Original article

Development and validation of food and nutrition literacy instrument in young people, Turkey

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Abstract. *Background and aim:* To evaluate food and nutrition literacy, measurement tools that include declarative, procedural, and subjective knowledge output are needed. The present study aimed to develop a valid and reliable measurement tool that can evaluate FNL holistically in young people. *Methods:* This study was developed in nine steps under three phases:1) item development and content validity, 2) scale development including pre-testing of questions, sampling and survey administration (by sex with the quota sampling method), item reduction strategies, extraction of factors (exploratory factor analyses), and 3) scale evaluation including confirmatory factor analyses, reliability analyses (Cronbach's α, KR-20, intraclass correlation coefficient) and differentiation by "known groups" with total of 538 young people. *Results:* The instrument consisted of knowledge, attitude, and behavior domain dimensions: (1) knowledge as five factors and (2) attitude and behavior as four factors. After the analysis of the FNL instrument, 51 items were removed from 87 items. The final instrument has 36 items, of which 13 were in the domain of knowledge, 13 in the domain of attitude, and 10 in the domain of behavior. The total variance explained by the domain dimensions of the instrument was ≥55%. The confirmatory factor analysis fit indices were good. There was satisfactory internal reliability for the domain dimensions (≥0.60). There was external test-retest reliability (ICC ≥ 0.84). Women's knowledge level regarding criterion validity was higher than that of men, and the difference was statistically significant ($p < 0.05$). *Conclusions*: This 36 item, three domains dimensional FNL instrument can be used to assess food and nutrition literacy in young people. It can be used to assess and improve food and nutrition literacy in university settings.

Key words: Diet, adolescent, health promotion, health literacy, nutrition

1. Introduction

The issue of Food and Nutrition Literacy (FNL) is receiving growing attention because the incidence of diseases related to unhealthy nutrition is increasing worldwide, including Turkey. The World Health Organization (WHO) stated that more than 1.9 billion adults aged 18 years and over were overweight in 2016, corresponding to 39% of these adults. Approximately 13% of the world's adult population (11% of men and 15% of women) is obese, and the worldwide prevalence of obesity nearly tripled between 1975 and 2016 (1). According to the Turkey Nutrition and Health Survey 2019 report, the risk of cardiovascular disease is determined to be 54.2% high according to waist/hip circumference values in individuals aged 15 and over, and 34.0% are overweight, 27.8% are obese, and 3.7% are morbidly obese (2). In addition to obesity, unhealthy nutrition is a contributing factor for many chronic diseases and obesity-related comorbidities, such as cardiovascular diseases, cancer, and diabetes (3,4).

The term FNL (5-10), has been used slowly in recent years; however, this makes it possible to approach the concepts of FNL with a holistic perspective and proceed through a single terminology (6). Given the definitions made in FNL, we can define FNL as consisting of two outputs, namely process outputs, such as skills and self-efficacy, and result outputs, such as knowledge, attitude, and behavior. These outputs enable individuals to plan their daily meals, make conscious choices within the functioning of the food system in line with their current situation, prepare healthy meals, support the sustainable food system, and become advocates, approaching critically to environmental, social, and global changes (5-9). For people to be literate food and nutrition literacy, the existence, diversity, access, and financial affordability of foods are the top priorities. Although there are hidden factors that influence people's status, nutritional risk-taking, and healthy nutrition habits, also shaped by the influence of environmental determinants. The importance of being food and nutrition literate has been emphasized for individuals to continue their healthy nutrition practices from the late adolescence period (18-21 years) when they gain independence, until the end of their lives and for healthy aging. A high level of FNL enables people to perform healthier nutrition practices, while a low literacy level leads to unhealthy nutrition practices (11).

In Turkey, unhealthy nutritional practices are more common among young people, as they often do not comply with national nutritional guidelines (12). The late adolescent period corresponds to the university study years of young people in Turkey. Young people begin to make their own independent food choices in this period (13). Unhealthy food choices made during this period may negatively affect their well-being in later stages of their lives.

Furthermore, considering the assessment tools developed for FNL in the literature, it can be seen that these measurement tools mainly evaluate process outputs, such as cognitive and skill areas (6,7). There are no integrated assessment instruments available in the literature that measure FNL using result outputs; declarative (knowledge), procedural (attitude), and subjective knowledge (behavior), which are based on the FNL conceptual framework. In this study, we developed an FNL instrument to address this gap in literature.

2. Material and methods

The instrument development process was carried out in three phases (incorporating a total of nine steps) according to current guidelines (14). Detailed information about the steps made in each phase is given (Figure 1). The hypothesis that FNL consists of distinct measurable subjects and domain dimensions was specified before the data collection.

2.1. Phase 1 (Item development)

2.1.1. Step 1 Identification of domains and item generations

In the first phase, in order to conceptualize food and nutrition literacy, both national and international literature were searched (6-9,15-20). To determine the structure of food and nutrition literacy, the most cited conceptual framework of Vidgen and Gallegos (15) in the subject dimensions and the literacy mapping of Truman et al. (9) in the domain dimensions were used. Subject dimensions were determined as planning and management, selection, preparation, and eating, and domain dimensions were determined as results, knowledge, attitudes, and behaviors corresponding to declarative, procedural, and subjective knowledge.

Although deductive methods are dominant (21), in writing the draft survey items, the Turkey Nutrition Guide-2015 (22), scales were developed (6,7,19), and the publications and pages of the Ministry of Health of the Turkish Republic (22, 23) were utilized.

