

Perceived benefits and barriers of increased dietary fiber consumption: Validation of a decisional balance scale

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ABSTRACT

Article History

Received:

11/06/2015

Revised:

12/07/2015

Accepted:

29/07/2015

Keywords:

Benefits, Barriers,
Dietary fiber,
Diabetes type 2,
Questionnaire
validation

Background: This study was conducted to develop and validate a scale in order to assess perceived benefits and barriers (decisional balance) for improving dietary fiber consumption in patients with type 2 diabetes (T2D).

Methods: In order to develop the scale, focus-group discussions, in-depth interviews and literature review were carried out. Validity of the questionnaire was assessed using content validity, face validity and construct validity. The factor structure of the questionnaire was also extracted by performing both principle component analysis (PCA) and confirmatory factor analyses. Reliability was then estimated using internal consistency and test-retest analysis. Two groups of T2D patients participated in the study. 146 T2D patients participated in the content validity and the other 265 T2D patients were those whose data were used for the confirmatory factor analysis.

Results: The mean age of the participants was 52.3±7.6 years. PCA indicated two components representing benefits (Cronbach's $\alpha=0.75$) and barriers (Cronbach's $\alpha=0.71$). Confirmatory factor analysis supported the two-component structure [Goodness of Fit Index = 0.94, $\chi^2/df=1.56$ ($\chi^2=118.28$, $df=76$, $p<0.001$), RMSEA=0.046]. The Test-retest results, measured by interclass correlation (ICC), for all the items were between 0.62 and 0.78.

Conclusion: The designed questionnaire is valid and reliable to assess perceived benefits and barriers of dietary fiber intake in patients with T2D.

Introduction

Dietary fiber is known as an important component of a healthy diet. An increase in the dietary fiber intake in patients with type 2 diabetes (T2D) tends to improve glycemic control and decrease the consumption of glucose lowering medications and the insulin doses [1-4]. Dietary reference intake recommends 21-25 g

of dietary fiber for women and 30-38 g for men [5]. To meet this recommendation, health organizations advise patients to increase the consumption of fruits and vegetables, dried beans and whole grains [6]. There is little information about fiber intake in diabetic patients in Iran. In Shirinzadeh et al study, the mean intake of fiber in T2D patients was lower than recommended amount (14.7±3.7) [7]. In addition, fiber intake in the highest quintile of Iranian dietary pattern score and median fiber intake were about 16 g/day in two other studies in healthy populations [8, 9].

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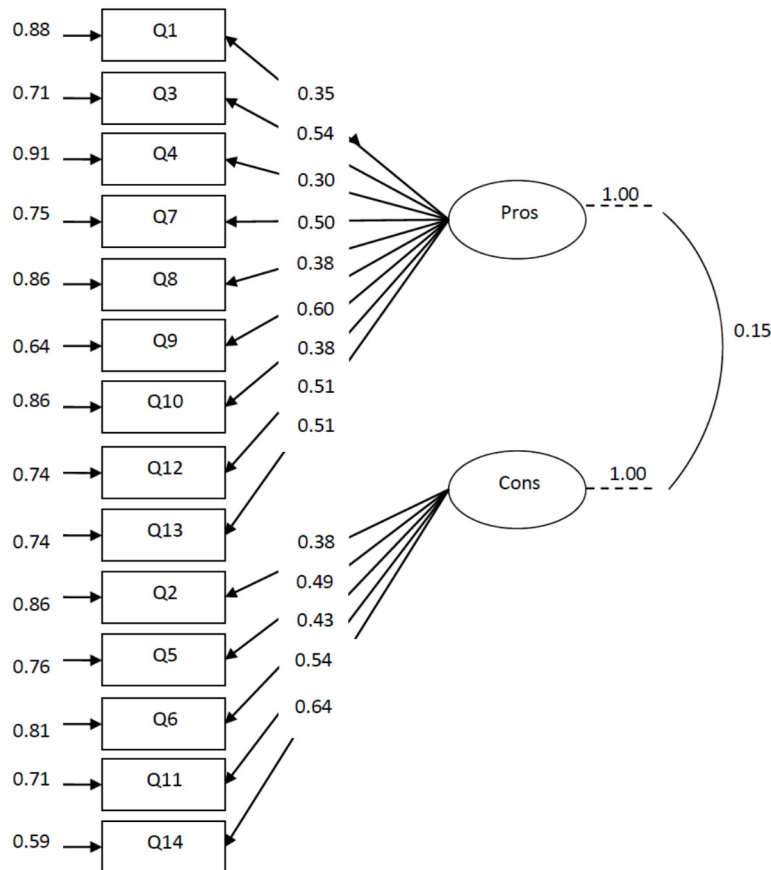


