

## Psychometric Properties of the Persian Version of the Diabetes Self-Management Questionnaire for Patients with Type 2 Diabetes in Iran

### Abstract

**Background:** Diabetes self-management questionnaire (DSMQ) is among the relatively new tools with comprehensive structure measuring various dimensions of self-care behaviors in diabetic patients. This study was carried out to evaluate psychometric properties of Persian version of DSMQ. **Methods:** A cross-sectional study was carried out from January to March 2017 among patients with type 2 diabetes mellitus (T2DM) referred to urban health centers, in Kerman, southeastern Iran. Data were collected from 589 patients using DSMQ. The DSMQ was translated into Persian by forward and backward translation method. Cronbach's alpha method and intraclass correlation coefficient (ICC) were used to measure internal consistency and test-retest reliability, respectively. In addition, construct validity was assessed by confirmatory factor analysis and exploratory factor analysis (EFA). **Results:** The sum-scale Cronbach's  $\alpha$  of DSMQ was equal to 0.82 for 30 participants. The mean inter-item correlation and mean item-total correlation of "Sum Scale" (SS) were equal to 0.21 (standard deviation (SD) = 0.22) and 0.53 (SD = 0.19), respectively. All items had item-total correlations higher than 0.30 except items 7, 11, and 15. For "SS," ICC was obtained as 0.93. EFA revealed a four-factor model accounting for 62.5% of the total variance. All indices were acceptable for the modified DSMQ with four factors ( $\chi^2 = 134.33$ , degrees of freedom = 89,  $P = 0.001$ , comparative fit index = 0.97, root mean square error of approximation = 0.044, Tucker-Lewis index = 0.96, and normal fit index = 0.92). **Conclusions:** The Persian version of DSMQ was found to have acceptable reliability and validity for assessing self-management among patients with T2DM.

**Keywords:** Diabetes mellitus, psychometric, self-care, self-management, validity and reliability

### Introduction

Type 2 diabetes mellitus (T2DM) is a progressive chronic disease with globally increasing trend in recent decades.<sup>[1]</sup> According to Diabetes Atlas, 451 million people lived with diabetes in 2017 worldwide, and it was estimated to rise to 693 million people by 2045.<sup>[2]</sup> The number of deaths related to diabetes was approximately 5 million people in 2017 imposing about 850 billion USD on global healthcare expenditure.<sup>[3]</sup> Diabetes with a prevalence rate of 11.4% among the adult population in 2015 is encountered as considerable health problem in Iran.<sup>[3]</sup> High prevalence of microvascular and macrovascular complications of diabetes such as retinopathy, nephropathy, peripheral neuropathy, diabetic foot, and ischemic heart disease develop in course of the disease.<sup>[4]</sup> Acute and chronic complications cause large number of premature deaths, decline in quality of

life as well as imposing high healthcare costs for disease control and treatment of complications.<sup>[5]</sup>

Proper control of the diseases leads to prevention or delay in the development of the long-term complications and premature deaths attributed to the disease.<sup>[4]</sup> To achieve optimal blood glucose control and prevent serious diabetes-related outcomes, the patients must comply with wide range changes in their daily life such as dietary, physical activity, and taking prescribed medications regularly and timely.<sup>[6]</sup> Moreover, they need to monitor blood glucose and receive healthcare follow-up regularly.<sup>[1]</sup> These positive modifications done by the patients in daily life are named self-management and are the most important aspect of diabetes control.<sup>[7,8]</sup> Studies have reported that high-level compliance with self-management by diabetic patients is associated with improving glycemic control and reducing diabetes-related morbidity and mortality.<sup>[1,9]</sup>

