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# Psychometric evaluation of dietary habits questionnaire for type 2 diabetes mellitus

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**Abstract.** This research evaluated the psychometric properties of English version of dietary habits questionnaires developed for type 2 diabetic patients. There is scarcity of literature about availability of standardized questionnaires for assessing dietary habits of type 2 diabetics in Saudi Arabia. As dietary habits vary from country to country, therefore, this was an attempt to develop questionnaires that can serve as a baseline. Through intensive literature review, four questionnaires were developed / modified and subsequently tested for psychometric properties. Prior to pilot study, a pre-test was conducted to evaluate the face validity and content validity. The pilot study was conducted from 23 October – 22 November, 2016 to evaluate the questionnaires' reliability and validity. Systematic random sampling technique was used to collect the data from 132 patients by direct investigation method. Questionnaires assessing diabetes mellitus knowledge (0.891), dietary knowledge (0.869), dietary attitude (0.841) and dietary practices (0.874) had good internal consistency reliability. Factor analysis conducted on dietary attitude questionnaire showed a valid 5 factor solution. Directions of loadings were positive and free from factorial complexity. Relying on the data obtained from type 2 diabetics, these questionnaires can be considered as reliable and valid for the assessment of dietary habits in Saudi Arabia and neighbouring Gulf countries population.

## 1. Introduction

National Council on Measurement in Education (NCME) has defined psychometrics as a technique that is devoted to testing, measurement, assessment, and related activities [1]. Psychometric evaluation is generally divided into two parts. The first part is concerned with the development and validation of assessment instruments such as questionnaires, tests and raters judgments etc. The other part is concerned with statistical research based on measurement theory. Psychometric evaluation of the questionnaires is an important phase of any research in order to make valid and reliable decisions. Various fields like, education, psychology and health sciences etc. conduct psychometric evaluation to define the properties of the items, scales and sub-scales of the developed or self-developed questionnaires. Health research which focuses on assessing or evaluating knowledge, attitude and practices (KAP) of a certain phenomenon or disease are classified as patient reported outcomes.



Therefore, it is necessary to carry out the psychometric evaluation of instruments when studying KAP in order to obtain valid and reliable results that can eventually lead to generalizability of results. Dietary habits are the outcomes of individuals or group of people regarding knowledge of foods they consume, what should be eaten, and making proper dietary choices relating to the consumption of vitamins, minerals, carbohydrates, proteins and fats etc. [2]. The purpose of this research was to carry out the psychometric evaluation of dietary habits questionnaires developed for assessing type 2 diabetics; diabetes mellitus knowledge, dietary knowledge, dietary attitude and dietary practices. A brief description of each questionnaire is given below.

#### *1.1. Diabetes mellitus knowledge questionnaire*

Diabetes mellitus knowledge (DMK) is defined as the “patient’s understanding of information about physiological aspects of diabetes as a disease and principles of diabetes management” [3]. The DMK questionnaire used in this research is the modified / extended version of DKQ questionnaire developed by Garcia [4]. The original version comprised of 24 questions and had a high internal consistency reliability (ICR) ranging from 0.73 – 0.84. The new version of DMK questionnaire used in this research comprised of 30 questions that was used to assess diabetics’ “understanding about diabetes, symptoms and knowledge, complications, food and exercise, medication, prevention and investigations” in more detail. Responses were coded as 1 = yes and 0 = no, and I don’t know. ICR for the modified version of the questionnaire is presented in table 1.

#### *1.2. Dietary knowledge questionnaire*

Dietary knowledge refers to the knowledge of concepts and processes related to diet and health, diet and disease, foods representing major sources of nutrients, and dietary guidelines including recommendations [5-7]. Literature was reviewed intensively to observe the pattern of questions recommended for assessing dietary knowledge of diabetics. Relevant questions were prepared and subsequently scrutinized. The self-developed dietary knowledge questionnaire (DKQ) used in this research comprised of 20 multiple choice questions (MCQs). The questions were designed to assess diabetics’ dietary knowledge about carbohydrates, lipids, proteins, food type and food choices. Each MCQ had only one correct answer. The responses were coded as 1 = correct and 0 = wrong, and I don’t know. ICR result for DK questionnaire is presented in table 1.

