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ORIGINAL ARTICLE

Psychometric Properties of Persian Version of Nutrition Literacy Inventory (NLI-28, 2017) among University Students

Elham Makiabadi[1], Abdolrahim Asadollahi[2], Mohammad Hossein Kaveh[3*], Mousa Salehi[4]

1. Department of Community Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
2. Department of Healthy Aging, School of Health, Shiraz University of Medical Science, Shiraz, Iran
3. Department of Health Education and Promotion, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran
4. Department of Clinical Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

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**Corresponding author:*
Mohammad Hossein Kaveh,
Department of Health Education and Promotion,
School of Health,
Shiraz University of Medical Sciences,
Shiraz, Iran.
Tel: +98-917-7068244
Email: kaveh@sums.ac.ir
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ABSTRACT

Background: Nutrition literacy is a key determinant of nutrition decision and behavior. This study investigated the psychometric properties of the Persian version of Nutrition Literacy Inventory (NLI-28) among university students.

Methods: In a cross-sectional study, 203 students (101 women and 102 men) were enrolled through a randomized cluster sampling method from the four dormitories of Shiraz University of Medical Sciences. The instrument was prepared through a translation and back-translation process and it was used as a self-administered inventory. The NLI-28 included three subscales i.e. functional nutrition literacy, interactive nutrition literacy, and critical nutrition literacy. The reliability and validity of the instrument were assessed by using exploratory and confirmatory factor analysis (CFA) and Cronbach's alpha coefficient.

Results: Mean of content validity ratio (CVR) for essential criterion, means of content validity index (CVI) for simply criterion, clarity criterion, and relevance criterion were obtained as 0.89, 0.9, 0.96, and 0.98, respectively. The coefficients of Cronbach's alpha (α=0.87), convergent validity (0.74), divergent validity (-0.11), and criterion validity (0.73) were estimated ($P<0.01$). The exploratory factor analysis demonstrated that the NLI-28 was organized into four factors, clarifying 78% of the scale's variance. Second-order confirmatory factor analysis pointed out that the factor was well matched up onto a principal factor. The four factors model was well appropriate for the data by the fit index technique to adjust the scale.

Conclusion: Well-adjusted reliability and psychometric properties of the NLI-28 were shown and also its usefulness for the relevant studies was demonstrated.

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Introduction

Health literacy is considered one of the basic skills required for making decisions related to health. However, there is evidence that most individuals

do not have sufficient knowledge about how to manage their health issues, and this is particularly true of health literacy related to nutrition (1). The consequences of low health literacy have been well documented for the US population denoting to the poorer knowledge (2), poorer health status (3), more hospitalizations (4), and higher health care costs (5) in comparison to those with greater health literacy.

Although health literacy plays an important role in decision-making related to health, and there is evidence that the situation in community-based areas is still far from ideal. According to surveys, about 56.6% of Iranian adults from five Iranian states (6) and 36% of American adults (7) had low health literacy. Nutrition literacy can be defined as the ability to obtain, process, and understand basic nutrition information (8) and is generally classified into three levels of functional, interactive, and critical. Functional nutrition literacy (FNL) refers to the extent to which an individual experiences difficulty in understanding and comprehending nutrition messages.

Interactive nutrition literacy (INL) can be defined as the cognitive and interpersonal skills needed to manage nutrition issues in partnership with professionals. Critical nutrition literacy (CNL) refers to the ability to analyze nutrition information critically, increase awareness, and participate in activities that help to address barriers (9-11). Because chronic diseases start slowly and frequently occur among young people who have no symptoms of their diseases, these youths continue to have poor nutritional lifestyles, and this can result in long-term disorders (12).

Nutritional literacy is a precondition for acquiring knowledge and skills about proper nutrition and for promoting healthy eating habits (13). Having an awareness of patients' literacy skills can make it easier to develop the required health information, so that they can understand it (14). However, the majority of registered dietitians do not address the health literacy of their clients. One reason for this may be that the clients do not have the vehicles or technology to access up-to-date nutrition literacy (15).

Nevertheless, because of the increasing incidence of diseases related to nutrition, it is vital to provide a suitable scale for measuring nutrition literacy in order to plan and evaluate interventions that can promote nutritional health. Therefore, this cross-sectional study was conducted to assess the reliability and validity of the Persian version of the nutrition literacy inventory (NLI-28) among students of Shiraz University of Medical Sciences in Shiraz, southern Iran during 2017.

