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Original Article

Food and nutrition literacy: a predictor for diet quality and nutrient density among late adolescents

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ABSTRACT

Background. Evidence regarding an individual's food and nutrition literacy (FNL), and its impact on dietary behaviours, could guide the development of more effective interventions. This study sought to examine the association between FNL and its components with diet quality and nutrient density among Iranian senior high-school students.

Methods. In this cross-sectional study, 755 senior high school students were recruited from high schools in Tehran, Iran. FNL was assessed using the Food and Nutrition Literacy Assessment Tool (FNLAT), a self-administered questionnaire which has been locally designed and validated. Dietary assessment was performed by obtaining two 24-hour dietary recalls. Healthy Eating Index-2010 (HEI-2010) and nutrient-rich food index 9.3 (NRF9.3) were calculated to evaluate diet quality. Socioeconomic status, anthropometric measures, and the health status of participants were also assessed.

Results. Higher FNL score was significantly correlated with higher HEI-2010 ($\beta = 0.167$, $p < 0.001$) and NRF9.3 ($\beta = 0.145$, $p < 0.001$) scores. Subgroup analysis indicated that these associations were significant only among males, but not females. Regarding components of FNL, skill dimension of FNL was a stronger predictor for HEI-2010 ($\beta = 0.174$, $p < 0.001$) and NRF9.3 ($\beta = 0.153$, $p < 0.001$) than knowledge ($\beta = 0.083$, $p = 0.054$ for HEI-2010 and $\beta = 0.107$, $p = 0.01$ for NRF9.3).

Conclusions. FNL may be a significant predictor of diet quality and nutrient density among late adolescents. To improve the effectiveness of food and nutrition education, emphasis must be placed on skill development.

Key words: adolescents, diet quality, food literacy, nutrient density, nutrition literacy.

Unhealthy eating habits are known as a major risk factor for non-communicable diseases (NCDs).[1,2] It has been estimated that improving dietary intakes could prevent one in every five deaths, globally.[3] Across the lifespan, unhealthy eating behaviors are highly prevalent among adolescents and youths in both developed and developing countries.[4] In Iran, a developing country, inappropriate dietary practices, including high consumption of unhealthy snacks and junk foods, breakfast skipping, and inadequate intake of whole grains, dairy products, fruits, and vegetables, are very common among youth.[5,6] Poor dietary practices developed during childhood and adolescence

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may persist into adulthood[7,8], deleteriously impacting health in later life.[9]

Concomitant to sociocultural and environmental factors affecting the quality of dietary intakes, personal knowledge and skills about food and nutrition could be an important predictor of food choices.[10,11] Lack of skills and knowledge about food and nutrition such as knowing what foods are made of, how food labels should be interpreted and used, how healthy food can be prepared, how accurate information can be achieved, etc., could be related to poor food choice and lower diet quality.[12] The concept of food and nutrition literacy (FNL) has been developed in order to address such competencies in three levels: functional, interactive, and critical.[13,14] Most of the existing research has focused on nutrition knowledge and its relation to eating behaviors.[10,15] Even nutrition education interventions have mainly addressed knowledge aspects rather than skills; a fact that may explain the relatively low effectiveness of such interventions.[11,16] In the FNL concept, although food and nutrition knowledge represents an essential component, strengthening skills concurrently with knowledge, in particular, has been posited as a more effective approach to promoting healthy and sustainable eating behaviors. Understanding the relationship between FNL (and its components) and dietary intakes could guide the development of more effective strategies. However, as FNL is a recently emerged concept, the number of studies examining the relationship between FNL and eating behaviors are limited.[17-23]

In the, albeit limited, extant literature, it has been suggested that FNL is positively correlated with diet quality and healthy eating behaviors.[17-25] However, in most of these studies, the extent to which each domain of FNL, i.e. knowledge and skills could predict the quality of dietary intakes has not been determined.[19-23] The two available studies that have addressed both skill and knowledge were conducted in children[17] and adults[18], but no evidence is currently available pertinent to adolescents or youth.