#### *1.3. Dietary attitude questionnaire*

Dietary attitudes are defined as “beliefs, thoughts, feelings, behaviours and relationship with food. They could influence people’s food choices and their health status” [8]. Measuring dietary attitudes can be useful to understand people’s relationship with food and their associated behavioural choices [9]. Diverse attitudes toward food may have an effect on overall health and contribute to cultural differences in non-communicable diseases [10]. Literature was reviewed to perceive the pattern of questions recommended for assessing dietary attitude of type 2 diabetics. Again a list of questions were prepared and then scrutinized in terms of relevance. The dietary attitude questionnaire (DAQ) used in this research comprised of 16 questions. All the questions were measured on 7-point Likert scale. The responses were coded as 7 = strongly agree, 6 = agree, 5 = somewhat agree, 4 = neutral, 3 = disagree, 2 = somewhat disagree and 1 = strongly disagree. ICR and exploratory factor analysis (EFA) are reported for this questionnaire, results are presented in table 1 and table 2.

#### *1.4. Dietary practices questionnaire*

In order to study the relationship between diet and health we need instruments that can accurately assess dietary intake of the individuals in a population. The Food Frequency Questionnaire (FFQ) is one the most common dietary assessment tool used in large epidemiologic studies to assess a link between dietary practices and health. The FFQ asks the participants to report average frequency of consumption of various foods over a defined period of time e.g. per month, per week or per day. Study conducted by Bowman [11] reported the reliability of FFQ to be 77%. Guerrero [12], tested the reliability of FFQ in 3 different ethnic groups (Filipino, White and Asians), results reported a reliability of 75%. The study

concluded that FFQ can be used to measure nutrient intake for adults and may be helpful in studying relationships between diet and chronic diseases. For the present research an intensive literature review was conducted to identify the foods that can represent various food groups. Moreover, the FFQ comprised of foods that are used mostly in Saudi Arabia. FFQ used in this research comprised of 9 food groups. The developed FFQ was used to assess and evaluate the dietary practices of type 2 diabetics for the last 3 months. Each food group covered relevant food items. The 9 food groups were proteins, carbohydrates, dairy products, lipids and fats, sweets and bakery, drinks, fruits, vegetables and, soups and sauces. The responses were recorded as “0 = not consumed, 1 = 1-3 times per month, 2 = once a week, 3 = 2-4 times per week, 4 = 5-6 times per week, 5 = once a day, 6 = 2-3 times per day, 7 = 4-5 times per day and 8 = 6 or more times per day”. ICR result for FFQ sub-groups is presented in table 1.

## 2. Methodology

Before conducting the pilot study, a pre-test was conducted to evaluate questionnaires face validity and content validity. The pre-test was conducted on a sample 25 patients. Face validity of the questionnaires was evaluated in-terms of 1) clarity of the wording, 2) possibility that the patients would be able to answer the questions and 3) layout, style and formatting. Five health professional experts were requested to assess the content validity of all four questionnaires in terms of “representativeness” and “clarity” on a 4-point scale [13]. Based on experts’ comments, modifications were done in all questionnaires before conducting the pilot study. Pilot study was conducted from 23 October – 22 November, 2016 to evaluate the questionnaires reliability and validity. Systematic random sampling technique was used to collect the data from 132 diabetics by direct investigation method. ICR was assessed by Cronbach Alpha, a general acceptable cut-off value is  $> 0.70$  [14]. Corrected item – total correlation (CI – TC) was also reported (cut-off  $\geq 0.30$ ) [15]. Exploratory factor analysis (EFA) was conducted on “dietary attitude” questionnaire only as it fulfilled the basic requirement for running EFA i.e. scale of measurement [16-18]. In addition, evaluation of EFA was carried out as suggested by Burton and Mazerolle [19]. Normality was checked by one sample Kolmogorov–Smirnov test (K-S test), however, assumptions of linearity and homoscedasticity were relaxed as suggested by Hair [20]. Kaiser-Meyer-Olkin (KMO) test (cut-off  $\geq 0.60$ ), Bartlett test for sphericity (should be significant at  $p < 0.05$ ), anti-image correlation (diagonal correlations should be  $\geq 0.50$ ), communalities (each item should explain at least 50% variation), Eigen values ( $> 1$ ), scree plot, the variance explained by the factors (at least 70%) and item loadings in rotated component matrix ( $\geq 0.50$ ) are also reported. A p-value of  $< 0.05$  was considered as statistically significant.

