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Validity and reliability of the Heart Disease Fact Questionnaire (HDFQ): a Rasch measurement model approach

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ABSTRACT

Aim: The aim of this study was to examine the validity and reliability of Turkish version of the Heart Disease Fact Questionnaire (HDFQ) as a measure to evaluate heart disease risk knowledge in individuals with diabetes.

Methods: This study was conducted in the primary care clinic on 326 individuals with type 2 diabetes. The Davis Method, Confirmatory Factor Analysis (CFA) and the Rasch Measurement Model used in the validity and reliability analyses.

Results: The validity analysis results showed Turkish version of HDFQ was content valid. The results of CFA showed the index results were very good fit. All items of the scale and the HDFQ were fit to the Rasch model and the items did not contain any differential item function. Person Separation Index showed HDFQ is reliable tool.

Conclusions: The Rasch Model provides an alternative way in dealing with the challenges faced in classic methods and it is recommended to be used in health sciences. Thus, the results of this study are important. Results show that the Turkish version of the HDFQ can be used for determining awareness of heart disease risk as well as for assessing the effectiveness of implemented interventions among individuals with diabetes.

1. Introduction

Diabetes is a steadily growing problem that is becoming increasingly prevalent around the world. Some of the most important outcomes of diabetes prevalence are the chronic complications that occur [1]. Cardiovascular disease, which are the leading causes of mortality and morbidity all over the world, are the best example of this [2]. Turkey is an area that has one of the highest prevalence rates for diabetes and this rate is steadily growing; mortality rates related to cardiovascular disease are also growing [3].

Besides being a major cardiovascular risk factor, diabetes adversely affects the prognosis for individuals with cardio-

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vascular disease and increases the risk of recurrence [4,5]. The American Diabetes Association (ADA) and the American Heart Association (AHA) have started a project within the scope of an International Diabetes Education Program that targets raising awareness in the population about diabetic heart diseases [6]. Studies examining the awareness of individuals with diabetes in the community about cardiovascular disease have pointed to the fact that these patients have quite limited knowledge about diabetes related cardiovascular risks. In fact, it has been found that many patients actually state that there is no relationship between diabetes and high blood pressure, high cholesterol and heart attacks [7]. Seeing to it that individuals become aware of cardiovascular risk factors and develop positive health behavior in this context contributes to the prevention and early diagnosis of heart diseases. In Turkey, however, there is no instrument that can be used to measure and assess the awareness of individuals with diabetes about cardiovascular risk factors. We believe that adapting such measuring instruments to the Turkish population is an important step that should be taken to determine awareness and provide guidance as to what interventions can be implemented.

The purpose of this study was to examine the validity and reliability of a Turkish version of the Heart Disease Fact Questionnaire (HDFQ) as a measure to evaluate heart disease risk knowledge in people with diabetes by using the Rasch Measurement Model.

2. Methods

2.1. Design

A methodological research design was employed to test the validity and reliability of the Heart Disease Fact Questionnaire (HDFQ) that was developed to assess the knowledge of individuals with diabetes about the risk of heart disease. Using the Rasch Measurement Model, the questionnaire was assessed in terms of its applicability to the Turkish population with Type 2 diabetes.

2.2. Setting and sample

The study was conducted between the period June 2017–May 2018 in the primary care clinic in Turkey.

There are differing opinions as to the number of participants a study sample must have for the purpose of testing validity and reliability; the most commonly employed method in the literature for establishing sample size is to have the number of participants be 5–10 times the number of items on the measuring instrument [8]. On the other hand, in situations where the number of items on a scale or its subscales is too few, or the theoretical construct or model is complex, when distribution of the data deviates from the normal, or when factor loadings are not too high, it is recommended that the sample size contain at least 300 participants [9]. At the same time, it is also known that percentage of error decreases the larger the sample size. At least, 300 individuals were planned to be included in the study and during the course of the data collection process, 326 individuals with Type 2 diabetes were found to match the inclusion criteria.

The inclusion criteria were

1 Diagnosed with Type 2 diabetes at least 6 months.
2 Being age 18 or over.
3 Being literate.
4 Fluency in understanding and speaking Turkish.