2.1.2. Step 2 Content validity

Field experts (seven public health professionals, three nutritionists, two health promotion and health education professionals and one adolescent health expert) were sent a draft survey with 93 items (37 questions+56 items). Experts were asked to evaluate the suitability of the prepared items to the subject and field dimensions, in accordance with the sent matrix. Experts rated each item as "appropriate", "appropriate but should be corrected," and "not appropriate". Content validity analysis was performed using statistical testing. In line with Lawshe's technique, Content Validity Ratio (CVR) and Content Validity Index

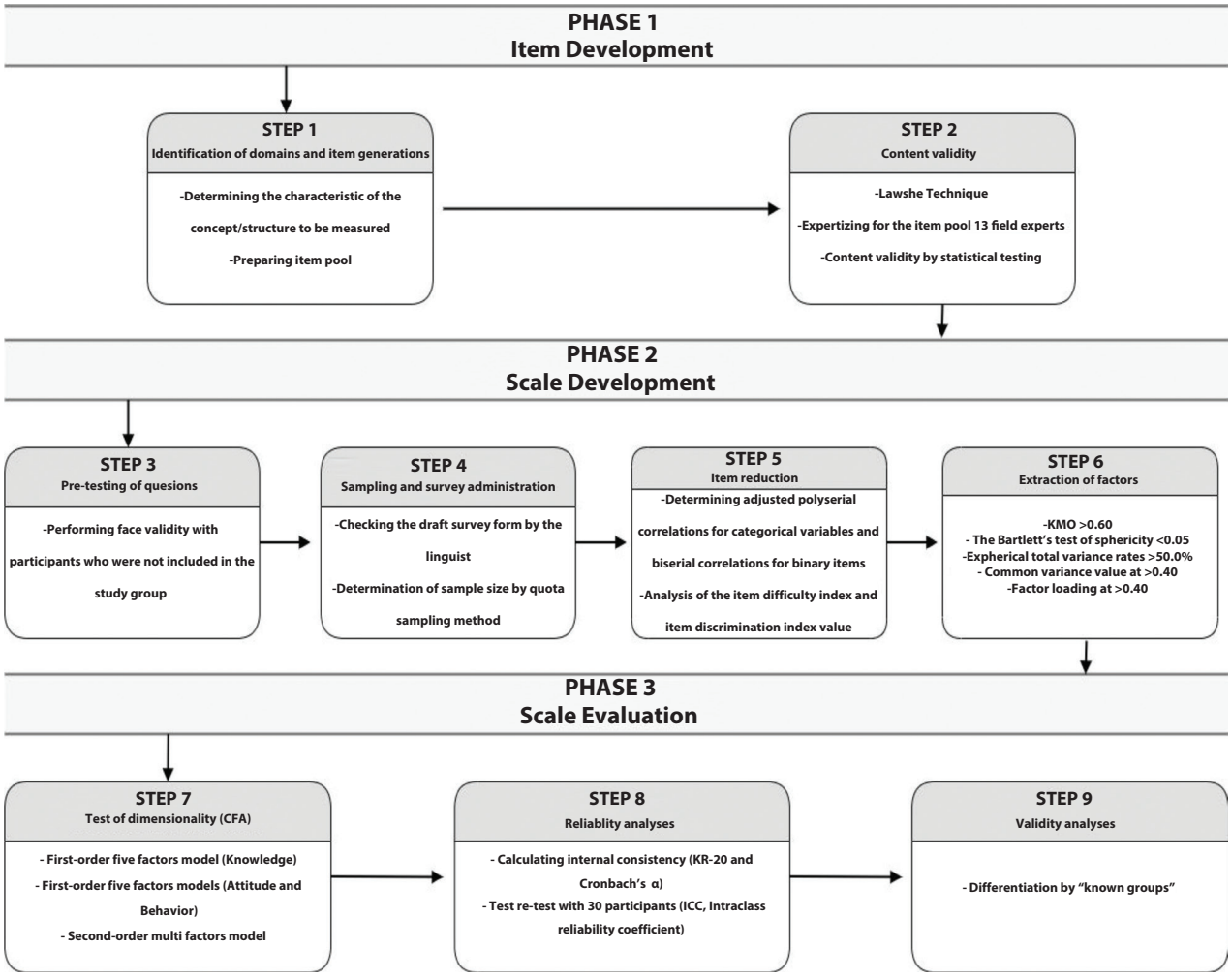

Figure 1. Flowchart of steps followed in the development of the FNL instrument.

(CVI) analyses were performed. If the CVR values are negative or zero, these items are eliminated in the first step. Whether items with a value greater than zero will remain on the scale is determined by looking at the Content Validity Criterion (CVC) (must be CVR>CVC). As 13 expert opinions were obtained in this study, the minimum value specified for the CVC is 0.54. Therefore, items with a value less than 0.54 should be deleted.

2.2. Phase 2 (Scale development)

2.2.1. Step 3 Pre-testing of questions

Face validity was conducted with 20 students (18-21 years) who were not included in the study group but were similar to the students in the sample group. To ensure face validity, (i) to identify confusing items, (ii) identify problematic items, (iii) evaluate item order, (iv) evaluate reponse options, and (v) evaluate the comprehensibility of items to the target population, a focus group interview was conducted.

2.2.2. Step 4 Sampling and survey administration

The research population in methodological type consisted of 4359 students aged between 18-21 years, who had been enrolled in the spring semester of the 2019-2020 academic year in faculties, colleges, and vocational schools located in the central campuses of X University. The quota sampling method is often

preferred in cases with time and resource constraints. Comrey and Lee suggested that a sample of 500 people was very good for scale development (24). The sample size was determined using the quota sampling method (female-male). The sex-specific sampling adequacy was determined to be 500 (Q= 500/4359 ≅ 0.11).

