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# A cross-sectional analysis of the association between diabetes self-care practices and blood glucose regulation among Egyptian diabetic patients

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**Abstract. – OBJECTIVE: Diabetes Mellitus (DM) is a main public health issue worldwide, with Egypt among the world's top countries with diabetic patients. Data on the degree of self-care behaviors of Egyptian diabetic patients is not fully reported. Therefore, the study aimed to assess the adequacy of diabetes self-management (DSM) habits among diabetic patients in Egypt and to identify associated socio-demographic factors that could negatively impact the patients' glycemic state, using a structured questionnaire.**

***SUBJECTS AND METHODS:*** **This study was a cross-sectional observational study. The diabetes self-management questionnaire (DSMQ) was used to assess diabetes self-care activities, which is a 16-item questionnaire. The statistical analysis was conducted on SPSS software, and the data were significant with a *p*-value <0.05.**

***RESULTS:*** **A total of 2,164 participants were included. The majority of the patients (83.8%) had type 2 DM. The mean glycated hemoglobin (HbA1c) of the study group was 8.44±1.99. Significant differences were found between different glycemic control groups both in terms of the DSMQ sum scores and the subscale scores, with the exception of physical activity. Moreover, there was a significant weak inverse correlation between the total DSMQ sum score and HbA1c ≥9.0% ($\rho$=-0.116, $p$<0.01). The overall internal consistency (Cronbach's alpha) was acceptable (0.756).**

***CONCLUSIONS:*** **The study indicated that patients with controlled blood glucose had significantly higher 'glucose management', and 'total DSMQ sum' scores compared to uncontrolled diabetic patients. All significant correlations between assessed parameters and DSMQ were weak.**

*Key Words:*
Diabetes, Self-management, Cross-sectional, Glucose management.

## Introduction

Diabetes Mellitus (DM) is a major public health burden ranked among the top 10 causes of mortality worldwide[1]. The incidence and prevalence of DM have been growing significantly, and recent global reports estimated that one in every 11 adults is diagnosed with DM[1]. Additionally, more than 400 million people are currently living with diabetes, globally, and there is an expectation to rise above 600 million by 2045[2].

The International Diabetes Federation (IDF), reported Egypt among the world's top 10 countries in the number of diabetic patients, where the prevalence in Egypt is 18.4 %[3]. According to official reports, in Egypt, the total diabetes management cost was estimated to reach EGP 25.2 billion (USD 3.5 billion) per year, where DM complications management cost represents 65% of the total cost[4].

DM is a chronic metabolic disorder of carbohydrate metabolism due to either insulin deficiency or insulin resistance leading to increase blood glucose levels[4]. The long term uncontrolled diabetes may lead to serious micro and macro-vascular complications responsible for the high rate of morbidity and mortality[3]. Therefore adequate self-care knowledge will


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play a crucial role in the achievement of the euglycemic state in diabetic patients and also will improve prognosis[5].

Hence, major efforts are required by health-relevant organizations to establish a standardized evaluation strategy to ensure a reliable improvement and awareness plan that offers sufficient knowledge about all aspects of diabetes risk factors, prevention, management, and complications[6,7].

The Diabetes Self-Management Questionnaire (DSMQ) is one of the most reliable and valid tools in diabetes self-management assessment[8,9]. DSMQ is a 16-item questionnaire that was classified into 4 subscales; glycemic control (GC), dietary control (DC), physical activity (PA), and Health-Care Use (HU)[9]. The different sectors of this questionnaire cover major self-care behaviors which directly affect glycemic control[8,9].

To date, data on the degree of self-care behaviors of Egyptian diabetic patients is not fully documented. Thus, the present study targeted to evaluate the adequacy of diabetes self-management (DSM) habits among diabetic patients in Egypt and to identify associated socio-demographic factors which could negatively impact the patients' glycemic state using a structured questionnaire (DSMQ).

## Subjects and Methods

### Study Design, Enrollment, and Ethical Considerations

A cross-sectional observational study was conducted in accordance with the Declaration of Helsinki in the outpatient clinics of 6th October Teaching Hospitals in Egypt between January and December 2021. Patients diagnosed with either type 1 or type 2 diabetes for at least a year were recruited using a consecutive sampling method to participate in the diabetic self-care survey study. Patients were included if they were at least 18 years old. Pregnant women and those with severe physical, mental, or cognitive impairments were excluded from participation. Ethical approvals were obtained from the Ethical Committee and Institutional Review Board of 6th October University. All participants signed written informed consent.