Materials and Methods

This cross-sectional study, conducted in 2017, aimed at validating the nutrition literacy inventory (NLI-28). The study used the cluster random sampling method to assess about 203 students (101 women and 102 men), with the mean age of 22.10±1.89 years, who were in the four dormitories of Shiraz University of Medical Sciences in Shiraz, southern Iran. The sample size was derived from the N/p ratio, i.e. the item to participant ratio should be at least 1:5, indicating five responders for each question in the scale (16). The 28-item questionnaire therefore, required a sample size of 140 participants. However, the sample size of the present study considered about 203 people.

The assessment tool for nutrition literacy was self-administered and involved a questionnaire prepared by Ndahura′s research team (17). Translation of the NLI-28 was done according to the four ordinal stages of translation and back-translation as recommended by the World Health Organization (18). The face and content validities of the questionnaire were evaluated by a panel of experts (six persons) and the content validity ratio (CVR) and content validity index (CVI) values were calculated.

The next step, which involved assessing face validity through a pre-testing phase, was carried out on ten participants who were from the same sampling group but would not be involved in the main study. The necessary corrections were then made to the final application test. Finally, for the main stage of the research, the tool was used on a sample of 203 people from the research community. The NLI-28 included three subscales of functional nutrition literacy (nine items), interactive nutrition literacy (nine items), and critical nutrition literacy (ten items).

The response for each item was given through a five-point Likert scale. For the positive questions, scores of five, four, three, two, and one were assigned to "Strongly agree", "Agree", "Neither agree nor disagree", "Disagree", and "Strongly disagree", respectively. The negative items were reverse scored as well. The score for each participant could be ranged from 28 (minimum) to 140 (maximum). So that the high score in NLI-28 means having higher nutrition literacy.

When collecting the data, the researcher visited the dormitories of Shiraz University of Medical Sciences, introduced herself to the students, and explained the study objectives. Regarding the ethical dimension, the participants were assured that their information would be kept confidential and their informed consent for taking part in the study was obtained orally. The Persian NLI-28 was

then given to the participants, and the questionnaires were answered anonymously and 98% of them returned the questionnaires. Inclusion criteria were the participants' interest to participate in the study and being a student of Shiraz University of Medical Sciences. Exclusion criteria included an incomplete filling out of the questionnaire.

All statistical analyses were performed using the Statistical Package for the Social Sciences software (SPSS, version 23, Chicago, IL, USA). To assess the reliability of the questionnaire, its internal consistency was measured (19). The internal consistency is an index that shows how many items in an instrument are related and homogeneous. Using this approach, a Cronbach's alpha coefficient of >0.7 represents acceptable reliability for the instrument (20, 21). The reliability of the NLI-28 was also assessed using the split-half method, and the Spearman-Brown coefficient was calculated for the entire scale and for both halves. This index is normally used in cases, where there are a large number of questions (22).

The CVR was used to quantify the extent of the experts' agreement. A CVR score of 0.80 or higher indicated good content validity (23). CVR and CVI values were calculated. CVR mean for essential criterion, CVI means for simply criterion, clarity criterion, and relevance criterion were obtained as 0.89, 0.9, 0.96, and 0.98, respectively. Therefore, the questions that had problems were reviewed and modified by consultation of experts in health education and nutrition sciences. Then, the students responded the modified questionnaire. In addition, in the present study, confirmatory factor analysis and fitness indicators were used to confirm the validity of the questionnaire structure.

Results

A total of 203 students were the study samples, 102 men (50.2%) and 101 women (49.8%) with a mean age of 22.10±1.89 years, and the mean weight (kg) and height (cm) of the male and female participants were 70.0±11.4 kilogram, 56.2±9.4 kilogram, 177±0.07 centimeter, and 162±0.06 centimeter, respectively. Majority the students replied to the study inventory (NLI-28). Table 1 shows the demographic characteristics, comparing NLI-28 overall score made between males and females regarding their gender and the discipline of study; while it revealed statistically significant difference

Table 1: Demographic characteristics of the sample and total scores of NLI-28 (n=203, P≤0.05)