Exclusion criteria were

1 Diagnosed with psychiatric condition
2 Having problems with sight or hearing

2.3. Data collection

In the data collection, a Sociodemographic and Medical Characteristics Data Collection Form developed by the researcher was used as well as the HDFQ.

2.3.1. Sociodemographic and medical characteristics data collection form

This form contains questions on the participants' sociodemographic (age, gender, level of education, marital status, employment, economic status) and medical characteristics (age of diabetes, whether or not they have received diabetes education, a diagnosis of heart disease).

2.3.2. Heart Disease Fact Questionnaire

This scale, consisting of 25 items, was developed by Wagner et al. to assess the level of knowledge individuals with diabetes have about heart disease [10]. The language of the original scale is English. The statements have been provided in full sentences that can be true or false and the responses to these are "Yes," "No" or "I do not know." Six of the statements in the scale are scored in reverse. For each correct answer, a score of 1 is received while each incorrect or "I do not know" answer receives a score of 0. The total score is calculated by multiplying the number of correct responses by four. Scores on the scale range from 4 to 100 [10]. The scale's reliability coefficient was reported as KR-20 = 0.77 and the measure was confirmed to be a valid and reliable measuring tool. The instrument was adapted into Chinese and its internal consistency reliability coefficient was found to be 0.86 [11].

2.4. The study process

2.4.1. Creating the Turkish version of the HDFQ

First, the permission of the author to translate the scale into Turkish was obtained via email, after which three separate researchers with fluent knowledge of Turkish and English were asked to review its psycholinguistic features, each researcher separately translating the scale from English into Turkish. Later, the researchers reviewed each statement for linguistic accuracy, meaningfulness and conceptual equivalence; the Turkish text was created from the translations selected as the most suitable. Using the back translation method, the scale was translated back into its original English language by an independent linguist, proficient in both Turkish and English, who had not seen the original text. An English native

speaker fluent in Turkish then edited this back translation. The researchers compared the text of the back translation with the original of the scale and then emailed it to the author for an evaluation of whether or not there were any inconsistencies. In line with the recommendations of the author, the term "diabetic" used in items 20, 22 and 25 was changed to "the individual with diabetes."

2.4.2. *Content validity testing of the instrument*

In the first stage of the testing for content validity, the opinions of 7 different experts that included a physician, a clinical nurse and five academic nurses were obtained. The assessment of the expert opinions was carried out with the Davis technique and the calculation of the Content Validity Index (CVI). In the Davis technique, the opinions of experts are rated on a four-point Likert-type scale. The number of experts marking the statements as "the item is appropriate" and "the item should be slightly revised" is divided by the total number of experts, arriving at the CVI for the relevant statement. If the CVI is greater than 0.80, it is accepted that the content validity of the item is sufficient; if it is less than this, the item is eliminated [12,13]. In this study, the CVI for items 1 and 3 was 0.85; CVI for the other items was 0.99. The item CVI's in this study were found to be noticeably high. This results showed that Turkish version of HDFQ scale and the items on it are content valid and no item was therefore removed. In line with the recommendations of the experts, the phrase "risk of heart disease" used in the Turkish version was changed to "risk of developing heart disease."

2.4.3. *Pilot study*

The final version of the scale, produced after the review of the experts, was implemented as a pilot study with 15 patients who had traits that were similar to the patients who would be taken into the study. Each of the items in the pilot study was found to be comprehensible and with the collection of the data, the validity/reliability study was continued.

2.5. *Statistical analysis*

The SPSS 24.0 software was used in the analysis of the study data, LISREL 8.80 in the Confirmatory Factor Analysis (CFA) and RUMM Version 5.3 was used for the Rasch analysis. The descriptive characteristics of the participants were analyzed using numbers, percentages and standard deviation, the Davis Method was used for testing the scale's content validity, CFA was used in determining construct validity, and the Rasch Measurement Model was used in the validity and reliability analyses. In the Rasch Measurement Model, the parameters of model fit statistics and reliability, item-model fit, item ability distribution fit, local independence of the instrument and the unidimensionality assumption were reviewed and differential item functioning was assessed.

