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Original article

Nutrition literacy as a determinant for diet quality amongst young adolescents: a cross sectional study

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Summary. The purpose of the present study was to assess the association between nutrition literacy and diet quality among young adolescents. In this cross-sectional study, 388 adolescents aged 13-15 were selected from secondary schools, Shiraz, Iran, using cluster random sampling method. The Revised Children's Diet Quality Index (RCDQI) was assessed using a validated Food Frequency Questionnaire (FFQ) and nutrition literacy was measured via a 3-dimensional questionnaire. Ordinal regression was used to examine the association between nutrition literacy and the quartiles of RCDQI as well as its components. RCDQI mean and standard deviation and total nutrition literacy (T-NL) were 65.19 ± 8.96 and 52.98 ± 7.15 among all the participants. Diet quality scores were higher in boys. Sources that were mostly used to collect nutritional information included the Internet (18.6%), families (15.2%) and books (13.1%). Among boys, an increase in T-NL (OR: 1.049; CI 95% 1.001-1.098), interactive nutrition literacy (OR: 1.13; CI 95% 1.033-1.236), and critical nutrition literacy (OR: 1.086; CI 95% 1.016-1.161) could enhance diet quality. Furthermore, increase in functional nutrition literacy was associated with lower sugar intake and better energy balance in boys and higher dairy intake in girls. Since there was an association between health literacy and diet quality amongst adolescents, health policy-makers should develop new strategies with focus to increase understanding of nutrition literacy during adolescence years.

Key words: health literacy, nutrition, dietary habits, diet quality, adolescence

Introduction

Proportional intake of healthy foods plays a significant role in growth and development of young individuals. On the other hand, unhealthy eating habits can leave adolescents predisposed to reduce learning ability and academic underachievement (1), in addition to prevalence of chronic disease (2).

Health literacy has been defined as the capacity to raise an individual health awareness to cope with personal requirements, which plays a critical role in health-related decisions and behaviors (3). Low health literacy in adolescence increases the chance of improper health status that reduces health-promoting behavior, especially in relation to nutrition (4). As an important aspect of health literacy, nutrition literacy is defined as the ability of an individual to obtain, process and understand nutritional information and services required to make proper (nutrition) decisions in their lives (5). Nutrition literacy falls into three categories of Functional Nutrition Literacy (FNL), Interactive Nutrition Literacy (INL) and Critical Nutrition Literacy (CNL) (6). In previous studies, nutrition-based health literacy were negatively associated with fat intake (7), and unhealthy food consumption (8). Also, by reviewing the literature we can see how nutrition literacy has shaped youth eating habits (8).

Exploring the nutrition literacy status and its relation with quantity and quality of dietary intake among youths might help to adopt effective strategies for promoting nutritional health among this critical age group.

Studies on nutrition literacy, especially on adolescents in Iran are very limited. Therefore, the purpose of this study was to assess the association between nutrition literacy and diet quality among young adolescents.

Method

Subjects

In this cross-sectional study, using cluster random sampling, 420 adolescents aged 13-15 were selected from fourteen private and public secondary schools from 4 educational districts in Shiraz, the largest city in southern Iran. One class (average of 30 students) was selected randomly from each school. Foreign students and adolescents with chronic disease or special diets were excluded from the study. Since completing all the 3 questionnaires was not possible in one day (due to tiredness), for this reason, data were collected through face to face interviews in 2 separate sessions with one week interval. A briefing session was held for parents prior to the research, and a written informed consent was obtained from families/ guardians.

Measurements

General and Anthropometrics questionnaire: The participants were asked about demographic characteristics such as age, gender and parents' education level and occupation. Height was measured without shoes to the nearest of 0.1 cm using a non-stretchable tape. Weight was measured in light clothing to the nearest of 0.1 kg using a digital scale (Seca, Germany). BMI was calculated as body weight (kg) divided by height square (m2). Based on World Health Organization (WHO) the participants' body mass index (BMI) percentile value was assigned to one category of either overweight or obese, normal and underweight (9).

Nutrition assessment: Adolescents dietary intakes were estimated based on the previous year using a validated food frequency questionnaire (FFQ) (10). RCDQI scores were calculated based on the studies by Kranz (11, 12). In relation to scoring, full points were assigned to adolescents with intakes within the recommended levels (ranging from 2.5 - 10 depending on the component), with reductions made proportionally for suboptimal intake and overconsumption.

