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CONTENTS

A valid and reliable nutrition knowledge questionnaire: an aid to assess the nutrition friendliness of schools of Dehradun, Uttarakhand

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ABSTRACT: The study aimed to develop a valid and reliable questionnaire as an aid to assess the nutrition friendliness of schools by assessing nutrition knowledge of early adolescents. Considering the school education as the major source of information, NCERT books of science for class 1st-8th were referred and 64 items were selected initially for the questionnaire. The study participants included 46.7 per cent boys, and 53.3 per cent girls of early adolescent age. For validating the questionnaire formed, it was tested in school setting. Validity (face and content), item difficulty and reliability (internal consistency reliability and test-retest reliability) of the questionnaire were the main outcome measured. Reliability coefficients such as Spearman-Brown and Cronbach's alpha were calculated for internal consistency of the test and for test-retest reliability Pearson's correlation coefficient was used. Final questionnaire developed had 39 items under 3 subscales. Cronbach's alpha coefficient was 0.73 for overall test along with significantly higher and positive ($r = 0.79$, $P < 0.001$) test-retest reliability coefficient. Mean scores from the questionnaire were lower in boys (Mean 59.07 ± 4.98, min: 47, max: 67) than girls (Mean: 60.75 ± 4.17, min: 56, max: 72) ($p=0.3231$). This tool had good reliability and also easy-to-administer with practical applications to assess nutrition friendliness of schools.

Key words: Early adolescents, nutrition knowledge, nutrition knowledge questionnaire, practices, reliability, validity

Any nation's future depends on the nutritional status of its children. Ensuring healthy growth and development of children assures the future of our next generation. Today worldwide children are not only suffering from under-nutrition but also over-nutrition along with micronutrient deficiencies (WHO, 2020). A tenfold increase has been observed in the number of obese children and adolescents have increased ten times from 1975 (11 million) to 2016 (124 million) and along with this 216 million children are lying on borderline of becoming obese i.e., they are overweight. Asian children are showing signs of rising obesity rates (WHO, 2017). Due to this, many adult onset diseases like hypertension, heart diseases and type 2 diabetes mellitus are now affecting the children too (Goran *et al.,* 2003). Childhood stage could be an early window of opportunity to prevent them from carrying this disease burden to their adulthood. Nutrition education has been the time-tested best method to inculcate the healthy lifestyle among children as health, nutrition and education are closely linked (UNESCO, 2001). Schools are the best place to serve as the transition centre for children, where their knowledge can be improved and healthy habits can be inculcated to prevent nutrition related morbidities in their childhood as well as in their adult age.

Adolescence period is known for the increased sense of autonomy and independence in children. Appropriate lifestyle and healthy food habits if developed during early adolescent years are likely to influence long term behaviors and result in greater chances to reduce lifestyle related morbidity and mortality in later life (Sichert-Hellert *et al.,*2011; Shah *et al,* 2010; Lobstein *et al.,* 2004). Therefore, any changes brought by an educative intervention during these shaping years are expected to continue in the adulthood as healthy habits (Rao *et al.,* 2007). As a common policy option, Nutrition-Friendly Schools Initiative (NFSI) was developed by WHO in 2005, to effectively address the increasing global public health problem of the nutrition-related double-burden of ill-health. One of the five core components of NFSI is 'developing a nutrition and health-promoting school curriculum'. Progress related to this component is best measured by assessing the nutrition knowledge of children studying in the

schools.

Also, in India various nationwide government programs such as Sarva Siksha Abhiyan (SSA), School Health program (SHP) in the year 2008 under National Rural Health Mission (NRHM), Rashtriya Kishor Swasthya Karyakram (RKSK) in the year 2014 by the Ministry of Health and Family Welfare (MoHFW) under National Health Mission (NHM) (www.nhm.gov.in), comprehensive school health policy of CBSE, all support knowledge dissemination on nutrition by inclusion of nutrition related topics in syllabus and curriculums for formal education. Therefore, it is necessary to have a valid and reliable epidemiological tool that can measure and monitor the effectiveness of such interventions. Even before studying impact of such programs on the eating habits, it is easier and better to measure the changes in nutritional knowledge first (Oz *et al.,* 2016). There are various factors that influence eating habits and nutritional knowledge is one of them (Vereecken *et al.,* 2012). There are studies which provide the evidences of the influence of nutritional knowledge on dietary intake (Asakura *et al.,* 2017; Grosso *et al.,* 2012).