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Previous studies introduced various tools to assess self-management in diabetic patients.<sup>[10]</sup> In two systematic review studies, over 40 instruments measuring self-management behaviors were introduced.<sup>[11,10]</sup> The instruments have different characteristics regarding number of dimensions, items, and scales for measurement and structure.<sup>[11]</sup> Diabetes self-management questionnaire (DSMQ) is among the relatively new tools with comprehensive structure measuring various dimensions of self-care behaviors in diabetic patients.<sup>[12]</sup> DSMQ measures five essential aspects of self-management including patients' dietary control, physical activity, medication adherence, blood glucose monitoring, and physician contact.<sup>[8,12]</sup> Compared to other self-management measuring tools, DSMQ has shown a higher correlation with glycosylated hemoglobin (HbA1c) as a main indicator of blood glucose control in diabetic patients.<sup>[8]</sup> Furthermore, several studies have reported satisfactory validity and reliability for DSMQ in various countries and languages.<sup>[12-15]</sup>

In Iran, there were few studies assessed psychometric properties of self-management measuring tools among diabetic patients.<sup>[16,17]</sup> To the best of our knowledge, there is no study assessed the validity and reliability of DSMQ. Thus, this study was conducted to assess the validity and reliability of Persian version of DSMQ, as well as determining application of this questionnaire in measuring the self-management among Iranian diabetic patients.

## Methods

### Participants and setting

A cross-sectional study was conducted between January and March 2017. The study population comprised T2DM patients who were referred to urban health care centers affiliated to Kerman University of Medical Sciences, southeastern Iran. 12 centers out of 43 urban health centers affiliated to Kerman University of Medical Sciences were selected through a random sampling method. Using a convenience sampling method, 50 patients from each 12 centers were enrolled in the study. Each health care center was considered as a cluster. Therefore, we used the proportion sample size formula and with considering design effect of 1.5, the sample size was calculated 600. Patients with duration disease less than 1 year and those with severe complications were excluded from the study. To assess the test-retest reliability, 30 patients completed the DSMQ in two time points with interval duration of 10–14 days.

### Measure

The English version of DSMQ was translated to Persian language by two qualified translators. After comparing two translations by one of the researchers, backward translation to English language was done. Finally, an expert panel consisted of the researchers and the translators confirmed the final version. The DSMQ consists of 16

items categorizing into four subscales including “Dietary Control” (DC) comprised four items, “Physical Activity” (PA) comprised three items, “Health-Care Use” (HU) comprised three items, and “Glucose Management” (GM) comprised five items.<sup>[12]</sup> Item 16 asks the participants about overall diabetes self-care, so its score only included in the total score. Each item asks the participants to assess their overall self-management conditions.<sup>[12-14]</sup> Answers were rated in a four-point Likert scale and options ranged from “applies to me very much,” applies to me to a considerable degree, applies to me to some degree, to “does not apply to me.” Response to each item of the DSMQ was scored from 0 to 3 (from “applies to me very much” to “does not apply to me”). Summation of scores for all items in each subscale was considered as raw scores for the subscale and also, summation of scores of all items (16 items) was considered as “Sum Scale” (SS).<sup>[12,13]</sup> Then, the raw scores were transformed to score range 0–10 according to raw score/theoretical maximum score \* 10;<sup>[12]</sup> the higher score for all the subscales and “SS” reflects better self-management level.

A trained interviewer completed the questionnaires by face to face interview with the participants. The purpose of the study and data confidentiality was explained to all the participants at the beginning of the interview. Then, the interview was conducted after obtaining informed written consent from all the participants. Participate who refused to participate in the study also continued to receive healthcare services including medical care for management of diabetes similar to the study participants. Furthermore, the study proposal was approved by the Ethics Committee of Kerman University of Medical Sciences (Ethical Code: IR.KMU.AH.REC.1396.1301).

### Statistical analysis

At first descriptive statistics, means and standard deviation were calculated for all variables. Cronbach's alpha method and intraclass correlation coefficient (ICC) were used to measure internal consistency and test-retest reliability, respectively. Cronbach's alpha was considered in five categories including: Excellent ( $\alpha > 0.9$ ), good ( $0.7 < \alpha < 0.9$ ), acceptable ( $0.6 < \alpha < 0.7$ ), poor ( $0.5 < \alpha < 0.6$ ), and unacceptable ( $\alpha < 0.5$ ). In addition, ICC value was recorded as poor (values less than 0.5), moderate (between 0.5 and 0.75), good (between 0.75 and 0.9), and excellent (greater than 0.90).<sup>[18,19]</sup> Moreover, inter-item correlations and item-total correlations were used to check internal consistency reliability. Exploratory factor analysis (EFA) was applied by the principal component method for 289 participants out of all randomly selected participants. Rotated component was reported to determine the dimensions of DSMQ. In addition, confirmatory factor analysis (CFA) was performed on 300 remaining participants. *P* value, comparative fit index (CFI; cutoff  $\geq 0.90$ ), Tucker-Lewis