Categories	Subcategories	N	%	M	F	95% CI[a]	Weight (kg)	Height (cm)	NLI-28[b]	SD	χ^2/P
Gender	Male	102	50.2	-	-	90-94	70.0(11.4)	177(.07)	99	9.01	17.0/.000
	Female	101	49.8			95-99	56.2(9.4)	162(.06)	93	9.02	
Discipline of Study	Nursing	34	16.7	22	12	92.43-99.72	63.50	171	95.82	9.85	12.5/.001
	Public Health	9	4.4	1	8	95.21-103.67	56.11	160	95.76	9.86	
	Occupational Health	9	4.4	7	2	81.49-101.61	69.67	176	99.44	5.50	
	Midwifery	8	3.9	0	8	87.25-110.24	58.00	165	91.56	13.09	
	Anesthesia Technician	10	4.9	6	4	89.64-102.35	57.10	163	98.75	13.75	
	Operating Room Technician	19	9.4	13	6	89.67-96.64	64.74	172	96.00	8.88	
	Radiology	29	14.3	11	18	94.40-102.49	61.41	167	93.16	7.23	
	Physiotherapy	17	8.4	11	6	90.67-96.49	65.00	173	98.45	10.63	
	Laboratory Sciences	20	9.9	11	9	91.97-102.32	66.80	173	93.59	5.66	
	Speech Therapy	15	7.4	4	11	88.03-100.76	59.20	167	97.15	11.06	
	Occupational Therapy	18	8.9	9	9	84.67-96.65	67.83	171	94.40	11.49	
	Health Information Technology	3	1.5	0	4	61.07-123.59	57.50	160	98.50	2.65	
	Management	8	3.9	8	0	95.25-102.12	74.33	175	92.33	12.58	
	Environmental Health	34	16.7	4	4	80.29-94.70	59.13	171	87.50	8.62	

a. 95% Confidence Interval for Mean. b. Nutrition Literacy Inventory-28

Table 2: Tests of normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
NLI-28[b]	0.534	102	0.020*	0.261	102	0.024

*This is a lower bound of the true significance. a. Lilliefors Significance Correction. b. Nutrition Literacy Inventory-28

Table 3: KMO and Bartlett's Test of NLI-28[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**704**
Bartlett's Test of Sphericity	Approx. Chi-Square	1990.00
	df	378
	Sig.	0.000

a. Nutrition Literacy Inventory-28

within samples (Table 1).

The coefficients of Cronbach's alpha (α=0.87), split-half (part 1 α=0.89 and part 2 α=0.73), convergent validity (0.74), divergent validity (-0.11), and criterion validity (0.73) were estimated (P<0.01). The discriminative power in the NLI-28 of sub-scales with overall score using Kolmogorov-Smirnov and Shapiro-Wilk tests of normality demonstrated an almost normal distribution (Table 2). Mean overall score was 95.08 (CI=93.68-96.49) and SD=10.1, minimum 6.017 and maximum 95.08. Discriminative power testing showed that the domains had a normal distribution (Table 2).

Regarding criterion validity, Pearson's correlation coefficients were significant and appropriate for all the sub-domains of NLI-28. This finding could suggest some specificity of these domains. Regarding contrast validity, according to Table 3, the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were conducted to evaluate the factorability. The KMO was 0.704 and the Bartlett's test of sphericity was less than 0.001, meaning that Exploratory Factor Analysis (EFA) can be applied to the obtained factors (Approx. χ^2=1990.0, df=378, P<0.001).

The exploratory factor analysis demonstrated that the 28-items of NLI-28 for student samples were organized into four factors, explaining 78% of the scale variance (Initial Eigenvalue=1.610). This scree plot showed that four of those factors explained most of the variability since the line started to straighten after factor four (Figure 1). Second-order confirmatory factor analysis indicated that the factors were designed well upon a principal factor. According to Table 4, the rotated factor matrix pattern of Varimax for the NLI-28's subscale questions was considered. In this regard, questions with factor loadings above 0.35 were selected (Table 4).