Uttarakhand is the state predominantly occupied by hilly regions where earlier malnutrition was only in the form of under nutrition, but now the over nutrition is also prevailing along with micro-nutrient deficiencies. In view of the contemplation above, this study was aimed to develop a valid and reliable questionnaire that measures the nutrition knowledge of early adolescents of age 11-14 years (N=30) studying in upper primary classes (6th to 8th). The questionnaire developed will simultaneously try to measure their lifestyle and dietary practices, and related awareness that prevent the nutrition related co-morbidities.

MATERIALS AND METHODS

Study area, data and sampling: This study uses primary data collected from the early adolescent children of age 11-14 years studying in upper primary classes (6th to 8th) for the generation of a nutrition knowledge questionnaire. As the questionnaire developed was going to be used for another study in Dehradun district of Uttarakhand, the data for the present study was collected from another district of Uttarakhand i.e., Tehri Garhwal, during July-August 2019. As the minimum sample size for any statistical analysis should be 30, same numbers of children were chosen randomly to become part of the study. Study population included 46.7 per cent boys and 53.3 per cent girls.

The questionnaire aimed to measure the nutrition knowledge under three domains (i) basic nutrition (ii) practices and (iii) awareness. For this the questionnaire items were collected and further subjected to testing of their validity and reliability.

Item generation: Considering the school education as the major source of information, NCERT books of science for class 1-8th were studied and used as a base for the selection of questions. Also, Yellow book 1-2 for children of 1st -8th class by FSSAI under "Safe and Nutritious Food Initiative" were studied for item selection. An item pool of 64 questions was designed which included three major domains: (i) basic nutrition which included questions on balanced diet, nutrient deficiency and food preparation and handling; (ii) practices which included reading nutrient information and labels on packaged food, meal skipping, fruit consumption, physical activity and personal hygiene and (iii) awareness and beliefs regarding junk foods, screen time, daily physical activity, sleep duration and good eating habits.
The first domain consisted questions with true/false type responses, second (always/sometimes/never) and third (agree/neutral/disagree) domain questions consisted responses with 3 point Likert scale. The item pool was subjected to content analysis.

Validity of the test: Validity refers to how well a test measure what it is purported to measure (Phelan and Wren, 2021). For this, the face validity and content validity of the test was judged by an expert panel of 10 members. Panel consisted of 5 subject experts in the field of nutrition, 3 extension education experts and 2 school teachers.

For face validity, expert's comments were taken to

ascertain that whether the test appears to be assessing the intended construct under study. For content validity, experts were asked to score the questions/ statements for their clarity [4= clear, 3= need minor revision 2= need major revision, 1= unclear] and relevance [4=Relevant, 3= relevant but need minor revision, 2= need major revision, 1= irrelevant] on a 4 point ordinal scale (Zamanzadeh *et al.,* 2015). Questions/ statements with 70 per cent content validity index (I-CVIs) were retained. Some questions were reworded for ease of understanding.

Questionnaire in pre-test: The questionnaire was pre-tested in a group of upper primary students of 11-14 years of age from a school serving to students of middle-income group (n=30). The group consisted of 10 students (5 boys and 5 girls) of each class from 6^{th} to 8^{th}. Each item was given maximum 2 marks and minimum 0 for a correct response and an incorrect response respectively.

Item difficulty: The item difficulty was determined by the Per centage of students in the group who performed correctly on the item. Items with 20-90 per cent difficulty level were considered acceptable. The following formula is used to find difficulty level (Boopathiraj and Chellamani, 2013).

$$DL = \frac{Ru + Rl}{Nu + Nl}$$

Where,
Ru = the number students in the upper group who responded correctly
Rl = the number students in the lower group who responded correctly
Nu= Number of students in the upper group
Nl= Number of students in the lower group

Item discrimination: Item discrimination is calculated by ranking the students according to total score and then selecting the top 27 per cent and the lowest 27 per cent in terms of total score. For each item, the Per centage of students in the upper (PU) and lower groups (LU) answering correctly were calculated. The difference between the PU and LU gives the item discrimination index (ID) i.e., IDs= PU-LU. A higher item discrimination index (ID) means, that item can effectively discriminate between respondents with high knowledge and to respondents with low knowledge. Items with 0.00 and negative ID were discarded (Boopathiraj and Chellamani, 2013).

