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Research Article

Psychometric Performance of the Diabetes Self-Management Questionnaire (DSMQ) Among Individuals Attending a Referral Hospital in Port Harcourt, Nigeria

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Abstract

Objectives: The Diabetes Self-Management Questionnaire (DSMQ) has been judged a better statistical predictor of glycaemic control relative to the widely used Summary of Diabetes Self-Care Activities Measure. Our aim was to assess the psychometric properties of an adapted 14-item DSMQ among Nigerians with diabetes at the University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria.

Methods: The DSMQ was administered to 119 type-2 diabetes patients, selected by stratified sampling, as part of diabetes perceived severity study. The DSMQ with its 4 subscales was tested for reliability using inter-item correlation and Cronbach's alpha; and criterion-related, concurrent validity against fasting blood sugar, the existing measure of glycaemic control. Confirmatory Factor Analysis (CFA) using Principal Component approach was conducted for factor-based construct validity.

Results: Cronbach's alpha was 0.48 for the sum scale, 0.45 for the GU subscale, 0.07 for the DC subscale, 0.18 for the PA subscale and 0.12 for the HU subscale. The mean-item correlation was 0.75. CFA with rotation using the Oblique Oblimin extracted 4 factors that all items correlated satisfactorily with. For the GM subscale 3/5 items loaded into one component, 2/3 items of the PA subscale and 2/3 of the DC subscale. Pearson correlation between the DSMQ sum score and the current blood glucose was -0.13 (p=0.16).

Conclusion: The DSMQ-14 tool and its subscales demonstrated moderate internal consistency. Though a four-component construct was validated, it was divergent from the original subscales. Concurrent validity was also not confirmed between the DSMQ and fasting blood sugar. The DSMQ deserves further testing and adaptation for local use.

Introduction

The number of people living with diabetes has quadrupled since 1980 to 422 million adults in 2015 with most living in developing countries; the number is likely to double in the next 20 years [1]. A growing number of Nigerians and residents of Port Harcourt in the Niger Delta area, now suffer from Diabetes [2-6]. The condition has become well known among Nigerians due to its increasing prevalence and rising public health significance [7]. Likewise, there is an increase in access to a wide spectrum of care, from orthodox medicine offered at formal public and private institutions to informal private, and alternative traditional care providers [5,7].

The peculiarity of diabetes as a chronic, non-communicable disease with life threatening effects [3,8] and multiple modifiable and non-modifiable risk factors [9] has warranted its management to include many day-to-day self-care handled by patients themselves and/or their families beyond the medical care provider [10].

Diabetes self-care involve seven essential behaviors: healthy eating, being physically active, monitoring of blood sugar, compliant with medications, good problem-solving skills, healthy coping skills and risk-reduction [11]. All seven behaviors have been found to be positively correlated with good glycemic control, reduction of complications and improvement in quality of life [11]. Several tools have been designed to assess or measure patients' adherence [10,12-16].

The most widely used questionnaires to assess diabetes self-care and regimen adherence is the Summary of Diabetes Self-Care Activities Measure (SDSCA) developed by Toobert et al [10]. However, recent evaluations did not support its consistent and substantial correlations with Glycosylated haemoglobin (HbA1c) [15], the major measure of glycaemic control [17]. Hence the rising popularity of the relatively new Diabetes Self-Management Questionnaire (DSMQ), which

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has been reported to exhibit better internal consistency and validity [18,19]. However, DSMQ like other assessment tools essentially evaluate self-reports of adherence to self-care behaviors, hence the performance of any tool could vary across populations, health care settings and diverse social prompts [19,20]. There is no report of the validation of the DSMQ in any Nigerian population. The aim of this paper is to report the psychometric properties of an adapted 14-item version of the DSMQ-16 among Nigerians attending the diabetes clinic at the Port Harcourt Teaching Hospital, Port Harcourt in July-August 2017.

Materials and Methods

Study design, participants and data

The study used data from a cross-sectional study investigating the influence of the health belief model on disease perceived severity and adherence to self-care management among 119 type-2 diabetes adults receiving care at the University of Port Harcourt Teaching Hospital, Port Harcourt in southern Nigeria. Data was collected in July-August 2017 using an interviewer-administered, structured questionnaire that included a section on diabetes self-care management adapted from the DSMQ-16 [15].

