	0.292	0.084	-0.115	1.035
Children	0.000	0.000	0.025	0.000	0.001
Educational level	0.417	0.716	0.092	-0.993	1.827
Health-related major	-0.001	0.001	-0.137	-0.003	0.001
Smoking	-0.263	0.244	-0.057	-0.743	0.216
Physical activity	-0.775*	0.253	-0.168	-1.273	-0.276
Model 3					
Age	0.042*	0.013	0.222	0.016	0.068
Gender	0.419	0.301	0.076	-0.173	1.011
Children	0.000	0.000	0.060	0.000	0.001
Educational level	0.621	0.741	0.137	-0.837	2.080
Health-related major	-0.001	0.001	-0.210	-0.003	0.001
Smoking	-0.381	0.253	-0.082	-0.878	0.117
Physical activity	-0.990*	0.254	-0.214	-1.489	-0.490
* Significant at P < 0.05					

Model 1: adjusted for gender, children, educational level, health related major, smoking and physical activity.

Model 2: adjusted for home food environment variables (e.g., availability of whole wheat pasta, rice or flour, whole grain or brown bread, fresh/frozen fish, low-fat or non-fat dairy, sweets and pastries and regular soft drinks).

Model 3: adjusted for food environment in stores variables (e.g., motivation to select place of food shopping (variety, quality and price) and importance of taste, nutrition, price and convenience when shopping for food).

CI = confidence interval

Home Food Environment and MD Adherence as Assessed by Multivariable Linear Regression

Association of home food environment with MD score in the study population, as assessed by multivariable linear regression is presented in Table 5. Before adjustment for the effects of individual characteristics, there were significant associations between availability of whole wheat pasta, rice or flour; whole grain or brown bread, fish at home and a borderline significant association between availability of regular soft drinks at home and MD score. Specifically, unavailability of whole wheat pasta, rice or flour; wholegrain or brown bread, and fish at home were found to be associated with a decrease of 0.747, 0.541 and 1.137 points in the MD score, respectively (Model 1). However, unavailability of regular soft drinks was found to be associated with an increase of 0.475 points in the MD score. After controlling for the effects of individual characteristics, availability of whole wheat pasta, rice or flour and fish at home remained to be significantly associated with MD score whereas the associations between availability of whole grain or brown bread and regular soft drinks at home and MD score vanished. Specifically, unavailability of whole wheat pasta, rice or flour and fish at home were found to be associated with a decrease of 0.714 and 1.084 points in the MD score, respectively (Model 2).

Table 5

Association of home food environment with MD score as assessed by multivariable linear regression.

	Unstandardized β	SE	Standardized β	95% CI	
Model 1					
Whole wheat pasta, rice or flour	-0.747*	0.247	-0.165	-1.232	-0.261
Wholegrain or brown bread	-0.541*	0.260	-0.112	-1.052	-0.031
Fresh/frozen fish	-1.137*	0.238	-0.254	-1.606	-0.668
Low-fat or non-fat dairy	-0.053	0.248	-0.012	-0.542	0.436
Sweets and pastries	0.444	0.336	0.071	-0.218	1.105
Regular soft drinks	0.475*	0.240	0.107	0.002	0.947
Model 2					
Whole wheat pasta, rice or flour	-0.714*	0.249	-0.158	-1.204	-0.223
Wholegrain or brown bread	-0.450	0.259	-0.093	-0.959	0.059
Fresh/frozen fish	-1.084*	0.237	-0.243	-1.551	-0.617
Low-fat or non-fat dairy	0.177	0.254	0.039	-0.324	0.678
Sweets and pastries	0.437	0.339	0.070	-0.230	1.104
Regular soft drinks	0.312	0.248	0.070	-0.177	0.801
*Significant at $p < 0.05$					

Model 1: Effects of availability of whole wheat pasta, rice or flour, whole grain or brown bread, fresh/frozen fish, low-fat or non-fat dairy, sweets and pastries and regular soft drinks on MD diet score.

Model 2: Effects of availability of the same variables as those in Model 1 after adjustment for the effects of individual characteristics (age, gender, children, educational level, health-related major, smoking and physical activity).

CI = confidence interval

Food Store Environment and MD Adherence as Assessed by Multivariable Linear Regression

Association of food store environment with MD score in the study population, as assessed by multivariable linear regression is presented in Table 6. Before adjustment for the effects of individual characteristics, there was a significant association between perception of availability of easy to cook foods at food stores as important and MD adherence score. Specifically, perception of availability of easy to cook foods as important was found to be associated with a decrease of 0.783 points in the MD score

(Model 1). After controlling for the effects of the individual characteristics, perception of availability of easy to cook foods as important remained to be significantly associated with MD score and was found to be associated with a decrease of 0.765 points in the MD score (Model 2).

