

# Nutrition Knowledge Scale (NKS): Development, Factor Structure, and Validation for Healthy Adults

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**Abstract.** *Objective:* Valid and reliable scales are required to determine and evaluate nutritional knowledge. This research aims to develop the nutrition knowledge scale for adults and to examine the factor structure, validity, and reliability. *Methods:* Initially, the Nutrition Knowledge Scale (NKS) was constituted, paying attention to content and construct validity. The content validity index (CVI) was found as 0.884. Five hundred eighty-five (371 females, 214 males) volunteers consisting of healthy adults completed the general information form and NKS. For test-retest reliability, 164 (28.03%) participants completed the NKS again within four weeks following the first conduct. *Results:* As a result of Explanatory Factor Analysis (EFA), NKS items were collected under one factor. According to the results of the Confirmatory Factor Analysis (CFA), all fit indices were found at an acceptable level. Cronbach's alpha value calculated for reliability analysis of NKS is 0.851. The intraclass correlation coefficient (ICC) calculated for test-retest reliability is 0.863. *Conclusion:* This research indicates that NCS is an acceptable, valid, and reliable scale that covers all aspects of nutritional knowledge and can be used in future research for determining and evaluating the nutritional knowledge level of adults.

**Key words:** Nutrition knowledge, scale, factor structure, reliability, validity

## Introduction

Adequate, balanced, and healthy nutrition is the basis for maintaining health and preventing diseases in all stages of life (1, 2). For this reason, people must have correct nutritional knowledge and convert this knowledge into behavior (3).

Nutritional knowledge includes information about nutrients, nutritional sources, and requirements, healthy nutrition recommendations, and nutrition health-disease relationship (4). It is assumed that nutritional knowledge will lead to an improvement in the diet by providing individuals the necessary information about choosing healthy foods, preparing and

consuming these foods in line with healthy nutrition recommendations. According to this assumption, individuals will change their diets appropriately when they get accurate information about what they should eat and the effects on their health when eating the wrong or unhealthy foods (5, 6, 7). Studies conducted with different groups have indicated that high nutritional knowledge is associated with a healthy lifestyle and healthy food selection (2, 8, 9). Nutrition education, as one of the important applications in terms of nutritional knowledge, plays an important role in increasing the awareness of the individual and the society and consequently in improving public health (10).

Some of the studies to measure nutritional knowledge have been conducted with valid and reliable measurement tools (2, 4, 11-14) and some with questionnaires developed by the researchers themselves, which validity and reliability have not been proven (14-18). In a systematic review including 16 868 articles and 308 papers published by Newton et al. in 2019, it was found that only 31.3% of the studies provide validity and/or 40.3% reliability analysis (19). In a comprehensive systematic review published by Spronk et al. in 2014, it was reported that most of the questionnaires used in studies on nutritional knowledge were not valid and were insufficient (20).

The questionnaires used in researches without validity and reliability are far from psychometric measurements and the classification and scoring of nutritional knowledge level were determined by the researchers without statistical evaluation (15, 21).

It is difficult to measure the level of knowledge, and a good scale structure is required for valid and reliable measurements (3). Nutritional knowledge scales developed to date have some limitations. The nutrition knowledge scale developed by Towler and Shepherd (1990) does not make a systematic inquiry about the relationship between nutrition and disease and dietary recommendations, and the authors do not provide information about content validity (22). There is no information about the structural validity or test-retest reliability for the questionnaire developed by Anderson et al. (1988), which tests individuals' familiarity with nutritional terms, their knowledge about current nutritional recommendations, and practical applications of these recommendations. It has also been reported to have poor internal consistency (23). Resnicow et al. (1997) and Stafleu et al. (1996) focused on a particular aspect of nutrition in the nutritional knowledge scales they developed such as fat and cholesterol knowledge (24, 25). The nutrition knowledge scale developed by Steenhuis et al. in 1996 was for elementary school children (26), and the scale developed by Said et al. (2020) in Lebanon was for adolescents (7). Calella et al. (2017) developed the General and Sport Nutrition Knowledge Questionnaire in Adolescents and Young Adults (GeSNK) scale for adolescents and young adults (6). Scales that

focus on specific groups such as athletes and coaches are also available (1, 27, 28).

The most widely used nutritional knowledge scale to date is the General Nutrition Knowledge Questionnaire (GNKQ) which was developed by Parmenter and Wardle in English in 1999 and validity and reliability were made (5). The scale has been adapted in different languages (29-34). GNKQ, adapted into Turkish by Alsaffar (2012) on Turkish university students, has been used as the only valid and reliable nutritional information scale for the Turkish population until recently (29). The scale which investigates basic nutritional knowledge in a wide range of areas was revised by Kliemen et al. (2016) in line with expert opinions toward the developments in the field of nutrition and changes in the habits of the society (35). However, the revised version of the scale has not yet been adapted for the Turkish population.