Ethical approval

Ethical clearance for the study was obtained from the University of Port Harcourt Research Ethics Committee. Informed consent was obtained verbally from each study participant after reading through a standard written description of the purpose and procedure of the study.

Measures

The DSMQ-16 is a well validated and widely used 16-item self-report scale for the measurement of diabetes self-management as a statistical predictor of glycaemic control in type-2 diabetes (Schmitt et al, 2016). The items are in four subscales: 'Glucose Management' (GM), 'Dietary Control' (DC), 'Physical Activity' (PA), and 'Health-Care Use' (HU); and rated on a Likert scale ranging from 0(does not apply) to 3 (very much applies) to derive a summed score for a 'Sum Scale' (SS). The DSMQ description is detailed in Schmitt et al [15] and Bukhsh et al [19].

Two of the original 16 items of the DSMQ questionnaire developed by Schmitt and colleagues were removed based on contextual judgments while yet retaining its four subscales. Thus the GM subscale comprised of five statements: items 1, 4, 6, 10, 12; DC subscale comprised of three statements: items 2, 5, 9; PA subscale comprised of three statements: items 8, 11, 13; and 'Health-Care Use' (HU): comprised of two statements: items 3, 7. The last item (item 14) is an overall rating of self-care done by respondents, thus its score is included only in the 'Sum Scale'.

Statistical analysis

Descriptive statistics, means and standard deviation, were computed for all measures. Differences in scores were tested using one-way ANOVA test. Statistical significance was set at $p<0.05$.

Inter-item correlations, item-total correlations and Cronbach's alpha were used to investigate internal consistency reliability of the adapted DSMQ. Items within the scale were correlated using Pearson's correlation while Cronbach's alpha was generated for the DSMQ as a whole and for each subscale. Item internal consistency was considered substantial when correlation between an item and its hypothesised scale (corrected for overlap) was >0.40 [21], and an alpha of 0.70-0.80 was desirable [22].

For validity, both construct and concurrent validity were investigated. Confirmatory Factor Analysis (CFA) was conducted to confirm the validity of the DSMQ subscales. A four-factor model representing the four DSMQ subscales was tested. Communalities were calculated to assess the homogeneity of retrieved scale that was extracted using Principal Components. The knick-criterion and Kaiser-criterion (Eigenvalue>1) as well as the Scree Plot were used to determine and validate the optimal/expected number of factors [22,23]. An oblique rotation using the Oblimin with Kaiser Normalization method was chosen because the factors were expected to correlate. Items with loadings exceeding 0.40 on one factor and less than 0.30 on any other factor are generally regarded as items with good scaling properties [22]. A loading threshold of 0.5 was set for rotated items.

Criterion-related concurrent validity of the instrument was also investigated using Pearson's correlations to test the performance of the adapted DSMQ against the routine measure of glycaemic control used at the hospital, Fasting Plasma Glucose (FPG) [17]. Criterion contamination was avoided by taking the blood samples before administering the questionnaire.

Missing data were handled by list wise exclusion. Analyses were performed using SPSS version 20.0 for Windows (SPSS Inc. Chicago IL.).

Results

Item characteristics and internal consistency

The item characteristics were acceptable, with the lowest standard deviation being 0.83 for the item about taking medication as prescribed (Table 1). The lowest mean was recorded for the item on eating sweets or high calorie foods occasionally (1.47 on a scale of 0 to 3). Internal consistency appeared low with all the item-total correlations being <0.4 (Table 1) but the inter-item correlations varied widely with all performing above the Determinant of 0.012 (Table 2). There was no multi-linearity or singularity in the data ($r<0.8$).

The mean inter-item-correlation was high at 0.75 indicating satisfactory homogeneity of the DSMQ items and the Cronbach's alpha for the 14 items was 0.48 i.e. for the total sum scale, indicating a moderate internal consistency (Table 3). Deleting items made very little difference in the reliability of the DSMQ, except for deleting item C8 which resulted in marginal improvement in alpha to 0.55 (Table 1).