index (TLI; cutoff  $\geq 0.90$ ), root mean square error of approximation (RMSEA; cutoff  $< 0.08$ ), and normal fit index (NFI; cutoff  $\geq 0.90$ ) were reported for the model fit.<sup>[20]</sup> CFA was run using the maximum likelihood estimation method and the items with factor loading less than 0.3 were deleted. All analyses were performed using SPSS software 20 and AMOS software 23. *P* values less than 0.05 were considered as statistically significant.

## Results

### The participants characteristics

Five hundred and eighty-nine completed questionnaires of 600 the participants were used to data analysis. Eleven questionnaires were excluded because of uncompleted data (response rate: 98.1%). Majority of the participants (67.9%,  $n = 400$ ) were female and 73.4% ( $n = 423$ ) of them were married. Mean (SD) and median age of the patients were 56.40 (11.9) and 57 years, respectively. Sixty-two percent ( $n = 365$ ) of them had high school education or higher and 22.2% ( $n = 131$ ) were employed. The median disease duration and treatment duration were 7 years (mean = 8.63, SD = 7.8) and 6 years (mean = 7.84, SD = 5.6), respectively. Over half of the patients (51.3%,  $n = 302$ ) had at least one diabetes-related complications and 29.2% ( $n = 172$ ) of them had insulin in their treatment regimen.

### Item analysis, internal consistency, and test-retest reliability

The distribution of item characteristics is shown in Table 1. The average of total scores of the DSMQ was equal to 33.1 (SD = 5.7). The sum-scale Cronbach's  $\alpha$  of DSMQ was equal to 0.82 for 30 participants showing that internal consistency was acceptable. Cronbach's  $\alpha$  coefficient for GM, DC, PA, and HU subscales was obtained as 0.7,

0.69, 0.65, and 0.64, respectively. Moreover, if each of 16 items in the questionnaire was deleted, the Cronbach's  $\alpha$  coefficient did not increase more than 0.02; hence, it is not necessary to delete any item in order to increase internal consistency. The mean inter-item correlation was equal to 0.21 (SD = 0.22). Mean item-total correlation of "SS" was equal to 0.53 (SD = 0.19). The mean item-subscale correlations were equal to 0.66 (SD = 0.10) for GM, 0.71 (SD = 0.10) for DC, 0.63 (SD = 0.11) for PA, and 0.62 (SD = 0.19) for HU. All items had item-total correlations higher than 0.30 except items 7, 11, and 15. However, these three items were highly correlated with their corresponding subscales [Table 1].

ICC was utilized to check test-retest reliability between two measurements and was obtained as 0.93. In addition, ICCs were equal to 0.9 for GM, 0.86 for DC, 0.8 for PA, and 0.9 for HU. High similarity between two measurements for "SS" and the subscales confirmed test-retest reliability.

## Construct Validity

### EFA results

EFA suggested a four factor structure, explaining 62.5% of total variance. As a result, the factors could explain a significant percentage of the total variance. The scree plot shows that the eigenvalues related to the first four dimensions were more than 1 and subsequent eigenvalues were almost equal [Figure 1]. The first factor, which accounted for 29.7% of the total variance had an eigenvalue 4.76. This factor, denoted by "Glucose Management", was explained by items 1, 4, 6, 10, and 12. The second factor, labelled "Dietary Control", accounted for 13.7% of the variance. This factor included items 2, 5, 9, and 13. The third factor denoted by "Physical Activity", accounted for 10.5% of the variance and consisted of items 8, 11, and

