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Development and validation of diet quality index for Indian elderly

[1]Monika Jain, [2]Payal Jain, [3]Anjali Kumari

[1]Professor, Food Science and Nutrition Division, Banasthali Vidyapith, Rajasthan-304022, India, drmonikajain2000@gmail.com
[2]Assistant Professor, Department of Food and Nutrition, School of Science and Technology, Vanita Vishram Women's University, Surat, Gujarat, 87payaljain@gmail.com
[3]Senior Research Fellow, Food Science and Nutrition Division, Banasthali Vidyapith, Rajasthan-304022, India, anjali.kumari9457@gmail.com

Abstract

Background: There is no food-based index to examine the diet quality of Indian elderly. Aim: This study aimed to develop a food-based diet quality index for Indian elderly based on Indian dietary guidelines, evaluate the reliability and validity and examine this index in relation to dietary intake. Methods: A cross-sectional study was conducted on 30 elderly participants of Banasthali Vidyapith, Rajasthan for preliminary testing. Diet quality assessment was done by EDI and Indian EDI. For the development of Indian diet quality index, relevant literature was surveyed; the elderly were interviewed, opinions of experts were sought and 30 statements were framed which were then scrutinized critically to choose 15 and was finally tested on 60 elderly for the standardization of this index. Reliability was analyzed by Cronbach's alpha method, split half method, and test-retest method. Validity was also analyzed by face and content validity and floor and ceiling effect. Results: Reliability of Indian EDI was 0.75, 0.40 and 0.99 by Cronbach's alpha methods, split-half coefficient and test- retest method respectively. This index conformed to face validity as well as content validity which were judged by 30 subject matter experts. This index did not exhibit floor and ceiling effects, reflecting good content validity. All the participants were classified into the category of unhealthy diet by EDI. As per Indian EDI assessment lesser participants were falling in the unhealthy diet category and more in moderate healthy diet category. Conclusion: Indian EDI is an appropriate tool to evaluate the diet quality of Indian elderly subjects.

Keywords: Diet quality, Elderly dietary index, Reliability, Validity.

INTRODUCTION

The World Health Organisation (WHO) identified that healthy ageing in the 21st century is one of the most significant global health problems (Landi et al., 2019). As a population, elderly people are more vulnerable to various nutritional deficiencies, cognitive and functional inability, which are associated with deterioration of their nutritional status (Jain et al., 2021). Inadequate intake of diet and poor nutritional status have been observed in the elderly due to many factors that include unemployment, staying alone and lack of social support. Accordingly, these factors contribute to the adoption of unhealthy dietary habits and poor quality of diet by older people. Unhealthy dietary patterns and inadequate diet quality make them more prone to various physical ailments and diseases (Dominguez et al., 2022). The pattern of dietary intake by older people is shifting towards lower consumption of fruits

and vegetables and higher intake of fats and oils (English et al., 2021). An adequate intake of dietary nutrients is vital to maintain the quality of life and wellness of older people (Jain et al., 2015). It is imperative to assess food consumption to keep an eye on the nutritional status of the geriatric population because it helps in the recognition of nutritional deficiencies and also provides extensive guidance to devise effective measures to improve the health and nutritional status of the elderly (Khole et al., 2018). Yet, studies comprehensively evaluating the overall quality of the diet are incipient and scant, especially in the geriatric population of India. Therefore, studying lifestyle behaviour such as diet quality is a need of the hour to prevent chronic diseases and promote good health.

In that regard, there is increasing interest in recent years to construct diet quality indices for overall dietary assessment. Various dietary indices such as Healthy Eating Index (HEI), Diet Quality Index (DQI), Healthy Diet Indicator (HDI) and Mediterranean Diet Score (MDS) have been used to examine diet quality. But these are based on USDA guidelines (Gill et al., 2015). and are not appropriate to reflect the diet quality of Indian elderly. There is a need to develop a diet quality index for the elderly based on Indian dietary guidelines. Considering the current scenario and the importance of monitoring and determining of diet quality of the elderly, the main aim of the present endeavour was to develop a diet quality index as per Indian dietary guidelines for the elderly. Validity and reliability were also analyzed to improve the diagnostic accuracy of the tool.