The subscales showed low internal consistencies and homogeneity with the exception of the Glucose Management subscale with alpha of 0.45 and mean inter-item correlation of 0.52 (Table 3).

Construct validity (Confirmatory factor analysis)

The items from all the subscales of the DSMQ were subjected to factor analysis. Kaiser-Meyer-Olkin Measure of Sampling Adequacy

Table 1: Item characteristics, item-total correlation and internal consistency in case of deletion.

Item	Mean Score	Standard Deviation	Corrected Item-Total Correlation	Cronbach's α if Item Deleted
A1 Check blood sugar levels with care and attention	2.45	0.95	0.288	0.438
A4 Take diabetes medication as prescribed	2.66	0.83	0.333	0.434
A6 Record blood sugar levels regularly	1.89	1.27	0.126	0.477
A10 Do not check blood sugar levels frequently enough	1.95	1.28	0.237	0.444
A12 Forget to take/ skip diabetes medication	2.28	1.11	0.225	0.449
one-way ANOVA test [**ANOVA**, p-value]	***10.48***	*0.001**		
B2 Choose food to easily achieve optimal blood sugar	2.14	1.01	0.304	0.432
B5 Occasionally eat lots of sweets/ high-carb foods	1.47	1.17	-0.078	0.528
B9 Follow specialist's dietary recommendations	1.87	1.28	0.134	0.475
one-way ANOVA test [**ANOVA**, p-value]	***10.07***	*0.001**		
C8 Do physical activity to achieve optimal sugar levels	1.48	1.33	-0.117	0.548
C11 Avoid physical activity, although good for diabetes	2.08	1.22	0.335	0.416
C13 Skip planned physical activity	2.08	1.22	0.19	0.459
one-way ANOVA test [**ANOVA**, p-value]	***9.02***	*0.001**		
D3 Keep recommended doctors' appointments	2.61	0.85	0.345	0.43
D7 Avoid diabetes-related doctors' appointments	2.13	1.13	0.202	0.455
Student t-test [**t-test**, p-value]	***3.69***	*0.001**		

was high at 0.637 and Bartlett's Test of Sphericity was significant (chi-square=502.4, df=91, p<0.01) confirming the suitability of conducting a CFA. All the 14 items except one showed high communality of over 0.5 variance (ranging between 0.77 to 0.47). However, following the extraction by principal components method, four components emerged with Eigenvalues over 1.0, accounting for 59.98% of the cumulative variance. The first four Eigenvalues were 3.4, 2.6, 1.3, and 1.2. The Scree Plot supported this; the 'breaks' explained by the Knick-criterion, suggested a 3- or 4- dimensional factor structure in the DSMQ. We went with the Kaiser criterion of a maximum of 4 factors in order to replicate and test a 4-subscale structure of the DSMQ previously reported [18,19].

The unrotated loadings of each of the items in the 4-factor solution is displayed in the Component Matrix (Table 4), The first two components (factors) loaded strongest showing more interrelations between the items, with correlations above 0.5. The pattern matrix for the rotated four-factor solution is presented in Table 4. Rotation method was the Oblimin oblique with Kaiser Normalization. All the DSMQ items (including the 14th, an overall rating) correlated strongly into 4 components; items were considered as belonging to a factor if their loadings on that factor were above a threshold of 0.5. However, the items did not load satisfactorily into the defined DSMQ subscales.

As shown in table 5, 3/5 items of the GM subscale, loaded into one component (Factor 2) while the remaining 2 items loaded into

Table 2: Inter-Item Correlation Matrix.

