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Original Article

Development of a reliable and valid adolescence nutritional knowledge questionnaire

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Summary. We aimed to develop a valid and reliable questionnaire to measure the knowledge level of adolescents. We performed a comprehensive literature review and chose 49 items for the questionnaire. Totally 11 items were excluded from the questionnaire. Spearman's rank correlation coefficient was used to measure the level of agreement between responses at test and re-test. Finally, the questionnaire consisted of 38 items and three subscales, including 12 items that were incorrect statements. The adolescent population who participated in the study included 43.9% boys, and 56.1% girls. A total of 9.7% were overweight, and 4.6% were obese. Cronbach's alpha coefficient was 0.85 overall. Retest reliability scores were significant ($r = 0.69$, $P < 0.001$). Median scores from the questionnaire were lower in boys (Median: 24 min: 0, max: 34) than girls (Median: 26 min: 7, max: 36) and in adolescents living in rural areas (median: 22, min: 7, max: 32) compared with those living in urban areas (median: 26 min: 0, max: 36) ($p<0.001$). The instrument is a practical and easy-to-administer tool with acceptable reliability in high school students.

Key words: nutrition, adolescent, knowledge level, reliability, validity

Introduction

Dietary habits affect the everyday life of adolescents, from their healthy growth and development to school success and daily performance. Poor dietary habits also increase the likelihood of iron-deficiency anemia and may increase the risks of chronic diet-related diseases, such as ischemic heart disease and cancer (1, 2). One of the most important health problems in adolescents is obesity, according to the "Health Behavior in School-aged Children" survey (HBSC). A large-scale study of 15-year-old adolescents in Turkey between 2001 and 2002 reported that 14% of boys and 5% of the girls were overweight or obese. These percentages increased to 17% and 6%, respectively, in another study in 2009-2010 (3).

Behavioral patterns that develop during adolescence likely influence long-term behaviors because identity development and increased autonomy and independence that occur during this time (4). Also it is suggested that dietary habits are one of the predisposing factors of obesity like lifestyle patterns and consumption of high caloric foods (5). Therefore, the dietary habits of adolescents must be a public health priority (6). Any changes that occur as a result of an educative intervention during these formative years are more likely to continue into adulthood as healthy preferences (4). The morbidity and mortality that are associated with lifestyle diseases could be reduced if satisfactory nutritional practices are adopted early in life and maintained over the long term (7-9). The Ministry of Health of the Republic of Turkey developed an action plan entitled "Turkey Healthy Eating and Active Life Program (2010-2014). The plan envisages an adolescent obesity intervention that supports healthy eating and physical activity using interactive educational and behavioral support. An epidemiological tool to measure and monitor the effectiveness of interventions is needed. An evaluation of the efficacy of a nutritional intervention program should be measured

using changes in nutritional knowledge before changes in eating habits.

There are many factors that influence eating habits, including nutritional knowledge (10). Evidence of the influence of nutritional knowledge on dietary intake was demonstrated in several previous studies (11-14). Programmes that aim to increase nutritional knowledge have positive results according to several studies (10). However, other studies found no significant relationship. Explanations for these inconsistent results include poor measurements of knowledge (e.g., lack of relevance, poor conceptualization, different levels of specificity of knowledge and dietary habits), different measurements of knowledge, poor measurements of dietary intake, lack of statistical power and the failure to consider that nutritional knowledge is just one of the many factors that influence dietary behavior (15).

There are no validated and commonly used tools to measure nutritional knowledge in nutrition intervention programmes for adolescents in Turkey. Therefore, we developed a valid and reliable questionnaire to measure the knowledge level of adolescents.

Materials and methods

Establish the face and content validity of the Adolescent Nutrition Knowledge Questionnaire (ANKQ)

Initially, we examined recent literature and educational materials from the Turkey Public Health Agency about nutritional problems in adolescence and related causal factors. We performed a comprehensive literature review and discovered many items that measured nutritional knowledge level. We chose 49 items for the questionnaire according to specialists' recommendations. The items were enumerated according to specialists' recommendations and issue integrity. The items were assessed in three domains: adequate and balanced nutrition (1st to 11th, 36th, and 37th items), essential nutrients (12th to 35th items), and malnutrition-related diseases (40th to 49th items). Items consisted of complete sentences of correct or incorrect statements. We asked adolescents to answer 'right', 'wrong' or 'do not know' for each item. Seventeen of the items were incorrect statements.