There were covariates between some items, i.e. item No. 1 between factors No. 1 and 4; item No. 27 between factors No. 3 and 4 in Persian version of NLI-28. It may indicate that covariate item of these factors could be reconstructed. Additionally, the item No. 11 was omitted because of least predicting variance within the all of items. Regarding confirmatory factor analysis, the weighted least squares (WLS)

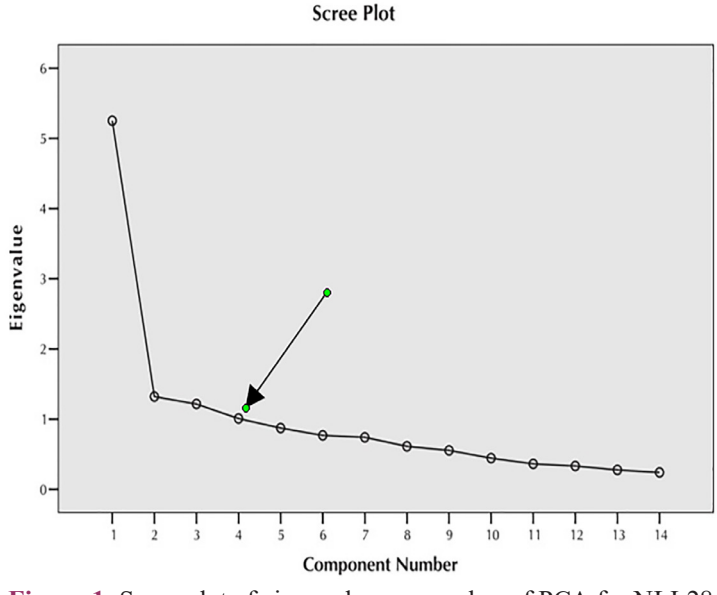

Figure 1: Scree plot of eigenvalue vs. number of PCA for NLI-28.

Table 4: Varimax Rotated Factors Matrix[a] of the NLI-28[b] (n=203)

Items	Component			
	1	2	3	4
1. I find that the language used by nutrition, health and food experts difficult to understand.	0.510			0.517
2. I find it difficult to understand the jargon (words) used by nutrition, health and food experts.	0.778			
3. When I read information about nutrition, food or diet I find it difficult to understand.	0.807			
4. I find it difficult to know how I should change my diet when I get dietary advice from the doctor, nurse or the like.	0.775			
5. When I read information about nutrition, food or diet I need someone to help me understand it.	0.732			
6. I am not familiar with World Health Organization (WHO) recommendation for daily intake of fruits and vegetables.	0.422			
7. I am familiar with the food pyramid.	0.353			
8. When I read an article about nutrition, food or diet I find words that I don't know.	0.391			
9. I am familiar with the concept of a 'balanced diet'.	0.626			
10. I have gathered information about diet from various sources that I think is relevant for me.		0.699		
12. I discuss about diet with my friends, family and relatives.		0.575		
13. I have changed my eating habits based on the information about diet that I have gathered.		0.700		
14. I do not follow public debate about diet for example on television, and radio.		0.512		
15. I often read material about what constitutes a balanced diet.		0.621		
16. I readily take the initiative to discuss with dietary experts (for example a doctor, nurse or the like) about healthy eating.		0.496		
17. When I want information about diet I do not know which departments within the health service that I can go to for help.		0.470		
18. I have discussed my thoughts about diet to someone else (for example my friends, family, relatives, a doctor, nurse or the like).		0.557		
19. I would readily get involved in political issues targeted at improving people's diet.			0.744	
20. I am willing to take an active role in measures aimed at promoting a healthier diet at my college.			0.490	
21. I expect my college to serve healthy food.			0.637	
22. I try to influence others (for example my family and friends) to eat healthy food.			0.715	
23. It is important for me that the college canteens have a good selection of healthy food.			0.750	
24. I tend to be influenced by the dietary advice I read in newspapers, magazines etc.			0.648	
25. I trust the various diets that I read in newspapers, magazines, etc.			0.656	
26. I believe that the media's presentation of scientific findings about nutrition, diet, food is correct.			0.353	
27. I find it difficult to distinguish scientific information from non-scientific information about diet.			0.479	0.609
28. When I read information about nutrition, diet or food it is important to me that it is based on scientific evidence.			0.508	

a. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 8 iterations. b. Nutrition Literacy Inventory-28.

were used to estimation method available in SPSS, version 23. The aim was to approve the fitness of the four-factor model emerged from EFA.

The adequacy of the model was evaluated using the comparative fit index log likelihood, Akaike's information criterion (AIC), finite sample corrected AIC (AICC), Bayesian information criterion (BIC), consistent AIC (CAIC), root mean square error of approximation (RMSEA), goodness-of-fit statistic (GFI), adjusted goodness of fit index (AGFI), incremental fit index (IFI), and comparative fit index (CFI). These values for the four-factor 28-item model all suggest that the model provides a moderately good fit.