Methods

Diet quality indices consist of nutrients components and a combination of different food groups that are based on healthy dietary guidelines and focus on the prevention of various physical ailments and diseases (Kim et al., 2003).

Development of Diet Quality Index for Indian elderly

A pilot study was conducted on 30 elderly participants of Banasthali Vidyapith, Rajasthan to develop a blueprint of the desired index. All participants were apprised of the aim of this study and their informed written consent was collected. The current study was carried out following ethical guidelines on human subjects as suggested by Indian Council of Medical Research (2017).

Diet quality index was developed in tune with the information gathered from the pilot survey and in accordance with Indian dietary guidelines to reflect the diet quality of geriatric population of India. Before developing the proposed diet quality index, items/components of the index were analysed. At first, the diet quality of the elderly (≥65 years) was assessed using the Elderly Dietary Index (EDI), which is an international tool of diet quality, as per USDA dietary guidelines. During the administration of Elderly Dietary Index (EDI), some additional dietary components which were not present in EDI were noticed. During the evaluation of all dietary information on EDI, some components were found unsuitable for Indian elderly such as olive oil, meat, seafood and fish. The need to incorporate some other dietary items which are an inevitable element of Indian elderly was felt. For the completion of the main aim of this study, dietary guidelines for Indian elderly (ICMR, 2010) were analysed and advice from experts was also sought. Some unsuitable dietary items/components of EDI were omitted and some appropriate dietary components were included in the index. A blueprint of the index composed of 30 components was prepared. The first draft was given to 30 participants. During the period of administration, participants were found to experience difficulty in some words. After discussion with experts, several changes were accordingly made to address the problems. As per experts' opinion, some unsuitable and irrelevant items of index were dropped; while some related items were clubbed into a similar category. After that, questions were simplified, errors resolved and

consecutively adhered to avoid all the uncertainties.

This index was divided into two parts. Both parts of the tool consisted of 14 dietary components including cereals (refined and whole), pulses (refined and whole), vegetables, fruits, milk and milk products, desserts/ sweets, fats and oils, sugar, beverages, nonvegetarian foods. The first part consisted of foods from all the food groups to represent diet variety. It covered quantitative data on the number of servings from different food groups. The second part contained all the information on commonly consumed foods from each food group.

Scoring and cut-offs

Each component of the index was scored using a 5-point scoring scale. The lowest part accorded was 1 while the highest was 5. The existing dietary recommendations for Indians were used to create scoring for each item of index (NIN, 2010). Highest scoring was given for consuming the recommended quantity in terms of number of serving from each food groups. Scoring of diet variety components was observed in different pattern and calculated as "totalling the number of foods an individual ate in a day in amount sufficient to contribute at least half of serving in a food group". In diet variety, highest score (5) was assigned to a person who consumed at least half a serving of >8 different foods per day. A person was assigned the lowest scoring (1) if he/she consumed <3 different food items in a day. Highest score expressed that participants were meeting the guidelines for the number of servings of each dietary food groups while lowest score expressed that diet quality had low compliance to recommendations. Maximum possible scores and minimum possible scores were 75 and 15 respectively. The components of this index, along with the scoring system are presented in table 1.