The ANKQ benefitted from several other questionnaires, guidelines and studies: items 1-10, 13, 14, 33, 47, 48 and 49 were created from the educational materials of the Turkey Public Health Agency; items 11, 15-24, 27, 28, 29, 31, 34, 35, 42-46 were derived from a questionnaire in the "Validation of a general nutrition knowledge questionnaire in a Turkish student sample"; items 12, 25, 26, 30, 32, 40, 41 were obtained from a questionnaire in the "Influences of constructivist-oriented nutrition education on urban middle school students"; and items 38 and 39 were derived from the "Food knowledge survey", which was created by Deakin University (16-18).

Seven experts (Four epidemiology specialists, two dieticians and a high school teacher) were asked to review the items in the questionnaire to determine the construct validity. They were asked to assess the items in three groups: 'essential', 'useful but inadequate' or 'unnecessary'. The specialists' found three unnecessary items, and these items were excluded from the questionnaire. A Turkish language specialist evaluated the completed questionnaire, and the necessary changes were made. A pilot study of the questionnaire was performed on 27 high school students who were asked to insert written comments and provide verbal feedback. All of the students reported that the numbered items were clear. Cronbach's alpha coefficient was 0.87 for the pilot study.

Study group and procedure

The Ethics Committee of Eskisehir Osmangazi University and high school management reviewed and approved the study. All participants gave informed consent.

The study was performed in Eskisehir between November and December 2013. Eskisehir where the majority of people deal with agriculture and industry is located in Central Anatolia and has a population of 790,000. There are 40,000 high school students in the city.

The sample size was calculated as 460 students based on the statement "sample size should be 5 to 10 times the number of items in the study questionnaire" (19). However, we assumed that individuals may be lost during test-retest period. Therefore, the sample size was increased by 50%, for a total of 711 students.

The study was performed in two randomly selected high schools from urban and rural areas based on the sample size.

Evaluation

Participants completed a questionnaire on sociodemographic characteristics, including age, sex and socioeconomic status. The questionnaire also included whether the participant had received nutritional training.

Students were asked to record their weight without clothes and height without shoes. These data were recorded in kilograms (kg) and centimeters, respectively, to compute the body mass index (BMI) as weight (kg) divided by height (m^2). The analysis presented here used the international BMI standards for young people adopted by the International Obesity Taskforce (IOTF), which are called the IOTF BMI cut-off points (20).

Questionnaire administration required between 20 and 25 min. Re-tests were performed 2 weeks after the first application. Students who were not in school, answered less than 90% of the questionnaire or did not complete the re-test were excluded from the study.

Reliability analysis

Discrimination and difficulty indices

Difficulty and discrimination indices were calculated for each item. The difficulty index confirms that an appropriate range of results, which are neither too easy nor too difficult, is assessed for the population under study. Knowledge questions should be not too easy or too difficult, and an appropriate range falls between 20% to 80% correct responses. This index is calculated using the formula P= (H+L/N)*100, where P is the item difficulty index, H is the number of students answering the item correctly in the high achieving group, L is the number of students answering the item correctly in the low achieving group, and N is the total number of students in these two groups. Other reliability tests include measures of robustness, such that tests can differentiate based on a range of ability, e.g., high or low knowledge. This factor was measured quantitatively using an item discrimination index, which measures the ability of the item to discriminate between participants who do well on the test and participants who do not. The discrimination index was calculated using the formula d= (H-L/N)*2. The suggested criterion for inclusion is that items should correlate with the total score beyond a value of 0.20 (21). Five items were excluded from the questionnaire based on the difficulty and discrimination indices. The upper limit was 90% for the study difficulty index. Items that were too easy, too hard or exhibited low selectivity were excluded.

Internal Consistency

Cronbach's alpha coefficient and item total correlation were calculated for the reliability analyses of each subscale. Items greater than 0.20 of total item correlations were considered reliable. Three items were less than 0.20, and these items were excluded from the questionnaire (22).