### Instruments and Measures of the Diabetes Self-Care Activities

The questionnaire used to assess diabetes self-care activities was the diabetes self-management questionnaire (DSMQ)[9]. It is 16 items in total, comprised of four subscale scores. The first is 'Glucose Management' (5 items) about the regularity of medication intake and self-monitoring of blood glucose. The second subscale is 'Dietary Control' (5 items) about disease-related facets of diet (e.g., diet habits poorly impacting glycemic control and compliance to dietary advice). The third is 'Physical Activity' (3 items) about the regularity of physical activity, followed by 'Health-Care Use' (3 items). The final item is 'Sum Scale', which asks for an overall assessment of self-care. The questionnaire was translated and linguistically validated and revised into Arabic by 2 Arabic native speakers and qualified translators.

### Data Collection Procedures

All patients diagnosed with DM type 1 or 2 presenting to the outpatient clinic were screened for inclusion. The study's goals, risks, benefits, and the right to withdraw were explained to those fulfilling the inclusion and exclusion criteria and signed a consent form.

A data collection form was used to gather clinical and demographic information from patients. This included age, gender, marital status, educational level, and employment status as sociodemographic data. General and physical examination was performed to document all the participants' weight, height, and body mass index (BMI). Patient and medication history collected included recording the duration of DM, type of antidiabetic treatment received, and comorbidities. To evaluate their glycemic control, a blood sample was collected from the patients, and the glycated hemoglobin (HbA1c) was measured after the participant enrollment.

The structure of DSMQ was self-administered to patients through face-to-face (15- 20 minutes) interviews. If patients could not read or write, they were thoroughly introduced to all the facets of the questionnaire to verify that all questions were addressed. The accuracy of the data was reviewed by researchers.

### Sample Size Calculations

For data collection, we used a convenience sampling method. For calculating the sample size[10], we used the equation: $n=z^2P(1-P)/d^2$. Under a 95% Confidence Interval (CI), 50% response distribution, and 0.05 margin of error, the minimum sample size for representing large populations was 384 participants.

### Statistical Analysis

The statistical analysis was conducted on IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY, USA). The dichotomous data were expressed as counts and percentages, whereas the continuous ones were using means and standard deviations. The data significance was considered when the $p$-value <0.05. The tests used to measure significance were Chi-square for dichotomous data and Mann-Whitney for the continuous data.

The tests used for comparisons between glycemic control groups (known-group validity) were Kruskal-Wallis and post-hoc pairwise comparisons. Patients' glycemic control was classified according to HbA1c values into (HbA1c ≤7.5%), (HbA1c 7.6-8.9%) and (HbA1c ≥9%).

Regarding the convergent validity (correlations), coefficients were Spearman's ρ correlation for continuous data or point-biserial correlation for dichotomous data. The criteria used for the interpretation of correlations were: little or no correlation for 0-0.25; fair correlation for 0.25-0.5; moderate to good correlation for 0.5-0.75; and very good to excellent correlation for ≥0.75[11].

Internal consistency was used to measure the questionnaire's reliability, and Cronbach's α coefficient was calculated and interpreted according to the reported criteria[12]. The evaluation of the item properties was by corrected item-total correlations, and the expected scale's reliability coefficient increased if the item was deleted.

## Results

### Demographic and Clinical Characteristics

A total of 2,164 participants responded to the questionnaire, Table I shows the demographic and clinical data of respondents.

The majority of the patients (83.8%) had DM type 2 and were females (51.6%). The mean age and BMI of the participants were 50.57±13.51, and 29.69±5.32, respectively. The participants were predominantly married (90.3%), employed (57.1%), received a bachelor's education (43%), and lived in urban residences (52.8%).

The largest proportion (39.8%) of the patients had a short DM duration of 1 to 5 years, followed by 6 to 10 years (37.2%). The mean glycated hemoglobin (HbA1c) of the study group was 8.44±1.99%. The most common comorbidity was hypertension (32.4%); however, 49.9% had no comorbidities. The majority of the patients were non-smokers (78.4%) and had no diabetic complications (62.1%).

There were significant differences between type 1 and 2 patients in terms of age ($p$<0.001), BMI ($p$<0.001), marital status ($p$<0.001), educational level ($p$=0.041), duration of diabetes ($p$<0.001), and HbA1c level ($p$<0.001).

### DSMQ Scores

Table II shows the DSMQ sum and subscale scores of the participants. The mean reported DSMQ sum was 5.59±1.52. The DSMQ sum scores of types 1 and 2 DM patients were comparable.

