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ORIGINAL CONTRIBUTION

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Food insecurity is associated with lower adherence to the Mediterranean dietary pattern among Lebanese adolescents: a cross-sectional national study

Farah Naja[1] · Leila Itani[2] · Samer Kharroubi[1] · Marwa Diab El Harake[1] · Nahla Hwalla[1] · Lamis Jomaa[1]

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Abstract

Purpose To derive dietary patterns (DPs) of Lebanese adolescents (10–18 years) and evaluate associations between identified DPs and household food insecurity (HFI).

Methods Data on adolescents ($n = 693$) were drawn from a national survey conducted in 2015 on a representative sample of Lebanese households with children. In addition to a sociodemographic questionnaire, data collection included the validated Arabic-version of the Household Food Insecurity Access Scale, used to evaluate HFI. Dietary intake was assessed using a 187-item validated food frequency questionnaire. Associations between HFI scores and DPs were examined using multiple linear regressions.

Results HFI was observed in 55.2% of the study sample. Two DPs were derived among adolescents: Western and Lebanese-Mediterranean (LM). The Western DP was characterized by higher consumption of sweetened beverages, fast foods, sweets, and refined grains, whereas the LM DP was characterized by higher intakes of fruits, vegetables, dairy products, and whole grains. Scores of the Western DP were negatively associated with fiber, calcium, iron, and vitamins A and D, while the LM DP scores were positively correlated with fiber, proteins, iron, calcium, and vitamins A and D ($p < 0.01$). LM DP scores were also negatively correlated with total fat, saturated and polyunsaturated fats, $p < 0.05$. After adjustment for sociodemographics, multiple linear regression showed that higher HFI scores were associated with lower adherence to LM DP among adolescents ($\beta = -0.026$, 95% CI -0.046, -0.006).

Conclusions HFI was associated with lower adherence to the Mediterranean pattern among Lebanese adolescents. Preventive strategies are needed to promote better diet quality among food-insecure youth.

Keywords Food insecurity · Dietary pattern · Diet quality · Adolescents · Mediterranean · Lebanon

Introduction

Adolescence is the transitional phase between childhood and adulthood during which nutritional needs of individuals are increased due to the rapid growth and changes in body composition associated with puberty [1, 2]. Nutritional intake during adolescence is also critical for the development of lifelong eating behaviors and prevention of diseases [3]. Dietary behaviors that adolescents adopt during this stage can modify their risk of obesity and non-communicable diseases across the life course [4].

Unhealthy eating habits are common in adolescents worldwide and have been reported in both high-income and low- to middle-income countries [5–7]. The most commonly reported unfavorable dietary behaviors among adolescents include (1) high intake of fast foods and other foods high in fat; (2) low intake of fruits, vegetables, and dairy foods; (3) erratic eating behaviors, such as meal skipping [8, 9]. Several individual, social, and environmental factors (such as eating out and food related advertisements) may affect adolescents' food choices and nutrient intake during this critical phase, including their preoccupation with self-image

✉ Lamis Jomaa
lj18@aub.edu.lb

1 Department of Nutrition and Food Sciences, Faculty of Agricultural and Food Sciences, American University of Beirut, PO Box 11-0236, Riad El Solh, Beirut 1107-2020, Lebanon

2 Department of Nutrition and Dietetics, Faculty of Health Sciences, Beirut Arab University, PO Box 11-5020, Riad El Solh, Beirut 1107-2809, Lebanon

[1, 3], peer pressure [3, 10], parental influence [2, 3], family dynamics and socioeconomic status [1, 11], including household food insecurity (HFI).

HFI, defined as the inability of the household to secure, either from its own production or through purchases, nutritious, adequate and safe food for meeting the dietary needs of all members of the household [12], can further complicate the nutritional problems associated with adolescence. HFI has been associated with lower consumption of healthy food groups and poor diet quality [13], including protein-rich foods, fruits and vegetables [14, 15], and it can contribute to insufficient intake of essential vitamins and minerals among adolescents [16, 17]. Studies show that exposure to HFI during this particularly vulnerable period could adversely affect adolescents' dietary habits, as postulated by others, by acting as a psychological stressor for the adolescent leading to less than optimal nutrition [10, 18]. A recent review by Eicher-Miller and Zhao [19] showed that the relationship of food insecurity with key dietary outcomes among US adolescents aged 12–19 years has received minimal attention compared to younger children. Nevertheless, authors emphasized the importance of examining this relationship during adolescence, as this pediatric stage has the most potential for negative impacts on the youth's dietary intakes [19]. In addition, HFI can have serious implications on the overall health of adolescents, including poorer mental [20] and physical health [21], as well as lower academic and psychosocial development [22].

Although several studies, to date, examined the relationship between HFI with dietary intake and quality of adolescents [19, 23, 24], none of these studies investigated the relationship between HFI with dietary patterns (DPs) among this age group. The latter represents a dietary assessment approach that aims at identifying patterns of food consumption by individuals rather than individual food groups or nutrients [25]. In fact, the DP approach is considered to be more comprehensive than the traditional approaches in nutritional epidemiology, as it looks beyond the single nutrients or foods consumed and attempts to capture the broader picture of diet that is hypothesized to discriminate between health and disease [26]. Among studies exploring the DPs adopted by children and adolescents; a 'Western' DP, characterized by the high intake of fast foods, processed foods, sweets, and salty snacks, has consistently been reported [27-29]. This pattern was associated with higher risk of obesity and non-communicable diseases (NCDs), including cardio-metabolic risk factors (such as lipid profile and blood glucose), cardio-vascular disease (CVD) and hypertension [30, 31].

Lebanon is a middle-income Eastern Mediterranean country that represents a unique setting to explore the relationship between HFI with DPs among adolescents. The country is currently undergoing a rapid nutrition transition [32] reflected through the adoption of Western-like DPs and lower adherence to the traditional Lebanese-Mediterranean (LM) diet among both adults and adolescents [33, 34]. In addition, evidence indicates a worrisome increase in obesity prevalence (7.3% in 1997 vs. 10.9% in 2009) among Lebanese children and adolescents (aged 6–18 years) [35]. Concomitantly, the country is witnessing alarming HFI rates reaching 49.3% of Lebanese households with children 4–18 years old [36]. The present study aims to derive DPs of Lebanese adolescents (10–18 years) and evaluate associations between identified DPs and HFI using data from a national cross-sectional survey conducted on a representative sample of Lebanese households with children.

Methods

Study design and population

Data for the present study were drawn from a national cross-sectional survey of Lebanese households with children aged 4–18 years, entitled the Lebanese Food and Nutrition Security Survey (L-FANUS). The survey was conducted in years 2014 and 2015. Households were the primary sampling unit and were selected using a two-stage stratified cluster sampling approach. Within this framework, the six Lebanese governorates constituted the various strata. These governorates consisted of 26 districts (Caza); and neighborhoods within districts were made up the various clusters. Clusters within districts were chosen based on probability proportional to size sampling. Within each cluster, households were selected using systematic sampling approach. Further details about the sampling framework are presented in Jomaa et al. [36]. For a household to be eligible to be part of the survey, the following inclusion criteria were considered: (1) the household had to include a mother and child aged 4–18 years; (2) both mother and child had to be Lebanese; (3) both mother and child had to be healthy, i.e., not suffering from any chronic illness that may affect their dietary intake or taking medications that could affect their nutritional status. In the original national survey, a total of 4076 households were approached and 3147 agreed to participate (response rate 77%), of which 1209 were eligible and completed the study. For the purpose of the present study, data for children aged 10–18 years with complete dietary intake data were included for analysis ($n = 693$). The availability of 693 participants allowed for the detection of an effect size of $r = 0.11$ (r, correlation coefficient) at a power of 80% and an alpha error of 0.05 [37]. In addition, the distribution of this sample across the six administrative governorates of Lebanon was similar to that reported for that age group by the Central Administration of Statistics

(CAS) [38]. The protocol of the survey received ethical approval from the Social and Behavioral committee of the Institutional Review Board at the American University of Beirut (Protocol number NUT.LJ.03). Written informed consent and written assents were obtained from mothers and children above 6 years of age, respectively, prior to their participation.