Reliability of the test: "Reliability refers to the degree of consistency in measurement and to the lack of error" (Gidron, 2013). A test will be reliable when it gives the same repeated result under the same conditions. Two types of reliability (i) internal consistency reliability (split-half method and Cronbach's alpha) and (ii) test-retest reliability were calculated. Spearman-brown coefficient for split half reliability and Cronbach's alpha were calculated using SPSS 20. A reliability coefficient of 0.70 was acceptable.

For test-retest, a test (T2) was formed by removing the items from pre-test (T1) after item difficulty and item discrimination analysis and calculating internal consistency reliability. The students were tested with new test (T2) and were re-tested using the same test after a period of 15 days; Pearson's correlation coefficient was calculated between the total marks obtained by students in the two tests. A reliability coefficient of 0.70 means the test provided consistent results over a period time.

Statistical analysis: Most of the statistical analysis was done using Ms Excel 2007. Reliability coefficients such as Spearman-Brown and Cronbach's alpha for internal consistency of the test and Pearson's correlation coefficient for test-retest reliability were analyzed using SPSS ver. 20.

RESULTS AND DISCUSSION

The process of validating the questionnaire included construct validity, item difficulty, item discrimination and reliability.

Content validity: From an item pool of 64 questions, the construct validity analysis resulted in a selection of 45 items retained within the 3 domains. Items with 70 per cent content validity index (I-CVI) for their clarity and relevance were retained. Among

items scored for revision, those with minor corrections were reframed and items with major corrections were discarded.

Item difficulty: The item difficulty analysis was done only for items in first domain (nutrition knowledge) because it had true/false type responses. For other two domains, responses were framed on 3 point Likert scale, which were framed mainly to assess their practices and beliefs. Item difficulty analysis and item discrimination is usually not performed for Likert scale items.

The item difficulty for 35 items ranged from 20-100 per cent and difficulty level for the overall test (i.e., the average of all items) was 61.03 per cent. For maximizing the validity and reliability, the optimal item difficulty level is kept 50. However, this does not mean every item should have difficulty level of 50 per cent, simply that the average of all items should be 50 per cent. The optimal difficulty level for the overall test with true/false type responses should be 85 per cent (www.geneseo.edu).

Usually in any test questions with 20-80 per cent difficulty level are included. Here the relatively easy questions with difficulty level between 80-90 per cent were also considered for inclusion in the questionnaire, based on literature citing that if the study group under consideration is supposed to have a lower knowledge, a higher cut-off can be used. Five items were having more than 90 per cent difficulty level therefore discarded (Oz *et al.,* 2016), leaving 30 items behind for further analysis.

Item discrimination: Item validity index, measures the ability of the item to discriminate between the best and worst performers in the test. The 30 items after item difficulty analysis were subjected to item discrimination. Four items with 0.00 and negative item discrimination index were discarded. The item discrimination index for remaining 26 items ranged from 12.5 to 87.5.

After analysis of validity, item difficulty and item discrimination of the 64 items in the item pool, total 46 items were left for further reliability analysis (Table 1).

It is important to evaluate whether the test items are efficient enough to assess students' knowledge based on the difficulty and discrimination indices of the test items. It was done only for the "Nutrition Knowledge" domain which consisted of 23 items as other two domains had Likert scale responses for the questions and that was not quiet feasible. Difficulty and discrimination indices of the items in the questionnaire ranged between 20 to 90 per cent and 12.5 to 87.5, respectively. Previous studies also reported that a discrimination index of 20 or higher is acceptable (Brown, 1976; Crocker and Algina, 1986). Similarly, Anderson *et al.* (2002) reported 5-95 per cent item difficulty and 6.00 to 83.00 item discrimination range for their nutritional knowledge questionnaire.

Reliability: There are four different types of reliability *viz*., inter-rater reliability (i.e., measuring the consistency of the same test conducted by different people), parallel forms reliability (i.e., measuring the consistency of different versions of a test which are designed to be equivalent), test-re-test reliability (i.e., measuring the consistency of same test over time) and internal consistency reliability (i.e., measuring the consistency of the individual items of a test). Here only two type of reliability were calculated i.e., (i) Internal consistency reliability and (ii) Test-retest reliability.