### Known-Groups Validity (Comparisons Between Glycemic Control Groups)

Different glycemic control groups were found to be significantly different in the total DSMQ scores and all the sub-scores except the physical activity score, as shown in Table III.

The results revealed that patients with HbA1c ≤7.5% reported significantly higher 'glucose management', and 'total DSMQ sum' scores than those with HbA1c ≥9.0% ($p$<0.001 and $p$=0.013, respectively). Other scores (DC, PA, HU, and diabetes self-care) showed non-significant variations between these two groups. On the other hand, patients with HbA1c ≤7.5% reported significantly higher 'dietary control', 'health care use', and 'total DSMQ sum' scores than those with HbA1c 7.6-8.9% ($p$<0.001, $p$=0.008, and $p$=0.007, respectively), with non-significant variations between these groups in the other subscale scores. Finally, patients with HbA1c 7.6-8.9% reported significantly higher scores than those with HbA1c ≥9.0% in all scores except the 'physical activity' score, which showed no significant difference.

### Convergent Validity

The correlations between the DSMQ score (and subscales) with assessed parameters are fully reported in Table IV.

There was a significant but little correlation between the DSMQ sum score and HbA1c ≥9.0% (r=-0.116, $p$<0.01), as well as little correlation between the glucose management score and HbA1c ≥9.0% (r=-0.124, $p$<0.01).

Only significant but little correlations were found among assessed parameters (age, BMI, marital status, duration of diabetes, comorbidities, smoking status) and HbA1c, and DSMQ scores and subscales. Figure 1 demonstrates the correlation between the DSMQ sum score and HbA1c.

**Table I.** Demographic and clinical characteristics

| | Total (n = 2,164) | DM type 1 (n = 349) | DM type 2 (n = 1 ,815) | *p*-value |
|---|---|---|---|---|
| Gender, N (%) | | | | 0.814† |
| Male | 1,048 (48.4%) | 167 (47.9%) | 881 (48.5%) | |
| Female | 1,116 (51.6%) | 182 (52.1%) | 934 (51.5%) | |
| Age (Years) mean ± S.D. | 50.57 ± 13.51 | 42.58 ± 0.87 | 52.11 ± 0.29 | < 0.001‡* |
| BMI Mean ± S.D | 29.69 ± 5.32 | 28.19 ± 0.29 | 29.98 ± .12 | < 0.001‡* |
| Marital status N (%) | | | | < 0.001†* |
| Single | 210 (9.7%) | 102 (29.2%) | 108 6%) | |
| Married | 1,954 (90.3%) | 247 (70.8%) | 1,707 (94%) | |
| Employment N (%) | | | | 0.609† |
| Employed | 1,236 (57.1%) | 195 (55.9%) | 1,041 (57.4%) | |
| Unemployed | 928 (42.9%) | 154 (44.1%) | 774 (42.6%) | |
| Residence N (%) | | | | 0.846† |
| Rural | 1,021 (47.2%) | 163 (46.7%) | 858 (47.3%) | |
| Urban | 1,143 (52.8%) | 186 (53.3%) | 957 (52.7%) | |
| Level of Education N (%) | | | | 0.041†* |
| Primary | 114 (5.3%) | 17 (4.9%) | 97 (5.3%) | |
| Intermediate | 484 (22.4%) | 72 (20.6%) | 412 (22.7%) | |
| Secondary | 197 (9.1%) | 30 (8.6%) | 167 (9.2%) | |
| Bachelor | 930 (43%) | 173 (49.6%) | 757 (41.7%) | |
| Postgraduate | 279 (12.9%) | 43 (12.3%) | 236 (13%) | |
| Illiterate | 160 (7.4%) | 14 (4%) | 146 (8%) | |
| Duration of diabetes (years) N (%) | | | | < 0.001†* |
| 1 years-5 years | 862 (39.8%) | 106 (30.4%) | 756 (41.7%) | |
| 6 years-10 years | 804 (37.2%) | 110 (31.5%) | 694 (38.2%) | |
| 11 years-20 years | 498 (23%) | 133 (38.1%) | 365 (20.1%) | |
| HbA1c (3 months) N (%) | | | | < 0.001†* |
| HbA1c ≤ 7.5% | 852 (39.4%) | 112 (32.1%) | 740 (40.8%) | |
| HbA1c 7.6-8.9% | 601 (27.8%) | 56 (16%) | 545 (30%) | |
| HbA1c ≥ 9.0% | 711 (32.9%) | 181 (51.9%) | 530 (29.2%) | |
| Comorbidities N (%) | | | | 0.18† |
| Chronic kidney disease | 48 (2.2%) | 13 (3.7%) | 35 (1.9%) | |
| Chronic liver disease | 36 (1.7%) | 2 (0.6%) | 34 (1.9%) | |
| Heart disease | 43 (2%) | 6 (1.7%) | 37 (2%) | |
| Hypertension | 702 (32.4%) | 123 (35.2%) | 579 (31.9%) | |
| Malignancy | 9 (0.4%) | 1 (0.3%) | 8 (0.4%) | |
| Respiratory disease | 31 (1.4%) | 4 (1.1%) | 27 (1.5%) | |
| No Comorbidity | 1,079 (49.9%) | 162 (46.4%) | 917 (50.5%) | |
| More than one comorbidity | 216 (10%) | 38 (10.9%) | 178 (9.8%) | |
| Smoking status N (%) | | | | 0.617† |
| Yes | 468 (21.6%) | 79 (22.6%) | 389 (21.4%) | |
| No | 1,696 (78.4%) | 270 (77.4%) | 1,426 (78.6%) | |
| Diabetic complications N (%) | | 0.032†* | | |
| Yes | 820 (37.9%) | 150 (43%) | 670 (37.9%) | |
| No | 1,344 (62.1%) | 199 (57%) | 1,145 (63.1%) | |
| Anti-diabetic medication N (%) | | | | 0.126† |
| Insulin only | 461 (21.3%) | 81 (23.2%) | 380 (20.9%) | |
| Insulin + oral hypoglycemic medication | 314 (14.5%) | 60 (17.2%) | 254 (14%) | |
| Oral hypoglycemic medication | 1,389 (64.2%) | 208 (59.6%) | 1,181 (65.1%) | |