**Table 1: Distribution of item scores, internal consistency in case of deletion, scale, and total correlations**

Item	Mean (SD)	Cronbach's alpha if item deleted	Item-subscale-correlation	Item-Total Correlation
1	2.07 (0.77)	0.80	0.78	0.56
2	2.32 (0.67)	0.79	0.75	0.74
3	1.71 (0.85)	0.79	0.76	0.74
4	2.11 (0.57)	0.80	0.6	0.59
5	2.04 (0.79)	0.81	0.68	0.51
6	1.68 (0.86)	0.79	0.77	0.73
7	2.18 (0.67)	0.84	0.33	0.21
8	1.96 (0.58)	0.81	0.75	0.46
9	1.68 (0.67)	0.80	0.6	0.55
10	2.07 (0.77)	0.81	0.63	0.50
11	2.64 (0.56)	0.82	0.57	0.27
12	2.43 (0.63)	0.82	0.54	0.36
13	2.32 (0.67)	0.79	0.84	0.79
14	1.39 (0.63)	0.79	0.64	0.69
15	2.46 (0.58)	0.82	0.56	0.21
16	2.07 (0.72)	0.81	0.73	0.52
Total Cronbach's Alpha		0.82		

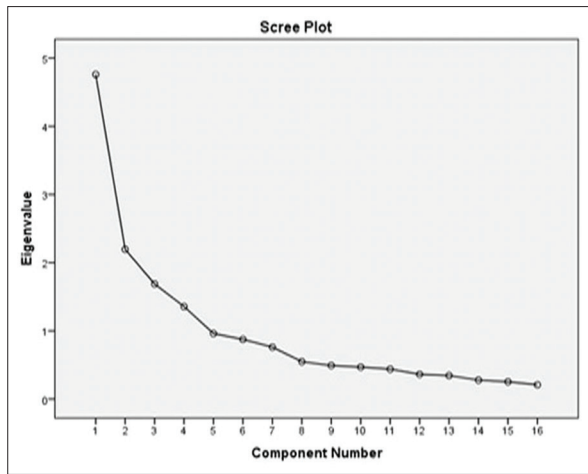


Figure 1: The scree plot obtained from exploratory factor analysis

15. The fourth factor, entitled "Health Care", accounted for 8.5% of the variance. This factor included items 3, 7, and 14 with an eigenvalue of 1.35 and accounting for 8.5% total variance. Rotated factor loadings, eigenvalues, and percentage of total variance for all components are illustrated in Table 2. Items 4 and 12 had acceptable factor loading (0.501 and 0.489) for their corresponding factor (GM) but factor loadings for these items were 0.467 and 0.483 in factor 4 (HU), respectively. In addition, item 14 had factor loading values of 0.474 and 0.448 for its corresponding factors (HU) and factor 1 (GM), respectively. Besides, item 16 had moderate factor loading in all the factors.

### CFA results

CFA was performed for 300 participants in two scenarios. In the first scenario, CFA was assessed for all items and with respect to four dimensions. In this scenario, factor loading of item 5 and item 14 were lower than 0.3; hence, we deleted them from the model. The mentioned parameters for unmodified model of DSMQ with four factors were as follows:  $\chi^2 = 404.8$ ,  $DF = 59$ ,  $P < 0.001$ ,  $CFI = 0.79$ ,  $RMSEA = 0.14$ ,  $TLI = 0.73$ , and  $NFI = 0.77$ . When unmodified model was used, all indices were not acceptable. All indices were acceptable for modified DSMQ as presented in Figure 2 ( $\chi^2 = 100.9$ ,  $DF = 56$ ,  $P = 0.001$ ,  $CFI = 0.97$ ,  $RMSEA = 0.05$ ,  $TLI = 0.96$ , and  $NFI = 0.94$ ). Moreover, in the second scenario, the single factor model was assessed so that, all 16 items aggregated on one factor. The mentioned parameters for unmodified model of DSMQ with all 16 items were as follows:  $\chi^2 = 1003.1$ ,  $DF = 104$ ,  $P < 0.001$ ,  $CFI = 0.45$ ,  $RMSEA = 0.18$ ,  $TLI = 0.36$  and  $NFI = 0.42$ . In addition, modified DSMQ for single factor (self-care or self-management) revealed  $\chi^2 = 95.96$ ,  $DF = 60$ ,  $P < 0.001$ ,  $CFI = 0.98$ ,  $RMSEA = 0.05$ ,  $TLI = 0.96$ , and  $NFI = 0.94$ , indicating an adequate fit [Figure 3].