Table 6

Association of food store environment with MD score as assessed by multivariable linear regression.

	Unstandardized β	SE	Standardized β	95% CI	
Model 1					
<i>Importance to select food store</i>					
Variety	0.024	0.382	0.004	-0.727	0.774
Quality	-0.762	0.563	-0.093	-1.870	0.346
Price	-0.538	0.487	-0.068	-1.497	0.421
<i>When shopping for food, how important is</i>					
Taste	-0.415	0.862	-0.029	-2.111	1.280
Nutrition	0.208	0.542	0.022	-0.859	1.275
Price	-0.098	0.437	-0.015	-0.957	0.761
Convenience	-0.783*	0.397	-0.115	-1.564	-0.001
Model 2					
<i>Importance to select food store</i>					
Variety	0.017	0.379	0.003	-0.729	0.763
Quality	-0.725	0.546	-0.089	-1.799	0.349
Price	-0.094	0.426	-0.014	-0.932	0.745
<i>When shopping for food, how important is</i>					
Taste	-0.669	0.855	-0.047	-2.351	1.012
Nutrition	-0.177	0.528	-0.019	-1.216	0.863
Price	-0.513	0.478	-0.065	-1.453	0.427
Convenience	-0.765*	0.385	-0.112	-1.524	-0.007
*Significant at $p < 0.05$					

Model 1: Effects of food store environment (e.g., motivation to select place of food shopping (variety, quality and price) and importance of taste, nutrition, price and convenience when shopping for food) on

MD score.

Model 2: Effects of the same variables as those in Model 1 on MD score, after adjustment for the effects of individual characteristics (age, gender, children, educational level, health-related major, smoking and physical activity).

CI = confidence interval

Discussion

The present study aimed to investigate independent individual and food environment determinants of MD adherence among Lebanese adults. Overall, 64% participants had a moderate-to-fair adherence to the MD, and 20% had good adherence level.

Individual Determinants of MD adherence

Older age, having children, having a health-related major, and following a regular routine of physical exercise were identified as characteristics associated with increased adherence to the MD while gender, living area, marital status, educational level, eating habits and BMI were not associated with adherence levels. According to our analyses, old age and regular routine of physical activity were the only determinants which maintained statistically significant association with adherence levels, after controlling for multiple individual and food environment variables. The observed association between age and MD adherence is similar to previous findings from studies conducted in Lebanon and other Mediterranean countries [11, 12, 21, 22]. One explanation could be that older adults tend to maintain traditional dietary habits whereas younger adults are more exposed to new and “fashionable” food products (high-calorie and nutrient-poor ultra-processed foods). In this study, regular physical activity was strongly associated with higher MD adherence levels, a finding similar to those reported among Spanish [23, 24] and Lebanese adults [12].

In view of the inconsistent findings from the literature and the disproportionate gender distribution in the study sample (~ 80% females), the lack of a statistically significant association between gender and adherence to the MD was expected. No statistically significant association was found between educational level and adherence to the MD, contrary to the findings from the literature where higher educational levels were associated with higher MD adherence [12, 21, 25]. However, the majority of the study participants (80%) had university level education which may account for the lack of a statistically significant association between educational level and MD adherence. No statistically significant association was found in this study between BMI and MD adherence: no association between BMI and MD adherence [21, 26], or negative association [27].

Home Environment Determinants of MD adherence

Studies examining the association of home food environment with MD adherence particularly among adults living in Mediterranean countries are very few. Our finding that the availability of healthy foods

(e.g. whole wheat pasta, rice or flour, fresh/frozen fish, low-fat or non-fat dairy) and unavailability of unhealthy foods (e.g. pastries, chips, regular soft drinks) at home were significantly associated with higher MD adherence is consistent with previous findings which revealed positive associations between fruit and vegetables at home and healthy eating/fruit and vegetable intake in adults, proxies for the MD [28, 29]. Moreover, our findings were in line with previous studies that reported negative associations between salty snacks and sweets availability at home and healthy eating/fruit and vegetable intake in adults [30]. The availability of whole wheat pasta, rice or flour and fish at home remained significantly positively associated with MD score after controlling for the effects of individual characteristics. Moreover, an inverse significant association was found between accessibility to unhealthy foods (e.g., sweets and pastries on kitchen counter) and MD adherence level, similar to previous findings on accessibility to and increased consumption of fruits and vegetables at home [28, 30].