We have previously reported low FNL status of Iranian late adolescents[26]; however, the association between FNL status and eating behaviors remained unclear. Considering the gaps in the current knowledge base, this study was conducted to examine the association between food and nutrition literacy, and its component, with diet quality and nutrient density among Iranian senior high-school students.

Material and Methods

The data of the current school-based cross-sectional study was collected in the city of Tehran from November 2017 to April 2018. The participants were 755 senior high-school students, aged 17-18 years, recruited from different socioeconomic districts through multistage cluster randomized sampling method. Being enrolled in senior high-school grade, not following any special diet, and willingness to participate in the study were the inclusion criteria. If a participant did not meet inclusion criteria, he/she would be replaced by another student through random selection. Of the recruited participants, 621 provided complete demographic, dietary intake, and FNL data (Fig. 1).

Food and nutrition literacy

Food and nutrition literacy (FNL) was assessed by Food and Nutrition Literacy Assessment Tool (FNLAT). This self-administered 60-item questionnaire has been developed and validated for Iranian late adolescents and youth.[27] FNLAT includes two main subscales i.e., knowledge and skills. Knowledge is a unidimensional subscale (food and nutrition knowledge), while skill consists of 5 dimensions, including functional skills (by which people can function effectively in everyday situations), interactive skills (interpersonal communication skills related to food and nutrition and seeking food and nutrition information), advocacy (capacity for taking social actions to promote healthy and sustainable food choices), critical

analysis of information (appraising food and nutrition information critically), and food label reading skill.[27] The scores for total FNL and each dimension could range from 0 to 100, with higher scores indicating a higher level of FNL. FNLAT scores <45, >45-60<, and >60 are interpreted as poor, moderate, and adequate level of FNL, respectively.

Dietary intakes

In order to assess dietary intakes, two 24-hour dietary recalls were obtained through in-person interviews with students and complementary phone interview(s) with their mothers or someone who is responsible for food preparation at home. The USDA automated multiple-pass method was used to enhance the accuracy of the collected 24-hour recalls.[28] Trained nutritionists carried out dietary assessment interviews and analysis. For nutrient analysis of the diet, a modified version of Nutritionist IV software in which Iranian foods had been added was used. Under and over reporters were identified according to the method suggested by McCrory et al.[29] and excluded from the analysis (n= 80).

In order to evaluate the quality of the diet, the Healthy Eating Index 2010 (HEI-2010) was calculated using the method explained by the National Cancer Institute.[30] Using this index, reported dietary intakes were compared with the US dietary guidelines. The calculated score could range from 0 to 100, with higher scores representing a healthier diet. Nutrient-Rich Food 9.3 score (NRF9.3) was calculated for the whole diet as a measure of nutrient density. The details of the NRF9.3 calculation have been described by Drewnowski et al.[31] Briefly, the calculation of NRF9.3 is based on 9 nutrients to encourage (or qualifying nutrients), including protein, dietary fiber, vitamin A, vitamin C, vitamin E, calcium, iron, magnesium, potassium; and 3 nutrients to limit (or disqualifying nutrients), including saturated fat, added sugar, and sodium. NRF9.3 is calculated as the sum of the percentage of reference daily values (RDVs) for qualifying nutrients (NR9) minus the sum of the percentage of maximum recommended value (MRVs) for disqualifying nutrients (Lim3). All daily values were calculated per 2000 kcal. The RDVs and MRVs suggested by Drewnowski et al., which are based on different sources i.e., World Health Organization (WHO) and the United States Food and Drug Administration (FDA)[31],were used in the present study.

Covariates

Based on existing evidence[26,32-35], some covariates were considered in the present study. Socioeconomic status was evaluated using a questionnaire in which students were asked about their parents' education level and job position, home appliances and facilities ownership (or type in some cases), and residential house features. A unidimensional SES variable was created from several socioeconomic variables, using principal component analysis (PCA). Participants were also asked about their health status and that of their families. Students' weight was measured using the Seca digital weighing scale to the nearest 0.1 kg, without shoes, and with minimum clothing. Height was measured in a normal standing position of shoulders and without shoes, using a wall-fixed tape measure. WHO AnthroPlus software was applied to calculate body mass index (BMI) for age z-score, and WHO criteria were used to define obesity and overweight.[36]

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the National Nutrition and Food Technology Research Institute (NNFTRI) ethics committee (IR.SBMU.nnftri.Rec.1396.166).