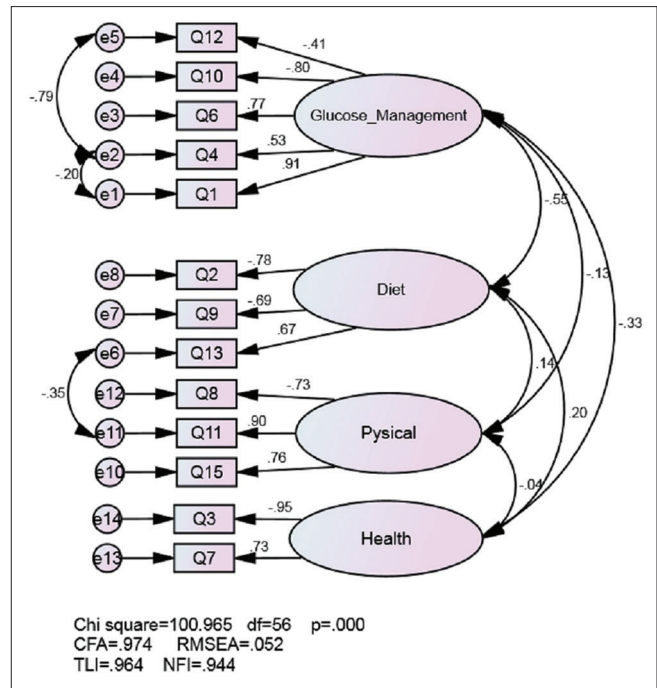


Figure 2: Modified confirmatory factor analysis for DSMQ for four factors

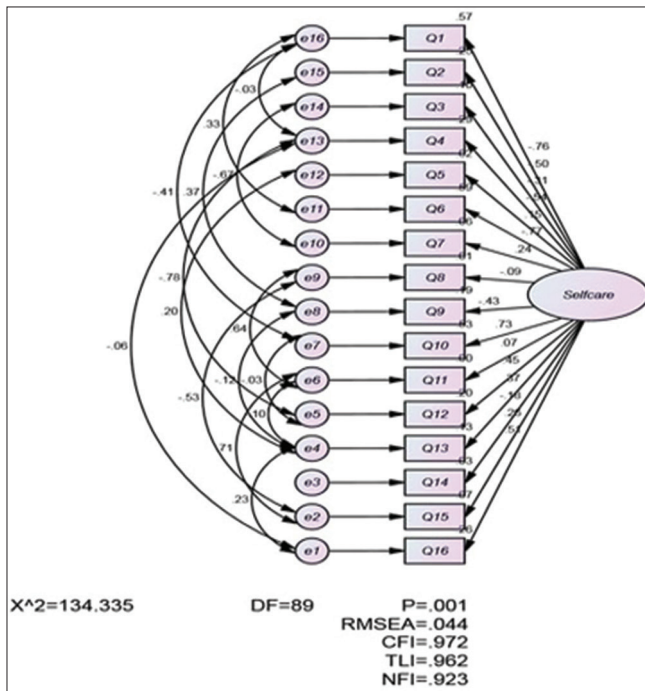
### Discussion

The present study was carried out to evaluate the psychometric properties of the Persian version of the DSMQ in a sample of patients with T2DM in Iran. The results of the current study indicated that the Cronbach's  $\alpha$  coefficient of reliability index was equal to 0.82 and ICC was equal to 0.93, suggesting that internal consistency and test-retest reliability of the questionnaire was acceptable. As a result, the questionnaire was found to be reliable in Iran. In addition, exploratory and confirmatory factor analysis was used to assess the construct validity. EFA results revealed that the questionnaire consisted of four dimensions including GM, DC, PA, and HU similar to the original version. In addition, these four dimensions were confirmed by CFA.