Consequently, the four-factor model was appropriate for the data and the fit index techniques for adjusting the scale. According to Table 5, the indexes of the model's goodness of fit refer to the integrity of the four-factor model with data. The χ^2 to degrees of freedom was less than 2 in efficient

Table 5: The Goodness of Fit Indexes Model[a] of the NLI-28[b]

Indexes	Value	df	Value/df
Deviance	1558.00	197	80.35
Scaled Deviance	203.000	197	
Pearson Chi-Square	1558.00	197	80.35
Scaled Pearson Chi-Square	203.00	197	
Log Likelihood[c]	328.00		
Akaike's Information Criterion (AIC)	519.00		
Finite Sample Corrected AIC (AICC)	530.00		
Bayesian Information Criterion (BIC)	322.04		
Consistent AIC (CAIC)	353.04		
Root Mean Square Error of Approximation (RMSEA)	0.002		
Goodness-of-Fit Statistic (GFI)	0.942		
Adjusted Goodness of Fit Index (AGFI)	0.910		
Incremental Fit Index (IFI)	0.957		
Comparative Fit Index (CFI)	0.963		

a. Information criteria are in small-is-better form. b. Nutrition Literacy Inventory-28. c. The full log likelihood function is displayed and used in computing information criteria.

models. It was closer to zero and would be better. The root mean square error of approximation (RMSEA) must be less than 0.05, indicating good models (24). The model pointed out the goodness of fit of this model in the study. Additionally, AIC, AICC, CAIC, and BIC (Schwarz criterion) values were shown in bold face to indicate that the corresponding model was favored by the criterion.

As closer measure to 1 in the comparative fit index (CFI), goodness-of-fit statistic (GFI), the adjusted goodness of fit index (AGFI), and the incremental fit index (IFI), they referred to the goodness and fit of model. They were more than 0.90 (Table 5). Results from the factor analysis indicated that all the item loadings were significant at the $P<0.05$ level and all were above 0.70. This indicated further improvement for the generalizability of the revised model to samples in academic settings.

Discussion

There has been a gap in availability of a valid scale for measuring nutrition literacy in Iranian Society. The aim of this study, therefore, was to assess the reliability and validity of a Persian version of nutrition literacy inventory (NLI-28). Since nutritional literacy should be considered, when planning and evaluating nutritional health promotion interventions in the community, the tools used in this study can be a good response to this necessity. The desirability of CVR and CVI values in this study revealed that the Persian version of NLI-28 followed a proper and logical trend.

Reliability means repeatability, and it is assessed through various methods (25). Cronbach's alpha coefficient ($\alpha=0.87$) was used to determine the internal consistency, showing good reliability of the questionnaire. This coefficient was 0.54 for the tool used in the study of Ndahura on teenagers in Uganda (17). Therefore, the reliability of that tool for re-use in the Ugandan student population, as well as for use in other populations, is doubtful. In the study by Guttersrud et al., measuring the critical NL of 473 students, the Cronbach's alpha coefficient was also calculated to be 0.69-0.80 (26).

The Cronbach alpha coefficient of the Nutritional Literacy Scale (NLS) was also 0.84; therefore, the questionnaire had appropriate and acceptable internal consistency (27). Also, in studies that assessed the reliability of the Health Literacy Questionnaire (HLQ), Cronbach's alpha showed suitable and acceptable values; Cronbach's alpha coefficients for the Maindal et al. (28) in Denmark, Osborne et al. (29) in the general population in Australia, Nolte et al. (30) in Germany, and Elsworth et al. (31) in Australia that were equal to 0.83, 0.88, ≥0.77, and ≥0.80, respectively.

These differences may be due to age, language, socioeconomic, and cultural differences among target group populations. Having a higher internal consistency coefficient in the current study shows the stability and reliability of this questionnaire for studies concerned with the Iranian youth population. In this study, the statistic (KMO=0.704) and Bartlett Test (less than 0.001) indicated the factorability of this questionnaire. In Ndahura's study, the KMO was greater than 0.60, and the Bartlett was significant ($P\leq0.05$) (17).

Correlation coefficients were calculated for all NLI-28 constructs; the strongest correlation was between FNL and Grand-NL constructs ($r=0.835$, $P<0.01$), and the weakest correlation was between CNL and FNL constructs ($r=0.164$, $P<0.05$).