Data collection

Data were collected using face-to-face interviews with study participants. The interviews took place in the household and lasted for approximately 45 min. A team of trained nutritionists carried out data collection and completed a multi-component survey with questions on the (1) sociodemographic and lifestyle characteristics, (2) household food insecurity (HFI) and (3) dietary intake of children. A detailed description of the survey questions is presented below.

Sociodemographic and lifestyle characteristics

Sociodemographic characteristics of study participants included close-ended questions related to age and sex of the child, crowding index (CI), education level and employment status of the mother and father, whether the mother studied a health-related major in university, area of residence (rural, urban), and physical activity. The crowding index (CI) was used as a proxy measure of socioeconomic status and calculated as the total number of household members divided by the total number of rooms in a household (excluding kitchens, bathrooms and balconies) [39]. This index has been previously used in Lebanon and other Arab settings, providing consistently reliable results [36, 39]. Households with less than two persons per room were considered to have a lower crowding index as compared to those with two or more persons per room. For the assessment of physical activity, a modified version of the Children and Youth Physical activity questionnaire was used [40]. Using this questionnaire, information regarding the types and duration of activities during the past week (weekdays and weekends) was collected, including activities at school and extra-curricular activities. In this study, children were classified as meeting or not meeting physical activity requirements if they engaged or did not engage in 420 min per week of moderate to vigorous activities, respectively, as per World Health Organization recommendations of physical activity in young individuals [41]. Moderate physical activities are the ones having metabolic equivalents (METs values) between 4 and 6, such as walking and volleyball, while vigorous physical activities, such as running, football and basketball have METs values greater than 6 [42].

Household food insecurity

HFI status was examined using the valid and reliable Arabic version of the Household Food Insecurity Access Scale (HFIAS) [43]. The latter is a nine-item measurement tool of food access (quantity and quality) originally developed by the US Agency for International Development-funded Food and Nutrition Technical Assistance project [44]. It reflects the experience of FI among the participant and their household members within the previous 4 weeks. The respondent is first asked an occurrence question [whether the condition in the question happened at all in the past 4 weeks (yes or no)]. In the case of an affirmative answer to the occurrence question, a frequency-of-occurrence question followed to indicate whether the condition happened rarely (once or twice), sometimes (three to ten times) or often (more than ten times). A standard scoring procedure was used whereby 0, 1, 2, or 3 points were allocated for "non-occurrence", "rare", "sometimes", and "often", respectively. The total HFIAS score ranged between 0 and 27, with higher scores indicating higher levels of HFI. Scores were used to categorize households into four levels of HFI (food secure, mildly, moderately or severely food insecure) depending on the number of positive responses to questions related to severe conditions, and as per the HFIAS measurement and indicator guide [44].

Dietary intake

Dietary intake of children was assessed using the Arabic-translated 187-item Food Frequency Questionnaire (FFQ), referring to intake over the past year. The validity and reliability of this questionnaire were previously examined among Lebanese children [45]. The FFQ included three sections: the food list, the portion size and the frequency response. The food list encompassed the 187 items, representing foods usually consumed by Lebanese children. In addition, the list included an open-ended question where participants could report additional foods consumed on a regular basis and which do not appear on the questionnaire's food list. For the estimation of the portion size, children were given the option to report intake using a reference portion size (cups, spoon and plates) or in grams. The frequency of the child's food intake was indicated by how many times per day, week or month the child has consumed the food. The Nutritionist Pro software (Nutritionist Pro, Axxya Systems, San Bruno, CA, version 5.1.0, 2014) was used for the analysis of the dietary intake data and to estimate energy, macro- and micro-nutrients' intakes. For the age group considered in this study (10–18 years old), participants were the primary respondents, in the presence of the mothers who answered clarifying questions when asked.

Derivation of dietary patterns

Principal component factor analysis (PCFA) was used for the examination of DPs in the study population. The 187 food items were grouped into 24 food groups, depending on similarities in ingredients, nutrient profile and/or culinary usage (TS1, supplementary table). Daily consumption of each of the 24 food groups was calculated by adding the daily portion intake of each item in this group. These 24 food groups were entered in the PCFA and DPs were derived using a Varimax rotation of factors; where the axes are maintained at 90 degrees. The following diagnostic measures were undertaken before conducting the PCFA: examination of the correlation matrix of all variables, the Kaiser–Meyer–Olkin test (> 0.7) and the chi square for Bartlett test of sphericity ($p < 0.05$). The decision as to how many factors to be retained was taken based on (1) the Kaiser criterion (eigenvalue greater than 1), (2) the scree plot (inflection point) and (3) relevance and interpretability of the factors. For all participants and for each factor, scores were calculated using the least squares regression method, where for each factor the mean was equal to zero. Each participant had a score on each identified pattern. The higher the factor score of a DP indicated higher adherence to this particular pattern. Factor loadings indicated the strength and direction of the association between the food groups and the identified patterns. For the naming of the patterns, food groups with a factor score greater than 0.3 were considered [46]. In case a variable had factor loadings > 0.3 on more than one of the identified patterns, the pattern with the highest loading was considered for labeling.

Statistical analyses

Various sociodemographic and lifestyle characteristics were described using means ± standard deviations and proportions representing continuous and categorical variables, respectively. These characteristics were compared across categories of HFI using chi-square and independent *t* tests. The associations of the identified DPs with energy and macro- and micro-nutrient intakes (energy-adjusted) were examined using Pearson's correlation coefficients. These coefficients were compared between the identified patterns using Steiger's test for dependent correlations. Partial correlations were used to investigate the association between the HFI score (as derived from the HFIAS questionnaire) and that of each identified DP, adjusting for adolescent's age, gender and significant correlates of HFI. Associations between HFI scores and DPs were also conducted using multiple linear regressions. Age, child's gender and variables found to be significantly associated with HFI (CI, father's and mother's education, mother's major in health, and mother and father's employment) were entered in the multiple linear regression model. Results from the multiple linear regression model were expressed as beta coefficient (β) with 95% confidence intervals (CI). All analyses were two tailed and a p value < 0.05 was considered statistically significant. The Statistical Package for the Social Sciences was used for all computations (SPSS) (version 19.0, SPSS Inc., Chicago, Illinois, USA).

Results

Characteristics of the study population are presented in Table 1. The mean age of participants was 13.81 ± 2.38 years with a higher percentage of girls as compared to boys (53.2% vs. 46.8%). Seventy percent of households (70.3%) had a crowding index below 2. Over 50% of mothers and fathers had an intermediate education or less (59.9% of fathers and 55.1% of mothers). Five percent of mothers studied a health-related major at the university level. While the majority of fathers were employed (91.4%), only 22.5% of mothers were employed. Three of four participants were residing in urban areas (77.5%) and almost one in two participants failed to meet the physical activity recommendations (Table1). Overall, out of 693 participants, 308 were food secure (44.44%), 218 belonged to the mild/moderate HFI category (31.45%) and 164 were food insecure (23.67%). Chi-square test results showed that a higher crowding index, a better father's and mother's education, as well as mother and father's employment are significantly associated with lower proportions of participants belonging to food-insecure categories (mild/moderate food insecure and severe food insecure) (Table 1).