Table 1. *Indian EDI with its components and scoring system.*

S. No.	Components	Scores				
		5	**4**	**3**	**2**	**1**
1	Whole cereals	6-9 s/ d	4-5 s/ d	2-3 s/ d	1 s/ day	<1 s/ d
2	Refined/ processed/ fortified cereals	6-9 s/ d	4-5 s/ d	2-3 s/ d	1 s/ d	<1 s/ d
3	Whole/ husked pulses	2 s/ d	>2 s/ d	1 s/ d	<1 s/ d	Never/ rarely
4	Washed/ dehusked pulses	2 s/ d	>2 s/ d	1 s/ d	<1 s/ d	Never/ rarely
5	Milk and milk products	>3 s/ d	3 s/ d	2 s/ d	1 s/ d	<1 s/ d
6	Vegetables	>3 s/ d	3 s/ d	2 s/ d	1 s/ d	<1 s/ d
7	Fruits	>2 s/ d	2 s/ d	1 s/ d	<1/7-3/7 s/ d	Never/ rarely
8	Non-vegetarian foods	1/7-2/7 s/ d	1/7 s/ d	Never/ rarely	3/7-4/7 s/ d	≥4/7 s/ d
9	Sweets/ desserts	1/7-2/7 s/ d	3/7-4/7 s/ d	4/7-5/7 s/ d	>5/7 s/ d	Never/ rarely
10	Fats and oils	4-5 s/ d	2-3 s/ d	<2 s/ d	>5 s/ d	Never/ rarely
11	Indigenous foods (Fenugreek seed/ bittergourd/ multi grain/ oat flour incorporated recipes)	>6 recipes in a week	5-6 recipes in a week	3-4 recipes in a week	1-2 recipes in a week	Never/ rarely
12	Medicinal herbs	5 items in a week	4 items in a week	3 items in a week	1-2 items in a week	Never/ rarely
13	Sugar	4-5 s/ d	2-4 s/ d	<2 s/ d	>5 s/ d	Never/ rarely

14	Beverages (Tea/ coffee/ *thandai*)	2-3 cups/ glasses/ day	1-2 cups/ glasses/ day	1/2-1 cups/ glasses/ day	<1/2cups/ glasses/ day	Never/ rarely
15	Dietary variety	At least half s/d of more than 8 different foods	At least half s/d of 7-8 different foods	At least half s/d of 5-6 different foods	At least half s/d of 3-4 different foods	At least half s/d of less than 3 different foods

Standardization of Indian EDI

For standardization a study was conducted on 60 elderly of age ≥60 years, residing in Banasthali Vidyapith. Participants were excluded if they had any chronic diseases such as cardiac diseases, cancer and diabetes as this tool was not developed according to any specific disease. The participant selection was random.

Reliability

Reliability assesses the consistency of the tool. A tool is considered reliable if it yields the same results for an individual under consistent conditions. In the present study, three methods were used to examine the reliability of the tool, as mentioned below.

Cronbach's alpha method

Cronbach's alpha method is used to examine the reliability of scale that contain any combination of item type (ITAP, 2003). This method is used to assess how well items of individual index fit together in measuring the same construct.

$$Coefficient\ \alpha = \frac{k}{k-1}\left[1 - \frac{\sum s_i^2}{s_t^2}\right]$$

Where, "∑" is the operational symbol meaning the sum of, "k" is the number of separately scored test items, "si2" is the variance of subjects' scores on a particular test item, "st2" is the variance of the total test scores and "∑ si2" is the sum of the item variances for all test items.

Split – half method

Spearman-Brown prophency formula was used to determine the internal consistency evaluation of this index (Asthana & Agrawal, 1982).

$$r_w = \frac{2r_h}{1 + r_h}$$

Where, "rh" is the correlation between the two halves of the test and "rw" is the correlation for the whole test

Test-retest method

This test measures the stability of a test over time. The test- retest reliability measures the correlation between the results of same test (Gabrenya & Arkin, 1980).

Validity of Indian EDI

Face validity

It is the degree to which a test seems "on its face" to measure what it purports to measure (Anastasi, 1988). In the present endeavour, face validity was measured by distributing the Indian EDI among participants to confirm that all the necessary dietary components are present or not.

Content validity

Content validity examines the degree to which the components on a test represent the entire questionnaire. In the present study, it was assessed by 30 subjects matter experts (SMEs) belonging to the different fields (psychology, education, sociology, food science and nutrition and statistics). Lawshe (1975) constructed the formula recognized as content validity ratio was used to estimate levels of content validity.