Some index components were not compatible with the Iranian dietary pattern. For example, whole grain breads are not easily accessible in some districts, as they are only sold in specific supermarkets and bakeries. On the other hand, daily consumption of natural juices is not a routine dietary habit among Iranians, hence, no one had a juice intake higher than 360 ml (12 Oz) per day to be scored as "excess juice" in the index (12). Thus, juice intake was included in the "fruit" category (13). Therefore, the scores for these two food items were considered zero in the RCDQI scoring.

Total physical activity (adolescent physical activity and recall questionnaire-APARQ) (14) was an indicator for energy balance in adolescents. Following classification of physical activity into "sedentary", "moderate" and "vigorous" categories, each individual energy intakes was evaluated to estimate their energy requirements (EER) ±10%, appropriate for age, gender and 3 levels of physical activity, and then they were scored for both under- and over-consumption of energy.

The total RCDQI score was 90 and the adolescents' dietary intakes were assessed using Nutritionist-4, which was modified based on the Iranian food composition table (15) for Persian foods.

Knowledge: General nutrition knowledge questionnaire (GNKQ) (16) was used to assess the participants' nutritional knowledge. Scoring system was based on 1 and zero point for correct and incorrect/ "I don't know". The questionnaire reliability was assessed in the present study (Cronbach's α= 0.76).

Nutrition literacy questionnaire (NLQ-20): this is a 34-item, five-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) including the three main domains of nutrition literacy. In addition to 20-item NLQ, some additional descriptive questions were used as well. (17).

Its content validity was confirmed by a panel of experts (n=7). Face validity was assessed in a group of 25 adolescents. After omitting 3 items, the 7-item construct of functional nutrition literacy was validated through principal component analysis (loading factor> 0.4, eigenvalue>1 and varimax rotation) and its reliability was confirmed by calculating Cronbach's alpha coefficient (α=0.63). Similarly, through this process the construct validity and reliability of final 6-item interactive NL (alpha=0.65) and 7-item critical NL

(alpha=0.74) were confirmed. In total, the NLQ-20 scores ranged from 20 to 100.

In the descriptive part, adolescents were asked about possible sources of information related to nutrition that they have used recently (books, pamphlets, family, friends and classmates, doctors or health care providers, Internet, library, magazines, newspapers, radio, television programs, traditional herbal drug sellers). Secondly, we assessed adolescents' self-efficacy in obtaining information that they required (How confident are about you getting nutrition-related advice or information if you needed it?) using a 5-point Likert scale ranging from 1 (not confident at all) to 5 (completely confident). Third, the participants were asked to answer the question: "how much do you trust the information about nutrition, diet or food coming from each of the following sources?"; the 13 sources included doctors, nurses or health care providers, dietitians, family, friends, books, newspapers and magazines, Internet, television, radio, public clinics or hospitals, private clinics or hospitals and international organizations.

Statistical analysis

Descriptive analysis was done to assess demographic and anthropometric characteristics, as well as the descriptive part of nutrition literacy. All covariates with p values < 0.2 under single variable analysis were entered into the regression analysis. Ordinal regression was used to evaluate the association between nutrition literacy and the quartiles of RCDQI, as well as its components. P value <0.05 was considered to be statistically significant. Data were analyzed via SPSS (ver.24) and Nutritionist-4 (modified for Persian food) was used to assess dietary intakes.

Ethics

This study was conducted according to the Declaration of Helsinki and all procedures involving human subjects were approved by the local ethics committee of Shiraz University of Medical Sciences (IR-SUMS.REC.1395.S133). Written informed consents were obtained from all parents/guardians.

Results

Total of 388 adolescents participated in this study (response rate= 92.38%), out of which 64.2% were female and total of 26% were overweight or obese. Mean and standard deviation of T-NL equaled to 65.19 ± 8.96 among all the participants. FNL was higher in girls (p=0.001); however, CNL was significantly higher in boys (p=0.015). Of all the participants, 68.1% had mentioned that they looked for information about nutrition diet or food, and the most visited sources included the Internet (18.6%), family (15.2%) and books (13.1%). Total of 26.3% were completely, and 41.3% somewhat confident that they could get nutrition-related information if they needed it. There was a significant weak and positive correlation between trust and CNL (r=0.132, p=0.013). Moreover, the barriers had a negative relationship with FNL (p=0.001) and CNL (p=0.046). Although knowledge score was significantly higher in girls compared to boys (p=0.001), their diet quality score was not accordant and mean RCDQI score was higher among boys (p=0.002). Demographic and anthropometric characteristics and general information are reported in Table 1.