## 3. Results

### 3.1. Demographics

The data was collected from 132 patients. Mean age of the patients was  $43.68 \pm 5.84$  years. Majority of the patients were males as compared to females (65.9% vs 34.1%). Major chunk of the patients were married (n = 104; 78.8%), singles (n = 22; 16.7%) and only 5% patients were divorced / separated. More than 50% of the patients received education till secondary / middle followed by primary (n = 33; 25%), illiterates (n = 19; 14.4%) and graduates (n = 09; 6.8%). Two fifth of the patients (n = 53; 40.2%) were doing own business, Government employees (n = 47; 35.6%) and house wives (n = 32; 24.2%). Majority of patients’ (n = 35; 26.5%) monthly income was between 5,001 – 10,000 SAR followed by 3,000 – 5,000 SAR (n = 22; 16.7%), only 12.9% patients were earning between 10,001 – 15,000 SAR. Around 10% patients were earning  $< 3,000$  SAR per month, whereas, only 3% patients’ monthly income was more than SAR 15,000. Most of the patients’ physical activity was low (n = 99; 75%), around 15% were performing moderate physical activity and only 10% were performing intense physical activity.

### 3.2. Psychometric Analysis

Internal consistency reliability and CI-TC are reported for all four questionnaires including sub-scales of dietary practices questionnaire. The Cronbach Alpha of DMK questionnaire was (0.883). One item “kidneys produce insulin” had negative CI-TC (-0.139), this item was deleted and the analysis process

was re-run on 29 items. The Cronbach Alpha raised to (0.891) which showed that the questionnaire still has good ICR. The CI-TC for DMKQ ranged from 0.358 – 0.529. All the values were above  $\geq 0.30$  cut-off value. Cronbach Alpha for DK questionnaire was (0.869) which showed that the questionnaire has good ICR. The CI-TC for DKQ ranged from 0.364 – 0.588. All the values were above  $\geq 0.30$  cut-off value. Cronbach Alpha of DA questionnaire was (0.841) which again showed that the questionnaire has good ICR. The CI-TC for DAQ ranged from 0.350 – 0.573. All values were above  $\geq 0.30$  cut-off value. Dietary practices questionnaire had 99 items in total within 9 sub-groups. ICR was reported for each sub-group instead of all items as suggested by Kline [18]. The Cronbach Alpha for “protein” group was (0.908), “carbohydrate” group (0.903), “dairy products” group (0.879), “lipids and fats” group (0.890), “sweets and bakery” group (0.855), “drinks” group (0.837), “fruits” group (0.847), “vegetables” group (0.897) and for “soups and sauces” group Cronbach Alpha was (0.782). The analysis of 9 sub-groups showed good – excellent ICR that ranged from 0.782 – 0.908.

**Table 1.** Summary of reliability analysis.

Questionnaire	(ICR)*
<b>Diabetes Mellitus Knowledge</b>	0.891
<b>Dietary Knowledge</b>	0.869
<b>Dietary Attitude</b>	0.841
<b>Dietary Practices</b>	
<b>Proteins</b>	0.908
<b>Carbohydrates</b>	0.903
<b>Dairy Products</b>	0.879
<b>Lipids &amp; Fats</b>	0.890
<b>Sweets &amp; Bakery</b>	0.855
<b>Drinks</b>	0.837
<b>Fruits</b>	0.847
<b>Vegetables</b>	0.897
<b>Soups &amp; Sauces</b>	0.782

( $n = 132$ ) \*Internal Consistency Reliability (Cronbach Alpha)