Figure 1. Confirmatory Factor Analysis. Chi-Square=118.28, df=76, P-value<0.001, RMSEA=0.046

To improve dietary fiber intake in a population, it is required that nutrition education strategies and food policies address such factors as social factors and personal beliefs, which affect dietary behaviors [10]. These consist of barriers and facilities that have perceived impacts on nutrient intake or specific diet adherence. The Decisional Balance construct used by Prochaska and DiClemente in transtheoretical model (TTM) is based on Janis and Mann's theory [11] in 1977 and it is both qualitative and quantitative construct which involves a person weighing his/her own pros (facilitators) and cons (barriers) of making a change. The development of long-term internal motivation is induced or inhibited by how pros and cons are weighed. A perception of pros for the behavior often reveals facilitating factors in a person's life and environment, which can help him/her to change; the perceived cons often show barriers, which will require to be considered for behavioral changes. Considering these barriers is important to arrange effective

interventions in order to help diabetic patients improve their health behavior and better control their disease [12].

Several factors have been associated with diabetes diet adherence and could increase fruit and vegetable intake and decrease fat intake in community surveys. Previous studies have shown that psychosocial factors are more important determinants than demographic ones for fruit and vegetable consumption [13-16]. Variables such as price, time, and convenience, accessibility to healthy food, preparation skills, and social support were perceived to influence food choice and eating a healthy diet [10]. Chuan Ling et al. have shown that price, time, pesticides, and allergic reactions were some of the main barriers to eating more fruits and vegetables. In addition, some of their main benefits observed in their community were providing vitamins and minerals, following recommendations, better appearance, better feeling and preventing constipation [17].

To increase fiber consumption in diabetic

Table 1. Demographic characteristics of the participants

		Main study sample* (n=146)		Sample for the CFA** (n=265)
		Number	%	Number
Age (year)	Mean (SD)	52.3 ± 7.6		52.8±7.0
Duration of diabetes (year)	Mean (SD)	9.1 ± 6.8		9.0±6.1
Sex	Male	82	56	161
	Female	64	44	104
Education	Primary and lower	22	15	41
	Secondary & high school	85	58	135
	University	39	27	89
Marital status	Married	134	92	234
	Single/divorced	12	8	31
Employment	Unemployed	12	8	40
	Employed	92	63	132
	Retired	42	29	93

* Principle component analysis and Reliability

** Confirmatory Factor Analysis

Table 2. Principle component analysis and test-retest data of decisional balance questionnaire of high fiber foods consumption

Items	Factors	
	F1	F2
1- I Feel better when I eat more fruits, vegetables and legumes	0.466	0.183
2-Eating more fruit and vegetables would be expensive	0.177	0.510
3-Eating vegetables and legumes help me to decrease my blood glucose	0.670	0.124
4- I prefer to get vitamins from fruits and vegetables than from supplements	0.474	-0.220
5-It is difficult to get enough fruit, vegetable and legumes when I eat out	0.105	0.648
6-Lack of family awareness of nutrition demands in diabetes	0.234	0.567
7-Fruit, vegetables and legumes help me feel less hungry	0.660	0.017
8-Fruits & vegetables help keep me regular (avoid constipation)	0.542	0.177
9-My family encourage me to eat more fruit, vegetable and legumes	0.670	-0.130
10-I eat more fruits and vegetables if my family and friends do	0.537	0.143
11-I am not in mood to prepare and cook vegetable and legumes	-0.113	0.674
12-Eating fruits, vegetables and legumes would help me to maintain my weight	0.515	0.104
13-Doctors or nutritionist recommend me to eat more fruits, vegetables and legumes	0.653	-0.133
14-I am too busy to eat fruits, vegetables, legumes and whole bread	-0.126	0.754
Variance%	32.7	25.7
Variances% for 2 factors	58.4	