Table 1: Items retained in each domain after different stages of analysis

S. No.	Analysis Stage		Domains			Total Items
		Acceptance level	Nutrition Knowledge	Practices	Awareness and beliefs	
1.	Item pool		42	12	10	64
2.	Content validity	70% acceptance	35	11	9	55
3.	Item Difficulty	20-90%	30	11	9	50
4.	Item Discrimination	> 0.00	26	11	9	46

As only one person was involved in conducting the study and also only one version of the test was used, inter-rater reliability and parallel forms reliability method were not performed.

i. *Internal consistency reliability* is the degree to which every item measures the same construct. There are wide varieties of internal consistency measures that can be used. The most popular one are Split-half reliability and Cronbach's alpha.

In Split-half reliability the test items are first divided into two halves. And then the correlation between the total scores of two halves is calculated (spearman-brown coefficient). There could be various ways to divide the test into two halves but the best method is to divide it in odd numbered and even numbered item set. Whereas, the arithmetic average of all split-half estimates gives the Cronbach's alpha value of that test.

Reliability coefficients were calculated domain wise as each domain had different type of responses. The domains 2 and 3 did not show an adequate reliability but the internal consistency improved on combining the two domains. Domain wise reliability coefficients are given in the Table 2.

The initial value of spearman-brown coefficient and Cronbach's alpha for domain 1 were 0.647 and 0.675 respectively which were not quite acceptable therefore three items were deleted to bring the reliability coefficients in acceptable range i.e., 0.70. Thus, the final values of spearman-brown coefficient and Cronbach's alpha obtained for domain 1 were 0.818 and 0.704 respectively. For domain 2 and 3 combined, the values obtained for spearman-brown coefficient and Cronbach's alpha were 0.709 and 0.694 respectively, by deleting 2 items each from domain 2 and 3.

ii. Test-retest reliability is the degree to which the measurement's results are consistent over time. A high positive and statistically significant correlation was observed between the scores of test and the retest which was administered after 15 days ($r = 0.79$, $p < 0.001$) using Pearson's correlation analysis. The correlation coefficient of the "nutrition knowledge" domain was 0.74, "practices" domain was 0.86, and the "awareness" domain was 0.48. A scatter plot of the test-retest scores of the nutrition knowledge questionnaire is shown in Figure 1.

The test–retest correlations of the various domains varied between 0.48 and 0.74, which was slightly higher than a study which also was performed on early adolescents by Anderson *et al.* (2002). Test–retest correlations of different domains of knowledge

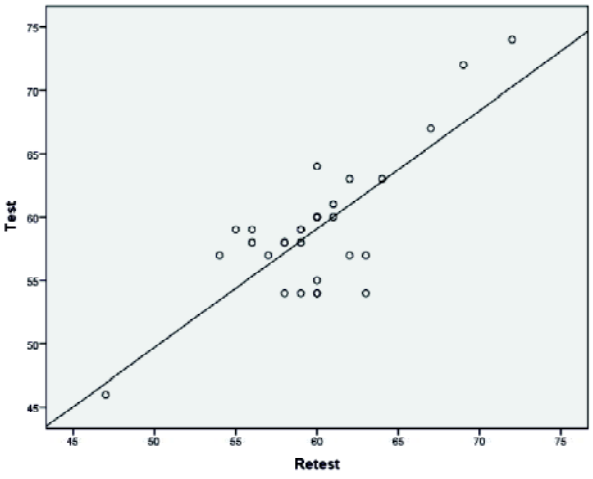

Fig. 1: Scatter plot for two tests of test-retest reliability.

Table 2: Reliability coefficients for different domains

	Stage	No. of Items	Spearman-Brown	Cronbach's alpha# coefficient#	# reliability coefficient
Domain 1 (Nutrition Knowledge)	Initial	26	0.647	0.675	> 0.9 = Excellent > 0.8 to < 0.9 = good >0.7 to < 0.8 = acceptable >0.6 to < 0.7 = questionable >0.5 to < 0.6 = poor <0.5= unacceptable
	Final	23	0.818	0.704	
Domain 2 (Practices) and Domain 3 (Awareness and beliefs)	Initial	11+ 9	0.580	0.452	
	Final	9+7	0.709	0.661	