2.6. *Ethical considerations*

The permission of Julie Wagner for the adaptation of the questionnaire into Turkish and its subsequent use was obtained via email. Prior to the data collection, the participants' verbal and written consent, the permission of the Provincial Health Directorate under which the family health center where the study took place was operating, and of the ethics committee of the Dokuz Eylül University, Non-interventional Clinical Study Review Commission (Date: 27/07/2017, Decision No. 2017/19-33, Protocol No. 3424-GOA) were obtained.

Table 1 – Distribution of participants' sociodemographic and medical characteristics.

Sociodemographic and medical characteristics	n	%
Gender		
Female	193	59.2
Male	133	40.8
Marital status		
Married	245	75.2
Single	81	24.8
Educational status		
Elementary school	132	40.5
Middle school	44	13.5
High school	53	16.3
College/university	97	29.8
Employment status		
Employed	48	14.7
Unemployed	74	22.7
Retired	204	62.6
Economic status		
Income less than expenditure	38	11.7
Income equal to expenditure	210	64.4
Income greater than expenditure	78	23.9
Received education on diabetes		
Yes	145	44.5
No	181	55.5
Cardiac disease		
Yes	128	39.3
No	198	60.7

3. Results

3.1. *Sociodemographic characteristics of the participants*

The mean age of the participating individuals was 64.29 ± 11.48 (min:30-max:91) years; their diabetic age was 11.33 ± 8.25 (min:1-max:40) years. The other descriptive characteristics of the participants are shown in Table 1.

3.2. *Confirmatory factor analysis results*

We performed CFA in our study to assess construct validity in order to consider the unidimensionality of the construct, which is a criterion of the Rasch Measurement Model, and further our analysis. It was seen in the CFA that the chi-squared degree of freedom statistic (x^2/df) was 1.81, the Goodness of Fit Index (GFI) was 0.90, the Adjusted Goodness of Fit Index (AGFI) was 0.87,the Comparative Fit Index (CFI) was 0.91 and the Root Mean Square Error Approximation (RMSEA) was 0.048. It was observed that the CFA results showed that the factor loads of the HDFQ varied between 0.15 and 0.51 ($p < 0.01$).

3.3. *Rasch analysis results*

It was seen in the CFA that the Turkish version of the HDFQ provided the unidimensional construct required for Rasch

analysis and later, a dichotomous Rasch Model was used to evaluate the validity and reliability of the instrument.

3.3.1. *Model fit of the scale and reliability*

The model fit statistics were first analyzed and it was found that the mean item fit statistic was -0.192 ± 1.44, the mean person fit statistic was -0.248 ± 0.86 and the value of the Person Separation Index (PSI) considered as the Reliability Coefficient in Rasch model analysis was 0.76. The model fit and reliability of the HDFQ presented in Table 2.

3.3.2. *Model fit of the items*

The model fit statistics of the items was next considered and it was found that residuals varied between −2.406 and 2.477 of the items and there were no significant differences in the item chi-squared values on the level of Bonferroni Significance ($p > 0.002$). The model fit of the items are given in Table 3. The item-total correlations of the items of the scale were examined with predicted point-biserial correlation values and it was seen that these values varied between 0.21 and 0.523, exhibiting statistical significance (Table 3).

3.3.3. *Item difficulty and person ability*

It was found that item difficulty values were in the range of −1.934 and 3.864. In the examination of the items in terms of their distribution according to the level of ability of the individuals in the sample, it was seen that the measure provided more information especially for individuals with a competence level of between −3 and 3 (Fig. 1).

3.3.4. *Local dependency and unidimensionality*

The local independence assumption was tested with principal component analysis of item residuals and it was observed that the correlation coefficients belonging to the item pairs varied between −0.201 and 0.276.

3.3.5. *Differential item functioning*

In order to determine whether the items on the HDFQ were biased against sub-populations, Differential Item Functioning (DIF) analysis was performed to detect whether the items contained a differential item function according to gender. It was found that the predicted F values for the gender groups, the F values for gender Class Interval interaction and the predicted F value for the overall test were not statistically significant ($p > 0.001$).

4. Discussion

It is known that cardiovascular complications can be the cause of death for many individuals with diabetes and this is a fact that makes it a priority to focus on raising awareness in the community about cardiovascular disease in diabetes. This study, whose pivot point was the need felt in Turkey for a instrument that can assess knowledge of risks of heart disease among individuals with diabetes, was based on an adaptation into Turkish of the HDFQ developed by Wagner et al. [10]. The results obtained indicate that the HDFQ is a valid and reliable tool that can be used for the Turkish population.