Test-retest reliability

The stability of the instrument over time was tested using the test-retest reliability method. Spearman's rank correlation coefficient was used to measure the level of agreement between responses at test and re-test.

Scoring

The final scale had 38 items with three sub-dimensions. The expression was incorrect for 12 items. Each correct answer was worth 1 point. Incorrect statements were encoded inversely to the other items. The maximum score was 38 for the entire scale: 9 for "adequate and balanced nutrition", 21 for "essential nutrients", and 8 for "malnutrition-related diseases" sub-dimensions. The minimum score was zero for the entire scale and all sub-dimensions.

Statistical analysis

SPSS version 20.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for data analysis. The demographic characteristics of the study group were reported using descriptive statistics (frequencies, proportions, means and medians). Initially, the normality of the total scores was tested using the Kolmogorov-

Smirnov normality test and graphs. To calculate the cut-off points, scores received from the questions were divided into two sets with K-Means clustering analysis. Then, the points obtained by reference to the cluster properties were evaluated by the ROC Analysis. Nutrition knowledge levels of those who obtained 22.5 and over scores as a result of the ROC Analysis were considered to be adequate. Therefore, the median scores were compared using Kruskal Wallis (and Bonferroni's ad hoc test) and Mann-Whitney U tests.

Results

There were a total of 789 students in the schools and the study group consisted of 711 students (90.1%). The adolescents who participated in the study included 43.9% boys and 56.1% girls. A total of 28.3% were living in rural areas, and 71.7% were living in urban areas. The mean age of adolescents was 16.0 years (SD 1.19, min. 14 years, max 20 years). Of the adolescents, 37.4% was 15 and lower, 23.2% was 16 years, and 39.4% was 17 and over years. W7e divided age group as 15 and lower, 16, 17 and over according to information that grade 1 students were 15 years of age roughly, grade 2 students were aged 16 years of age roughly and grade 3 students were 17 years of age roughly. Data on BMI scores showed that 85.7% of the adolescents were normal, 9.7% were overweight, and 4.6% were obese.

Discrimination and difficulty indices

The difficulty index of the first item, the definition of an adequate and balanced diet, was 97.04% (easy items), and a low discrimination index was found (0.05). A low difficulty index (14.13%, difficult items), in combination with a low discrimination index (0.00), was found for the frequency of basic food groups consumption. Finally, low difficulty indices were found for the identification of olive oil and sunflower oil, comparisons between fruit juice and fruit, and a comparison of iron amount between meat and spinach. These items were excluded from questionnaire.

The discrimination and difficulty indices of adequate and balanced nutrition subscales ranged between 31.01%- 83.54% and 0.24-0.36, respectively, essential nutrients subscales ranged between 19.40%-86.91% and 0.20-0.50, respectively, and malnutrition-related disease subscales ranged between 61.39%-83.75% and 0.28-0.49, respectively. Reliability analyses and difficulty and discrimination indices of the items are summarized in Table 1.

Internal consistency

Internal consistency was assessed by calculating Cronbach's alpha, and the value was 0.62 for adequate and balanced nutrition subscale, 0.78 for the essential nutrients subscale, 0.70 for the malnutrition-related disease subscale and 0.85 for overall items. The deletion of any item from questionnaire produced Cronbach's alpha values that ranged between 0.58-0.62 for the adequate and balanced nutrition subscale, 0.75-0.77 for the essential nutrients subscale, and 0.65-0.70 for malnutrition-related disease subscale. Corrected item total correlation coefficient ranged between 0.20-0.36 for the adequate and balanced nutrition subscale, 0.20-0.44 for the essential nutrients subscale and 0.23-0.46 for the malnutrition-related disease subscale.

The largest change in Cronbach's alpha occurred in the adequate and balanced nutrition subscale. The largest change in Cronbach's alpha was attributable to settlement area when socio-demographic properties were taken into account. Significant changes were not noted in age group. The largest change to Cronbach's alpha also occurred in the adequate and balanced nutrition subscale when sex was taken into account.
The subscale and overall Cronbach's alpha values of the subscales and overall ANKQ for the study population grouped by socio-demographic properties are summarised in Table 2.