In our study, Cronbach's  $\alpha$  was equal to 0.82 for the SS of Persian version of DSMQ among patients with T2DM. In the original study, Cronbach's  $\alpha$  was equal to 0.84 for the SS, which is similar to our finding.<sup>[12]</sup> It was reported as 0.96 for Urdu versions which is higher than our finding,<sup>[14]</sup> but in two studies conducted in Thailand and Nigeria, it was reported as 0.73 and 0.43, respectively, which are lower than other studies.<sup>[14,15]</sup> In addition, in our study, Cronbach's  $\alpha$  coefficient was equal to 0.7, 0.69, 0.65, and 0.64, respectively, for GM, DC, PA, and HU subscales. In the original study, they were reported as 0.77, 0.77, 0.76, and 0.60 for these four subscales, which are nearly as same as with our results.<sup>[12]</sup> They were reported between 0.73 and 0.91 in Urdu version, which are higher than our results for all the subscales.<sup>[13]</sup>

**Table 2: Rotated factor loadings of the DSMQ items and eigenvalues and corresponding percentage of variance explained (standard random 50%)**

Item	Glucose Management	Factor 1	Factor 2	Factor 3	Factor 4
1	Check blood glucose carefully	<b>0.806</b>	-0.070	-0.094	-0.171
4	Receive diabetes medication as physician recommendations	<b>0.501</b>	-0.245	-0.005	-0.467
6	Do regular recording of blood glucose level	<b>0.817</b>	-0.072	-0.178	-0.014
10	Do not check blood glucose regularly	<b>-0.751</b>	0.049	0.057	0.186
12	Avoid intentionally/forget to take diabetes medication	<b>-0.489</b>	0.309	-0.002	0.483
<b>Dietary Control</b>					
2	Select food to easily attain optimum level of blood glucose	0.295	<b>-0.645</b>	-0.161	-0.049
5	Eat plenty of sweetmeat or high-carb foods occasionally	-0.013	<b>0.768</b>	-0.023	0.109
9	Comply with diet as specialist's recommendations	0.168	<b>-0.711</b>	-0.115	-0.123
13	Have occasional real "food binges"	0.031	<b>0.771</b>	0.009	0.079
<b>Physical Activity</b>					
8	Do physical activity to attain optimum levels of blood glucose	0.076	-0.106	<b>-0.848</b>	-0.038
11	Skip physical activity, in spite of its usefulness for diabetes	-0.060	0.088	<b>0.881</b>	0.000
15	Avoid regular and planned physical activity	-0.113	0.015	<b>0.859</b>	-0.008
<b>Health Care</b>					
3	Do medical appointments as recommendations	0.212	-0.144	-0.011	<b>-0.719</b>
7	Avoid medical appointments on diabetes	-0.106	0.109	-0.050	<b>0.809</b>
14	See diabetes care providers more often	0.448	-0.149	0.090	<b>0.474</b>
16	Poor diabetes self-care	-0.430	0.411	0.219	<b>0.453</b>
Eigenvalue		4.76	2.19	1.68	1.35
Variance explained (%)		29.74	13.72	10.5	8.47



**Figure 3: Modified confirmatory factor analysis for DSMQ for single factors with all 16 items**

The results of the current study showed that the mean inter-item correlation was equal to 0.21 reflecting low heterogeneity. In the original study, it was reported as 0.25, which is in line with our results.<sup>[12]</sup> But, in the studies carried out in Pakistan and Nigeria, the mean inter-item correlation was reported as 0.76 and 0.52, respectively,

which are considerably higher than the results of the current study and the original one.<sup>[13,14]</sup> Low heterogeneity for the questionnaire is reasonable because the tool consisted of four subscales each of which assesses different aspects of diabetes self-management.<sup>[12,21]</sup> In our study, item-total correlations were lower than 0.3 for items 7, 11, and 15. In the original study, it was reported lower than 0.3 for items 14 and 15.<sup>[12]</sup> However, in both studies, item-subscale correlation was relatively high for all items. In case of the DSMQ as a multidimensional scale, it is rational that each item had high correlation with the corresponding subscale. In our study, mean item-total correlation (0.53) was a bit higher than the original version (0.46), reflecting low correlation in both studies.<sup>[12]</sup> Our study was the first study investigated ICC, sum-scale ICC, and ICC for four subscales. All the ICC values were high; as a result, test-retest reliability was acceptable for DSMQ. In sum, internal consistency and test-retest reliability were acceptable for Persian version of DSMQ.