The PCFA revealed two main DPs in the study population: 'Western' and 'Lebanese-Mediterranean (LM)' patterns. Together these DPs explained 19.71% of the total variance (10.16% and 9.55% for the Western and LM patterns respectively, Table 2). The main food items/groups that constituted the Western pattern were sugar-sweetened beverages, fast foods, sweets, salty snacks, condiments and refined grains. All the aforementioned groups had positive factor loading greater than 0.4. Other food groups which also loaded positively on this pattern were meat (0.38), alcohol (0.37), eggs (0.28), fats and oils (0.27) in addition to roasted and salted nuts and seeds (0.27). The LM DP, on the other hand, was characterized by higher loads of food groups such as fruits and vegetables (0.64), dairy products (0.53), mixed dishes (0.44), whole grains (0.43), in addition to olive oil (0.37), olives (0.26) as well as roasted unsalted and raw nuts and seeds (0.20). It is important to note that while meat, refined grained and eggs loaded higher on the Western DP, these food groups also loaded positively on the LM (factor loading on the LM DP: 0.32, 0.33 and 0.22 for refined grains, meat and eggs, respectively) (Table 2). Similarly, olives had positive loadings on both the Western

Table 1 Socioeconomic and lifestyle characteristics of the study population ($n = 693$)

	Total ($n = 693$)	Food security status: Food secure ($n = 308$)	Mild/moderate food insecurity ($n = 218$)	Severe food insecurity ($n = 164$)	Significance
Age	13.8 ± 2.4	13.8 ± 2.4	13.7 ± 2.3	14.0 ± 2.4	$p = 0.335$
Sex					$X^2 = 0.036$, $p = 0.98$
Males	323 (46.8)	143 (46.4)	103 (47.2)	77 (47.0)	
Females	367 (53.2)	165 (53.6)	115 (52.8)	87 (53.0)	
Crowding index					$X^2 = 60.92$, $p < 0.001$
< 2 person per room	485 (70.3)	261 (84.7)	138 (63.3)	86 (52.4)	
≥ 2 person per room	205 (29.7)	47 (15.3)	80 (36.7)	78 (47.6)	
Father's education					$X^2 = 62.30$, $p < 0.001$
Intermediate or less	406 (59.9)	135 (44.1)	154 (72.0)	117 (74.1)	
High school/technical diploma	180 (26.5)	105 (34.3)	44 (20.6)	31 (19.6)	
University	92 (13.6)	66 (21.6)	16 (7.5)	10 (6.3)	
Mother's education					$X^2 = 91.20$, $p < 0.001$
Intermediate or less	380 (55.1)	110 (35.7)	148 (67.9)	122 (74.4)	
High school/technical diploma	196 (28.4)	117 (38.0)	45 (20.6)	34 (20.7)	
University	114 (16.5)	81 (26.3)	25 (11.5)	8 (4.9)	
Mother studied a health major					$X^2 = 5.21$, $p = 0.07$
No	344 (94.8)	169 (92.3)	90 (95.7)	85 (98.8)	
Yes	19 (5.2)	14 (7.7)	4 (4.3)	1 (1.2)	
Father's employment status					$X^2 = 17.51$, $p < 0.001$
Not employed	59 (8.6)	14 (4.5)	19 (8.7)	26 (15.9)	
Employed	631 (91.4)	294 (95.5)	199 (91.3)	138 (84.1)	
Mother's employment status					$X^2 = 29.79$, $p < 0.001$
Not employed	535 (77.5)	210 (68.2)	180 (82.6)	145 (88.4)	
Employed	155 (22.5)	98 (31.8)	38 (17.4)	19 (11.6)	
Residence					$X^2 = 2.81$, $p = 0.245$
Rural	155 (22.5)	77 (25.0)	41 (18.8)	37 (22.6)	
Urban	535 (77.5)	231 (75.0)	177 (81.2)	127 (77.4)	
Physical activity‡					$X^2 = 1.071$, $p = 0.59$
Not meeting recommendations	333 (48.3)	149 (48.4)	110 (50.5)	74 (45.1)	
Meeting recommendations	357 (51.7)	159 (51.6)	108 (49.5)	90 (54.9)	

Continuous variables are presented as means with their SE, whereas categorical variables are reported as n and %

‡Children were classified as meeting or not meeting physical activity requirements if they engaged or did not engage in 420 min per week of moderate to vigorous activities, respectively, as per World Health Organization recommendations of physical activity in young individuals [42]

and the LM patterns, though higher loadings were noted for the LM DP (0.22 and 0.26 for the Western and LM patterns, respectively) (Table 2).

The results of the Pearson's correlation analysis used to examine the associations of the derived DPs with energy and energy-adjusted macro- and micro-nutrient intakes are presented in Table 3. The scores of both patterns were significantly associated with energy, with the Western DP having higher correlation coefficient as compared to the LM DP (0.74 vs 0.46, respectively). The scores of the Western DPs were positively associated with alcohol ($r = 0.30$), cholesterol ($r = 0.11$) and caffeine ($r = 0.19$), and negatively associated with carbohydrates ($r = -0.12$), proteins ($r = -0.13$), calcium ($r = -0.31$), vitamin A (retinol equivalents) ($r = -0.31$), vitamin D ($r = -0.15$), iron ($r = -0.17$) and fiber (-0.35). On the other hand, the LM DP was positively and highly correlated ($r \geq 0.30$) with fiber ($r = 0.36$), proteins ($r = 0.36$), iron ($r = 0.30$), vitamin A ($r = 0.36$); moderately correlated ($r < 0.3$) with carbohydrates ($r = 0.12$), calcium ($r = 0.10$) and vitamin D ($r = 0.22$); and negatively weakly correlated ($r < -0.3$) with total fat, saturated, polyunsaturated fats, alcohol and caffeine ($r = -0.18$, -0.09, -0.26, -0.10 and -0.16, respectively), $p < 0.05$ (Table 3).

Table 2 Factor loading matrix of the main dietary patterns prevalent among study participants ($n=693$)

	Dietary patterns	
	Western	Lebanese-Mediterranean
Sugar-sweetened beverages	0.71	–
Fast foods	0.60	–
Sweets	0.54	–
Salty snacks	0.52	–
Refined grains	0.42	0.32
Condiments	0.42	–
Meat	0.38	0.33
Alcohol	0.37	–
Eggs	0.28	0.22
Fats and oils	0.27	–
Nuts and seeds (roasted salted)	0.27	–
Fruits and vegetables	–	0.64
Dairy products	–	0.53
Mixed dishes	–	0.44
Whole grains	–	0.43
Legumes	–	0.40
Ham	–	0.40
Starchy vegetables	–	0.37
Olive oil	–	0.37
Olives	0.22	0.26
Hot drinks	–	0.22
Nuts and seeds (raw and roasted unsalted)	–	0.20
Lebanese dressing	–	0.20
Kaak	–	0.19
Total variance explained	10.16	9.55

Loadings less 0.1 were removed for simplicity

Table 3 Correlations between dietary patterns scores and energy-adjusted macro- and micro-nutrient intakes of study participants