Increases in T-NL enhanced diet quality in boys (OR: 1.049; CI 95% 1.001-1.098), and increases in INL had increased the odds for being in the higher quartiles of the RCDQI score by 1.13 times (CI 95% 1.033-1.236). Furthermore, increase in CNL was associated with better diet quality (OR: 1.086; CI 95% 1.016-1.161); however, FNL had no association with the RCDQI score. In girls, no associations were observed between diet quality and total nutrition literacy or its components (Table 2).

As shown in Table 3, further analysis revealed the association between intake of food items and nutrition literacy. Among boys, an increasing FNL was associated with higher sugar score quartile, which showed lower intake of sugar (OR, 1.071; 95% CI, 1.002-1.146). In addition, increase in this nutrition literacy component enhanced dairy intake in girls (OR, 1.049; 95% CI, 1.001-1.098) and improved energy balance in boys by 1.082 times (95% CI, 1.011-1.159). Increases in INL raised the odds for energy score by 8% in boys (OR, 1.080; 95% CI, 1.011-1.154) and increased CNL improved vegetable intake in this gender group (OR, 1.080; 95% CI, 1.011-1.154). Augmentations in T-NL could also lead to increased vegetable intake in male adolescents (OR, 1.043; 95% CI, 1.001-1.087).

Table 1. Demographic and anthropometric characteristics, and nutrition literacy, knowledge and diet quality score among study subjects

Demographic characteristics	**Boys (n=139)**	**Girls (n=249)**
Age, mean (SD)	14.37 (0.91)	13.64 (0.92)
Education district, n (%)		
District 1 (medium to high socio-economic status)	92 (66.2)	143 (57.4)
District 2 (low socio-economic status)	47 (33.8)	106 (42.6)
Mother education, n (%)		
Illiterate & Primary education	14 (10.6)	26 (11.3)
High school & diploma	106 (80.3)	151 (65.3)
University education	12 (9.1)	54 (23.4)
Father education, n (%)		
Illiterate & Primary education	10 (7.7)	18 (7.9)
High school & diploma	91 (70)	137 (60.1)
University education	29 (22.3)	73 (32.0)
Anthropometric characteristics		
BMI, n (%)		
Underweight	26 (18.7)	32 (12.9)
Normal weight	73 (52.5)	156 (62.7)
Overweight and Obese	40 (28.8)	61 (24.4)
General information		
Nutrition literacy, mean (SD)		
FNL	21.17 (2.93)	22.28 (3.68)
INL	20.05 (3.39)	19.75 (4.25)
CNL	24.21 (4.20)	22.95 (5.05)
T-NL	65.35 (7.26)	65.10 (9.83)
Confidence to get required nutrition information		
Completely confident	38 (27.9)	62 (25.4)
Very confident	20 (14.7)	43 (17.6)
Somewhat confident	60 (44.1)	97 (39.8)
A little confident	5 (3.7)	17 (7)
Not confident at all	13 (9.6)	25 (10.2)
Barriers, mean (SD)	20.74 (7.97)	21.61 (6.20)
Trust, mean (SD)	43.34 (9.73)	43.37 (9.31)
Knowledge, mean (SD)	52.50 (18.44)	58.89 (16.23)
RCDQI score, mean (SD)	54.50 (6.34)	52.12 (7.44)

BMI, body mass index; FNL, functional nutrition literacy; INL, interactive nutrition literacy; CNL, critical nutrition literacy; T-NL, total nutrition literacy; RCDQI, revised children diet quality index.

Discussion

In the present study, there was a significant association between nutrition literacy and diet quality amongst adolescents, and it was shown that increase in T-NL and its components such as INL, and CNL could enhance diet quality among boys. Furthermore, increases in FNL were associated with lower sugar intake and better energy balance in boys and higher dairy intake in girls. Results are discussed in detail.