2.2.3. Step 5 Item reduction

Adjusted item-total correlation (polyserial correlations and biserial correlations), item difficulty, and item discrimination indices, which are mostly used to reduce the item pool (14) were calculated. The item difficulty index (p_j) and item discrimination index value (r_{jx}) of the knowledge questions in the FNL instrument were calculated using the Item and Test Analysis Program (Version 19.1.4/Copyright © 2003-2018 Gordon P. Brooks). To assess the r_{jx} of Likert-type items, floor and ceiling effect analyses were carried out for the upper 27% and lower 27% groups (145 students). In particular, we excluded items with a low r_{jx} (< 0.20), non-discriminating items or negatively discriminating items, and a correlation value of less than 0.20. The high t-test values and significant p-values of the items in the attitude and behavior domain dimensions can be interpreted as the high discriminative power of these items.

2.2.4. Step 6 Extraction of factors

In this study, various criteria were used to determine the appropriate number of factors in line with the current guidelines (14). For EFA, the principal component analysis method, Kaiser criterion (≥ 1.0), explained total variance rates (>50.0%), and scree plot were used to determine the appropriate factor number. Only the behavior domain dimension and, explained total variance rates were considered, while the others were ignored. In addition to the above criteria for the EFA, the following exclusion criteria were considered: Kaiser Mayers Olkin Measures of Sample Adequacy value remaining at the level of ≤ 0.50, Bartlett's test of sphericity (> 0.05), common variance value of < 0.40, factor loading of <0.40, difference between items with cross-loadings ≤ 0.10, and not having a factor loading. In the factor analysis trials, a total of 38 items were excluded because they could not meet the above criteria.

2.3. Phase 3 (Scale evaluation)

2.3.1. Step 7 Test of dimensionality (CFA)

Confirmatory factor analyses were performed using the AMOS 23.0.0 (Build 1607, USA) program. To confirm and validate the factor structure and dimensionality of the developed measure, first and second-order multifactor CFA analyses were performed on the knowledge, attitude, and behavior domain dimensions of the FNL instrument. The model fit indices considered were chi-square statistics ($\chi 2/df$), p value, Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR).

2.3.2. Step 8 Reliability analyses

The internal consistency and reliability of the FNL instrument domain dimensions were assessed using the KR-20 and Cronbach's α values, and the test-retest reliability was assessed using the Intraclass Correlation Coefficient (ICC) (95% CI). Experts determined a special criterion for item deletion processes. If the item was deleted, in case of an increase of more than 5% in the reliability coefficient, it was decided to remove the relevant item from the scale in accordance with the literature.

Because it is not appropriate to evaluate the food and nutrition literacy instrument over the total score and different question structures, the reliability coefficient values of only the domain dimensions were calculated. Test-retest analyses were conducted on 30 students within 2-3 weeks using Google Form of the COVID-19 pandemic using Google Forms. In the first application, 49 (excluding seven people) completed the questionnaire. The age of the seven participants did not meet the condition of participation in the study. Thirty participants refill in 2-3 weeks is 30 (n:15 men and n:15 women). In addition, Tukey's additivity test was conducted to show the summability of the field-dimension scores.

2.3.3. Step 9 Validity analyses

For final validity testing, we assessed differentiation by "known groups". Based on the information in the literature that the level of knowledge in food literacy and nutrition literacy is higher in women than in men, the level of literacy was evaluated using sex t-test analysis.

3. Results

3.1. Phase 1 (Item development)

3.1.1. Step 1 Identification of domains and item generations

As a result of the literature review, a comprehensive definition and conceptual framework of food and nutrition literacy were created, and the competencies of food and nutrition literacy were visualized (Figure 2). While the process outputs of food and nutrition literacy are self-efficacy and skill, the outcome outputs are knowledge, attitude, behavior, and advocacy. In this study, however, only the outputs of literacy (according to Truman et al.) were considered, advocacy was not included. Adhering to the conceptual framework of Vidgen and Gallegos, a pool of 93 items was created to reflect the components of the three domain dimensions. The knowledge domain dimension consists of questions with three options (true, false, I do not know), attitude (completely agree to completely disagree), and behavior (always never) domain dimensions with a 5-point Likert-type items.

3.1.2. Step 2 Content validity

After obtaining expert opinions, some amendments were made to create a consensus. As a result of the assessment of the 93 items made by the 13 experts, six items with CVR less than 0.54 were removed (five questions plus one item). The number of items sent to the experts before and after the expert opinion, respectively; knowledge domain dimension 37/32, attitude domain dimension 28/26, and behavior domain dimension 28/29. The CVI values for the knowledge, attitude, and behavior domain dimensions of the FNL instrument were 0.848, 0.832, and 0.890, respectively. Short instructions were created by including informed consent forms in the draft survey. A linguist evaluated the draft survey.

3.2. Phase 2 (Scale development)

3.2.1. Step 3 Pre-testing of questions

Minor corrections were made by evaluating the feedback from 20 students (male:16; female:4). In the face validity application, in line with feedback from the students, incomprehensible items were transformed into an understandable form, the order of items was rearranged, material errors detected were eliminated, and necessary corrections were made concerning the layout. After the face validity application, the prepared draft survey form was reproduced and repeatedly checked by a linguist.

3.2.2. Step 4 Sampling and survey administration

All data were collected through paper and pen/pencil interview (PAPI). Before collecting the data, the students were informed of the study and their questions were answered. During the data collection process owing to the COVID-19 pandemic, 600 people were reached in May 2020. 62 of the 600 data collected from the sample were excluded from the SPSS (version 26.0; SPSS Inc., Chicago, Illinois, U.S.) for various reasons (e.g. not signing, answering by skipping pages, not writing the age, and extreme values) being deemed invalid. There were no significant changes due to the exclusion of surveys from the study. The valid dataset consisted of a total of 538 people. The final quota was Q = 538/4359 $\cong$ 0.13. A second tour could not be organized because of the COVID-19 pandemic.