F1: Benefits, F2: Barriers

patients, it is necessary to determine the reasons of low intake of fiber and perceived barriers and benefits, which diabetic patients meet for adherence to a high fiber diet. At the time of this study, there was no questionnaire to assess barriers and benefits of fiber intake in patients

with type 2 diabetes in the literature. Therefore, this study was designed, and its purpose was to develop a valid questionnaire that determines and assesses the facilitating factors, benefits and barriers, which have impacts on high fiber food consumption.

Table 3. Goodness of fit indices for decisional balance questionnaire

Goodness of fit indices		
	Analysis outcome	Recommended cut-off value
P-value	0.001	
X ² /df	1.56	≤2; ≤3 or 5
Root Mean Square Error of Approximation (RMSEA)	0.046	≤0.05 ; ≤0.08 or <0.10
Normed Fit Index (NFI)	0.84	≥0.90
Non-Normed Fit Index (NNFI)	0.92	≥0.90
Comparative Fit Index (CFI)	0.93	≥0.90
Incremental Fit Index (IFI)	0.94	≥0.90
Standardized root mean square residual	0.06	≤0.05 or 0.10
Goodness of Fit Index (GFI)	0.94	≥0.85-0.90

Table 4. Descriptive statistics and Cronbach's alpha

	Number of items	Mean (SD)	Cronbach' alpha	Intra-class correlation
Total items	14	2.85 (0.46)	0.73	0.72
Benefits	9	3.22 (0.17)	0.75	0.75
Barriers	5	2.20 (0.32)	0.71	0.65

Methods

Scale development

To develop a questionnaire to measure the decision balance in consuming high fiber foods in diabetes patients, the following procedures were applied:

1) Focus group discussions with a convenience sample of diabetic patients: six group discussions were held with 55 T2D patients aged 34 to 70 years old in the National Nutrition and Food Technology Research Institute. These patients were recruited from the "Charity Foundation for Special Diseases" and "Iranian Diabetes Society" in Tehran, Iran.

2) In-depth interviews with nutrition specialists: in-depth interviews were carried out with 3 nutrition specialists and diet therapists in the mentioned centers. Discussions and interviews were tape recorded and transcribed. Data were analyzed using the Strauss and Corbin's analytical method [18] for qualitative studies. The results obtained from this part were explained in details elsewhere [19]. In summary, perceived benefits of high-fiber food consumption included better blood sugar control and improved gastro-intestinal function. The main perceived barriers were personal (lack of awareness, lack of interest, lack of sufficient time, cost, dental problems, false beliefs, fear of hyperglycemia, fatigue, and gastrointestinal problems); social (family pressure, and lack of family support); and educational (low level of education, not-sufficient information provided by health services).

3) Literature review: There was no study on barriers and benefits of fiber intake in such target

group, so we had to find the closest subjects. An item pool was generated from the literature regarding barriers and benefits of fruit and vegetable consumption and healthy diet adherence [12, 17, 20-34].

In brief using the above-mentioned producers, a 46-item questionnaire was prepared and subjected to content and face validity.