In addition, social-environmental influences within the home such as parent's and siblings' support to make healthy food choices and frequent family meals were not found to be significantly associated with MD adherence level. The only existing evidence is found in studies on children and adolescents where significant positive associations were found, probably due to participants' young age, implying that these participants' dietary choices were still highly influenced by familial behaviors and communication patterns [31].

Food Store Environment Determinants of MD adherence

Our study found a significant association between those who perceived no importance of food stores' proximity to their houses and higher MD adherence level, contrary to previous findings that reported insignificant associations of food stores' proximity with fruit/vegetable consumption [32, 33], possibly due to either Lebanese neighborhoods being easier to walk around to food stores without public transportation, or the Lebanese's preference to purchase high-quality, nutritious foods even if outside the neighborhood. In addition, our study found that participants who perceived food quality and variety as important in selecting place of food shopping had lower MD adherence level; these associations, however, became insignificant after controlling for confounders and are consistent with two studies which found no association between perceived store quality and food availability to a healthy eating index [29] after controlling for sociodemographic factors [34]. One study, which showed an inverse association between availability/variety of in-store fruits and vegetables and fruit and vegetable consumption was only partly consistent with our findings [28] whereas two studies, which showed positive associations between perceived availability of healthy foods [35] and quality of fruits and vegetables [28] with daily fruit and vegetable consumption disagreed with our findings.

The only food store environment variable which emerged as an independent determinant of MD adherence was perceived importance of convenient meals during food shopping. Participants who perceive convenient or easy to cook meals when shopping in food stores as important are less likely to follow the MD.

Strengths and Limitations

To the best of our knowledge, this study is the first to examine the relationship between food environment at home and in food stores and adherence to MD among Lebanese adults. In our study, we collected data on many covariates reported to have associations with MD adherence level, exploring the associations between individual and food environment factors and MD adherence, before and after controlling for confounders. The findings of this study ought to be considered considering several limitations. First, the cross-sectional design of the study does not allow the identification of causal associations between home and store food environment and MD adherence. Second, the target sample was a convenient sample making over-sampling of a particular subgroup of the population cannot be ruled out. Third, the use of self-filled frequency questionnaires may have resulted in an overestimation of foods considered healthy and underestimation of foods considered unhealthy. The interpretation of frequencies and importance may have been different among participants, when responding to questions about the food environment. Fourth, individuals were asked to reflect on the conditions prior to February 2020, preceding the COVID-19 pandemic and the economic crisis. This raises possibility of memory bias among participants. Fifth, we did not carry out a study of the validity and reliability of the adapted NEMS-P-MED questionnaire prior to its use. Finally, the 14-MEDAS adherence score represents a valid and easy tool for a rapid screening rather than exact assessment of the adherence to the Mediterranean dietary pattern.

Conclusion

Overall, our study showed moderate-to-fair adherence (64%) to the Mediterranean Diet among Lebanese adults. Younger individuals and those who do not engage in regular physical exercise were less adherent to the MD, highlighting the need for health promotion efforts directed at younger age groups, across genders, with fairly low levels of physical activity to emphasize the advantages of the MD and encourage adherence. We identified the home environment as the most influential environmental setting associated with MD adherence. Participants with increased access to healthy foods at home, specifically fish and whole wheat pasta, rice, or flour, had higher MD adherence levels. As for the food environment in stores, perceived importance of easy to cook foods when shopping for food in stores was found to be the strongest predictor of the MD score. The over-representation of young, highly educated females in our sample and the choice of the instrument to screen for MD adherence may partly explain the lack of expected associations between other socio-demographic, lifestyle and environmental factors with MD adherence. Larger observational studies among the general Lebanese population may be needed to validate our findings and understand the mechanisms underlying the effect of food environment on MD adherence.

Abbreviations

14-MEDAS

14-item Mediterranean Diet Adherence Screener

BMI

Body Mass Index

CDC
Center for Disease Control and Prevention
DM
Diabetes Mellitus
LMD
Lebanese Mediterranean Diet
MD
Mediterranean diet
MENA
Middle East and North Africa
NEMS-P-MED
Perceived Nutrition Environment Measures Survey in the Mediterranean Context
SPSS
Statistical Package for the Social Science.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Notre Dame University-Louaize. Written informed consent was obtained from all participants.

Consent for publication

Not applicable

Availability of data and materials

Data files and materials pertaining to this publication are available in additional files.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Conceptualization, D.J., C.O.; methodology, V.E.K., R.M., D.J., C.O.; software, J.B.M.; validation, D.J.; formal analysis, V.E.K., R.M., J.B.M.; investigation, V.E.K., R.M.; resources, V.E.K., R.M., D.J.; data curation, J.B.M.; writing—original draft preparation, V.E.K., R.M.; writing—review and editing, D.J., J.B.M.; visualization,

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