Energy-adjusted nutrients†	Dietary patterns	
	Western	Lebanese-Mediterranean
Energy (Kcal)	0.74^{a},**	0.46^{b},**
Carbohydrates	−0.12^{a},**	0.12^{b},**
Total fat	0.07	−0.18**
Saturated fat	0.03	−0.09*
Monounsaturated fat	0.04	−0.07
Polyunsaturated fat	0.07	−0.26**
Proteins	−0.13^{a},**	0.36^{b},**
Alcohol	0.30^{**a}	−0.10^{b},**
Calcium (mg)	−0.31^{a},**	0.10^{b},**
Vitamin A (retinol equivalents) (mg)	−0.31^{a},**	0.36^{b},**
Vitamin D (ug)	−0.15^{a},**	0.22^{b},**
Iron (mg)	−0.17^{a},**	0.30^{b},**
Fiber (mg)	−0.35^{a},**	0.36^{b},**
Cholesterol (mg)	0.11^{a},**	0.14^{b},**
Caffeine (mg)	0.19^{a},**	−0.16^{b},**

*Pearson's correlations between dietary pattern scores with energy, macro- and micro-nutrients were statistically significant at $p<0.05$ (*); $p<0.01$ (**)

[a,b]Correlations significantly different at $p<0.05$ (Steiger's test for dependent correlations) https://www.psychometrica.de/correlation.html

[†]Macronutrients adjusted as percentage from total Kcal; micronutrients, fiber, sodium, sugar, cholesterol and caffeine adjusted per 1000 kcal

Partial correlations were conducted between HFI score with LM and Western DPs. Results showed that the higher the HFI score, the lower adherence to the LM DP (partial $r=-0.14$, $p=0.013$). No significant association was observed between HFI and the scores of the Western DP (Fig. 1a, b). After adjustment for variables found to be significantly associated with HFI, multiple linear regression analysis showed that the higher HFI score was associated with lower adherence to the LM DP among adolescents ($\beta=-0.026$, $p=0.012$, 95% CI -0.046, -0.006). The association between HFI and the Western DP remained non-statistically significant.

Discussion

The present study examined the association between HFI with derived DPs among adolescents (10–18 years) using a nationally representative sample of Lebanese households with children. Two DPs were identified in the present study: the Western and LM patterns. The Western DP was characterized by high intake of sugar-sweetened beverages, fast foods, sweets, salty snacks, refined grains, meats and alcohol, whereas the LM pattern reflected high intake of fruits and vegetables, dairy products, whole grains, olives and olive oil. In addition, the percentage of variance of dietary intake explained by these two DPs was found to be 19.7%, which was in the range of what has been reported previously among adolescents [27, 33, 47].

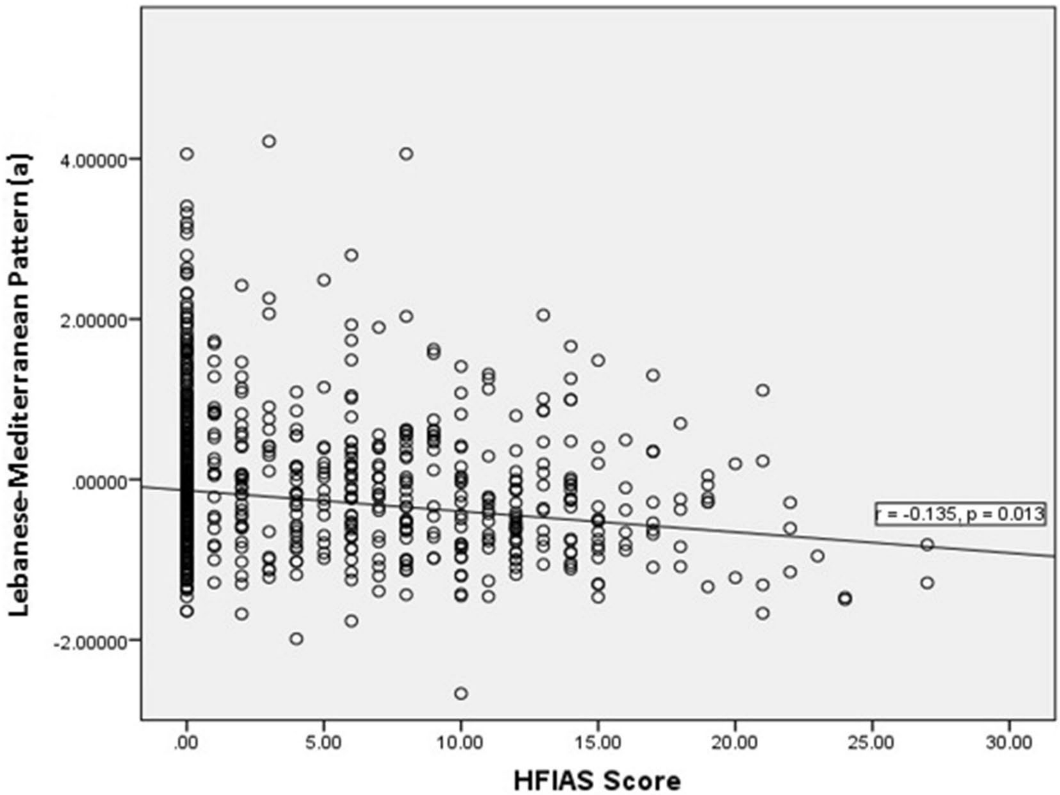
The Western and LM patterns derived in the present study were in line with the Western and the traditional LM patterns previously reported among Lebanese adolescents (13–19 years old) and with similar food groupings [48]. Comparable DPs have also been observed among adolescents in other middle-income countries, including Iran [47], Brazil [27], and Ghana [49] with the most consistent pattern reported in all studies being the "Western" or what is also called the "junk food", "fast food", or "the sweet tooth" pattern. Regardless of the nomenclature, this pattern is commonly characterized by the excessive intake of energy-dense foods that are high in sugars, saturated fats, and trans-fats [33, 47]. In addition, it has been consistently associated with the adoption of more Westernized and modern lifestyles that are popular among children and youth, and perceived to be convenient and reflective of greater independence [50]. Nevertheless, the Western pattern has been significantly associated with increased risk of obesity and cardio-metabolic risk factors across all age groups, including children and adolescents [30, 51].

The LM DP reported in the present study, on the other hand, included nutrient-dense foods, such as whole grains, fruits, vegetables and olive oil that were categorized in other studies as either "healthy", "prudent" or "traditional Mediterranean" patterns [52-56]. In addition, the positive and significant associations reported in the present study between the derived LM DP with fiber, proteins, iron, calcium, vitamins A and D together with its negative correlation with total fat, saturated, polyunsaturated fats, alcohol and caffeine further validate it as a healthy pattern. It is worth noting that the characteristics of a healthy Mediterranean diet (MD) may differ between studies due to geographic and cultural variations in cuisines across settings [57, 58], or to methodological variations in dietary assessment and factorial analysis adopted within individual studies [33]. Despite these differences, substantial evidence supports the MD, classically rich in fruits, vegetables and olive oil, for its protective effects against obesity and non-communicable diseases, including type II diabetes, metabolic syndrome, and cardiovascular diseases [30, 59].