EFA with varimax rotation was conducted on 16 items assessing dietary attitude of diabetics. One sample K-S test showed the presence of normality ( $p = 0.090$ ). EFA resulted in five-factor solution with eigenvalues greater than 1. The five-factor solution was also supported by scree plot. Kaiser-Meyer-Olkin (KMO) test value was 0.752 which is greater than the cut-off  $\geq 0.60$ . Bartlett’s test was also significant at  $p < 0.001$ , showing that there are enough data to be factorized. Screening of anti-image correlation showed that all diagonal correlations were above threshold value of 0.50, the range of correlations was from 0.632 – 0.928. All items in the Communalities were explaining more than 50% of the variation, the range of variations was from 0.538 – 0.941. Total variance explained by the factors was 79.31%. Factor 1 explained 30.57% variation and comprised of items 2, 8, 12, and 13. Factor 2 explained 19.15% variation and comprised of items 1, 3, 6, and 10. Factor 3 explained 14.63% variation and comprised of items 9, 14, and 16. Factor 4 explained 7.94% variation and comprised of items 4, and 15. Factor 5 explained 7.53% variation and comprised of items 5, 7, and 11 in table 2. Directions of loadings were positive and free from factorial complexity. The five factors were labelled as “food selection”, “health impact”, “healthy choices”, “food restraint” and “food categorization”.

**Table 2.** Rotated component matrix for dietary attitude questionnaire.

	Components					Communalities
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
<b>Item 12</b>	0.959					0.941
<b>Item 02</b>	0.958					0.937
<b>Item 13</b>	0.941					0.907
<b>Item 08</b>	0.774					0.687
<b>Item 01</b>		0.916				0.859
<b>Item 06</b>		0.888				0.823
<b>Item 03</b>		0.723				0.596
<b>Item 10</b>		0.601				0.572
<b>Item 14</b>			0.861			0.792
<b>Item 16</b>			0.803			0.760
<b>Item 09</b>			0.753			0.745
<b>Item 15</b>				0.931		0.932
<b>Item 04</b>				0.919		0.940
<b>Item 05</b>					0.867	0.821
<b>Item 11</b>					0.788	0.839
<b>Item 07</b>					0.609	0.538
<b>Eigen Values</b>	4.809	3.064	2.341	1.271	1.205	
<b>% Variance</b>	30.057	19.151	14.631	7.945	7.532	

( $n = 132$ ) Principal Component Analysis. Varimax rotation with Kaiser Normalization

#### 4. Discussion

The aim of this research was to evaluate the psychometric properties of questionnaires assessing diabetes mellitus knowledge, dietary knowledge, dietary attitude and dietary practices. In Saudi Arabia, type 2 diabetes mellitus is increasing at an alarming pace, moreover, there is scarcity of published literature on dietary habits of Saudi type 2 diabetics. As dietary habits vary from country to country, we experience through literature search that no reliable and valid questionnaires are available in local setting that can be used to assess and evaluate dietary habits of Saudi diabetics'. Therefore, after rigorous literature search, we developed four questionnaires and carry out their psychometric assessment. Results showed that these questionnaires are reliable and valid enough to be used in assessing and evaluating type 2 diabetics' dietary habits. Moreover, the use of these questionnaires can be extended to other Gulf – Cooperation – Council (GCC) countries that includes (Qatar, Bahrain, Oman, Kuwait, and United Arab Emirates) as the environment and eating habits are comparable to Saudi Arabia. The ICR of diabetes mellitus knowledge questionnaire obtained in this research was 0.891, this was comparable to the original version of this questionnaire that showed that ICR ranged from 0.73 – 0.84 [4]. Dietary knowledge and dietary attitude questionnaires also had good ICR of 0.869 and 0.841 respectively, however, due to scarcity of published literature these were not compared. Therefore, these findings can be considered as unique and can act as a baseline for future relevant studies. Dietary practices questionnaire which comprised of 9 sub-groups showed good – excellent ICR that ranged from 0.782 – 0.908. In this research, average ICR for dietary practices questionnaire was 0.874, which is greater than what was reported by Bowman [11] and Guerrero [12].

#### 5. Conclusion

Relying on the data obtained from type 2 diabetics, these questionnaires can be considered as reliable and valid for the assessment of dietary habits in Saudi Arabia and neighbouring Gulf countries population. These questionnaires should be valuable for scientific analyses as well as clinical use for patients with type 2 diabetes mellitus.



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