The Rasch Measurement Model was used in the adaptation of the questionnaire because of the alternative it provides in dealing with the challenges faced in evaluating the raw scores obtained from the correct responses to items. It is known that it is usually classic methods that are used in the validity and reliability studies of measuring instruments but the Rasch Measurement Model was preferred here due to the limitations presented by such classic psychometric techniques. Developed by Georg Rasch, the Rasch Measurement Model's most distinctive difference from classic methods is its capacity to predict the probability of a person's correctly responding to a particular item and to consider this along with the person's level of ability and the level of difficulty of each particular item. Another significant advantage it provides is the use of parametric testing in ordinal scales [14,15].

Among the principal assumptions of the Rasch Measurement Model is that the construct to be measured is unidimensional [16]. In our study, for the purpose of evaluating the validity of the internal construct and to test the unidimensionality assumption for our analysis, a theoretical model that associated all of the items with a single implicit variable was created and a CFA was performed. CFA is one of the most frequently used methods in validity and reliability studies and it is recommended in the adaptation of already developed instruments as well as in the examination of construct validity [8,17]. There is no consensus as to which goodness of fit index result can be considered a standard in factor analysis but it is recommended that at least three fit indices are considered [17]. The CFA results in our study were evaluated with x^2/df, RMSEA, CFI, GFI, AGFI values. Values on the CFA demonstrating x^2/df as <3, of CFI, GFI and AGFI as >0.90 and a RMSEA value of less than 0.05 show that the model is of good construct. It was seen in our study that the index results were a very good fit to the criteria values of the fit indices. It was also seen at the end of the analysis that the factor load of each item was at a significant level. The results obtained supported the unidimensional construct of the scale and therefore we continued with the Rasch Measurement Model and proceeded as a first step to determine the mathematical Rasch model that was appropriate for the type of data. Since the HDFQ used dichotomous scoring, a dichotomous Rasch model was used. This model is suitable for items that can be scored under two categories that are assumed to have equal levels of differential item functioning [18].

4.1. *Model fit of the scale and reliability*

The basic factor examined using model fit statistics is the fit of the instrument to the Rasch model. Here, the item-trait interaction statistic is calculated. For this purpose, item-fit residual values are considered and it is recommended that mean and standard deviation values approximate to 0 and 1 [19]. Also, the p value calculated for the two residuals with the t test is expected to be less than 0.05. We found in our study that the items in the instrument and the persons included in the sample displayed adequate fit to the model. When the log-likelihood chi-square values were considered, it can be said that the HDFQ's power of test-of-fit was "good" [16,20].

One of the data obtained from the model fit statistics is the Person Separation Index (PSI) value that is considered as

Table 2 – Model fit statistics and reliability of The HDFQ.

	Item-fit residual statistics	Person-fit residual statistics	Person-location statistics	Item-instrument interaction		
Scale	M ± SD	M ± SD	M ± SD	Log-likelihood Chi-square (Df)	p	Person separation index
HDFQ	−0.192 ± 1.438	−0.248 ± 0.858	0.634 ± 1.061	163.235	<0.001	0.755

Table 3 – Model fit statistics of items of The HDFQ.