	A1	A4	A6	A10	A12	B2	B5	B9	C8	C11	C13	D3	D7
A1	1	-	-	-	-	-	-	-	-	-	-	-	-
A4	0.252	1	-	-	-	-	-	-	-	-	-	-	-
A6	0.562	0.358	1	-	-	-	-	-	-	-	-	-	-
A10	0.03	-0.151	-0.033	1	-	-	-	-	-	-	-	-	-
A12	0.102	0.015	0.212	0.492	1	-	-	-	-	-	-	-	-
B2	0.598	0.201	0.177	0.034	-0.01	1	-	-	-	-	-	-	-
B5	0.245	0.172	0.198	0.005	0.153	0.265	1	-	-	-	-	-	-
B9	0.292	0.191	0.277	0.195	0.202	0.191	-0.108	1	-	-	-	-	-
C8	0.159	0.059	0.106	0.269	0.331	0.15	0.146	0.17	1	-	-	-	-
C11	0.047	0.063	0.125	0.356	0.396	-0.121	0.162	0.091	0.077	1	-	-	-
C13	0.176	-0.076	0.267	0.3	0.408	-0.053	0.188	0.259	0.111	0.428	1	-	-
D3	0.425	0.577	0.381	0.018	0.011	0.31	0.283	0.288	0.223	0.074	0.15	1	-
D7	0.243	-0.02	0.237	0.326	0.396	-0.021	0.14	-0.017	0.377	0.423	0.348	-0.068	1

Determinant=0.012

Table 3: Subscale characteristics and internal consistency.

Diabetes Self-Management Questionnaire Scales	Item number	Mean Score*	Standard Deviation	Cronbach's α coefficient (n=119)	Mean Inter-Item Pearsons's Correlation Coefficient (95% CI)	
Glucose Management (GM)	1,4,6,10,12	7.48	2.05	0.45	0.524	(0.374 - 0.647)
Dietary Control (DC)	2,5,9	3.66	1.37	0.068	0.248	(-0.021 – 0.455)
Physical Activity (PA)	8,11,13	3.76	1.55	0.184	0.426	(0.220 – 0.584)
Health Care Use (HU)	3,7	3.16	0.98	0.123	0.065	(-0.269 – 0.322)
DSMQ Sum Scale	**14-Jan**	**28.29**	**5.2**	**0.482**	**0.748**	**(0.676 - 0.810)**

*For the subscales, one-way ANOVA (p-value) =200.28 (0.001)

Table 4: Component Matrix of unrotated factor loadings of the DSMQ items.

Items	Component			
	1	2	3	4
A1Check blood sugar levels with care and attention	**0.618**	**0.502**	-0.193	-0.042
A4 Take diabetes medication as prescribed	0.349	**0.529**	0.415	0.14
A6 Record blood sugar levels regularly	**0.598**	0.368	0.126	0.079
A10 Do not check blood sugar levels frequently enough	0.449	**-0.496**	-0.206	-0.321
A12 Forget to take/ skip diabetes medication	**0.616**	-0.476	-0.034	-0.077
B2 Choose food to easily achieve optimal blood sugar	0.348	**0.561**	-0.39	-0.125
B5 Occasionally eat lots of sweets/ high-carb foods	0.401	0.183	-0.161	**0.644**
B9 Follow specialist's dietary recommendations	0.451	0.151	0.267	**-0.686**
C8 Do physical activity to achieve optimal sugar levels	0.471	-0.07	-0.46	-0.176
C11 Avoid physical activity, although good for diabetes	**0.509**	-0.453	0.191	0.25
C13Skip planned physical activity	**0.597**	-0.384	0.26	0.056
D3Keep recommended doctors' appointments	**0.523**	**0.536**	0.309	0.018
D7Avoid diabetes-related doctors' appointments	**0.548**	-0.377	-0.369	0.215
D14 Diabetes self-care is poor	0.221	**-0.525**	0.438	0.053

Factor 1 and 3 respectively. For the PA subscale, 2/3 items loaded into Factor 4 while the remainder into Factor 1; and 2/3 of the DC subscale items loaded into Factor 1 and the remainder into Factor 3. For the HU subscale, its 2 items loaded into Factor 2 and 3 respectively. In short, four subscales can be broadly identified, except that there is a redistribution of the items between the subscales.

Table 5: Pattern matrix of rotated factor loadings of the DSMQ items.