Nutrition Knowledge Level Scale for Adults (NKLSA) in Turkey which was developed recently by Batmaz (2018) contains subtitles such as basic nutrition and nutrition preferences but it does not cover the nutrition-health relationship. Besides, the scale was found to be poor in terms of test-retest reliability (36).

Nutrition knowledge and nutritional behaviors vary according to societies due to cultural differences in eating habits and nutritional recommendations. Although general nutritional information and recommendations are similar between developed countries, cultural differences in the diet need to be taken into account. For this reason, scales developed to measure nutritional information should be developed or adapted differently for each society. Therefore, there is a need for a standardized measurement tool to determine the level of general nutrition knowledge of Turkish society and to use it in related researches. The measurement tool should use nutrition knowledge and nutrition-health relation as a base and be comprehensive, and understandable for the general population. This research is aimed to develop a nutritional knowledge scale and examine its reliability and validity on the adult population in Turkey thus bring in the literature a new measurement tool that can be used in further researches.

## Materials and Methods

### *Development of the Nutrition Knowledge Scale (NKS)*

Dietary guidelines for Turkey (37) and international dietary guidelines and recommendations (38-40) have been examined and compared investigated to create the content of the NKS. Valid and reliable scales developed previously for measuring nutritional knowledge (3, 5, 6, 22-26, 35) and questionnaires conducted without validity and reliability analyses (15-18, 21) were collected and examined. After a comprehensive literature review, it was decided that the scale should consist of items covering the main titles of food and nutrient information, food preparation and cooking methods, and nutrition and health relationship. To develop NKS, a 112-item question pool was created by the researchers in line with the relevant literature. A qualitative evaluation was made by the researchers on the scale items, each question was analyzed and discussed, and the number of items was reduced to 73. The 73-item scale was evaluated by 12 experts in the field of nutrition and dietetics for its content validity, and the accordance of the items was scored. It was determined how many experts approved the possible options of each item by combining all forms in a single form. In this process, according to the opinions given by the experts, the content validity of the items was determined with the content validity rate developed by Veneziano and Hooper (1997) (41). For the content validity indexes of the items, the number of experts and the values of the obtained content validity rates were determined. According to expert opinions, 4 items were removed from the scale. The content validity index was 0.884 and the scale is statistically significant since it is  $CVI = 0.884 > 0.67$ . After these studies, the NKS was corrected and the final 69-item version was created.

### *Participants*

The research was carried out with 585 adult voluntary participants (371 females, 214 males) with an average age of  $34.94 \pm 11.48$  years. Participants were selected using a simple random sampling method

among those who were present in two hospitals in Turkey, namely a public hospital and a private hospital, as a patients' relative, hospital attendant, or visitor between June 2019 - February 2020. The criteria to be included in the research were determined as not having a known mental or physical illness that required treatment, being able to read and understand Turkish, and voluntarily participating in the research. The test-retest method was used to analyze reliability coefficients. The questionnaire was administered to the 164 (28.03%) participants again within four weeks after the first application.

### *Measures and Procedure*

Ethical approval (Date: 22.05.2019, Number: 109, Decision: 5) was attained from the Ethics Committee of İstanbul Okan University in compliance with the Helsinki Declaration. Approvals were attained from the hospitals to conduct the research.

Participants were invited to complete the NKS and general information form consisting of questions for learning their socio-demographic characteristics (age, gender, educational status, employment status) and anthropometric measurements (height, weight, body mass index) voluntarily. The questionnaires were handed out to participants and completed by the participants under the supervision of the researcher. The participants who accepted to determine the assessment protocols with a code to facilitate the repetition of the questionnaire for test-retest analysis, completed the NKS within four weeks after the first conduct of the questionnaire.

### *Nutrition Knowledge Scale (NKS)*

NKS, developed to determine the nutritional knowledge of adult individuals, consists of items related to the titles of food and nutrient information, food preparation and cooking methods, nutrition and health relationship. Scale items created in the five-point Likert type are scored between 4 and 0 towards the answer strongly agree to strongly disagree. Items representing misinformation about nutritional knowledge are scored in reverse.