Statistical analysis

Mean ± standard deviation (SD) of quantitative variables and frequency of ordinal/ nominal variables were reported as descriptive statistics. The distribution of categorical variables was compared between FNL levels, using the chi-square test. One-Way ANOVA was applied

to test whether means of normal-distributed quantitative variables were significantly different between FNL levels. Multiple linear regression was used to examine the association between FNL with dependent variables (HEI-2010 and NRF9.3 and their components). The assumptions of linear regression analysis, including homoscedasticity (using scatterplot of the residuals), and lack of multicollinearity (through checking VIF values), and autocorrelations (using Durbin Watson Statistic) were checked before running regression models. SPSS version 21.0 (SPSS Inc., Chicago, Illinois, USA) software was applied to carry out statistical analyses. Statistical significance was accepted at $p < 0.05$.

Results

Demographic characteristics and a description of additional variables of interest (weight status, HEI-2010, and NRF9.3) are summarized in Table I. A total of 755 students participated in this study, of whom, 621 had complete dietary intake (two 24-hour dietary recalls) and FNL data (Fig. 1). After excluding dietary intake mis-reporters, a final sample of 541 students was included in the analysis. In terms of socio-demographic status (SES), we compared included subjects (n = 541) to those who were excluded from the analysis. No significant difference was observed in SES variables (parent education and job position, city district) ($p > 0.05$); however, the distribution of males (n= 70, 32.7%) and females (n= 144, 67.3%) in the excluded subjects was significantly different from those who were included ($P < 0.001$). Post hoc power analysis indicated that the power of linear regression analysis with remaining sample size (n = 541) is still acceptable (for linear regression analysis of FNL predicting HEI-2010, noncentrality parameter $\lambda = 27.82$, critical F = 2.23, power = 0.991; and for linear regression analysis of FNL predicting NRF9.3, noncentrality parameter $\lambda = 29.33$, critical F = 2.23, power = 0.994).

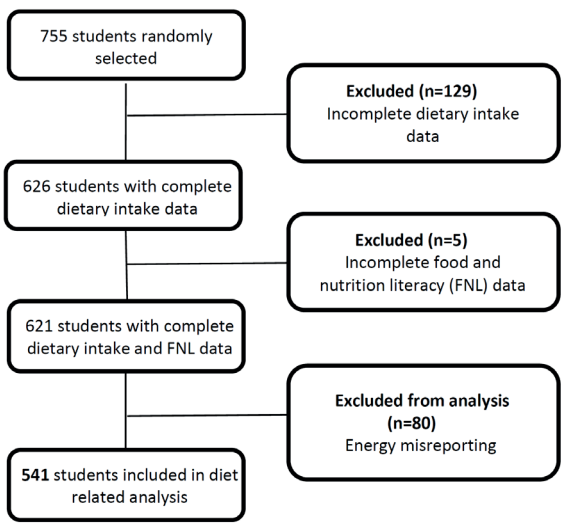

Fig. 1. Flow diagram of participants.

The results of linear regression analysis for the association between FNL and HEI-2010 and NRF9.3 are shown in Table II. A better FNL score was significantly correlated with higher HEI-2010 and NRF9.3 in the crude model. Entering the BMI-for-age z score in model 2 as well as further adjustment for other covariates (gender, SES, and suffering from a nutrition-related disease) did not alter these associations. As presented in Table II, subgroup analysis indicated that the association between FNL and HEI-2010 was statistically significant only among males ($\beta = 0.278$, $p < 0.001$), not females ($\beta = 0.021$, $p = 0.74$). Regarding NRF9.3, a similar result was found, as FNL was significantly related to NRF9.3 only in the males subgroup ($\beta = 0.197$, $p < 0.01$).