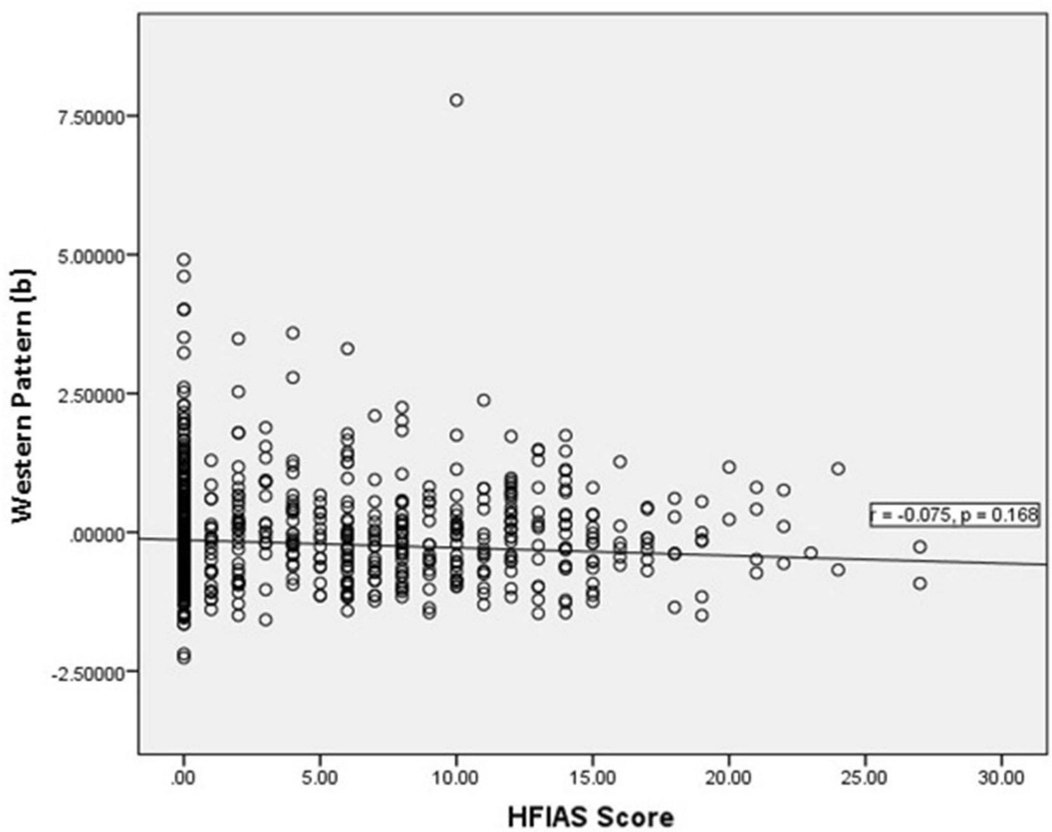
Findings from the present study highlight an inverse association between HFI with adherence to the LM pattern among adolescents in the multiple linear regression model. However, the association between HFI with Western DP was not found to be statistically significant. This is the first study to examine the association between HFI with DPs among adolescents showing similar results to two of three studies published to date among adults. One of these studies was conducted on 4657 adults living in New Zealand and it showed a significant inverse association between HFI with a derived 'healthy' DP ($B = -0.35$, $p < 0.001$) [60]; the latter being characterized with high consumption of fruits, low-fat milk and low intake of refined grains. Similarly, Rezazadeh et al. showed that low socioeconomic status and HFI were associated with detrimental DPs among two Iranian ethnic groups living in Urmia, Iran, and the adverse effect of HFI on diet quality was found to be stronger than their cultural and ethnic backgrounds [50]. The third study conducted on immigrant Latino mothers ($n = 105$) in rural communities in a Midwestern state in the US showed, contrary to our findings, that HFI was negatively associated with the adoption of a harmful DP (i.e., food secure mothers were more likely to adopt unhealthy eating behaviors, characterized by the consumption of fast foods, refined grains, salty snacks and sugar-sweetened beverages) [61]. Nevertheless, this association lost its predictive power after adjusting for the duration of stay in the US. Researchers argued that these results could have been reflective of immigration and acculturation factors that may trigger certain compensatory eating behaviors promoting the adoption of Western-like diets among food-secure women.

Among children and adolescents, previous research has shown strong links between HFI, poor diet quality and low dietary diversity scores reflected through lower intake of animal source food, including dairy products, as well as lower consumption of fruits and vegetables [13, 15]. HFI has also been associated with insufficient nutrient intakes of protein, calcium, phosphorous, and potassium among food insecure children (5–18 years) [16], yet increased intake of fat and sugar [62]. It is worth noting that only one study was identified to date exploring the association between HFI with adherence to the Mediterranean diet (MD) among university students in Greece [63]. Researchers reported an inverse relationship between severe HFI and adherence to the MD, thus indicating a higher selection of cheaper, energy-dense foods that are of lower quality diet instead of fruits, vegetables and other foods that constitute the traditional MD. These results support our findings and highlight that HFI can compromise not only the dietary quantity of adolescents, but also their dietary quality, which in turn can have serious adverse effects on their physical, cognitive, and psychological development and well-being [15, 22].

Several mechanisms can be considered to explain the low adherence of food insecure adolescents to the healthy LM DP observed in the present study. One explanation could be attributed to the 'substitution' effect linking HFI with diet, whereby higher quality or less calorically dense foods, such as fresh produce and lean sources of protein, are usually replaced among food insecure individuals with more energy-dense foods that are often high in simple carbohydrates and fat, yet the latter are cheaper on a per-calorie basis [13, 64]. Another explanation for our findings could be attributed to the overall decreased adherence to the MD reported among populations of the Mediterranean basin [63, 65, 66] with socioeconomic factors shown to be major determinants for this dietary shift among both adults and children [67]. In fact, a socioeconomic gradient in adhering to the MD has been recently observed in Mediterranean countries, such as Italy [68, 67] and Greece [63], whereby people with higher income and more material resources were found to adhere more to the traditional MD. The lower adherence to the MD has been attributed to the increasing prices of some Mediterranean food items and the economic crisis after the recession that started in 2007–2008 [68]. In Lebanon, the most recent poverty data from 2012 show that 27.4% of the Lebanese population are living below the national poverty line [69]. With the protracted Syrian refugee crisis in its 9th year,



Lebanese-Mediterranean Pattern (a)
4.00000
2.00000
.00000
-2.00000
r = -0.135, p = 0.013
.00
5.00
10.00
15.00
20.00
25.00
30.00
HFIAS Score



Western Pattern (b)
7.50000
5.00000
2.50000
.00000
-2.50000
r = -0.075, p = 0.168
.00
5.00
10.00
15.00
20.00
25.00
30.00
HFIAS Score

◀**Fig. 1** Associations between the household food insecurity score and that of the Lebanese-Mediterranean pattern (**a**) and Western pattern (**b**), among study participants ($n=693$)*. *The correlation lines presented in these figures are adjusted for age, sex, crowding index, mother's major in health, educational level and employment of fathers and mothers

poverty rates may have been exacerbated by the country's volatile political and economic situation, further threatening the food security of its population. In fact, previous research has shown that the national prevalence of HFI has reached 49.3% among Lebanese households with children [37]. These conditions may have contributed to increased socioeconomic disparities within the country and lower adherence to the healthy, yet more expensive, LM pattern, particularly among the most vulnerable and food-insecure groups.

Besides socioeconomic factors, the overall low adherence to the LM DP noted among our study sample could also have been influenced by other individual, social and environmental factors. A recent review by Idelson and Valerio highlighted that MD adherence was in fact low in children and adolescents, even in the Mediterranean countries, and that adherence to the MD was directly associated with physical activity, yet inversely correlated with sedentary behavior. Nevertheless, findings were inconsistent for gender, age, socioeconomic status and weight status [66]. Other factors that can influence the dietary choices of adolescents during this critical phase include family dynamics, peer pressure, and other environmental changes such as increased urbanization and modernization, which have been associated with lower adherence to the MD [66] and to dietary shifts that promote unhealthy lifestyle and dietary behaviors among adolescents [70]. Further studies are still needed to examine the relationship between MD adherence with demographic, lifestyle and anthropometric characteristics, as well as behavioral and health outcomes.