Table 2. Components of RCDQI, mean score, and mean intake based on score quartiles (lowest and highest quartiles) among boys and girl adolescents

Component	Scoring criteria	Max score	Boys			Girls		
			Mean score (SD)	Intake based on score quartiles, Mean (SD)		Mean score (SD)	Intake based on score quartiles, Mean (SD)	
				lowest	highest		lowest	highest
Added sugar %	≤10% of total energy intake	10	5.88 (3.51)	17.39 (3.71)	10.64 (3.68)	6.53 (3.37)	16.16 (10.57)	10.63 (3.34)
Total fat %	25%-35%	2.5	1.87 (1.01)	34.07 (4.85)	32.56 (3.31)	1.91 (0.98)	34.43 (4.15)	32.41 (3.47)
Linoleic acid %	≤ 5%-10%	2.5	1.70 (1.12)	9.90 (5.49)	8.42 (4.23)	1.46 (1.21)	11.46 (6.45)	8.04 (3.60)
Linolenic acid %	0.6%-1.2%	2.5	2.18 (0.53)	0.59 (0.26)	0.73 (0.28)	2.14 (0.59)	0.70 (0.32)	0.75 (0.27)
DHA+EPA%	≤10% of ALA	2.5	2.40 (0.43)	4.57 (2.91)	3.75 (3.15)	2.41 (0.44)	3.27 (3.18)	3.71 (2.93)
Total grain (OZ)								
Female	5-6 OZ	5	1.30 (1.01)	13.95 (4.97)	12.59 (3.18)	1.46 (1.18)	10.79 (4.07)	11.01 (2.39)
Male	6-7 OZ							
Fruit (Cup)								
Female	1.5 cup	10	8.68 (2.43)	1.98 (1.27)	3.40 (1.43)	8.69 (2.49)	1.81 (1.49)	3.05 (1.35)
Male	2 cup							
Vegetable (Cup)								
Female	2.5 cup	10	6.27 (2.39)	1.66 (0.82)	2.13 (0.63)	7.02 (2.70)	1.36 (0.78)	2.28 (0.82)
Male	3 cup							
Dairy (Cup)	3	10	5.46 (2.68)	1.26 (0.70)	1.98 (0.81)	4.96 (2.89)	0.96 (0.76)	2.12 (0.85)
Iron	EAR*	10	8.84 (2.50)	13.81 (5.54)	16.16 (3.38)	6.08 (3.30)	12.31 (4.93)	14.64 (4.03)
Energy	Energy ± 10% of EER	10	8.57 (1.48)	2790.69 (995.78)	2549.23 (640.09)	8.50 (1.81)	2158.19 (814.18)	2206.70 (478.89)

RCDQI, revised children diet quality index; DHA, Docosahexaenoic acid; EPA, Eicosapentaenoic acid; ALA, α-linolenic acid; EAR, Estimated Average Requirement; EER, Estimated Energy Requirement.

** ≤EAR = 0 points, EAR-RDA = 5 point, ≥RDA = 10 point*

Table 3. Association between RCDQI score quartile and nutrition literacy among boy and girl adolescents using the ordinal logistic regression (Odds ratio (OR) and 95% confidence interval (CI))

Variables	Boys			Girls		
	OR	95% CI		OR	95% CI	
		lower	upper		lower	upper
FNL	0.974	0.913	1.040	1.000	0.955	1.046
District						
1	1.414	0.733	2.727	1.829*	1.140	2.933
2	1.000			1.000		
knowledge	0.976**	0.959	0.993	1.002	0.988	1.016
INL	1.130**	1.033	1.236	1.019	0.970	1.071
District						
1	1.336	0.678	2.635	1.843*	1.144	2.967
2	1.000			1.000		
knowledge	0.976*	0.959	0.994	1.000	0.986	1.015
CNL	1.086*	1.016	1.161	1.015	0.978	1.053
District						
1	1.241	0.619	2.489	2.014**	1.243	3.262
2	1.000			1.000		
knowledge	0.972*	0.955	0.989	1.001	0.986	1.016
T-NL	1.049*	1.001	1.098	1.012	.987	1.037
District						
1	1.391	0.685	2.823	2.083**	1.260	3.442
2	1.000			1.000		
knowledge	0.985	0.967	1.003	0.999	0.983	1.015

RCDQI, revised children diet quality index; FNL, functional nutrition literacy; INL, interactive nutrition literacy; CNL, critical nutrition literacy; T-NL, total nutrition literacy.