Fifty-seven point six percent (n=310) of the students were female, and 42.4% (n=228) were male, with a mean age of 19.2 (±0.9), with a median was 19.0 years. The youngest student was 18 years old and the oldest was 21 years old.

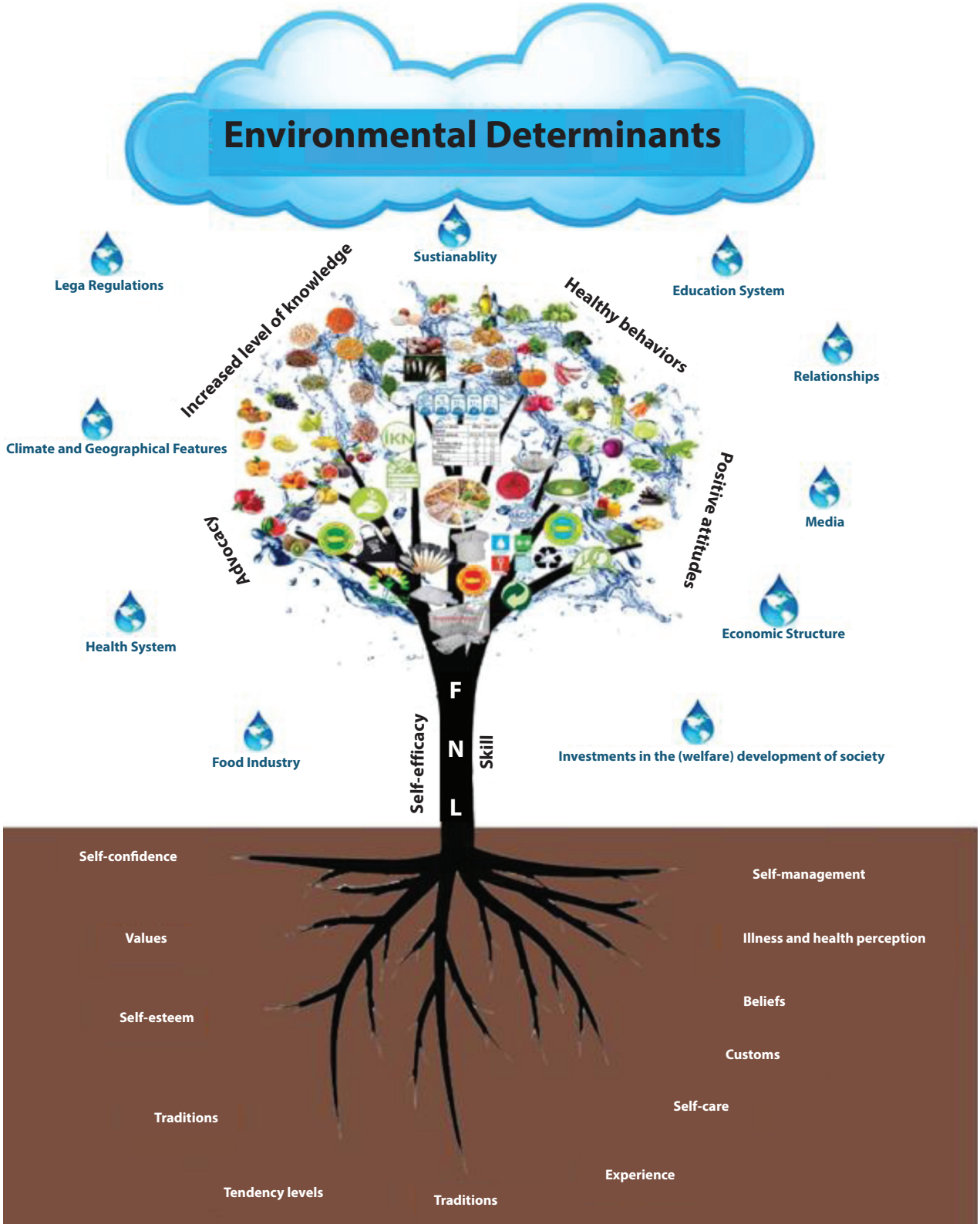

Figure 2. Representative food and nutrition literacy tree (32).

3.2.3. Step 5 Item reduction

Items with very low adjusted item-total correlations (< 0.30) and low r_{jx} values (< 0.30) were less desirable. (14) In the knowledge, attitude, and behavior domain dimensions, six, three and four items were excluded due to low item discrimination index, non-discriminating items, and correlation values, respectively. Only some items (A4, A6, A12, A13; B3, B7, B8) with corrected item-total correlation values between 0.21-0.29 in the domain dimensions of attitude and behavior in line with the opinions of experts were not deleted. These items were deemed important by experts. Thus, the number of items in the FNL instrument was 74.

3.2.4. Step 6 Extraction of factors

When problems, such as no factor loading, cross-loading, or low factor loading, were encountered, EFA analyses were performed by removing the relevant items each time. Thirteen, ten and fifteen items were removed, respectively, because they did not comply with the criteria determined at the beginning in the domain dimensions of knowledge, attitude, and behavior. A total of 36 items remained (knowledge:13; attitude:13 and behavior:10). The Kaiser Mayers Olkin value was in the range of 0.606-0.821. Bartlett's sphericity value was $p < 0.001$ for all tests. The common variance values of the remaining items in the domain dimensions range from 0.410 to 0.903. It was observed that the factor loads take values in the range of 0.457-0.946. In the FNL instrument, if the question or item was deleted, Cronbach's α values ranged from 0.533 to 0.761. The percentages of the explained total variance by the knowledge, attitude, and behavior domain dimensions of the FNL instrument were 60%, 55%, and 63%, respectively (Table 1).