Test-Retest reliability

A high positive correlation was observed between the total scores of the two applications using Spearman's rank correlation analysis ($r = 0.69$, $P < 0.001$). The correlation coefficient of the adequate and balanced nutrition subscale was 0.57, the essential nutrients subscale was 0.61, and the malnutrition-related diseases subscale was 0.44. A scatter plot of the ANKQ test-retest scores is shown in Figure 1.

Table 1. Reliability analyses and difficulty and discrimination indices of the items

Items	Corrected item total correlation	If item deleted Cronbach's alpha	Difficulty Index (%)	Discrimination Index
Adequate and balanced nutrition				
6. Regularly eating breakfast improves school performance	0.36	0.58	83.12	0.26
7. Especially milk and eggs should be consumed at breakfast.	0.35	0.58	81.01	0.24
9. We should drink 8-10 glasses of water every day.	0.31	0.59	83.54	0.26
10. We should drink at least 2 glasses of milk every day.	0.36	0.58	69.62	0.27
11. We should consume 5 portions of fruits and vegetables every day.	0.31	0.59	54.00	0.32
13. Consuming bread and cereals is important for adequate and balanced nutrition.	0.20	0.62	72.15	0.28
16. We should not consume meat more than 3 days a week.	0.31	0.59	55.90	0.33
34. According to the nutrition expert, the amount of salt a person consumes in a day should not exceed 6 grams.	0.32	0.59	60.54	0.33
48. Fast food is not suitable dietary in adequate and balanced nutrition.	0.25	0.61	81.01	0.33
Essential nutrients				
3. Nutrients are divided into six groups.	0.22	0.77	77.63	0.24
12. Energy content of carbohydrate group is richer than same account of fat group.	0.22	0.77	35.02	0.26
14. Fizzy drinks contain high amounts of sugar.	0.21	0.77	82.70	0.27
15. Pasta and rice are starchy foods.	0.32	0.76	78.48	0.34
17. Chicken and egg contain high amount of protein.	0.28	0.77	86.91	0.23
18. Chick pea, dried pea, lentils contain high amount of protein.	0.34	0.76	71.72	0.26
19. Nuts are an alternative to meat in terms of protein content.	0.40	0.76	24.47	0.30
21. The most reasonable act for limiting the amount of fat is consuming biscuits.	0.31	0.76	48.52	0.36
22. Bread contains high amount of fat.	0.35	0.76	64.76	0.43
23. Meat and chicken are important sources of omega-3 fatty acids.	0.42	0.76	19.40	0.20
24. When we consume animal fat, the amount of cholesterol in the body increases.	0.29	0.76	76.79	0.29
25. French fries is junk food.	0.32	0.76	39.02	0.22
26. "Light" article on the packaged products, means the protein content of the product is low.	0.34	0.76	47.89	0.50
28. Whole grain bread contains more vitamins and minerals than bread.	0.40	0.76	48.94	0.39
29. Vitamins A and C can be classified as antioxidant vitamins.	0.44	0.75	42.19	0.29
30. Green pepper and parsley contain high amounts of vitamin C.	0.38	0.76	54.43	0.33
32. Cheese contain high amount of calcium.	0.28	0.76	84.59	0.25
33. Calcium and vitamin D are important for strong bones.	0.20	0.77	86.49	0.25

(Continued...)

Table 1. Reliability analyses and difficulty and discrimination indices of the items **(Continued...)**

Items	Corrected item total correlation	If item deleted Cronbach's alpha	Difficulty Index (%)	Discrimination Index
35. Meat contains high amount of salt.	0.35	0.76	29.74	0.21
36. Bread contains more fibre than whole grain bread.	0.39	0.76	31.01	0.35
37. Apricot does not contain high amount of fibre.	0.33	0.76	45.56	0.36
Malnutrition related diseases				
40. Obese people have health problem more than normal.	0.42	0.66	83.75	0.28
41. Eating fish is a risk factor for cardiovascular diseases.	0.23	0.70	61.39	0.46
42. Obesity may be due to excessive fat consumption.	0.46	0.65	83.33	0.31
43. Consuming foods such as fruits and vegetables which have high amount fibre reduce the risk of getting cancer.	0.44	0.65	69.40	0.42
44. Reducing salt consumption does not reduce the risk of heart disease.	0.28	0.69	65.61	0.46
45. Over using of sugar and salt is associated with health problems s uch as diabetes, hypertension and heart disease.	0.42	0.66	67.51	0.49
46. The low consumption of fruits increases susceptibility to infectious diseases.	0.44	0.65	70.88	0.35
47. Adequate and balanced nutrition decreases the risk of anaemia.	0.42	0.66	76.37	0.33