The present study has a number of strengths. It is the first to derive DPs and their associations with HFI among a representative sample of adolescents. Another strength is the collection of dietary and anthropometric measurements by trained dietitians, increasing the accuracy of data and reducing the risk of a reporting bias. This study has a number of limitations that are worth considering. The cross-sectional design of the study allowed us only to examine associations rather than potential causal relationships between HFI with sociodemographic characteristics and dietary intake of adolescents. HFI was assessed at the household level and, therefore, may not be sufficient to understand how adolescents may perceive and report their experience of food insecurity. Nevertheless, every attempt was made to ensure that mothers, as proxy respondents, considered the food security of all household members when responding to these questions. In addition, this study relied on the use of the FFQ for dietary assessment, which may be limited by measurement errors, reliance on memory and the number of food items included in the food list. Thus, a number of measures were adopted to ensure the accuracy of data and reduce reporting bias. Field workers were dietitians who were well trained to administer the FFQ. The child/adolescent was the primary respondent of the FFQ, while mothers were present to provide any further clarifications or details and to reduce uncertainties and errors. Furthermore, the portion size section in the FFQ was designed to minimize burden on the participants and provided visual assistance with real-size photos for accurate estimation of intake. To lessen the restriction imposed by the fixed food list of the FFQ, a question about 'other foods usually consumed' was also asked at the end of the interview. It is important to note that FFQ remains one of the most suitable dietary assessment tools in epidemiological studies, as it provides information on the subject's habitual diet over longer periods of time [71–73]. In fact, the FFQ used to assess dietary intake in the present study was previously validated among children in Lebanon and has yielded plausible findings [34, 35, 74]. Another limitation is that factor analysis is a data-driven method, which tends to define population-specific patterns. Further, the use of factor analysis necessitates several arbitrary assumptions pertinent to the selection of food groups, the number of retained factors, and their labels [75]. In the present study, two- or three-factor solutions were possible; however, the selection of two DPs was made to maintain comparability with another national study that examined DPs among a representative sample of Lebanese adolescents and the association of these patterns with obesity [48]. In addition, the food groupings that were adopted in the present study were comparable with those reported by previous investigations conducted in Lebanon [33, 74] and other studies worldwide [47, 63].

Conclusion

The present study is the first to examine the association between HFI with derived DPs among adolescents. HFI was found to be associated with lower adherence to the LM DP, the latter being associated with better nutrients' intake compared to the Western pattern. These findings are integral for developing preventive strategies emphasizing the adoption of the healthy Mediterranean diet to promote better dietary quality, and prevent risk of chronic diseases among food insecure individuals, particularly youth.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standards The present study was approved by the appropriate ethics committee, and all procedures performed were in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

References

1. Demory-Luce D, Motil KJ, (2018) Adolescent eating habits. https://www.uptodate.com/contents/adolescent-eating-habits. Accessed 27 Mar 2019
2. Das JK, Salam RA, Thornburg KL, Prentice AM, Campisi S, Lassi ZS, Koletzko B, Bhutta ZA (2017) Nutrition in adolescents: physiology, metabolism, and nutritional needs. Ann N Y Acad Sci 1393(1):21–33. https://doi.org/10.1111/nyas.13330
3. Neumark-Sztainer D, Story M, Perry C, Casey MA (1999) Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. J Am Diet Assoc 99(8):929–937. https://doi.org/10.1016/S0002-8223(99)00222-9
4. Baird J, Jacob C, Barker M, Fall C, Hanson M, Harvey N, Inskip H, Kumaran K, Cooper C (2017) Developmental origins of health and disease: a lifecourse approach to the prevention of non-communicable diseases. Healthcare 5(1):14. https://doi.org/10.3390/healthcare5010014
5. Rodrigues PRM, Luiz RR, Monteiro LS, Ferreira MG, Gonçalves-Silva RMV, Pereira RA (2017) Adolescents' unhealthy eating habits are associated with meal skipping. Nutr J 42:114–120. https://doi.org/10.1016/j.nut.2017.03.011
6. Badr HE, Lakha SF, Pennefather P (2017) Differences in physical activity, eating habits and risk of obesity among Kuwaiti adolescent boys and girls: a population-based study. Int J Adolesc Med Health. https://doi.org/10.1515/ijamh-2016-0138
7. Kumar S, Ray S, Roy D, Ganguly K, Dutta S, Mahapatra T, Mahapatra S, Gupta K, Chakraborty K, Das MK (2017) Exercise and eating habits among urban adolescents: a cross-sectional study in Kolkata, India. BMC Public Health 17(1):468. https://doi.org/10.1186/s12889-017-4390-9
8. Neumark-Sztainer D, Story M, Resnick M, Blum R (1998) Adolescent nutrition: lessons learned from the minnesota adolescent health survey. J Am Diet Assoc 98:1449–1456. https://doi.org/10.1016/S0002-8223(98)00329-0
9. Bull NL (1992) Dietary habits, food consumption, and nutrient intake during adolescence. J Adolesc Health 13(5):384–388. https://doi.org/10.1016/1054-139X(92)90034-9
10. Lachance L, Sean Martin M, Kaduri P, Godoy-Paiz P, Ginieniewicz J, Tarasuk V, McKenzie K (2014) Food insecurity, diet quality, and mental health in culturally diverse adolescents. Ethn Inequal Health Soc Care 7(1):14–22
11. Scaglioni S, De Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C (2018) Factors influencing children's eating behaviours. Nutrients 10(6):706. https://doi.org/10.3390/nu10060706
12. FAO (2010) The state of food insecurity in the world. http://www.fao.org/3/a-i1683e.pdf. Accessed 21 Mar 2019
13. Belachew T, Lindstrom D, Gebremariam A, Hogan D, Lachat C, Huybregts L, Kolsteren P (2013) Food insecurity, food based coping strategies and suboptimal dietary practices of adolescents in Jimma zone Southwest Ethiopia. PLoS ONE 8(3):e57643. https://doi.org/10.1371/journal.pone.0057643
14. Laraia BA (2013) Food insecurity and chronic disease. Adv Nutr 4(2):203–212. https://doi.org/10.3945/an.112.003277
15. Hanson KL, Connor LM (2014) Food insecurity and dietary quality in US adults and children: a systematic review. Am J Clin Nutr 100(2):684–692. https://doi.org/10.3945/ajcn.114.084525
16. Kim HJ, Oh K (2015) Household food insecurity and dietary intake in Korea: results from the 2012 Korea National Health and Nutrition Examination Survey. Public Health Nutr 18(18):3317–3325. https://doi.org/10.3390/nu8120819
17. Kirkpatrick SI, Tarasuk V (2008) Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. J Nutr 138(3):604–612. https://doi.org/10.3390/ijerph15071424
18. Poole-Di Salvo E, Silver EJ, Stein RE (2016) Household food insecurity and mental health problems among adolescents: what do parents report? Acad Pediatr 16(1):90–96
19. Eicher-Miller HA, Zhao Y (2018) Evidence for the age-specific relationship of food insecurity and key dietary outcomes among US children and adolescents. Nutr Res Rev 31(1):98–113. https://doi.org/10.1017/S0954422417000245
20. Rani D, Singh J, Acharya D, Paudel R, Lee K, Singh S (2018) Household food insecurity and mental health among teenage girls living in urban slums in Varanasi, India: a cross-sectional study. Int J Environ Res Public Health 15(8):1585. https://doi.org/10.3390/ijerph15081585
21. Smith C, Richards R (2008) Dietary intake, overweight status, and perceptions of food insecurity among homeless Minnesotan youth. Am J Hum Biol 20(5):550–563. https://doi.org/10.1002/ajhb.20780
22. Shanafelt A, Hearst MO, Wang Q, Nanney MS (2016) Food insecurity and rural adolescent personal health, home, and academic environments. J Sch Health 86(6):472–480. https://doi.org/10.1111/josh.12397
23. Rodríguez LA, Mundo-Rosas V, Méndez-Gómez-Humarán I, Pérez-Escamilla R, Shamah-Levy T (2017) Dietary quality and household food insecurity among Mexican children and adolescents. Matern Child Nutr 13(4):e12372. https://doi.org/10.1111/mcn.12372
24. Nakitto M, Asano K, Choi I, Yoon J (2017) Dietary intakes of adolescents from food insecure households: analysis of data from the 6th (2013–2015) Korea National Health and Nutrition Examination Survey. Nutr Res Pract 11(6):507–516. https://doi.org/10.4162/nrp.2017.11.6.507
25. Science Direct (2018) Dietary pattern—an overview. https://www.sciencedirect.com/topics/medicine-and-dentistry/dietary-pattern Accessed 15 Mar 2019
26. Slattery ML (2008) Defining dietary consumption: is the sum greater than its parts? J Clin Nutr 88(1):14–15. https://doi.org/10.1093/ajcn/88.1.14
27. Pinho Ld, Silveira MF, Botelho ACdC, Caldeira AP (2014) Identification of dietary patterns of adolescents attending public schools. J Pediatr (Rio J) 90(3):267–272. https://doi.org/10.1016/j.jped.2013.04.006
28. Hojhabrimanesh A, Akhlaghi M, Rahmani E, Amanat S, Atefi M, Najafi M, Hashemzadeh M, Salehi S, Faghih S (2017) A Western dietary pattern is associated with higher blood pressure in Iranian adolescents. Eur J Nutr 56(1):399–408. https://doi.org/10.1007/s00394-015-1090-z
29. Zhen S, Ma Y, Zhao Z, Yang X, Wen D (2018) Dietary pattern is associated with obesity in Chinese children and adolescents: data from China Health and Nutrition Survey (CHNS). Nutr J 17(1):68. https://doi.org/10.1186/s12937-018-0372-8
30. Cunha C, Costa P, De Oliveira L, Queiroz V, Pitangueira J, Oliveira A (2018) Dietary patterns and cardiometabolic risk factors among adolescents: systematic review and meta-analysis. Br J