As a result of the EFA, the knowledge domain dimension consisted of five factors, and the attitude and behavior domain dimensions consisted of four factors. Only in the knowledge domain did a new dimension emerge that was slightly different from the initially created model. Items in this dimension did not intervene because they both worked well and revealed an important subject (sustainable food system).

The r_{jx} values of the questions in the knowledge domain dimension varied between 0.43 and 0.83, and the mean item difficulty index value was 0.79. It was observed that the items in the dimensions of attitude and behavior had distinctive features at the $p < 0.001$ level (except for the A6 item; $p = 0.026$).

3.3. Phase 3 (Scale evaluation)

3.3.1. Step 7 Test of dimensionality (CFA)

In the first model, a first-order multi-factor analysis was applied to the knowledge, attitude, and behavior domain dimensions of the FNL instrument. In the second model, at second-order multi-factor model analysis was conducted and its suitability was investigated (Figure 3).

Factor loadings for the first-order five-factor analysis of the knowledge domain dimension ranged from 0.17-1.33. The ranges of factor loading values for the attitude domain dimension were 0.38–0.54 (planning and management), 0.28–0.65 (selection), 0.54–0.71 (preparing), and 0.36–0.71 (eating). The ranges of factor loading values for the behavior domain dimension were 0.41-0.69 (planning and management), 0.61-0.63 (selection), 0.50-0.52 (preparing) and 0.51-0.80 (eating). When the fit indices of the FNL instrument were examined, χ^2/df was ≤ 2.44, $p \leq 0.003$, GFI ≥ 0.90, CFI ≥ 0.90, RMSEA ≤ 0.05 (0.04-0.06), and SRMR ≤ 0.05 (Table 2).

3.3.2. Step 8 Reliability analyses

Kuder Richardson-20 and Cronbach's α reliability coefficients of the FNL instrument domain dimensions were 0.61, 0.76, and 0.73, respectively. The knowledge domain dimension had a KR-20 value that was below the acceptable threshold of 0.70. The Intraclass Correlation Coefficient (ICC) showing the test-retest reliability of the FNL instrument domain dimensions was satisfactory stability [≥ 0.84 (0.67-0.92)] (Table 3).

Tukey's additivity test results for the FNL instrument domain dimensions showed that the probability of non-additiveness was insignificant ($p > 0.05$).

3.3.3. Step 9 Validity analyses

The mean total score of the knowledge domain dimension of the FNL instrument was 10.51 ± 2.1 for

Table 1. Results from the exploratory factor analysis and reliability coefficient values if item deleted of FNL scale.

Dimension	Questions	Factor Loadings					KR-20 if item deleted
		Planning and Management	Selection	SFS[1]	Preparing	Eating	
Knowledge	Q 1- If inadequate and unbalanced choices are while planning the meal menu, the productivity of made the person decreases, and the person experiences lack of interest and attention.	**0.724**	-0.013	0.001	-0.007	0.127	0.605
	Q 2- When planning a meal menu, foods in different colours such as red, green and white should be included in the menu.	**0.703**	0.016	0.004	0.046	-0.129	0.620
	Q 3- Protect the material inside the package from moisture.	-0.052	**0.750**	0.049	0.148	-0.008	0.555
	Q 4- Throw the packaging to waste after using the product.	0.035	**0.671**	0.037	-0.199	0.028	0.586
	Q 5- It is used in the packaging of substances and materials that contacts with foodstuffs.	0.037	**0.707**	0.162	0.125	-0.135	0.545
	Q 6- Protect from sunlight.	-0.005	**0.778**	-0.123	-0.031	0.113	0.580
	Q 7- Indicates that the product is made from recycled material.	0.031	0.069	**0.927**	0.038	-0.005	0.533
	Q 8- Indicates that the packaging is made from recyclable material.	-0.025	-0.033	**0.946**	-0.063	0.043	0.565
	Q 9- When cooking on the grill, the distance between the coal fire and the meat should be 10-15 cm.	0.016	0.168	-0.046	**0.656**	0.071	0.588
	Q 10- Raw foods such as meat, chicken and fish should not let to contact with other foods.	0.035	-0.132	0.048	**0.599**	0.144	0.615
	Q 11- Taste controls of the food should be done with a separate spoon, not the spoon with which the food is mixed.	0.000	-0.015	-0.008	**0.680**	-0.151	0.605
	Q 12- Obesity and obesity risk are generally evaluated using the body mass index (calculation of weight versus height) method.	0.268	0.035	0.005	0.006	**0.741**	0.597
	Q 13- Unhealthy diet and sedentary life lead to very serious health problems such as obesity, diabetes, cancer and heart diseases.	-0.222	0.015	0.044	0.049	**0.761**	0.605
	Eigenvalue	1.02	2.68	1.45	1.47	1.17	
	Explained Variance %	8	21	11	11	9	