Statistical tests: †Chi square, ‡Mann-Whitney U; **p*-value ≤ 0.05 is considered significant. N: number, SD: standard deviation, BMI: body mass index, DM: diabetes mellitus, HbA1c: glycated hemoglobin.

### *Reliability Analysis*

The overall internal consistency (Cronbach's alpha) was acceptable (0.756). The corrected item Item-Total Correlation for the subscales was as follows; (glucose management score: 0.519; DC score: 0.537; PA: 0.417; HU score: 0.512; diabetes self-care score: 0.381; total DSMQ sum score: 0.907).

**Table II.** Diabetes self-management questionnaire (DSMQ) score.

| Score mean ± S.D. | Total (n = 2,164) | DM type 1 (n = 349) | DM type 2 (n = 1,815) | *p*-value† |
|---|---|---|---|---|
| DSMQ SUM | 5.59 ± 1.52 | 5.54 ± 0.08 | 5.6 ± 0.036 | 0.757 |
| Glucose management score | 6.21 ± 2.03 | 6.19 ± 0.11 | 6.21 ± 0.047 | 0.967 |
| Dietary control score | 5.67 ± 1.84 | 5.73 ± 0.1 | 5.66 ± 0.043 | 0.407 |
| Physical activity score | 4.88 ± 2.37 | 4.88 ± 0.13 | 4.88 ± 0.05 | 0.736 |
| Health care use score | 5.85 ± 1.89 | 5.74 ± 0.1 | 5.88 ± 0.04 | 0.352 |
| Diabetes self-care score | 5.28 ± 3.23 | 5.29 ± 0.18 | 5.28 ± 0.075 | 0.983 |

Statistical tests: †Mann-Whitney U. *p*-value ≤ 0.05 is considered significant. N: number, SD: standard deviation, DSMQ: Diabetes self-management questionnaire, DM: diabetes mellitus.