Nutr 119(8):859–879. https://doi.org/10.1017/S0007114518000533

31. Nasreddine L, Naja F, Akl C, Chamieh MC, Karam S, Sibai AM, Hwalla N (2014) Dietary, lifestyle and socio-economic correlates of overweight, obesity and central adiposity in Lebanese children and adolescents. Nutrients 6(3):1038–1062. https://doi.org/10.3390/nu6031038
32. WHO (2010) Technical Paper. Regional strategy on nutrition 2010–2019. https://applications.emro.who.int/docs/EM_RC57_54_en.pdf. Accessed 21 Mar 2019
33. Naja F, Hwalla N, Itani L, Karam S, Mehio Sibai A, Nasreddine L (2015) A Western dietary pattern is associated with overweight and obesity in a national sample of Lebanese adolescents (13–19 years): a cross-sectional study. Br J Nutr 114(11):1909–1919. https://doi.org/10.1017/S0007114515003657
34. Naja F, Nasreddine L, Itani L, Chamieh MC, Adra N, Sibai AM, Hwalla N (2011) Dietary patterns and their association with obesity and sociodemographic factors in a national sample of Lebanese adults. Public Health Nutr 14(9):1570–1578. https://doi.org/10.1017/S136898001100070X
35. Nasreddine L, Naja F, Chamieh MC, Adra N, Sibai A-M, Hwalla N (2012) Trends in overweight and obesity in Lebanon: evidence from two national cross-sectional surveys (1997 and 2009). BMC Public Health 12(1):798. https://doi.org/10.1186/1471-2458-12-798
36. Jomaa L, Naja F, Kharroubi S, Hwalla N (2019) Prevalence and correlates of food insecurity among Lebanese households with children aged 4–18 years: findings from a national cross-sectional study. Public Health Nutr 22(2):202–211. https://doi.org/10.1017/S1368980018003245
37. Cummings SR, Hulley SB (1988) Designing clinical research: an epidemiologic approach. Williams & Wilkins, Philadelhia
38. Central Administration for Statistics (2006) Living conditions of households: the national survey of household living condition 2004. https://www.databank.com.lb/docs/Living%20conditions%202004%20-%20CAS.pdf.
39. Melki I, Beydoun H, Khogali M, Tamim H, Yunis K (2004) Household crowding index: a correlate of socioeconomic status and inter-pregnancy spacing in an urban setting. J Epidemiol Community Health 58(6):476–480. https://doi.org/10.1136/jech.2003.012690
40. Corder K, van Sluijs EM, Wright A, Whincup P, Wareham NJ, Ekelund U (2009) Is it possible to assess free-living physical activity and energy expenditure in young people by self-report? Am J Clin Nutr 89(3):862–870. https://doi.org/10.3945/ajcn.2008.26739
41. WHO (2010) Global recommendations on physical activity for health. https://scholar.google.com/scholar_lookup?title=Global+recommendations+on+physical+activity+for+health&publication_year=2010. Accessed 1 Aug 2019
42. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M (2008) Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc 40(1):181–188
43. Naja F, Hwalla N, Fossian T, Zebian D, Nasreddine L (2015) Validity and reliability of the Arabic version of the household food insecurity access scale in rural Lebanon. Public Health Nutr 18(2):251–258. https://doi.org/10.1017/S1368980014000317
44. Coates J, Swindale A, Bilinsky P (2007) Household food insecurity access scale (HFIAS) for measurement of food access: indicator guide. https://www.fao.org/fileadmin/user_upload/eufao-fsi4dm/doc-training/hfias.pdf. Accessed 20 Apr 2019
45. Moghames P, Hammami N, Hwalla N, Yazbeck N, Shoaib H, Nasreddine L, Naja F (2016) Validity and reliability of a food frequency questionnaire to estimate dietary intake among Lebanese children. Nutr J 15:4. https://doi.org/10.1186/s12937-015-0121-1
46. McCann SE, Marshall JR, Brasure JR et al (2001) Analysis of patterns of food intake in nutritional epidemiology: food classification in principal components analysis and the subsequent impact on estimates for endometrial cancer. Public Health Nutr 4:989–997. https://doi.org/10.1079/PHN2001168
47. Kafeshani O, Sarrafzadegan N, Nouri F, Mohammadifard N (2015) Major dietary patterns in Iranian adolescents: Isfahan Healthy Heart Program Iran. ARYA Atheroscler 11(Suppl 1):61
48. Naja F, Hwalla N, Itani L, Karam S, Sibai AM, Nasreddine L (2015) A Western dietary pattern is associated with overweight and obesity in a national sample of Lebanese adolescents (13–19 years): a cross-sectional study. Br J Nutr 114(11):1909–1919
49. Abizari A-R, Ali Z (2019) Dietary patterns and associated factors of schooling Ghanaian adolescents. J Health Popul Nutr 38(1):5. https://doi.org/10.1186/s41043-019-0162-8
50. Rezazadeh A, Omidvar N, Eini-Zinab H, Ghazi-Tabatabaie M, Majdzadeh R, Ghavamzadeh S, Nouri-Saeidlou S (2016) Major dietary patterns in relation to demographic and socio-economic status and food insecurity in two Iranian ethnic groups living in Urmia Iran. Public Health Nutr 19(18):3337–3348. https://doi.org/10.1017/S1368980016001634
51. Rocha NP, Milagres LC, Longo GZ, Ribeiro AQ, de Novaes JF (2017) Association between dietary pattern and cardiometabolic risk in children and adolescents: a systematic review. J Pediatr (Rio J) 93(3):214–222. https://doi.org/10.1016/j.jped.2017.01.002
52. Okubo H, Sasaki S, Murakami K, Kim M, Takahashi Y, Hosoi Y, Itabashi M (2008) Three major dietary patterns are all independently related to the risk of obesity among 3760 Japanese women aged 18–20 years. Int J Obes (Lond) 32(3):541. https://doi.org/10.1038/sj.ijo.0803737
53. Denova-Gutiérrez E, Castañón S, Talavera JO, Flores M, Macías N, Rodríguez-Ramírez S, Flores YN, Salmerón J (2011) Dietary patterns are associated with different indexes of adiposity and obesity in an urban Mexican population. J Nutr 141(5):921–927. https://doi.org/10.3945/jn.110.132332
54. Wadolowska L, Hamulka J, Kowalkowska J, Kostecka M, Wadolowska K, Biezanowska-Kopec R, Czarniecka-Skubina E, Kozirok W, Piotrowska A (2018) Prudent-active and fast-food-sedentary dietary-lifestyle patterns: the association with adiposity, nutrition knowledge and sociodemographic factors in polish teenagers—the ABC of healthy eating project. Nutrients 10(12):1988. https://doi.org/10.3390/nu10121988
55. Mais LA, Warkentin S, Vega JB, De Oliveira MDRD, Carnell S, Taddei JAdAC (2018) Sociodemographic, anthropometric and behavioural risk factors for ultra-processed food consumption in a sample of 2–9-year-olds in Brazil. Public Health Nutr 21(1):77–86. https://doi.org/10.1017/S1368980017002452
56. del Mar BM, Martínez E, Llull R, Pons A, Tur JA (2012) Western and Mediterranean dietary patterns among Balearic Islands' adolescents: socio-economic and lifestyle determinants. Public Health Nutr 15(4):683–692. https://doi.org/10.1017/S1368980011002199
57. Abdullah N-F, Teo P, Foo L (2016) Ethnic differences in the food intake patterns and its associated factors of adolescents in Kelantan Malaysia. Nutrients 8(9):551. https://doi.org/10.1111/nyas.13330
58. Auma CI, Pradeilles R, Blake MK, Holdsworth M (2019) What can dietary patterns tell us about the nutrition transition and environmental sustainability of diets in Uganda? Nutrients 11(2):342. https://doi.org/10.3390/nu11020342
59. Schulze MB, Hoffmann K, Kroke A, Boeing H (2001) Dietary patterns and their association with food and nutrient intake in the European Prospective Investigation into Cancer and Nutrition (EPIC)—Potsdam study. Br J Nutr 85(3):363–373. https://doi.org/10.1079/BJN2000254