Dimension	Items	Factor Loadings				Cronbach's α if item deleted
		Planning and Management	Selection	Preparing	Eating	
Attitude	I 1- In order to prepare meals in a short time, ready-made foods, frozen foods and processed vegetables should be preferred.	**0.554**	0.088	-0.110	0.329	0.751
	I 2- Non-food needs should be given priority in our monthly budget.	**0.457**	-0.284	0.296	0.156	0.743
	I 3- I think a healthy menu consists of expensive foods.	**0.631**	-0.212	0.222	-0.060	0.747
	I 4- It is difficult to decide which group of foods should be included in a healthy menu.	**0.754**	0.184	-0.094	-0.214	0.760
	I 5- It is more important for me that the food is filling and delicious rather than being healthy.	0.194	**0.563**	0.078	0.435	0.739
	I 6- It is not beneficial to choose geographically marked food products (such as Malatya apricot, Finike orange, Taşköprü garlic) while shopping for food and beverage.	-0.049	**0.694**	0.231	-0.077	0.759
	I 7- I become glad when the rules are followed at all stages, from the field to the presentation of food products to the table.	-0.106	0.038	**0.801**	-0.001	0.738
	I 8- I don't think that reducing the amount of salt in bread is beneficial in terms of nutrition.	0.094	-0.053	**0.630**	0.111	0.734
	I 9- Trying new recipes with vegetables is a waste of time.	0.220	0.165	**0.544**	0.140	0.724
	I 10- It doesn't make me angry when the foods with broken or torn packagings are on the shelves.	-0.171	0.019	**0.834**	-0.042	0.740
	I 11- I find it difficult to cook based on the recipe.	0.182	0.162	**0.584**	-0.079	0.735
	I 12- Potatoes cooked with low oil in the oven should be eaten instead of french fries.	-0.038	0.171	-0.031	**0.796**	0.757
	I 13- Meals should not be skipped for a healthy diet.	-0.079	-0.210	0.095	**0.666**	0.761
	Eigenvalue	1.39	1.00	3.50	1.21	
	Explained Variance %	11	8	27	9	

Table 1 (*Continued*)

Dimension	Items	Factor Loadings				Cronbach's α if item deleted
		Planning and Management	Selection	Preparing	Eating	
Behavior	I 1- I reach information about how healthy food consumption should be.	**0.566**	0.314	0.063	0.331	0.686
	I 2- If I eat too much at one meal, I include foods with low energy value (such as vegetables, fresh fruit) in my next meal.	**0.686**	0.113	0.003	0.232	0.699
	I 3- In order to be able to eat healthy, I make sure to convey my requests to the officials/relevant persons at my school/institution or at the places where I stay/eat.	**0.719**	0.151	0.033	-0.188	0.719
	I 4- I guide my friends or acquaintances who have weight problems about what kind of foods they should stay away from.	**0.634**	0.019	0.085	0.332	0.699
	I 5- I drink at least 2 liters (8-10 glasses) of water a day.	0.015	**0.802**	0.232	0.132	0.699
	I 6- I do 30 minutes of brisk walking 4-5 days a week.	0.180	**0.765**	-0.006	0.174	0.695
	I 7- I cook the food with methods such as boiling, grilling, baking, steaming.	-0.020	-0.025	**0.801**	0.252	0.729
	I 8- While washing the vegetables, I soak and keep them in water for a long time several times.	0.084	0.216	**0.760**	-0.158	0.732
	I 9- I calculate my own body mass index.	-0.016	0.183	0.050	**0.843**	0.709
	I 10- I adapt the nutritional recommendations which I read from scientific sources to my daily diet.	0.423	0.242	0.069	**0.593**	0.681
	Eigenvalue	3.07	1	0.86	1.30	
	Explained Variance %	31	10	9	13	

[1] It is an abbreviation for Sustainable Food System.