CVR= (ne- N/2)/ (N/2)

Where, “CVR” is the content validity ratio, “N” is the total number of SME panelists (30) and “ne” number of SME panellists indicating “essential”

Floor and ceiling effect

Floor and ceiling effect is observed when >15% of participants achieve the highest or lowest scores respectively (McHorney & Tarlov, 1994). Extreme components absent in the upper or lower end of the questionnaire indicate the presence of floor and ceiling effect and it presents limited content validity. For the absence of floor or ceiling effects, a positive rating was assigned.

Statistical analysis

Analysis of data was done by using Microsoft Excel and IBM SPSS. A $p<0.05$ was considered statistically significant. Reliability and validity statistics were used for the standardization of Diet Quality Index for the elderly.

Results

Reliability assessment of Indian EDI

The Cronbach’s alpha coefficient for total score was 0.75, which indicated the Indian EDI had an acceptable range of internal consistency. An overall Cronbach’s alpha coefficient of >0.7 is considered desirable to indicate the reliability of this index in measuring diet quality. Reliability statistics of this tool was 0.40 by the split-half method, which was considered lower. The acceptance cut off range for split-half method fall between -1 to +1 indicating a perfect negative to perfect positive relationship between scores of two halves. Reliability was found excellent by the test-retest method, i.e., 0.99. The cut-off value of ≥0.9 for test-retest method is considered adequate and indicate excellent reliability of this index. Hence, we interpreted that this tool is considered as a reliable tool for diet quality assessment of Indian elderly.

Validity assessment of Indian EDI

This tool had face and content validity. Content validity of the scale was 0.52, indicated that at least half of subject matter expert (SME’s) rated the items as essential. This tool did not exhibit the floor and ceiling effect, indicating the presence of extreme items in the upper and lower end of the scale. Therefore, Indian EDI is a valid measure of diet quality of elderly.

Diet quality assessment by EDI

Distribution of participants according to statistically calculated tertiles of EDI is presented in table 2. After diet quality assessment, all the participants were classified in the unhealthy category and majority of participants were in 65-74 years of age group (young-old). Stratified analyses by gender showed that men had higher mean EDI score (24.1±1.48) as compared to women counterparts (23.8±1.43). The mean EDI scores were 22.7±2.07 (65-74 years), 24.8±0.75 (75-84 years) and 24.5±0.70 (≥85 years) on a possible scale of 15 to 75.

Diet quality assessment by Indian EDI

Distribution of participants according to statistically calculated tertiles of Indian EDI is presented in table 2. Diet quality assessment by Indian EDI showed that few participants were falling in the category of unhealthy diet (1st tertile) and they were in 65-74 year of age group (young-old), whereas none of the participants was falling in this category in 75-84 year of age group (middle) and ≥85 years of age group (old-old). In young-old age group (65-74 years), more than half of the participants were following a moderate healthy diet. More than one third of participants were following a healthy diet and majority of participants were in 65-74 years of age (young-old). None of the participants from old-old group (≥85 years) followed a healthy diet. Participants were habituated to intake of cereals based food products (pearl millet, maize, whole wheat, etc) largely. Intake of nonvegetarian food was low. The intake of buttermilk was higher by the participants instead of the intake of milk. Stratified analyses by gender showed that men had a slightly higher mean Indian EDI score

(42.2±2.79) than women counterparts (41.0±3.37). The mean Indian EDI scores were 42.4±3.21 (65-74 years), 41.1±1.94 (75-84 years) and 41.5±0.70 (≥85 years) on a possible scale of 15 to 75.