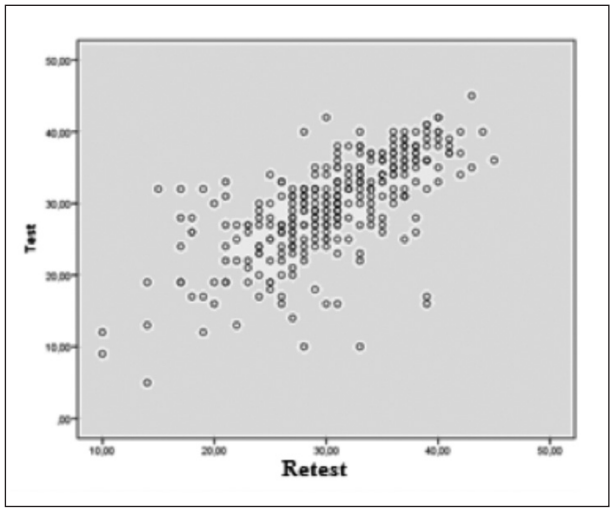

Figure 1. Scatter plot of the ANKQ test-retest scores.

The mean score of the questionnaire was 24.25±5.75, and the median score was 25 and ranged between 0-36. Median scores from the questionnaire were lower in boys (median: 24 min: 0, max: 34) than girls (median: 26 min: 7, max: 36) and participants living in rural areas (median: 22, min: 7, max: 32) compared with those living in urban areas (median: 26 min: 0, max: 36) ($p<0.001$). When we used Bonferroni post hoc test we determined p value=0.05/3= 0.0167 for the comparing mean scores of three groups. Thus, there was no relationship with age group and total scores ($p=0.018$) and no differences were found between BMI and total scores ($p=0.041$). It was found that, of the students, 64.1% had adequate knowledge level.

The distributions of total ANKQ scores according to various demographic characteristics of the study group are summarized in Table 3.

Discussion

This study developed a tool to measure adolescent nutritional knowledge level in an efficient and correct manner. It is important to evaluate the test items to determine its efficacy of assessing students' knowledge based on the difficulty and discrimination indi-

Table 2. The subscale and overall Cronbach's alpha values of the subscales and overall ANKQ for the study population grouped by socio-demographic properties

Variables		Cronbach's alpha value			
		Adequate and balanced nutrition	Essential Nutrients	Malnutrition related diseases	Total
Age	14-15	0.58	0.80	0.70	0.85
	16	0.68	0.79	0.67	0.86
	17-20	0.61	0.72	0.70	0.83
Sex	Boy	0.67	0.79	0.71	0.86
	Girl	0.55	0.76	0.65	0.83
Settlement area	Rural	0.48	0.66	0.58	0.76
	Urban	0.66	0.79	0.73	0.86
Total		0.62	0.78	0.70	0.85

Table 3. The distribution of total ANKQ scores according to various demographic characteristics of the study group (n=711)

Sociodemographic characteristics	n (%)	ANKQ scores Median-Mean (min-max)	Statistical Value z/KW; p
Sex			
Girl	399 (43.9)	26-25.01 (7-36)	3.455; 0.001
Boy	312 (56.1)	24-23.2 (0-34)	
Age group*			
14-15	266 (37.4)	24-23.61 (4-36)	8.045; 0.018
16	165 (23.2)	25-24.54 (0-35)	
17-20	280 (39.4)	25-24.65 (3-36)	
Settlement area			
Rural	201 (28.3)	22-21.81 (7-32)	8.532; 0.001
Urban	510 (71.7)	26-25.21 (0-36)	
Types of Family			
Nuclear family	638 (89.7)	25-24.31 (0-36)	0.974; 0.330
Extended family	73 (10.3)	25-23.73 (8-34)	
Socioeconomic status			
Good	236 (33.2)	26-24.68 (0-36)	4.171; 0.124
Moderate	451 (63.4)	25-24.09 (0-36)	
Poor	24 (3.4)	23-22.87 (8-33)	
BMI*			
Normal	609 (85.6)	25-24.09 (0-36)	6.367; 0.041
Overweight	69 (9.7)	25-24.68 (4-34)	
Obese	33 (4.7)	27-26.18 (10-33)	