60. Beck K, Jones B, Ullah I, McNaughton S, Haslett S, Stonehouse W (2018) Associations between dietary patterns, socio-demographic factors and anthropometric measurements in adult New Zealanders: an analysis of data from the 2008/09 New Zealand Adult Nutrition Survey. Eur J Nutr 57(4):1421–1433. https://doi.org/10.1007/s00394-017-1421-3
61. Torres-Aguilar P, Teran-Garcia M, Wiley A, Raffaelli M, Morales M (2016) Factors correlated to protective and risk dietary patterns in immigrant Latino mothers in non-metropolitan rural communities. J Immigr Minor Health 18(3):652–659. https://doi.org/10.1007/s10903-015-0212-2
62. Sharkey JR, Nalty C, Johnson CM, Dean WR (2012) Children's very low food security is associated with increased dietary intakes in energy, fat, and added sugar among Mexican-origin children (6–11 years) in Texas border Colonias. BMC Pediatr 12(1):16. https://doi.org/10.1186/1471-2431-12-16
63. Theodoridis X, Grammatikopoulou M, Gkiouras K, Papadopoulou S, Agorastou T, Gkika I, Maraki M, Dardavessis T, Chourdakis M (2018) Food insecurity and Mediterranean diet adherence among Greek university students. Nutr Metab Cardiovasc Dis 28(5):477–485. https://doi.org/10.1016/j.numecd.2018.02.007
64. Fram MS, Ritchie LD, Rosen N, Frongillo EA (2015) Child experience of food insecurity is associated with child diet and physical activity. J Nutr 145(3):499–504. https://doi.org/10.3945/jn.114.194365
65. Bamia C, Martimianaki G, Kritikou M, Trichopoulou A (2017) Indexes for assessing adherence to a Mediterranean diet from data measured through brief questionnaires: issues raised from the analysis of a Greek population study. Curr Dev Nutr 1(3):e000075. https://doi.org/10.3945/cdn.116.000075
66. Idelson PI, Scalfi L, Valerio G (2017) Adherence to the Mediterranean diet in children and adolescents: a systematic review. Nutr Metab Cardiovasc Dis 27(4):283–299. https://doi.org/10.1016/j.numecd.2017.01.002
67. Bonaccio M, Bes-Rastrollo M, de Gaetano G, Iacoviello L (2016) Challenges to the Mediterranean diet at a time of economic crisis. Nutr Metab Cardiovasc Dis 26(12):1057–1063. https://doi.org/10.1016/j.numecd.2016.07.005
68. Bonaccio M, Castelnuovo A, Bonanni A, Costanzo S, Lucia F, Persichillo M, Zito F, Donati M, Gaetano G, Iacoviello L (2014) Decline of the Mediterranean diet at a time of economic crisis. Results from the Moli-sani study. Nutr Metab Cardiovasc Dis 24(8):853–860. https://doi.org/10.1016/j.numecd.2014.02.014
69. The World Bank (2019) Poverty rates Lebanon. https://data.worldbank.org/indicator/SI.POV.NAHC?locations=LB. Accessed 10 May 2019
70. Archero F, Ricotti R, Solito A, Carrera D, Civello F, Di Bella R, Bellone S, Prodam F (2018) Adherence to the Mediterranean diet among school children and adolescents living in northern Italy and unhealthy food behaviors associated to overweight. Nutrients 10(9):1322
71. Shim J-S, Oh K, Kim HC (2014) Dietary assessment methods in epidemiologic studies. Epidemiol Health 36:e2014009
72. Cade JE, Burley V, Warm D, Thompson R, Margetts B (2004) Food-frequency questionnaires: a review of their design, validation and utilisation. Nutr Res Rev 17(1):5–22
73. Hu FB, Rimm E, Smith-Warner SA, Feskanich D, Stampfer MJ, Ascherio A, Sampson L, Willett WC (1999) Reproducibility and validity of dietary patterns assessed with a food-frequency questionnaire. Am J Clin Nutr 69(2):243–249
74. Naja F, Nasreddine L, Itani L, Adra N, Sibai A, Hwalla N (2013) Association between dietary patterns and the risk of metabolic syndrome among Lebanese adults. Eur J Nutr 52(1):97–105. https://doi.org/10.1007/s00394-011-0291-3
75. Martínez ME, Marshall JR, Sechrest L (1998) Invited commentary: factor analysis and the search for objectivity. Am J Epidemiol 148(1):17–19