### *Statistical Analysis*

Statistical analyses were carried out using IBM SPSS version 21.0 and IBM SPSS AMOS version 20.0 statistical software (IBM SPSS Inc., Chicago, IL, USA). The construct validity of the NKS was verified by Explanatory Factor Analysis (EFA). In determining the number of factors, the eigenvalue greater than one rule was used. Principal component factor analysis was used as factor extraction method. Factor loadings less than 0.30 were excluded in the analysis. Confirmatory factor analysis (CFA) was applied to test the accuracy of the construct revealed by EFA. Test-retest reliability was determined by using the intraclass correlation coefficient (ICC). Quarters were used to find the cut-off point and the scale scores were defined as “low, medium, good, very good” using three cut-off points. Weighted Kappa statistics were used for the reliability of the multi-category scale.

## **Results**

A total of 585 healthy adults, 371 women (63.42%) and 214 men (36.58%) participated in the research. The mean age of the participants was  $34.94 \pm 11.48$  years and body mass index was  $24.97 \pm 4.60$  kg/m<sup>2</sup>. In the research, the education level of participants were 1.03% (n=6) literate, 7.86% (n=46) primary school, 6.1% (n=36) secondary school, 19.15% (n=112) high school, and 65.81% (n=385) university graduate. 76.58% (n=448) of participants are working and 52.31% (n=306) are married. 17.26% (n=101) of participants reported they received nutrition education.

## **Construct Validity**

### *Explanatory Factor Analysis (EFA)*

EFA was performed to reveal the construct validity of the scale and to determine the factor loadings of the items. The scale consists of 69 items and, the items are scored between 0 and 4 points. Twenty-three items of the first 69-item scale reverse-scored because

they represent misinformation about nutritional information.

Factor loadings less than 0.30 were excluded in the EFA. After item extraction remaining 31 items were re-evaluated. The items were analyzed after renumbering. Items 1, 5, 6, 9, 10, 16, 17, 21, 27, 28 reverse-scored after renumbering.

Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett Sphericity test were calculated to determine the suitability of the data. The KMO value was found to be 0.862 and the Bartlett test result (3869.244,  $p < 0.001$ ) was found to be significant. The NKS consists of a single factor.

### *Confirmatory Factor Analysis (CFA)*

CFA was applied for the accuracy of this structure. The model obtained with CFA is given in Figure 1. When this model is tested, fit indices are presented in Table 2. As seen in Table 2, according to the CFA results, it was concluded that the model of the scale items with the relevant structure was appropriate, since all fit indices were acceptable.

## **Reliability**

### *Internal Consistency*

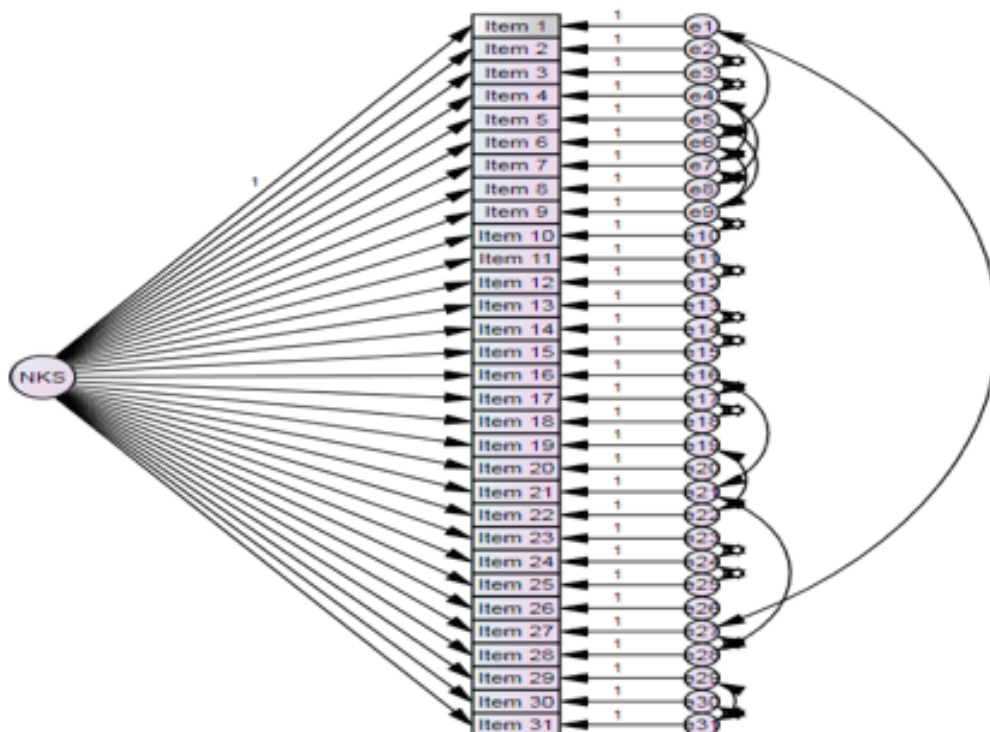
As a result of the analyzes carried out, the scale was finalized with 31 items that contain positive and negative situations. As a result of the reliability analysis for 31 items, the Cronbach's alpha coefficient was calculated as 0.851. The fact that the reliability coefficient of the scale in this research is close to 1 indicates that the scale has very high reliability. Tukey test was used for scale additivity and it was observed that the scale was additive ( $p < 0.001$ ). The values obtained show that this scale is a reliable measurement tool for measuring nutritional knowledge.