The linear regression coefficients for association between the main domains of FNL (knowledge and skills) and skills dimensions (interactive skills, food label reading skill, functional skills, critical analysis of information, and advocacy) with HEI-2010 and NRF9.3 are presented in Table III. As shown in Table III, after adjusting for covariates, HEI-2010 was positively correlated with skill domain ($p < 0.001$), functional skills ($p = 0.01$), interactive skills ($p < 0.001$) and advocacy ($p = 0.001$). Subgroup analysis indicated that these associations were statistically significant among males, but not females. Although food and nutrition knowledge was not a significant predictor for HEI-2010, when regression analysis

Table I. General characteristics of study participants by FNL status.

Characteristics	n	N (%) or Mean ± SD				P value
		Total	Poor FNL	Moderate FNL	Adequate FNL	
Gender	621					0.57 [a]
Male		309 (49.8)	79 (53.7)	158 (49.8)	75 (47.8)	
Female		312 (50.2)	68 (46.3)	159 (50.2)	82 (52.2)	
City district by SES	621					0.50 [a]
High SES		324 (52.2)	74 (50.3)	161 (50.8)	89 (56.7)	
Middle SES		153 (24.6)	33 (22.4)	83 (26.2)	37 (23.6)	
Low SES		144 (23.2)	40 (27.2)	73 (23.0)	31 (19.7)	
Major	621					0.06 [a]
Literature and Humanities		144 (23.0)	38 (25.9)	67 (21.1)	38 (24.2)	
Natural Sciences		215 (34.3)	36 (24.5)	121 (38.2)	56 (35.7)	
Mathematics		267 (42.7)	73 (49.7)	129 (40.7)	63 (40.1)	
Father education	620					0.32 [a]
Illiterate		11 (1.8)	1 (0.7)	6 (1.9)	4 (2.6)	
Under diploma		126 (20.3)	37 (25.2)	61 (19.2)	28 (17.9)	
High school diploma		286 (46.1)	72 (49.0)	142 (44.8)	72 (46.2)	
Associate degree or higher		197 (31.8)	37 (25.2)	108 (34.1)	52 (33.3)	
Maternal education	621					0.78 [a]
Illiterate		15 (2.4)	3 (2.0)	10 (3.2)	2 (1.3)	
Under diploma		130 (20.9)	34 (23.1)	66 (20.8)	30 (19.1)	
High school diploma		316 (50.9)	76 (51.7)	156 (49.2	84 (53.5)	
Associate degree or higher		160 (25.8)	34 (23.1)	85 (26.8)	41 (26.1)	
Weight status	593					0.13 [a]
Normal		337 (56.4)	89 (64.0)	172 (56.2)	73 (49.3)	
Overweight		147 (24.6)	26 (18.7)	76 (24.8)	45 (30.4)	
Obese		114 (19.1)	24 (17.3)	58 (19.0)	30 (20.3)	
Student's age	621	17.82 ± 0.39	17.88 ± 0.45	17.79 ± 0.38	17.82 ± 0.39	0.09 [b]
Paternal age	613	48.62 ± 5.53	48.85 ± 5.90	48.63 ± 5.43	48.28 ± 5.39	0.66 [b]
Maternal age	616	43.18 ± 5.24	43.44 ± 5.43	43.08 ± 5.16	43.16 ± 5.24	0.76 [b]
HEI-2010 score	541	66.56 ± 10.43	64.87 ± 10.31	66.17 ± 10.16	69.16 ± 10.71	**0.003** [b]
NRF9.3	541	404.41 ± 175.4	380.01 ± 160.2	398.64 ± 168.6	442.05 ± 198.5	**0.012** [b]
NR9	541	669.49 ± 151.0	642.20 ± 137.8	666.90 ± 144.0	703.37 ± 172.2	**0.004** [b]
LIM3	541	265.08 ± 62.7	161.06 ± 64.8	268.26 ± 60.3	261.32 ± 65.8	0.447 [b]