**Table III.** Comparisons between glycemic control groups.

| Score mean ± S.D. | HbA1c ≤ 7.5% | HbA1c 7.6-8.9% | HbA1c ≥ 9.0% | Sig. a† | Sig. b† | Sig. c† | *p*-value |
|---|---|---|---|---|---|---|---|
| Glucose management score | 6.46 ± 2.03 | 6.27 ± 1.98 | 5.84 ± 1.98 | 0.068 | < 0.001* | < 0.001 | < 0.001* |
| Dietary control score | 5.91 ± 1.82 | 5.56 ± 1.76 | 5.46 ± 1.89 | < 0.001* | < 0.001* | 0.482 | < 0.001* |
| Physical activity score | 4.99 ± 2.44 | 4.88 ± 2.26 | 4.73 ± 2.37 | ns | ns | ns | 0.218 |
| Healthcare use score | 6.09 ± 1.93 | 5.82 ± 1.87 | 5.59 ± 1.83 | 0.008* | < 0.001* | 0.126 | < 0.001* |
| Diabetes self-care score | 5.52 ± 3.34 | 5.23 ± 3.11 | 5.03 ± 3.15 | 0.054 | 0.009* | 0.583 | 0.02* |
| Total DSMQ sum score | 5.84 ± 1.62 | 5.56 ± 1.38 | 5.33 ± 1.46 | 0.007* | < 0.001* | 0.013 | < 0.001* |

Statistical tests: †post-hoc pairwise comparisons, ‡Kruskal-Wallis Sig. a: significant difference between the first and second group. Sig. b: significant difference between the second and third group.Sig. c: significant difference between the third and first group. **p*-value ≤ 0.05 is considered significant. ns: non-significant, S.D: standard deviation, DSMQ: Diabetes self-management questionnaire.

## Discussion

This study targeted to investigate the adequacy of diabetes self-management (DSM) habits among diabetic patients in Egypt (types 1 and 2), which, according to the IDF 10th edition, is the second country in the Middle East and North Africa in terms of diabetic people numbers (aged 20-79 years)[3]. Moreover, we aimed to identify the associated factors using DSMQ.

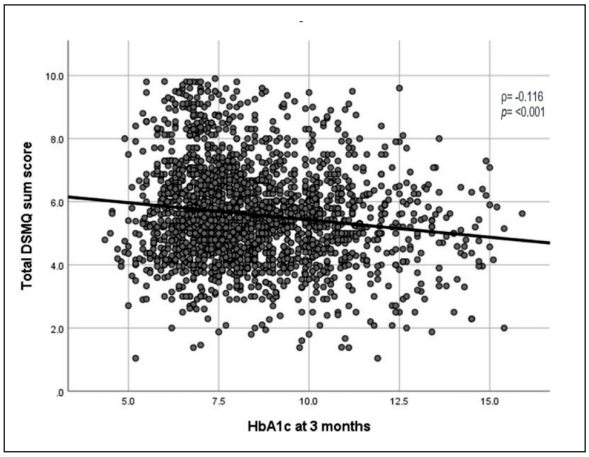


**Figure 1.** Correlation analysis between the total DSMQ sum score and HbA1c.

According to the known-groups validity analysis, the results indicated significant variations between patient groups with different glycemic control, confirming the questionnaire's capacity to distinguish between patients' practices and align with the original questionnaire results[9]. Our study showed that patients with HbA1c ≤7.5% reported significantly higher 'glucose management', and 'total DSMQ sum' scores than those with HbA1c ≥9.0%, and significantly higher 'dietary control', 'health care use' and 'total DSMQ sum' scores than those with HbA1c 7.6-8.9%. Meanwhile, patients with HbA1c 7.6-8.9% showed significantly higher scores than those with HbA1c ≥9.0% in all scores except the 'physical activity' score.

The above findings indicate the relationship between questionnaire scores (except physical activity) and the HbA1c values and questionnaire score adequacy in distinguishing between the groups with different HbA1c values. Additionally, they support the fact that patients practicing

appropriate self-care management, and exhibiting additional concern regarding their disease, have better glycemic control and reduced risks of diabetes-associated late complications[13-15]. On the other hand, a Hungarian version of the DSMQ only revealed significant variations in DSMQ sum scores between HbA1c levels ≤7.5% and HbA1c levels ≥9% groups, as well as between the HbA1c 7.6% - 8.9% and above ≥9% groups, with non-significant variations among the HbA1c levels ≤7.5% and HbA1c 7.6%-8.9% groups. This suggests that the Hungarian version questionnaire could only distinguish between patient groups with satisfactory against elevated HbA1c levels[16]. This discrepancy could be explained by our larger sample size (N=2,164), compared to theirs (N=221). Other possible reasons could be due to the authors' mentioned limitations, such as their use of HbA1c values reported over six months and their use of different laboratories[16].