Items in the HDFQ	Location parameter (item difficulty) logit	SH	Item fit (residuals)	Chi-square	Degree of freedom	p	Item-test correlations (PT BISERIAL)
M1	1.625	0.131	2.056	9.809	4	0.043	0.243
M2	−0.086	0.128	2.184	6.968	4	0.137	0.305
M3	0.182	0.124	2.477	4.803	4	0.308	0.293
M4	−1.29	0.161	1.194	14.904	4	0.014	0.210
M5	−0.046	0.127	1.951	11.254	4	0.023	0.315
M6	−1.934	0.195	−1.537	6.244	4	0.181	0.437
M7	−0.407	0.133	−1.859	6.475	4	0.166	0.523
M8	−0.704	0.141	−1.181	5.179	4	0.269	0.480
M9	−0.155	0.129	0.799	4.033	4	0.401	0.391
M10	1.655	0.131	0.49	3.992	4	0.407	0.307
M11	0.776	0.122	−0.221	0.562	4	0.967	0.427
M12	−2.773	0.262	−0.273	0.602	4	0.962	0.245
M13	−1.562	0.174	0.282	2.356	4	0.670	0.360
M14	−0.686	0.14	−1.446	7.064	4	0.132	0.483
M15	−0.887	0.146	−2.137	8.709	4	0.068	0.510
M16	−1.127	0.154	−1.12	2.891	4	0.576	0.469
M17	−0.277	0.131	0.721	4.764	4	0.312	0.465
M18	1.353	0.126	−1.616	13.574	4	0.008	0.498
M19	−0.21	0.13	−1.21	5.696	4	0.223	0.498
M20	1.612	0.131	−0.971	9.255	4	0.055	0.455
M21	0.783	0.122	−2.406	17.79	4	0.003	0.537
M22	3.864	0.247	−0.649	4.768	4	0.311	0.276
M23	−0.657	0.139	−0.497	5.378	4	0.250	0.492
M24	−0.922	0.147	−0.62	1.703	4	0.790	0.462
M25	1.871	0.136	0.785	4.464	4	0.346	0.310

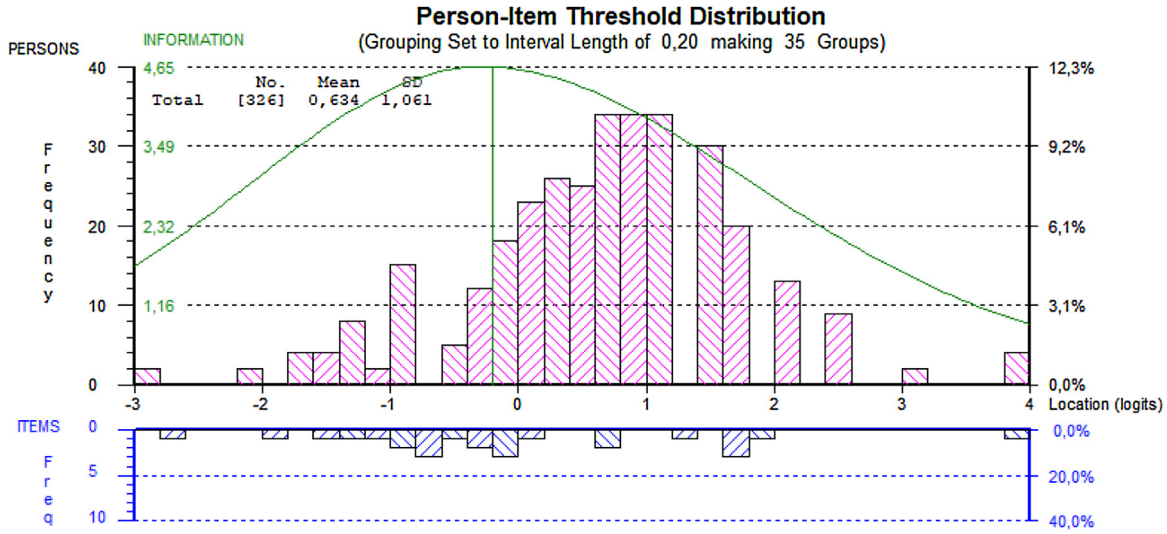

Fig. 1 – Person-item threshold distribution.

the Reliability Coefficient in Rasch model analysis. Calculating the ratio of the observed reliability coefficient variance to true variance reflects the consistency of the questions on the scale and to what degree the scale predicts what is being examined [21]. The reliability coefficient varies between 0 and 1 and the lowest value desired for the reliability of the measure

is 0.7 [22,23]. Because the instrument measures knowledge and also simultaneously queries independent factors such as blood pressure, smoking and hyperlipidemia, this may create difficulties in evaluating the individual's total score and reliability coefficient [10]. The Rasch measurement model used in our study puts together many elements that might have an effect on a common plane, thus standardizing these to create an impartial and effective model of measurement. Our results showed that the HDFQ was a reliable tool in assessing the knowledge of individuals about risk of heart disease. The reliability coefficient found during the development of the scale was 0.77; this was 0.86 in the Chinese adaptation. In the validity testing of the measure on students, the coefficient was found to be 0.73. While classic evaluation methods were used in these studies, their results are similar to ours [10,11,24].