District 1: medium to high socio-economic status, District 2: low socio-economic status

**p<0.05, **p<0.01*

Table 4. Association between RCDQI components score quartile and nutrition literacy among boy and girl adolescents using the ordinal logistic regression (Odds ratio (OR) and 95% confidence interval (CI))

	Sugar score		Dairy score		Vegetable score		EER score	
	OR	CI 95%	OR	CI 95%	OR	CI 95%	OR	CI 95%
Boys								
FNL	1.071*	1.002-1.146	0.950	0.888-1.016	1.012	0.947-1.082	1.082*	1.011-1.159
INL	1.038	0.952-1.131	1.062	0.974-1.157	1.057	0.969-1.154	1.089*	1.082-1.098
CNL	1.012	0.949-1.080	1.047	0.981-1.117	1.080*	1.011-1.154	0.968	0.907-1.033
T-NL	1.041	0.998-1.086	1.013	0.973-1.054	1.043*	1.001-1.087	0.994	0.955-1.034
Girls								
FNL	0.958	0.914-1.003	1.049*	1.001-1.098	1.020	0.974-1.068	0.999	0.954-1.046
INL	1.000	0.952-1.050	1.028	0.979-1.080	0.970	0.924-1.019	1.052	1.001-1.106
CNL	1.008	0.971-1.046	0.992	0.956-1.030	0.997	0.961-1.035	1.036	0.996-1.076
T-NL	0.995	0.974-1.016	1.012	0.991-1.034	0.996	0.975-1.017	1.018	0.997-1.040

RCDQI, revised children diet quality index; EER, Estimated Energy Requirements; FNL, functional nutrition literacy; INL, interactive nutrition literacy; CNL, critical nutrition literacy; T-NL: total nutrition literacy.

Knowledge, district (distric 1, district 2), BMI entered the ordinal analysis as covariates.

**p<0.05*

Diet quality in adolescents

Our RCDQI score was lower compared to other studies (13, 18), mainly because we did not have a score for whole grains and excess fruit juice consumption.-

In our study, mean percentage of added sugar was higher than the amount recommended by dietary guideline (less than 10% of calories per day), which is in line with other studies in Iran (19-21). Although mean intake of total fat met the recommended amount, it was higher than the optimal level of 30%. It seems that fat intake has increased in recent years among Iranian adolescents, which is in line with the consumption of fast-foods and processed foods (22, 23). The main staple food in Iran are refined wheat and rice, forming the main portion of our carbohydrate intake (24). Therefore, policy-makers should make whole grain products more accessible and affordable for everyone in order to reach the dietary recommendations of whole grains as a preventive measure to reduce the increasing rate of non-communicable diseases.

In this study, vegetable intake was very low amongst the adolescent population, which was congruent with a systematic review in Iran (25). Despite schools' free-milk-distribution program implemented by the Iranian Ministry of Health and Medical Education, present study shows that mean intake of dairy products is lower than the recommended amount, and in 2014, Iran's per capita consumption of milk and dairy products was announced at almost half the world average (26).

Overall, most of the RCDQI components assessing adolescents' diet quality requires more attention and improvement that should be considered in nutritional education programs and policies.

Nutrition literacy in adolescents

In spite of relative enhancement of nutrition knowledge following educational interventions, limited improvements were observed in dietary behaviors (27). This may be due to the failure of those interventions to improve nutrition literacy as an important mediator between nutrition-related knowledge and practice (8). Different aspects of nutrition literacy are discussed separately as follow.

Knowledge: Knowledge was higher among girls, which was not in line with their T-NL and diet quality in our study. In a systematic review, four out of nine studies revealed that females had greater food knowledge than males, and one found that females had poorer dietary practices despite their greater nutritional knowledge, which is consistent with the present study (8). Evidence indicates that knowledge alone is usually not enough to change individual behaviors such as dietary choices (8).