### *Test-Retest Reliability*

The scale was reapplied to 164 (28.03%) participants within 4 weeks. The intraclass correlation coefficient (ICC) was found to be 0.863, indicating that the scale has high reliability.

**Table 1.** Item loads as a result of factor analysis

Items	Item loadings	Items	Item loadings
Item 1	0.377	Item 17	0.347
Item 2	0.353	Item 18	0.432
Item 3	0.302	Item 19	0.489
Item 4	0.368	Item 20	0.488
Item 5	0.330	Item 21	0.428
Item 6	0.426	Item 22	0.397
Item 7	0.432	Item 23	0.472
Item 8	0.345	Item 24	0.403
Item 9	0.395	Item 25	0.520
Item 10	0.396	Item 26	0.619
Item 11	0.376	Item 27	0.442
Item 12	0.346	Item 28	0.552
Item 13	0.340	Item 29	0.613
Item 14	0.394	Item 30	0.568
Item 15	0.462	Item 31	0.542
Item 16	0.464		
KMO:0.862			
Bartlett :3869.244 p<0.001			
Cronbach's alpha:0.851			



**Figure 1.** CFA model

**Table 2.** Model conformity degree statistics

Model	$X^2$ statistic ( <i>df</i> )	CMIN/ <i>df</i>	GFI	AGFI	CFI	RMSEA
CFA model	962.387(410)	2.347	0.986	0.974	0.941	0.048

Note. CMIN = minimum discrepancy; *df*= degrees of freedom; GFI= Goodness of fit index; AGFI= Adjusted Goodness of fit index; CFI = Comparative fit index; RMSEA = Root mean square error of approximation.

### Mean Scores and Determination of Cut-off Points

The highest score that can be obtained from the scale is 126, and the evaluation is made on the total score. The mean NKS was found to be  $89.82 \pm 14.45$  in the research. It is evaluated that as the score obtained from the scale increases, the level of nutritional knowledge increases, and as the score decreases, the level of nutritional knowledge decreases.

Quarters were used to find cut-off points on the scale score. With the quarters, 3 cut-off points were used as “low, medium, good and very good”. Cut-off point 1 is found as 79, Cut-off point 2 is 90, and Cut-off point 3 is 101. The classification was made as low nutrition knowledge level ( $\leq 79$ ), medium nutrition knowledge level (80-90), high nutrition knowledge level (91-100), and very high nutrition knowledge level ( $\geq 101$ ). Accordingly, 147 (25.13%) of participants have low nutrition knowledge, 161 (27.52%) of participants have medium nutrition knowledge, 139 (23.76%) of participants have high nutrition knowledge and 138 (23.59%) have very high nutrition knowledge in the research. Weighted Kappa statistic was examined for the reliability of the multi-category scale. The weighted Kappa statistic was found to be 0.551 and according to the Kappa statistic was a good agreement.

### Discussion

With this research, it was aimed to develop a new scale for determining the nutritional knowledge level for adults, to prove its validity and reliability by examining the factor structure of this scale, and to bring it to the literature as a measurement tool that can be used in future studies. Two recent systematic reviews reported that the majority of tools used in research to

measure nutritional knowledge are not valid and reliable (19, 20).

NKS was constituted in five-point Likert type by researchers, to determine the nutritional knowledge level of adult individuals using dietary guidelines (37-40), and previous studies (3, 5, 6, 22-26, 35) after a comprehensive literature review. NKS created at the end of a multi-stage process that includes quantitative and qualitative methods and after EFA applied to the scale the final version of NKS was gathered under one factor and consisted of a total of 31 items covering the subjects of food and nutrient information, food preparation and cooking methods, and nutrition and health relationship. The factor structure determined by EFA was confirmed by the CFA result. According to the CFA results, all fit indices were found at acceptable levels.