[a] Statistical significance was examined using chi-squared test
[b] Statistical significance was examined using one-way ANOVA test
FNL: food and nutrition literacy, HEI: healthy eating index, NRF: nutrient rich food, SD: standard deviation, SES: socio-economic status
NR9, Sum of the percentage of reference daily values (RDVs) for qualifying nutrients
LIM3, Sum of the percentage of maximum recommended value (MRVs) for disqualifying nutrients

was performed by gender, the β coefficient value was significant in males (β = 0.143, p = 0.01). NRF9.3 was significantly correlated with both skill (p < 0.001) and knowledge (p = 0.01) domains of FNL, although the observed association was relatively weaker with the knowledge domain (β = 0.107 vs. β = 0.143 in the skill domain). Among skill dimensions, functional skills (p = 0.04), interactive skills (p = 0.002), and advocacy (p = 0.001) were positively associated with NRF9.3. These skill dimensions were significant predictors of NRF9.3 only in the males subgroup.

Table II. The results of linear regression analysis for FNL predicting diet quality (HEI-2010) and nutrient density (NRF9.3) by gender.

	All			Males			Females		
	β	SE	R^2	β	SE	R^2	β	SE	R^2
HEI-2010									
Model 1	**0.167*** **	0.041	0.028	**0.276*** **	0.052	0.076	0.022	0.064	0.064
Model 2	**0.168*** **	0.041	0.029	**0.275*** **	0.053	0.078	0.030	0.588	0.002
Model 3	**0.167*** **	0.041	0.050	**0.278*** **	0.051	0.147	0.021	0.066	0.003
NRF9.3									
Model 1	**0.168*** **	0.006	0.028	**0.185** **	0.007	0.034	**0.145***	0.009	0.021
Model 2	**0.156*** **	0.007	0.024	**0.188** **	0.009	0.034	0.108	0.011	0.014
Model 3	**0.154*** **	0.007	0.054	**0.197** **	0.009	0.061	0.102	0.011	0.023

Model 1: Crude model
Model 2: Adjusted for BMI for age
Model 3: Adjusted for BMI for age, SES, suffering from nutrition-related disease, gender (only for "All" column).
*** P < 0.001, ** P < 0.01, * P < 0.05
FNL: food and nutrition literacy, HEI: healthy eating index, NRF: nutrient rich food, SES: socio-economic status

The relationship between components of HEI-2010 and NFR 9.3 with total FNL score and two main domains of FNL (knowledge and skill) are presented in Table IV. Among HEI-2010 components, total fruits, whole fruit, greens and beans, seafood and plant proteins, refined grains, and sodium were significantly predicted by total the FNL score and skills score. The association between the "total vegetable" score and total FNL and skills score were statistically significant ($p < 0.05$) but negligible ($\beta < 0.1$). Knowledge score also had a significant but negligible correlation with the score of "whole fruit" ($\beta = 0.089$). Regarding NRF9.3 components, the score of vitamin C ($p = 0.002$), calcium ($p = 0.03$), and potassium ($p < 0.001$) were significantly correlated with total FNL score, but the β value for calcium showed a poor association ($\beta = 0.097$). While the knowledge score had no significant relation with NRF9.3 components, a higher skill score was significantly associated with a higher intake of vitamin C ($p = 0.001$), magnesium ($p = 0.02$), and potassium ($p < 0.001$) scores.

Discussion

The findings of the present study indicated that food and nutrition literacy (FNL) could be a significant predictor of diet quality and nutrient density among late adolescents, especially adolescent males. Similarly, the positive association between Food/nutrition literacy and dietary diversity[17], diet quality[18-20,23], healthy eating behaviors[21,24,25], healthy dietary pattern[22] has been reported in different age groups.

Adolescents and youths who have higher levels of FNL have more information about nutrition and foods; and are more skilled in applying basic food and nutrition knowledge, preparing healthy meals, seeking food and nutrition information, appraising such information (critical analysis skills), and even advocating to address barriers to healthy and sustainable food choices.[37] Although all these competencies can result in healthier food choices, and approaches to develop these competencies should be included in educational programs, the results of the current study indicated that food and nutrition related skills were a stronger predictor for healthy eating behavior than knowledge. In the present study, the knowledge domain of FNL was not associated with the components of HEI-2010 and NRF9.3, whereas higher levels of food and nutrition related skills were significantly associated with a higher intake of fruits (total and whole fruit components), vegetables (green and beans components), seafood and plant proteins, and lower intakes of refined grains and sodium; in addition to a

Table III. The results of linear regression analysis for FNL components predicting diet quality (HEI-2010) and nutrient density (NFR9.3) by gender.