4.2. *Model fit of the items*

The item-model fit statistics examine the fit to observed data of the predicted data in the Rasch model created. In this examination, residual values and goodness of fit statistics in terms of the chi-square statistic are calculated for each item and person. For the residual values, those that do not exceed 2.5 indicate that the model is a good fit [25]. The chi-square value obtained is not expected to be significant; this means that the responses to the items are not differentiated in terms of the hierarchical order of ability, reflecting the invariance of the scale [26]. That some items need much more knowledge than others has the potential of being misleading in the classic method when the evaluation is made on the basis of the raw scores of the items. The Rasch model at this stage thus provides a solution to the misleading quality of measures [14,27]. In our study, the fit of the residuals on the basis of each item and the item fit to the model of all of the items were within the limits expected from the Rasch model. Moreover, the chi-squared values that were not found to be statistically significant ($p > 0.002$) according to the Bonferroni Adjusted alpha level are further proof of the model-item fit.

The item total score correlations were calculated and these values varied between 0.21– 0.523, indicating that all of the item correlations were statistically significant. The item-total score correlations indicated the correlation between the scores obtained on the items of the HDFQ and the scale's overall score. A positive high item-total correlation means that the item results are similar and that the internal consistency of the measuring instrument is high. The lower limits of the correlation coefficient are reported as 0.15–0.30 in the literature [28,29]. In the original form of the HDFQ, item-total score correlations varied between 0.18–0.41 while in the validity and reliability study of Lee and Shiu, this range was 0.15–0.67. These are higher than what we found in our study [11].

4.3. *Item difficulty and person ability*

It is known that in a group showing normal distribution, the ability distribution of 99.97% of individuals is in the range of −3 to 3. As the item's level of difficulty draws closer to −3, even individuals at the lowest ability level tend to answer the question correctly, indicating in other words that the question is very easy. As the level of difficulty draws closer to 3, only those individuals with higher levels of ability can answer correctly, which means that very few participants answer correctly, in turn indicating that the question is a difficult one [25]. It was observed that the hardest question in the measuring tool was question 22 and that the easiest was question 12 (Table 3). Item difficulty indices have been studied in the literature in the context of an instrument's reliability analysis and it has been reported in one study that measurements made using the classic method produce results of between 0.20 and 0.95. The same study discussed the fact that fewer correct answers were given to questions 22 and 25 compared to the other items and that these items would increase the sensitivity of the scale in educational interventions and were not removed from the instrument specifically for this reason [10]. Our results showed that the items were sufficiently balanced in terms of their distribution according to the level of ability of the individuals and for this reason, there was no need felt to remove any of the items from the measure (Fig. 1).

4.4. *Local dependency and unidimensionality*

The local independence assumption is tested by performing a principal component analysis (PCA) on item residuals. When residual correlations of item pairs are ≥0,30, this means that the local independence assumption has been violated and it is recommended that the relevant items are removed from the scale [30]. It was noted that the correlation coefficients of the item pairs varied between −0.201 and 0.276 and that the critical threshold had not been exceeded. Also, because there was no linear relationship between the residuals, it was accepted that the scale measured a unidimensional construct.

4.5. *Differential item functioning*

Another factor that can affect model fit is when different groups in the sample (such as men and women) have the same level of ability but respond to a particular item differently. In order to determine whether items contain a bias, Differential Item Functioning (DIF) is tested. DIF analysis proves whether or not instruments can be cross-validated. The items in our study were examined in terms of their level of difficulty as according by gender and it was found that the items did not contain any differential item function according to different sub-populations (e.g., men/women) in the same study population, showing that the HDFQ's internal structure was valid.

5. Conclusions

The results of study indicated that the Turkish version of the HDFQ was a valid and reliable instrument. It is therefore believed that the scale can be used by healthcare providers for determining the awareness of the risks of heart disease as well as for assessing the effectiveness of implemented interventions among individuals with diabetes.

Conflict of interest

The authors state that they have no conflict of interest.

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