For content validity, expert panels were consulted including 10 nutrition and 3 health education experts who reviewed the questionnaire to ensure necessity, relevance, clarity and simplicity of the items in order to calculate Content Validity Ratio (CVR) and Content Validity Index (CVI). A three-point rating scale was used to assess the necessity of each item as follow: (1) not necessary, (2) useful, but not essential, (3) essential. To keep each item in questionnaire, CVR should be 54% or more [35]. The relevance, clarity and simplicity of the items were also assessed using a four-point rating scale: Questions which rated as 3 or 4 were used to calculate the CVI. Waltz & Bausell [36] recommended 0.75 for the acceptable lower limit. Items which did not gain acceptable value were omitted from the questionnaire and 21 statements containing 10 barriers (cons) and 11 benefits (pros) eventually remained.

For face validity, the 21-item questionnaire was administered to a convenience sample of 20 T2D patients in order to pretest and assess clarity and readability of the items. Most of the items were easy and understandable. However, some minor modifications were made in order to make the sentences more comprehensible. This pre-

final version of the questionnaire was then provided for Construct Validity.

Statistical analysis

As for Construct validity, we performed both principal components analysis (PCA) and confirmatory factor analyses with two separate samples. To perform PCA, a sample of 146 T2D patients, aged 34 to 70 years, were entered into the study. The patients were recruited from “the Charity Foundation for Special Diseases” and “the Iranian Diabetes Society” in Tehran, Iran, and the questionnaires were completed face to face. PCA with Varimax rotation was conducted to explore the underlying factor structure of the decisional balance. Scree plot was used to extract components. Items were excluded if they were loaded lower than 0.4 or loaded ≥ 0.4 on at least two factors [37]. Before conducting the factor analysis of the instrument, Kaiser–Meyer Olkin measure of sampling adequacy and Bartlett’s test were conducted to determine whether at least one factor (or component) could be extracted from the data. It has been reported that when it is between 0.90 and 1.00 the sample size is excellent, 0.80-0.89 is very good, 0.70 to 0.79 is good, 0.60 to 0.69 is average, 0.50 to 0.59 is weak, and when it is less than 0.50 it is not acceptable [38].

Confirmatory Factor Analysis was performed using LISREL (Scientific Software International, version 8.8, Inc.2006) to determine whether the proposed factor model could provide a good model fit and validate the proposed structure of the Decisional Balance questionnaire. With a sample of 265 T2D patients, whose data were collected face to face, we evaluated some goodness-of-fit indicators including: the relative chi-square (χ^2/df), Goodness of Fit Index, the Root Mean Square Error of Approximation (RMSEA), Normed Fit index (NFI), Non-Normed Fit Index (NNFI) Incremental Fit Index (IFI), Comparative Fit Index (CFI) and Standardized root mean square residual that were reported as the analysis outcomes. Several goodness-of-fit indicators including in Confirmatory factor analysis: goodness of fit index (GFI), adjusted goodness of fit index (AGFI), RMSEA, NFI, and CFI were selected for reporting the analysis outcomes. The GFI and AGFI are chi-square based calculations independent of degrees of freedom. The recommended cut-off values for acceptable values are ≥ 0.90 . The RMSEA tests the fit of the model to the covariance matrix. As a

guideline, values of < 0.05 indicate a close fit and values below 0.11 are an acceptable fit. The NFI and CFI values range from 0 to 1 with a value of 0.90 and greater being acceptable fit to the data [39]. The simple fit index is called relative chi-square (χ^2/df), which is the minimum sample discrepancy divided by degrees of freedom. Values below 1.0 indicate an ‘over fitted’ model, and values larger than 2.0 or 3.0, and the more moderate limit of 5.0 indicate that the model does not fit the observed data and requires improvement [40, 41].

For reliability, internal consistency was also assessed for the final version of the questionnaire, using Cronbach’s alpha, which indicates how well a set of items measures a single dimensional latent construct and how likely item responses will correlate with each other. The alpha values of 0.60 or above were considered satisfactory [42]. Stability of the scale was established by measuring the test–retest reliability to make sure that the results produced were consistent over time. The participants ($n=146$) were interviewed again two weeks after the first completion of the questionnaire and the Intra-class Correlation Coefficient reliability was calculated. The following category was selected to interpret the agreement levels: 0-0.2 as slight, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial, and 0.81-1 as almost perfect [43]. All analyses except confirmatory factor analysis were done using SPSS 16.