	FNL domains						Skill dimensions														
	Knowledge			Skills			Functional			Interactive			Advocacy			Analysis of information			Food label reading skills		
	β	SE	R^2	β	SE	R^2	β	SE	R^2	β	SE	R^2	β	SE	R^2	β	SE	R^2	β	SE	R^2
HEI-2010																					
All[a]	0.083	0.038	0.028	0.174***	0.038	0.053	0.103*	0.025	0.033	0.182***	0.024	0.055	0.143**	0.022	0.043	0.046	0.028	0.025	0.032	0.014	0.023
Males[b]	0.143*	0.038	0.091	0.285***	0.048	0.0151	0.201***	0.033	0.110	0.278***	0.029	0.148	0.181**	0.029	0.103	0.015	0.036	0.072	0.061	0.018	0.075
Females[b]	0.011	0.049	0.003	0.036	0.061	0.004	0.005	0.037	0.003	0.047	0.042	0.005	0.077	0.034	0.009	0.087	0.042	0.011	0.00	0.021	0.003
NRF9.3																					
All[a]	0.107*	0.005	0.042	0.153***	0.006	0.054	0.086*	0.004	0.038	0.137**	0.044	0.050	0.138**	0.004	0.050	0.021	0.005	0.031	0.061	0.002	0.034
Males[b]	0.097	0.006	0.031	0.210***	0.008	0.066	0.132*	0.005	0.040	0.207***	0.005	0.066	0.139*	0.005	0.042	0.007	0.006	0.023	0.069	0.003	0.027
Females[b]	0.111	0.009	0.024	0.088	0.011	0.020	0.038	0.006	0.014	0.044	0.007	0.014	0.133*	0.006	0.030	0.051	0.007	0.015	0.041	0.004	0.014

[a]Adjusted for BMI-for-age, suffering from nutrition-related diseases, SES, and gender
[b]Adjusted for BMI-for-age, suffering from nutrition-related diseases, and SES
*** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$
BMI: body mass index, FNL: food and nutrition literacy, HEI: healthy eating index, NRF: nutrient rich food, SES: socio-economic status

higher amount of vitamin C, potassium, and magnesium in the diet. Indeed, the findings of the present study provide further evidence that food/nutrition knowledge alone is not sufficient to establish positive changes in dietary behaviors.[38] This notion should be taken into account by educational program planners and curriculum designers, especially in the context of the Iranian education system which is predominantly focused on knowledge aspects, rather than skill development.[39,40]

The other notable finding of the present study was that FNL was a significant predictor for diet quality and nutrient density among males, but not females. Similar findings have been reported by another study conducted among Iranian adolescents (aged 13-15), where subgroup analysis indicated that the association between nutrition literacy and diet quality (assessed by revised children diet quality index) was significant only among males.[20] Indeed, evidence suggests that the possibility of misreporting in dietary intakes is higher among females than male adolescents.[41] Although we excluded misreporters from the analysis, the method used to identify misreporters is based on comparing reported energy intake with energy requirement. There is the possibility that some people tend to report healthier dietary intakes (than their actual values) meanwhile their reported energy intake may be plausible. Also, the eating behaviors of adolescent females are more likely to be influenced by factors like body image, self-esteem, or self-evaluation than males[42,43], which may overshadow the impact of their FNL level on eating practice. Finally, the limited number of studies comparing this relationship between female and male adolescents[20] makes it difficult to draw a reliable conclusion and explanation in this regard, thereby warranting further research.

In the present study, NRF9.3 was calculated to assess the nutrient density of the diet. To our knowledge, this is the first study that has examined a nutrient density score in relation to FNL. This score can be calculated for individual foods, as well as for the whole diet.[44]

Table IV. Multiple linear regression relationships between FNL (and its domain) and components of HEI-2010 and NFR 9.3.