Table 2. *Distribution of participants on the basis of statistically calculated tertiles of EDI and Indian EDI.*

Diet quality index	Interpretation	All participants		Age (Years)					
				65-74		75-84		≥85	
		N	%	n	%	n	%	N	%
EDI	Unhealthy diet (scores: 10-28)	60	100.0	54	90.0	5	8.3	1	1.6
	Moderate healthy diet (scores: 29-31)	-	-	-	-	-	-	-	-
	Healthy diet (scores: ≥32)	-	-	-	-	-	-	-	-
Indian EDI	Unhealthy diet (scores: 15-38)	4	6.6	4	6.6	-	-	-	-
	Moderate healthy diet (scores: 39-42)	35	58.3	30	50.0	4	6.6	1	1.6
	Healthy diet (scores: ≥43)	21	35.0	20	33.3	1	1.6	-	-

Discussion

Although, various studies have employed diet quality index to determine overall diet quality in the elderly (Fernades et al., 2018; Khaje-Bishak et al., 2014), among which development of EDI has received considerable attention. But EDI based on USDA guidelines cannot properly reflect Indian dietary patterns. Therefore, diet quality indexes for Indian elderly following Indian dietary guidelines need to be developed. As far as we know this is the first study that explores the development of a diet quality index to reflect the diet quality of the geriatric population of India.

In this study, diet quality in the elderly was assessed by EDI and Indian EDI. Based on Indian EDI, none of the participants was classified in the unhealthy category belonging to the middle age group and old-old group, whereas few participants of 65-74 year of age group (young-old) were falling in this category. The elderly with poor oral health had consumed lower servings of vegetables and fruits and had compromised diet quality scores than those with healthy teeth (Sahyoun et al., 2003). USDA, CNPP (1995) reported that only one-third of the participants had eaten recommended servings of major food groups. Sharkey et al., (2002) state that the risk of dietary and nutritional inadequacy is greater among rural elderly women, as it represents a potential health threat to the whole geriatric populations. Inadequate dietary intake and poor nutritional status may be due to impaired dentition, low educational attainment, and low family income. In the current study, the elderly female had lower mean scores of EDI and Indian EDI when compared with the elderly male. In contrast to our results, a study reported a higher diet quality score for female than male (Williams et al., 2017).

In general, the results showed that consumption of cereal based food products was high. The consumption of cereals is related to the prevention of chronic illness occurring in old age (Mozaffarian et al., 2003). Low consumption of milk was also observed in this study. These results are consistent with the previous study and described the high prevalence of calcium deficiency in older adults due to low intake of milk and milk products (Fernades et al., 2018). Our study revealed a scenario that requires some modifications in dietary patterns and behavior in the geriatric population of India.

Our study presents demerits that need to be discussed. First, it was a cross-sectional study where temporality and causality cannot be proven. Second, the sample size was small, so it is necessary to extend and replicates our observation to the large population. Third, in the development of Indian EDI, similar scoring was given to all nonvegetarians' foods. Fourth,

post-translational validity was not carried out for translated EDI.

Additionally, the current study has a few merits. First, Indian EDI is a simple and practical tool to assess the diet quality of community-dwelling elderly people. Second, this tool can be applied in other studies for the assessment of the diet quality of geriatric populations. Third, our findings have some important implications for policymakers and health care professionals to put the policies into action for the maintenance of health and upgrading the quality of life for the greying population in India.

Conclusion

Diet quality indices are important measures in understanding dietary patterns and evaluating the attributes of dietary quality for the prevention of nutritional deficiencies. A wide range of dietary indices has recently been developed to recognize the elderly who are at nutritional risk. Although studies on the development of dietary indices from India are scant. Therefore, the current study was designed to construct an index for diet quality assessment in the elderly. This nutritional screening tool is reliable and valid for use in the community-dwelling elderly population. Diet quality assessment by Indian EDI revealed that the diet of most of the participants was moderately healthy.

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Declaration of conflicting interests

None declared

Ethical approval

The study enrolled the subjects after seeking informed consent. The Research Advisory Committee of the Department did not suggest the need for getting the ethical approval from Institutional Ethical Committee as the data collection from human subjects was completely non invasive. A written informed consent was obtained from participants for data collection and publication of this study.

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