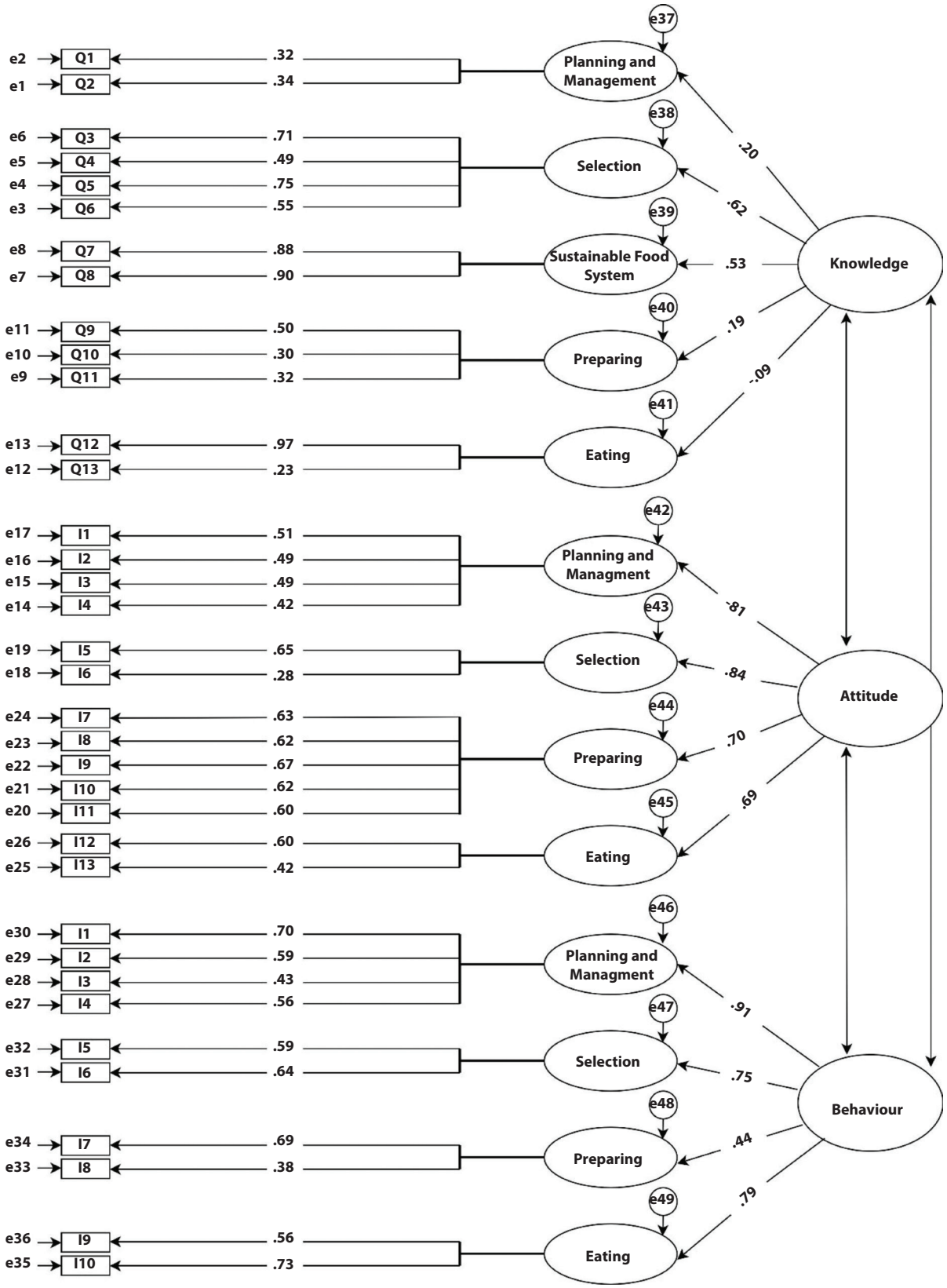

Figure 3. Demonstration of the second-order confirmatory factor analysis factor loadings of FNL instrument.

Table 2. The fit indice values of the first order and second-order model of FNL Instrument (n=538).

CFA Fit Indexes[1]	First-Order			Second-Order
	Knowledge	Attitude	Behavior	
χ^2	105.682	141.487	53.813	1022.370
df	54	58	29	578
χ^2/df	1.957	2.439	1.856	1.769
p value	<0.001	<0.001	0.003	<0.001
GFI	0.970	0.961	0.980	0.902
CFI	0.957	0.925	0.970	0.895
RMSEA (90% CI)	0.042 (0.030-0.054)	0.052 (0.041-0.063)	0.040 (0.023-0.056)	0.038 (0.034-0.042)
SRMR	0.035	0.046	0.033	0.048

[1] Chi-square (χ^2); the degrees of freedom (df); the Goodness of Fit Index (GFI); the comparative fit index (CFI); the Root Mean Square Error of Approximation (RMSEA); Confidence Interval (CI); Standardized Root Mean Square Residual (SRMR)

Table 3. Cronbach's α coefficient, ICC for the FNL instrument dimensions.

Dimensions of FNL[1]	Number of questions/items	Cronbach's α (n=538)	ICC (95% CI) [2] (n=30)
Knowledge	13	0.605	0.91 (0.80-0.96)
Attitude	13	0.761	0.88 (0.75- 0.94)
Behavior	10	0.727	0.84 (0.67-0.92)

[1] It is an abbreviation for Food and Nutrition Literacy
[2] ICC= Intraclass Correlation Coefficient; CI: Confidence Interval

females and 10.05±2.1 for males. In addition, looking at the median score (female: 11.0, male: 10.0), we observed that females had a higher score than males, and this difference was statistically significant (p = 0.005) (Table not shown).

3.4. Scoring

The ranges of total scores between the minimum and maximum values in the knowledge, attitude and behavior domain dimensions of the FNL instrument were 0-13, 13-65 and 10-50 points, respectively.

The cutoff points for each domain dimension were determined. To be able to compare with the FNL instrument and to avoid problems as a result of adaptations, all the scores that can be obtained from the field dimensions of the FNL instrument have been standardized as 0-50 points. For the sake of comparability, the three scores were standardized on a scale from a minimum of 0 (lowest FNL level) to a maximum of 50 (best FNL level), using the formula (25):

$$\text{FNL Index} = [(\text{FNL Index Mean} - 1)\ X\ (50:4)]$$

The ability of both scoring systems to predict each other was examined using regression analysis (min. R^2= 0.81; p < 0.001) (Table 4).

4. Discussion

The 36-item instrument, comprising three outputs (26 Likert-type items plus 10 knowledge questions), was validated in a population of Turkish young people using mixed methods. This is the first study evaluate

Table 4. Cut-off points of the FNL instrument domain dimension scores.

	Cut-off points	Standardized equivalents of 50 points	The state of predicting each other of scores	Scoring categories
Knowledge	≤ 9 point	0-32 point	B= -1.04; SE: 0.063; β= 0.31; t= 2697.504; p < 0.001; R= 0.913; R^2= 0.834	Inadequate FNL knowledge level
	10-11 point	33-42 point		Limited FNL knowledge level
	≥ 12 point	43-50 point		Excellent FNL knowledge level
Attitude	≤ 43 point	0-25 point	B= -1.71; SE: 0.088; β= 0.08; t= 2220.107; p < 0.001; R= 0.898; R^2= 0.806	Inadequate FNL attitude level
	44-51 point	26-33 point		Limited FNL attitude level
	≥ 52 point	34-50 point		Excellent FNL attitude level
Behavior	≤ 25 point	0-18 point	B= -0.84; SE: 0.061; β= 0.10; t= 2319.872; p < 0.001; R= 0.901; R^2= 0.812	Inadequate FNL behavior level
	26-33 point	19-29 point		Limited FNL behavior level
	≥ 34 point	30-50 point		Excellent FNL behavior level

* Simple linear regression analysis was applied.

FNL in young people using a comprehensive model that includes output aspects of declarative, procedural, and functional knowledge. The measurement tools to be developed include identifying the role of attitudes and behaviors (8), exploring the dimensions of planning and management (20,26), trying to capture all the components of Vidgen and Gallegos, developing more comprehensive measurement tools (20), going beyond functional skills (27), and not only focusing on declarative knowledge (17). The developed FNL scales are limited in number, and modelings has been performed on process outputs by focusing on declarative knowledge and skill areas (6,7,10). In this measurement tool, the subject dimensions were based on the components of Vidgen and Gallegos (15), which are the most accepted in the literature, and they were developed with different modelling regarding the domain dimensions, covering declarative, procedural, and functional knowledge outputs (9). Measurement tools developed for food literacy and nutrition literacy have been criticized for their narrow scope and for being aimed at process outputs. In our country, there are no comprehensive measurement tools that holistically deal with FNL. This measurement tool, which we developed in accordance with Turkish culture to evaluate FNL levels, can contribute positively to the reduction of health problems associated with unhealthy nutrition, which is an important public health problem, as well as the main risk factor worlwide and in our country, and to raising healthy generations.