The questionnaire was designed to assess decisional balance to eat more dietary fiber using the following format: "How important is each statement to you, in your decision to eat, or not to eat, high fiber foods?" Participants responded to each item using a five-point Likert scale ranging from ‘not at all important (1)’ to ‘extremely important (5)’.

Ethical Consideration

“All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.” The Ethics Committee of ‘National Nutrition and Food Technology Research Institute’ approved the study. All the participants gave their permission by signing an informed consent form.

Results

Two groups of T2D patients enrolled in the study. 146 (82 male and 64 female) T2D patients participated in content validity. The mean age of participants was 52.3 ± 7.6 years. The mean duration of diabetes was 9.1 ± 6.8 years and most participants had secondary and high school education (54.1%). The other 265 T2D patients were those whose data were used for the confirmatory factor analysis. The characteristics of the study samples are shown in Table 1. Factor analysis is one of the important methods for testing the construct validity of an instrument, and was used to determine the factor structure of the items. The calculated Kaiser–Meyer–Olkin was 0.78, indicating that the sample was large enough to perform a satisfactory factor analysis and the Bartlett’s test was significant ($p < 0.001$) which means the data is suitable for reduction. The Principal Component factor Analysis, revealed two components that jointly constituted 58.4% of the total item variance. Fourteen items out of 21 loaded above 0.40 (Table 2). The results for confirmatory factor analysis are shown in Table 3 and Figure 1. The results provided a good fit to the data with $\chi^2/df = 1.56$ ($\chi^2 = 118.28$, $df = 76$, $p < 0.001$), Goodness of Fit Index = 0.94, RMSEA = 0.046, NFI = 0.84, NNFI = 0.92 and CFI = 0.93. The Test–retest results measured by ICC were between 0.62 and 0.78. The Cronbach’s alpha coefficient values were 0.75 for benefits and 0.71 for barriers. The data are shown in Table 4.

Discussion

The purpose of this study was to develop a scale for assessing decisional balance including barriers and benefits of high fiber diet consumption based on TTM. It is well accepted that in the context of this model, the decisional balance is an important determinant of achieving stable behavioral changes [44,45]. The decisional balance usually refers to the benefits and barriers in performing a given desirable behavior. Perceived benefits and barriers of such questionnaires could also be used in other behavioral change models such as social cognitive theory (SCT). Thus, we developed a questionnaire that consisted of two factors namely ‘barriers’ and ‘benefits’. For benefits, we included items that were very similar to those of previous investigations [12,13,17,20,46-48] but after careful examinations for the barriers, we removed some items. For instance, items related

to ‘worries related to the usage of pesticides’, ‘dislike of taste’, ‘missing favorite foods’ and ‘gastrointestinal problems’ that were mentioned in some studies [13,17,34,46,48] were omitted in this questionnaire in the course of the validation process. Additionally ‘limited shelf-life of fresh fruit and vegetables’ was designated unnecessary by the expert panel but exists in some questionnaires [46-48]. ‘Difficulty of behavioral change’ was also mentioned by Ma [13] but was omitted in our study during the process of construct validity.

To make sure if the scale is appropriate to assess perceived benefits and barriers of dietary fiber intake, content and construct validity was assessed. Content validity is the most critical step to design questionnaires and is the first kind of validity that must be assessed during a scale design. Also it is defined as a prerequisite of other validities. Making sure of content validity, adequacy and desirability can effectively improve the quality of the new scale and also increase the reliability of the questionnaire [49].