Cronbach's alpha value of NKS was found as 0.851, and this value indicated that the scale has very high reliability. Total Cronbach's alpha is 0.97 for GNKQ, which is the most widely used scale developed to date (5), 0.89 for the Turkish version (29), and 0.93 for the revised version (GNKQ-R) (35). NKLSA, which has been developed recently in Turkey, Cronbach's alpha is 0.72 for the first part and 0.70 for the second part (36). As a result of this research, the Cronbach's alpha value (0.851) calculated to determine the internal consistency of NKS indicated that NKS has a high degree of internal consistency and is a reliable measurement tool for measuring nutritional knowledge.

For test-retest reliability, the ICC value for NKS was found as 0.863. Test-retest reliability of some scales developed to date is between 0.82 and 0.98 (5, 6, 28, 35). It has been reported that NKLSA does not fully provide test-retest reliability (36). The high test-retest reliability level of this research (0.863) indicates that NKS has high reliability and supports the stability of its measurements over time.

In this research, it was developed a comprehensive, understandable, and standard measurement tool for use in relevant studies and evaluation of the general nutrition knowledge based on the nutritional knowledge and nutrition–health relationship. NKS has excellent reliability and internal consistency, as well as high test-retest reliability with content and construct validity.

This research is important in terms of bringing to the literature a new valid and reliable measurement tool that covers all aspects of nutritional information that can be used in future studies to determine the nutritional knowledge level of adults.

**Conflict of interest:** The authors declare that they have no conflict of interest.

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**Nutrition Knowledge Scale-NKS (Beslenme Bilgi Ölçeği-BBÖ)**

No	Lütfen her madde için en uygun olan seçeneği işaretleyin.	Kesinlikle katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Kesinlikle katılmıyorum
1	Protein yalnızca hayvansal besinlerden sağlanır.					
2	Meyvelerde en fazla bulunan karbonhidrat türü früktozdur.					
3	Sütün karbonhidratı laktozdur.					
4	Balık omega 3'ün en iyi kaynağıdır.					
5	Yağlar vücuda en az enerji veren besin ögesidir.					
6	Kolesterol yalnızca bitkisel besinlerde bulunur.					
7	Süt ve süt ürünleri kalsiyumun en iyi kaynaklarıdır.					
8	D vitamini güneş ışınları ile vücut tarafından yapılabilmektedir.					
9	B grubu vitaminler yağda eriyen vitaminlerdir.					
10	Çilek, domates, yeşil sebzeler ve turunçgiller C vitamininden yetersizdir.					
11	Et grubundaki besinler protein, demir ve çinkodan zengindir.					
12	Kuru baklagiller protein, kalsiyum, çinko, magnezyum ve demir yönünden zengindir.					
13	Karbonhidrattan zengin olan ekmek, makarna, pirinç ve bulgur tahıl grubundaki besinlerdendir.					
14	Sebze ve meyvelerin önemli bir kısmını su oluşturmaktadır.					
15	Taze sebze ve meyveler, tam tahıllı ürünler ve kurubaklagiller en iyi posa kaynaklarıdır.					
16	eker ve şekerli besinler mümkün olduğunca çok tüketilmelidir.					
17	Bal kan şekerini yükseltmez.					
18	B12 yetersizliğinde sinir sistemi hastalıkları ve anemi görülür.					
19	Günlük tuz tüketimi 1 tatlı kaşığından (6 gram) fazla olmamalıdır.					
20	Balık ve fındık, ceviz, badem gibi yağlı tohumların sık tüketilmesi kalp sağlığı açısından faydalıdır.					
21	Kan kolesterol seviyesi yüksek olan bir birey sakatat ve hayvansal yağları tüketmelidir.					
22	Posanın kanser ve kalp hastalıklarına karşı koruyucu etkisi vardır.					
23	Yemekle birlikte çay, kahve, kola gibi içeceklerin içilmesi demirin vücutta kullanımını azaltır.					
24	Yemekle birlikte salata ve meyve gibi C vitamini kaynaklarını tüketmek demirin vücutta kullanımını artırır.					
25	İyot yetersizliği guatr hastalığına neden olur.					
26	Meyve ve sebzeler içerdiği C vitamininden dolayı bağışıklık sistemini güçlendirir.					
27	İshal (diyare) olan bir kişi besin ve su tüketimini sınırlandırmalıdır.					
28	Posalı besinler bağırsak sağlığı için zararlıdır.					
29	Kalsiyum ve D vitamini kemik sağlığı açısından önemlidir.					
30	A vitamini içeren besinler göz sağlığı için faydalıdır.					
31	Probiyotikler bağırsak sağlığını korumaya yardımcıdır.					