In the EFAs, the initially designed model structure was revealed in the attitude and behavior domain dimensions, with only a slight difference in the knowledge domain dimension. When the literature is examined, if there is a difference between the model that the researchers designed initially and the final model, it may be necessary to modify the model, even if it is small (6,7,10). The emergence of a factor different from the first model in the knowledge domain dimension of the FNL instrument was acceptable as a small change. Additionally, it is thought that this situation is at a level that does not cause a problem in the general modelling of the instrument. When the items under the new factor were examined, it was decided to name them sustainable food systems. This dimension was defined in line with the millennium development goals. In at sustainable food system, emphasis is placed on responsible food consumption. This dimension, where a consensus was reached on the relevance of the questions, is called reducing per capita global food waste by half at the consumer level by paying attention to the packaging of the food products consumed and changing the way of consuming and exhibiting conscious, environmentally sensitive consumer purchasing behaviors (28).

However, the factor loading of the subject dimensions of planning and management, preparation and

eating remained low in the knowledge domain dimension. In the evaluation of related subject dimensions and items with low factor loadings, both the opinions of experts and other criteria (for reasons such as high factor loading in EFA, good item discrimination, and the status and importance of the dimension when the mentioned items were removed) were carefully examined. Before removing any item from the instrument, it was considered appropriate to omit it because it was necessary to examine it from many aspects and decide to remove it. The model fit indices indicate that the absence of these items does not affect the validity of the FNL instrument.

Confirmatory factor analysis index values were found to be at a satisfactory level. In the second-order model, the CFI and GFI were very close to the 0.91. These values are low, but within the acceptable range. At the same time, we emphasize that all model fit indices should be evaluated together since it would not be correct to make a decision by looking at any model fit index. Generally, the CFA results for the FNL instrument were good, indicating that the instrument model matched its theoretical structure and validity.

As it is not appropriate to use the total score from the domain dimensions of the FNL instrument, only the reliability coefficients of the domain dimensions are given. The scoring of each domain dimension should be evaluated independently.

The reliability coefficients of the FNL instrument domain dimensions, except for the knowledge domain dimension, generally exceeded the standard of 0.70. The KR-20 coefficient value of the knowledge domain dimension was the minimum acceptable value. This may be due to the limited number of questions in the knowledge domain dimension, but 0.60 is an acceptable value for knowledge questions (29). Similar findings have been reported on FNL scales, including knowledge questions (6,7,10). Additionally, lower reliability estimates do not necessarily negate the value of the domain dimension because experts evaluate the dimensions and items. The internal consistency coefficients of the field dimensions of the FNL instrument were reliable.

Although there are different sample groups in the literature, studies show that women have a higher level of knowledge regarding FNL than men (16,18,30). Similarly, in this study, the FNL knowledge level of the women was significantly higher than that of the men. We can say that this criterion, which we determined for the knowledge domain dimension of the FNL instrument, meets the criterion validity because it is compatible with previous studies. Since there is no generally accepted output of the outputs as attitude and behavior in food and nutrition literacy, only declarative knowledge output has been evaluated. Its use with instrumentsthat measure the same dimensions in future studies may reveal its effectiveness.

The test-retest stability coefficient values in the domain dimensions of the FNL instrument were ≥ 0.84. An ICC above 0.75 are defined as excellent (31). The ICC value of our instrument and the Cronbach's α values for these coefficient values were high and showed a significant relationship.

In the literature, some of the scales developed for food literacy or nutrition literacy are evaluated using the total score (6,7,10) whereas others are evaluated using cut-off points (16, 18). The suitability of the cutoff points of both scoring systems was also demonstrated through the analyses. Each domain dimension was evaluated within itself during the scoring of the FNL instrument. Creating the scoring system of the instrument, determining the cut-off points, and revealing the relationship structure based on evidence.

A limitation of our study is that a larger sample size could not be reached due to the COVID-19 pandemic. Additionally, both EFA and CFA were performed on the same sample group, which is a limitation. Future studies should confirm the factor structure and reliability of a larger and more representative sample group.

5. Conclusions

The final instrument has 36 questions/items, of which 13 exist in the domain of knowledge, 13 in the domain of attitude, and 10 in the domain of behavior. The FNL instrument developed as a result of this research is unique in terms of handling the situation from many aspects by designing in line with the new outputs, being a model designed with a different approach in the evaluation of FNL, filling in the gap

stated in the literature with regard to this issue, and making an important contribution to the literature.

In nutrition and dietetics clinics, determining and approaching literacy levels at the first contact with patients and before giving the diet will contribute to the development of nutritional health. The developed instrument can also play an important role in evaluating the effectiveness of health education and health promotion programmes. In addition, educational modules specific to literacy levels can be developed.

The developed FNL instrument was applied to 18-21 age group students studying at X University. Thus, additional studies are required to apply the developed instrument to groups with different sociodemographic characteristics. It is believed that it will be important to add the sustainability and advocacy dimensions in the scale studies to be developed. It is thought that adapting the instrument to different languages and using it in international comparisons will contribute to the scientific field.

Ethics Statement: The study involving human participants was reviewed and approved by the Sinop University Human Research Ethics Committee. The participants provided their written informed consent to participate in this study.

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