The results of the present study showed that factor loadings were high for four factors in EFA. 15 items out of 16 items (except item 16) fell in the four factors like the original study.<sup>[12]</sup> Although items 4 and 12 were in factor 1 (GM), they had considerable factor loading with factors 4. In addition, item 14 fell in factor 4, but it had a bit high factor loading in factor 1. Items 4 and 12 asked about medication adherence and item 14 asked about regular medical appointment. Results of a study performed in Iran demonstrated that the patients received medical care by the physicians had better compliance with

treatment.<sup>[22]</sup> Appointment adherence and communications with physicians are positively associated with adherence to treatment.<sup>[23]</sup> Therefore, regarding the direct association between medication adherence and health care use, considerable factor loadings occurred for items 4 and 12 in factor 4 as well as items 14 in factor 1 can be justified. Like the original study, in our study, item 6 fell in factor 1 (GM), but the factor loading was higher (0.82 vs. 0.50) compared to the original study.<sup>[12]</sup> Unlike our study, in the original study, this item had remarkable factor loading for factor 2(DM).<sup>[12]</sup> Item 16 evaluated overall rating of self-care and the loading factor was moderate for this item in all factors, which is in line with the original version.<sup>[12]</sup>

The results of CFA showed adequate model fit between single factors with all 16 items. Consistent with the finding, the original study and Urdu version have reported appropriate fit for SS model.<sup>[12,13]</sup> According to the results of CFA, factor loadings were low and insignificant for items 5 and 14. However, the CFA indices improved after deleting items 5 and 14. Factor loading for these items in CFA and EFA was considerably lower in the study compared to the original version attributing to cultural differences.<sup>[13]</sup> Bukhsh *et al.* also stated that lower loading factors for HU subscale can be explained by differences in healthcare infrastructure and facilities in developed countries compared to developing countries.<sup>[13]</sup>

To the best of our knowledge, psychometric properties of two instruments for measuring of diabetes self-management behaviors including the diabetes self-management scale (DSMS) and the Diabetes Numeracy Test15 (DNT- 15) were assed in Iran.<sup>[16,17]</sup> Although both of the tools as well as DSMQ have shown good reliability and validity in Iranian diabetes patients, DSMQ is the preferred tool for assessing behavioral problems related to glycemic control.<sup>[8,16]</sup> In addition, DSMQ as a brief questionnaire (16 items) is more practical for clinical and research purposes than DSMS (35 items).<sup>[8,16]</sup> Moreover, DNT-15 was designed specifically to asses numeracy skills related to diabetes self-care behaviors, but DSMQ is a relatively comprehensive instrument that covers important aspects of diabetes self-management.<sup>[24,25]</sup>

This study was the first research assessed psychometric properties of DSMQ among patients with T2DM in Iran; however, there were some limitations. First, there was not any record on hemoglobin A1c level in medical records of the participants; hence, it was not possible to use hemoglobin A1c level to assess the criterion validity. Although there are other questionnaires assessing diabetes self-management such as the Summary of Diabetes Self-Care Activities Measure, they were not used in this study to evaluate the convergent validity, which was considered as the second limitation.

## Conclusions

The Persian version of DSMQ was found to have acceptable reliability for assessing self-management among patients with T2DM. Although the EFA and CFA results revealed good construct validity, factor loading for item 14 in CFA and EFA was considerably lower compared to the original version. DSMQ is a simple scale measuring the self-management. Therefore, DSMQ can be applied for Iranian diabetic patients by the healthcare providers and researchers.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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## Conflicts of interest

There are no conflicts of interest.

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