Items	Component			
	Factor 1	Factor 2	Factor 3	Factor 4
A1 Check blood sugar levels with care and attention	-0.2	0.624	-0.403	0.043
A4 Take diabetes medication as prescribed	0.068	0.773	0.3	0.018
A6 Record blood sugar levels regularly	0.098	0.674	-0.116	0.055
A10 Do not check blood sugar levels frequently enough	0.337	-0.192	-0.594	-0.235
A12 Forget to take/ skip diabetes medication	0.549	0.017	-0.46	-0.053
B2 Choose food to easily achieve optimal blood sugar	-0.491	0.408	-0.439	0.019
B5 Occasionally eat lots of sweets/ high-carb foods	0.087	0.339	-0.107	0.675
B9 Follow specialist's dietary recommendations	0.106	0.445	-0.202	-0.722
C8 Do physical activity to achieve optimal sugar levels	-0.063	0.009	-0.693	-0.012
C11 Avoid physical activity, although good for diabetes	0.691	0.095	-0.112	0.185
C13Skip planned physical activity	0.682	0.213	-0.15	-0.018
D3Keep recommended doctors' appointments	0.049	0.824	0.086	-0.06
D7Avoid diabetes-related doctors' appointments	0.314	-0.087	-0.592	0.329

Concurrent validity

Mean current blood glucose (fasting plasma glucose) for the study participants was 8.28±3.74 mmol/L. Pearson correlation between the DSMQ sum score and the current blood glucose was -0.13 (p=0.16). R2 was 0.017 indicating the DSMQ scale predicted just about 2% of the variance in the current blood glucose. Additional analysis showed a comparable pattern of negative (i.e. reverse) correlations with the subscales: GU (-0.19, p=0.04); DC (-0.12, p=0.21); PA (-0.04, p=0.68); and HU (-0.02, p=0.86).

Discussion

This is the first study to evaluate the psychometric properties of the DSMQ in a Nigerian population of patients with type-2 diabetes. The adapted 14-item version that was evaluated maintained the essential 4-subscale structure of the original DSMQ-16.The assessment found the adapted DSMQ to have good psychometric properties with moderate reliability (0.48). Overall internal consistency was comparable to that of the original German version of the DSMQ by Schmitt et al [15] but lower than a Pakistani version translated by Bakhsh et al [19]. Also, a high mean item-total correlation (0.75) was observed, higher than the original version's mean of 0.25 [15] but similar to the Pakistani version. Though, Schmitt at al [15] had argued that the total scale should be expected to be heterogeneous since the questionnaire items assess different aspects of self-care.

However, the consistencies of the subscales were lower when compared with these two versions [15,19]. The mean items scores and alpha for the Health-Care Use subscale were the lowest as similar to that of the original and Pakistani versions. But as Bukhsh et al [19] also observed, this could be because of the poorer health infrastructure and health-seeking behavior in countries like Nigeria. For clarity, the two items on the Health-Care Use subscale ask about keeping the doctor's appointment, which for various reasons, is often missed by some patients in southern Nigeria [24].

Factor analysis validated a four-subscale structure of the DSMQ with strong interactions. However, the questionnaire items were redistributed into newly emerging components different from the original DSMQ subscales [15]. This poses confusion about whether or not to regroup the items based on their performance, more so that deleting any of the items made little difference in improving the total scale reliability.

Concurrent validity was poor; indicating that the DSMQ-14 did not prove to be a predictor of glycaemic control like the original DSMQ [15,18,19] and other tools like the SDSCA [10]. Perhaps this is because it was tested against fasting plasma glucose [4,5] rather than glycosylated haemoglobin [17], which the other tools have been measured against [18]. Though there is a clear relationship between these two measurements of patients' glycaemic control, glycosylated haemoglobin reflects average blood glucose levels over the past two-three months [25].

A possible limitation of this assessment might arise from the administration of the tool at the clinic, and patients tend to give favourable responses to please the health workers that handed them the questionnaires. Also, self-administration of the questionnaire was the approach taken to counter this and improve anonymity. However, patients may have exhibited differences in their understanding of the questionnaire items. As previously mentioned, the tool was tested against fasting plasma glucose rather than glycosylated haemoglobin, which is not a readily available test in such settings as our due to resource constraints.

Conclusion

The DSMQ-14 tool composite score and its subscales except the 'health care use' subscale demonstrated moderate to high internal consistency and was considered reliable. However, a four-subscale construct was validated for the DSMQ-14 but emerged different from its original structure. Concurrent validity was not confirmed in the expected direction between the DSMQ tool and the routine measure of glycaemic control at the University of Port Harcourt Teaching Hospital. We recommend further testing and adaptation of the DSMQ for local use in Nigerian settings.

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