Meanwhile, Ndahura's study obtained the strongest and weakest correlation coefficients between INL-disscuss and Grand-NL (r=0.67, P<0.01) and FNL and CNL-media (r=0.09, P<0.05), which the strongest and weakest correlation coefficients between constructs in our study were significantly greater than in Ndahura's study (17).

In the constructing questionnaire, one attitude item--"I use the internet when I am looking for information about nutrition such as diet"-- was deleted because it had the least variance of prediction among all the items. In the study of Ndahura, the lowest score among the INL construct items for adolescents was attributed to this item; Ndahura explained that the reason could be high prices and limited access of teenagers to the Internet in Uganda (17). In Ndahura's study, subjects broadcast on radio and television were food advertisements; therefore, it could be concluded that those who had higher nutrition literacy were less likely to follow the content provided by radio and television (17).

But, the youth had a different understanding of the question, and their perception of the subjects provided by radio and television, scientific and validated nutritional programs such as Hello Doctor, and Your Doctor. It is, therefore, useful to follow radio and television programs that provide scientific and validated nutrition and diet advice. In most texts, nutrition literacy had three main domains of functional, interactive, and critical (9-11). But in many cases, more structures were related to each of the three main domains.

For example, the number of nutritional literacy sub-scales was reported in some studies: Ndahura (17) seven sub-scales (FNL, INL, INL discuss, CNL action, CNL media, CNL influence, Grand NL); Kjøllesdal (32) four sub-scales (FNL, INL, CNL action, CNL scientific); Dalane (33) three sub-scales (INL, CNL action, CNL scientific); and Blegen (34) three sub-scales (FNL, INL, CNL). In this study, the results of exploratory factor analysis showed that 27 remaining items from the NLI-28 were divided into four factors for students, representing 78% of the scale variance.

The indices scores of the confirmatory factor analysis (AIC=519.00, AICC=530.00, BIC=322.04, CAIC=353.04, RMSEA=0.002, GFI=0.942, AGFI=0.910, IFI=0.957, and CFI=0.963) and (initial eigenvalue=1.610) showed acceptable fit for the questionnaire. Similar studies into health literacy also showed a satisfactory fit for the HLQ (28-30). In the factor analysis, all items, except items 1 and 27, were placed on their three dimensions (i.e. FNL, INL, and CNL). In the present study, a new factor (factor 4, including items 1 and 27) was formed.

Item 1 was one of the items of functional nutrition literacy, and item 27 was one of the items of the critical nutrition literacy. According to the text of item 1 (i.e., "I find that the language used by nutrition, health, and food experts difficult to understand"), and item 27 (i.e., "I find it difficult to distinguish scientific information from non-scientific information about diet"), the definition of functional nutrition literacy (i.e., an individual experiences difficulty in understanding and comprehending nutrition messages) and critical nutrition literacy (i.e., the ability to analyze nutrition information critically, increase awareness, and participate in actions to address barriers) (12-14), and similar studies (17, 32-34), these two items can be considered as a subset of functional nutrition literacy.

They were named the FNL scientific (i.e., an individual experiences difficulty in understanding and recognizing scientific and specialized nutrition information). The statistical analysis of the well-known groups, as well as the study by Ndahura, indicated that the Persian version of NLI-28 could differentiate well between sex subgroups (17). As the strengths of the study, it can refer to the novelty of the study in the Iranian Society and other Persian-speaking countries such as Tajikistan, Afghanistan, and Central Asia, the appropriateness of most of the tool validity and reliability indicators, and high response rate. However, being self-administered and relying on individual self-report data may have led to some degrees of bias in the results. However, it can be mentioned that, the level of education, proper collaboration, and the researcher's explanations minimized the amount of bias. The limitation of our study is that the study needs to conduct in other demographic groups (i.e. students-based population, athlete's youth and etc.), also in larger sample size and in divergent society.

Conclusion

According to the findings of this study, NLI-28 had a good validity and reliability for students and can be used to measure their nutrition literacy. In addition, due to the increasing prevalence of nutrition-related diseases, the availability of this scale was helpful in measuring nutrition literacy to plan and evaluate nutrition health promotion interventions and health policy-making for young people and students in the developing countries of the Middle East and Central Asia.

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Conflict of Interest

None declared.

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