In the present study, the Kaiser–Meyer–Olkin was 0.78 indicating that the sample was large enough to perform a satisfactory factor analysis. We used Scree plot to extract components (instead of the default eigenvalue) and selected two factors. PCA is a complex procedure with few absolute guidelines and many options. In this method, final decisions on determining which pattern solution to report, name, and analyze are subjective. Therefore, investigators must decide how many factors to retain. The default in most statistical software packages is to retain all factors with eigenvalues greater than 1.0 (Kaiser’s criterion). There is some agreement in the literature that this method is one of the least accurate methods in selecting the number of factors to retain [50]. Investigators also should make additional decisions, including choosing cut points for eigenvalues and factor loadings and the method of rotation. Scree plots are also often used to guide the selection process. Ultimately, a decision must be made as to which solution is the most ‘meaningful’ [51]. Overall a two-factor solution explained 58.4% of the observed variance. However, for a single dimensional tool the variance that explains at least 30% of variance is sufficient and thus applicable [38].

Although the χ^2 associated P-value was below the 0.05 significance level ($\chi^2 = 118.28$, $df = 76$, $p < 0.001$), the other indices reached acceptable levels in confirmatory factor analysis. There is

no universal agreement regarding which indices should be reported in the assessment of confirmatory factor analysis models. Therefore, the authors usually report a range of indices in assessing fit of the models.

The Cronbach's' alpha coefficient values of 0.70 or above are considered satisfactory for internal consistency of an instrument. In this study the alpha value for the 'barriers' was 0.71 and for the 'benefits' was 0.75 indicating adequate internal consistency for the questionnaire. Removing any item did not improve the Cronbach's' alpha. This value was lower compared with the decisional balance questionnaire for the fruit and vegetable consumption [17,48], but was similar to the studies by Mainvil [34] and Steptoe [52]. In addition, the stability of the questionnaire as assessed by test-retest analysis showed satisfactory results. The interclass correlation coefficient was 0.75 for the 'barriers' and 0.65 for the 'benefits'.

This tool is reliable and valid for studying decisional balance of dietary fiber intake and for evaluating barriers and benefits in this field in nutrition education programs for T2D patients. Its validity is supported by the experts who reviewed its content and the reliability of the questionnaire and by the relatively high internal consistency of the item scales. The test-retest reliability was also good.

Potential limitations need to be considered. Those participating in the study might have had greater interest in, or more experience with using outcome measures than those who chose not to participate. Like other self-report questionnaires, this one also may have some inaccuracies because of poor participant recall, lack of understanding of content and discomfort with self-disclosure. It is not easy to establish validity without multiple kinds of evidence. Lack of a gold standard in this area limits proper comparisons. Future studies using this questionnaire could help to overcome these problems.

Conclusion

The findings of our study suggest that this decisional balance questionnaire is a valid and reliable instrument for this purpose. A construct of perceived benefits and barriers could be used in some behavioral change models such as TTM and SCT and it would help researchers and/or policy makers choose appropriate strategies in intervention programs. Consuming dietary fiber

has been emphasized in promoting the health of diabetes patients and also it is important as an instrument to study barriers and facilitators of fiber intake that can be effective in developing interventions. However, application of this questionnaire needs to be confirmed in future studies.

Acknowledgments

The authors are grateful to the patients who participated in the study; and to the kind assistance of "the Iranian diabetes society" and "the Charity Foundation for Special Diseases". This study was supported by National Nutrition and Food Technology Research Institute, Tehran, Iran.

Conflict of interest

All authors declare that they have no conflict of interest.

Funding

This study was supported by National Nutrition and Food Technology Research Institute, Tehran, Iran.

Abbreviations

T2D: Type 2 Diabetes; **PCA:** Principle Component Analysis; **ICC:** Interclass Correlation; **TTM:** Trans-theoretical Model; **CVR:** Content Validity Ratio; **CVI:** Content Validity Index; **RMSEA:** Root Mean Square Error of Approximation; **NFI:** Normed Fit index; **NNFI:** Non-Normed Fit Index; **IFI:** Incremental Fit Index; **CFI:** Comparative Fit Index; **GFI:** Goodness of Fit Index; **AGFI:** Adjusted Goodness of Fit Index; **SCT:** Social Cognitive Theory.

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