Sources of knowledge: In our population, the most visited sources of nutrition and food information included the Internet, family and books. In Cash's study, dietitians, nutritionists and general physicians were the three most preferred sources, and were considered as most trustworthy, credible and effective. However, in line with our study, the most utilized sources of nutrition information were the Internet, friends, family and magazines (28). Zoellner et al., reported that the Internet is not a frequently used source of nutrition information among adults (29), and other studies found the major sources of food knowledge to be the family among adults (30-32) and relative classes among undergraduate students (31).

National surveys in the United State identified the Internet as the most popular source of health information (29). There is a huge amount of scientific and non-scientific information and biased advertising and news on Internet, but teenagers hardly ever refer to scientific data. These facts suggest that adolescents should be educated on how and where to find valid information.

Trust: In present study, there was significant, weak, positive correlation between trust and CNL. In Zoellner's study (29), nutrition literacy was significantly associated with the level of trust toward information sources, and the Internet was identified as the least trusted source of nutritional information by adults.

Confidence: Only about one forth (26.3%) of the adolescents were completely confident that they could get nutrition-related information if they needed it. Nutrition literacy was higher in people who reported a higher level of confidence, but the relationship was not statistically significant. Our result was in agreement with Zoellner's study in which adults with lower literacy level had less confidence in their ability to obtain nutrition information, but the trend was not sig-

nificant (29). However, in Ghaddar's study, health literacy was positively associated with self-efficacy (33). It seems that planners and policy-makers should raise confidence levels among this age-group in order to inspire better choice of nutritional information sources.

Barriers: There were significant negative relationships between functional and critical NL with the barriers to find food and nutrition information in our study. Zoellner et al., noted that adults with lower nutrition literacy rated higher for barriers to seek nutrition information than those with adequate literacy, but the trend was not significant (29).

Functional, Interactive and critical nutrition literacy: In this study, increases in INL, CNL, and T-NL had significantly enhanced diet quality among boys, but FNL was not associated with the RCDQI score. In girls, no association was observed between diet quality and T-NL or its components. In recent years, nutritional information has been delivered through textbooks and school health programs. In addition, access to various educational resources such as health channels and social networks has helped the teenagers to increase their knowledge, and consequently their FNL. Nonetheless, this knowledge by itself cannot improve nutritional behavior as it was not designed to affect their skills, motivation or behavior.

There was an association between food item intake and nutrition literacy in the present study. Increased FNL was associated with lower sugar intake and improved energy balance in boys and enhanced dairy intake in girls. Increased INL could increase the energy score and increases in CNL and T-NL could lead to increased vegetable intake. Since osteoporosis has become a public health concern in recent years, especially among women, many health and nutrition education programs have been assigned to this issue. The same is true for obesity and its related problems in both genders; therefore, it is expected that adolescents have better nutrition literacy in these contexts.

In a systematic review of 9 studies, only one had assessed the relationship between nutritional skills and dietary intake, and found an association between more frequent food preparation (as an interactive literacy), and increased fruit consumption in young boys, as well as increased fruit and vegetable intake in girls. It also had a negative association with the consumption of junk food items such as soft drinks in girls and fried foods in boys (8). INL such as frequency of reading food label was not associated with dietary intake in Huang et al., study (34). In another study, nutrition-based health literacy predicted lower fat intake, but it was not a significant predictor of fruit and vegetable intake among college students (7).

Few studies have assessed the relationship between nutrition literacy and food behavior in children and adolescents. Different tools were used to examine nutrition literacy in those studies, which mostly did not separate the various dimensions of nutrition literacy as we did. Thus, the studies are not easily comparable. Although the field of health literacy has grown immensely, it is still relatively new and there are still ongoing debates regarding its construct and measurement. Thus, further studies using multi-dimensional nutrition literacy questionnaire similar to what we used is highly recommended.

Conclusion

In recent years, nutritional education programs have increased among adolescents, and they have been successful in increasing nutritional knowledge. However, they have not been sufficient in promoting nutritional behavior. Furthermore, with increased access to information and communication technologies, the expected plan is to go beyond just delivering nutritional information, but also to develop higher cognitive and behavioral skills to promote healthy eating habits. Nutrition literacy, as a combination of knowledge, cognitive and behavioral skills, has the potential to resolve this issue and improve healthy decision-making regarding eating habits.

Nutrition literacy and its components have significant association with diet quality in adolescents, hence, public healthcare planners and policy-makers should develop new public health strategies with a focus on increased understanding of food literacy among adolescents, especially girls.

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