**Bonferroni's post hoc test.*

ces of the test items. The difficulty index revealed that items from the malnutrition-related disease subscale were easier than other subscales (21). Difficulty and discrimination indices of the ANKQ varied between 19.40%- 86.91% and 0.20-0.50, respectively. Brown and Crocker reported that a discrimination index of 0.2 or higher is acceptable, and the test item should differentiate between weak and knowledgeable students (23, 24). Anderson et al. developed a questionnaire of nutritional knowledge and found item difficulty and discrimination indices that ranged from 5%- 95% and 0.06 -0.83, respectively (1).

Cronbach's alpha coefficient, which represents internal consistency reliability, should be higher than 0.70 (22). Cronbach's alpha coefficients for the ANKQ were 0.85 for the entire scale and greater than 0.60 for all sub-dimensions, which implies that the scale exhibited considerable reliability. Byrd-Bredbenner reported a Cronbach's alpha value range of 0.63 to 0.73 for different groups when reported separately, and a value of 0.88 when all groups were combined (25). Another study of nutritional knowledge level reported a Cronbach's alpha value range of 0.71 to 0.82 (26). The higher Cronbach's alpha value for the entire questionnaire compared with the Cronbach's alpha value of each subscale may be explained by the higher heterogeneity in the total sample. The Cronbach's alpha value of students living in urban areas was higher than students living in rural areas. The problems in measuring a multi-factorial concept, such as nutrition knowledge, may be particularly difficult for students from socially disadvantaged backgrounds, where food choices differ and experience with written text, language ability and varied levels of writing, reading, cognitive and conceptual skills may all vary considerably (1). These reasons may have caused this result.

Corrected item-total score correlation coefficients were calculated to estimate the contribution of items to the conceptual construct and whether those items can better measure a feature. Items with a corrected item-total score correlation coefficient >0.40 are regarded as highly discriminative, coefficients between 0.21 and 0.40 are regarded as somewhat discriminative, and coefficients <0.20 are poorly discriminative (22). The minimum corrected item-total score correlation coefficient of the items was 0.20, and there were 8 items with a corrected item-total score correlation coefficient >0.40.

Scale stability over time, i.e., the extent to which repeated applications of the instrument achieve consistent results, was assessed using the test-retest reliability method (22). Test-retest is the application of an instrument twice to the same subjects under the same conditions, with a time interval that is long enough to prevent relevant recalls and short enough to disallow considerable changes in the construct being measured (27). The test–retest correlations of the subscales varied between 0.57 and 0.61, and overall it was 0.69. These results are comparable with literature. Anderson et al. reported test–retest correlations of different domains of knowledge varied between 0.38 and 0.58 in a sample of 11-year-olds (1). Low test-retest reliability coefficients in several studies were reported (28-30). We had higher internal consistency coefficients for subscales but a lower test-retest result. We suspect that some students might have been less motivated the second time because they thought that answering the same questionnaire would be useless, which produced more superficial and less accurate responses (31).

Median scores from the questionnaire were lower in boys ($p<0.05$). This outcome was expected because girls were more successful than boys in lessons at these schools. The total score achieved from the questionnaire increased with the increasing age of students. Whati et al. reported a similar result. It is likely that the younger students did not understand the questions as well as their older peers (26).

Limitations

The one of the most important limitations of the study was the self-reported weight and height values. Recording the participants' weight and height is not reliable. On the other hand there are some studies reporting an adequate level of reliability for the BMI values calculated by the self-reported body height and weight values (32-34).

Conclusion

Our instrument is a practical and easy-to-administer tool with acceptable reliability in high school students. The ANKQ can be used periodically to monitor changes in nutritional knowledge. Periodical evaluations are necessary to assess students who have higher nutritional knowledge levels and determine whether these students gain better dietetic behaviors and attitudes.

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Author disclosures

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