Even though our results showed significant correlations between age, BMI, marital status, duration of diabetes (11 to 20 years), comorbidities A, smoking status, as well as HbA1c ≥9.0%, and the DSMQ scores which could potentially support the convergent validity of the questionnaire, most of the reported correlations were weak. The highest one observed was an inverse correlation between the 'Glucose Management' subscale and HbA1c ≥9.0% in DM 1 patients (-0.215), reflecting little correlation. Overall, this study revealed a little inverse correlation with subscales 'Glucose Management', DC, 'HU', 'Diabetes Self-care', and sum score with HbA1c ≥9.0%, and also with 'DC', and 'PA' with the BMI. Likewise, Nigerian and Urdu questionnaire[6,17] versions showed significant correlations with HbA1c. However, both studies' results showed a moderate correlation (-0.56), as well as a strong inverse correlation (-0.78) between HbA1c and the sum score, respectively, which were more consistent with the original questionnaire study, reported a fair correlation (-0.40)[9]. On the other hand, the Hungarian version[16] showed an inverse fair correlation between the DSMQ sum score and the HbA1c values (-0.253), and between the BMI and physical activity.

Recently, Schmitt et al[18] pointed out the need to revise the DSMQ, as technological innovations like continuous glucose monitoring and automatic insulin delivery have altered terms and expressions in diabetes care. Moreover, the tool should cover some specific self-management parts better. Therefore, they presented a revised and updated tool version (DSMQ-R), which is a multidimensional questionnaire consisting of 27 items. They concluded that the results supported good clinometric properties of the DSMQ-R and that it could be beneficial for research and clinical practice and might aid in identifying the improvable self-management practices[18].

A high overall internal consistency was found (0.756), indicating an acceptable consistency, and a corrected item correlation for the total DSMQ sum scale of 0.907. Meanwhile, an Urdu version of the DSMQ showed a sum scale: $\alpha$=0.96[6]. Moreover, in the original questionnaire, internal consistency of the "Sum Scale" and the subscales (apart from the 'HU') was appropriate[9].

Type 2 DM management requires a lot of time, lifestyle modifications, and confidence to do so. Due to the associated high cost of diabetes control, healthcare providers are playing an active part in the provision of education for DSM[19]. Previous systematic reviews[20-23] of interventions regarding DSM indicated that diabetes education courses improve knowledge, self-care behaviors, and HbA1C decrease. Pharmacist-based educational interventions were associated with enhanced medication adherence and glycemic control[24,25]. Moreover, a recent study[26] highlighted the importance of maintaining a partnership between cardiologists and other healthcare professionals in implementing the evidence and care of type 2 DM patients. Alhabib et al[27] revealed the important role of clinical pharmacists in DM patient management in diverse settings globally. They concluded an urgent requirement to recognize and alter regulations allowing shared practice agreements among physicians, pharmacists, and other health professionals.

The strengths of this study include the large sample size, which adequately represents the study population. Furthermore, we followed the "Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)" guidelines for reporting this cross-sectional study[28]. On the other hand, the limitations include the small percentage of type 1 diabetes patients included.

Future research is required to support the convergent validity of the Egyptian DSMQ version, and an increase in the included type 1 DM patients is recommended. Also, the revised tool (DSMQ-R), as well as the role played by pharmacists and physicians in self-care management, should be taken into consideration.

## Conclusions

The study indicated that patients with good glycemic control (HbA1c ≤7.5%) had significantly higher 'glucose management', and 'total DSMQ sum' scores than those with poor glycemic control (HbA1c ≥9.0%), and significantly higher 'dietary control', 'health care use' and 'total DSMQ sum' scores than those with HbA1c 7.6-8.9%. Moreover, there were significant, yet little, correlations between age, BMI, marital status, duration of diabetes (11 to 20 years), comorbidities, smoking status, as well as HbA1c ≥9.0%, and the DSMQ. Finally, the overall internal consistency indicated was acceptable.

### Conflict of Interest
The Authors declare that they have no conflict of interests.

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### Informed Consent
Informed consent was obtained from all individual participants included in the study.

### Ethics Approval
The current study protocol was approved by the Research Ethics Committee at 6 October University in Egypt (PRC-Ph-2103013).

### Authors' Contribution
Engy Ahmed Wahsh: idea conception and design of the study; Ahmed Essam Abou Warda: acquisition of data; Rabab Ahmed El-Gazar: acquisition and revision of data; Alaa Ahmed Elshanbary: analysis and interpretation of data; Sarah Makram Elsayed: analysis and interpretation of data; Nouran Omar El Said: analysis and interpretation of data and supervision, critical revisions, writing of the manuscript.

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### Availability of Data and Materials
The data supporting this study's findings are available from the corresponding author upon reasonable request.

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