Table 3: Domain wise different items included in the final test

S. N.	**1.** Nutrition Knowledge About	Corrected Item-Total Correlation	S. N.	**2.**Practices followed	Corrected Item-Total Correlation
1	Energy from Carbohydrates	0.411	1.	Reading Nutrient Info. of packaged food	0.221
2	Macronutrients	0.233	2.	Reading Date of Manufacturing on packaged food	0.434
3	Effect of tea/coffee	0.138	3.	Reading Best before date on packaged food	0.160
4	Protein deficiency	0.472	4.	Reading Energy content of packaged food	0.330
5	Balanced diet	0.101	5.	Fruit consumed daily	0.484
6	Water soluble vitamin	0.318	6.	Meal(s) skipped	0.081
7	Fat soluble vitamin	0.229	7.	Washing hands before eating/cooking	0.000
8	Role of Vitamin C	0.349	8.	Physical activity performed daily	0.094
9	Vitamin C sources	0.150	9.	Eating slowly and proper chewing of food	0.411
10	Iron Deficiency Anemia	0.291			
11	Vitamin C and Iron	0.346		**3.Awareness present**	
12	Iodine Deficiency	0.054	1.	Adverse effect of fast food consumption on health	0.687
13	ORS	0.110	2.	Excessive sweets/sugary foods consumption causes tooth decay	0.000
14	Overcooking & nutrient loss	0.219			
15	Cooking benefits	0.039	3.	Sedentary lifestyle is undesirable	0.560
16	Vitamin destruction	0.549	4.	Adequate Sleep is must	0.298
17	Fermentation & Vitamin B	0.572	5.	Daily Exercise is essential	0.000
18	Vegetable washing & nutrient loss	0.213	6.	Good Eating habit is foundation of good health	0.000
19	Soaking pulses	0.346	7.	Good quality food leads good health	0.000
20	Pressure cooking benefits	0.131			
21	Use of different cooking oils	0.030			
22	Natural preservatives	0.504			
23	Microorganisms	0.169			

for their study ranged between 0.38 and 0.58. Test-retest reliability of the overall questionnaire was also higher (0.79) as compared to the study of Oz *et al.* in 2016 which reported an overall 0.69 test–retest correlation.

Average of scores obtained by boys (58 ± 5) were lower than average score of girls (60 ± 6) (p=0.4925). The result obtained were in line with the study of Oz *et al.* (2016) which attributed this to the better performance of girls in school lessons compared to boys. Average scores were significantly higher for class 7th children (μ=62), followed by class 8th (μ=60) and class 6th (μ=55) children respectively (p= 0.0162). Better performance of class 7th children can be attributed to their knowledge retention from the previous year as most of the questions are introduced in the syllabus at the level of class 6th.

To estimate the contribution of items to the conceptual constructs and whether those items can better measure a feature corrected item-total score correlation coefficients were calculated. Items were classified as poorly discriminative (<0.20), somewhat discriminative (between 0.21 and 0.40) and highly discriminative (>0.40) based on their corrected item-total score correlation coefficient values (Cam and Baysan, 2010). There were 10 items which were highly discriminative whereas 17 items were poorly discriminative. Minimum corrected item-total score correlation coefficient of the items was 0.00, and items with corrected item-total score <0.20 were still retained not to lose the measurability capacity that the item would offer. Thus, test comprised of 39 items in whole for which a Cronbach's alpha value was 0.73 (Table 3).

Cronbach's alpha coefficient representing the internal consistency reliability of a scale, should be higher than 0.70 (Cam and Baysan, 2010). Cronbach's alpha coefficients for the entire questionnaire was 0.73, 0.70 for domain 1 and 0.66 for domain 2 and 3 combined, which implies considerable reliability of the questionnaire. The split half reliability of the scale was also considerable because the Spearman-brown coefficients for the different domains of the questionnaire were greater than 0.70. Oz *et al.* (2016) reported a Cronbach's

alpha value greater than 0.60 for all sub-dimensions and a value of 0.85 for the entire scale. The higher Cronbach's alpha value for the entire questionnaire compared with the Cronbach's alpha value of each domain may be explained by the higher heterogeneity in the total sample.

CONCLUSION

The developed questionnaire had shown an adequate reliability and therefore can be used among early adolescents of 11-14 years. The tool developed has practical application and is easy to administer. Tool developed will help in assessing the nutrition friendliness of schools, particularly in the hill state of Uttarakhand. This nutrition knowledge questionnaire can be used to monitor the changes in nutrition knowledge levels, to assess the nutritional status and or change in dietary habits and practices with respect to the knowledge levels of early adolescents.

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