	Total FNL			Knowledge			Skills		
	β	SE	R^2	β	SE	R^2	β	SE	R^2
HEI-2010 components									
Total fruit	**0.104***	0.007	0.034	0.085	0.005	0.030	**0.101***	0.007	0.034
Whole fruit	**0.110***	0.008	0.038	0.089*	0.005	0.033	**0.108***	0.007	0.037
Total vegetables	0.094*	0.006	0.017	0.041	0.004	0.10	0.097*	0.005	0.015
Greens and beans	**0.0128****	0.008	0.029	0.042	0.006	0.013	**0.132****	0.008	0.030
Seafood and plant proteins	**0.113***	0.008	0.038	0.078	0.006	0.032	**0.108***	0.007	0.037
Refined grains	**0.115***	0.014	0.062	0.043	0.010	0.048	**0.122****	0.013	0.065
Sodium	**0.109***	0.007	0.020	0.060	0.005	0.012	**0.111***	0.006	0.020
NRF components									
NRF vitamin C	**0.140****	0.004	0.048	0.080	0.003	0.035	**0.143****	0.004	0.049
NRF calcium	0.097*	0.001	0.017	0.082	0.001	0.015	0.087	0.001	0.015
NRF potassium	**0.160*****	0.001	0.058	0.075	0.000	0.036	**0.162*****	0.001	0.058
NRF magnesium	0.083	0.001	0.021	0.005	0.001	0.015	**0.100***	0.001	0.025

Adjusted for BMI-for-age, suffering from nutrition-related diseases, SES, and gender
*** P < 0.001, ** P < 0.01, * P < 0.05
BMI: body mass index, FNL: food and nutrition literacy, HEI: healthy eating index, NRF: nutrient rich food, SES: socio-economic status

Among various NRF models, NRF9.3 has indicated the best validation results against HEI-2005[45] and has been reported to be associated with lower all-cause mortality risk.[46] In the present study, FNL and its components (especially in the skill domain) were significant predictors of NRF9.3., suggesting that improving FNL status may lead to consuming a diet rich in qualifying nutrients (e.g., dietary fiber, vitamin A, vitamin C, vitamin E, etc.) and limited in disqualifying nutrients (i.e., saturated fat, added sugar, and sodium) among adolescents and youth; the age group in which high consumption of unhealthy snacks and convenient foods (which are mostly energy-dense, nutrient-poor) are prevalent.[5,6] These findings reemphasize the importance of applying FNL promoting strategies in order to achieve health outcomes among adolescents and youth.

Although we provide a novel addition to the literature of practical relevance, this study had some limitations that are worth noting. The cross-sectional design of the study precludes causal inferences regarding the direction of the observed association between FNL and diet quality. In addition, we selected a representative sample of senior high-school students of Tehran city; however, the studied population is not a nationally representative sample of Iranian adolescents. Therefore, the results may not be generalizable, for example, to younger adolescents or rural communities, highlighting the need for further studies in these populations. In order to enhance the accuracy of the collected 24-hour recalls, we applied the USDA automated multiple-pass method, employed a trained nutritionist, and performed complementary interviews with parents; however, random and systematic errors in self-reported dietary assessment is inevitable.[47]

In conclusion, the results of the current study demonstrated that food and nutrition literacy may build a capacity to adopt healthy eating behaviors in late adolescents, especially among adolescent males. The results also highlighted the importance of focusing on skill development in the context of food and nutrition education, which may be useful in the development of effective intervention strategies.

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Ethical approval

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the National Nutrition and Food Technology Research Institute (NNFTRI) ethical committee (IR.SBMU.nnftri.Rec.1396.166).

Author contribution

The authors confirm contribution to the paper as follows: study conception and design: MA, NO, ES, HEZ; data collection: MA, NO, AD, BAE, SS, MM; analysis and interpretation of results: MA, CCTC, SS; draft manuscript preparation: MA, CCTC, NO. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interest.

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