Self-Monitoring of Blood Glucose among Patients with Type I Diabetes Mellitus in Buraidah City

Dr. Suhail Nasser AlQefari

Abstract:-
Introduction: Diabetes mellitus morbidity magnitude is increasing drastically throughout the globe including Saudi Arabia. As a result of increasing type 1 diabetes mellitus (T1DM), the disease burden, productivity, quality of life, and life expectancy are on the steadily rising.

Objectives: to estimate the frequency of self-monitoring blood glucose (SMBG) among T1DM patients, relationship of SMBG frequency with glycaemic control and compliance status.

Methods: A cross sectional study was conducted at Diabetic Centre, KFSH hospital. We conveniently selected all eligible patients who visited the diabetic centre during the period of 2 weeks. Self-administered questionnaire was used and FBS and HbA1C retrieved from hospital records.

Results: We surveyed 113 adult diabetic patients. Females comprised 72.6%, age range from 13 years to 60 years. Self-Monitoring of Blood Glucose (SMBG) frequency was 99.1% among the T1DM patients. More than half of the participants (50.4%) were diabetic for more than 10 years. And 99.1% were using basal and bolus insulin for their sugars control. Positive attitude was found among 103 (91.2%) of patients and 96 (85%) of patients practiced SMBG at least once a day. Mean HbA1C level was 9.28 ± 2.98. Age and education level were associated with better HbA1C levels.

Conclusions: Majority of reviewed type 1 diabetic patients at KFSH diabetic centre have positive attitude towards SMBG and frequently practiced it. The mean HbA1C was, however, suboptimal.

Keywords:- T1DM patients, SMBG, HbA1C level, Compliance, Attitude.

I. INTRODUCTION

Prevalence of diabetes mellitus is estimated to be higher in the future [1]. Besides, despite high prevalence of type 1 diabetes mellitus (T1DM), there is shortage of conducted studies in Saudi Arabia. However, researchers should focus on improving quality of life and enhancing better prognosis for T1DM patients [2]. In addition, compared with other children, Saudi children with T1DM have less metabolic control [3]. One of the important factors of modern therapy for diabetes mellitus is self-monitoring of blood glucose (SMBG). In fact, in order to achieve the targeted glycaemic control and to avoid hypoglycaemia, SMBG has been recommended. Well controlled HbA1C was associated with tighter SMBG testing [4].

In addition, SMBG systems have important role in reduction of complications of diabetes mellitus [5]. SMBG non-compliance and low frequency was due to defect in few skills including information, motivation and behavioral[6]. The cost of glucometers and strips, the fear of self-testing, psychological frustration, the unawareness of dealing with abnormal readings, and the lack of motivation were the influencing factors regarding SMBG in non-compliant T1DM patients [1].

On the other hand, in Sweden, despite the availability of glucometers and the strips at no cost, more than half of T1DM patients were not following the recommendations regarding daily SMBG tests [7]. More further, one third of T1DM patients were not compliant to routine SMBG but only when hypoglycaemia or hyperglycaemia was suspected [8].

A growing number of people, especially in poorer nations, are being struck by diabetes. By 2030, it is expected to be the world's sixth largest cause of death. Without immediate action, the number of individuals with diabetes is anticipated to climb from 371 million in 2012 to 552 million by 2030, according to new data from the International Diabetes Federation (IDF) [9]. This translates to almost three new instances every ten seconds, or about ten million each year. Additionally, according to the International Diabetes Federation, up to 187 million individuals may not know they have diabetes.

Approximately one in nine persons in the Middle East and North Africa region suffers from diabetes. In 2012, 34 million people aged 20 to 79 had diabetes, which is anticipated to quadruple in the next 20 years, reaching 10.9 percent of the population. The area is home to four of the top ten nations in the world for diabetes prevalence [9]. Twenty-four percent of the people between the ages of twenty and seventy-eight in Saudi Arabia had diabetes in 2012. It has been ranked as the fifth most diabetes magnitude nation in the world.

Diabetes-related complications are a leading cause of disability, decreased well-being, and mortality. There are a number of distinct ways in which diabetes complications may impact the body, and each person experiences them differently. International guidelines for identifying and evaluating the complications of diabetes are lacking. Comparisons across other groups are challenging since different procedures are used to determine whether or not these issues are present.

Many studies have shown at least one problem in 50 percent or more of patients when they are first diagnosed with the disease. Good blood glucose management in diabetics may postpone or avoid problems, according to

research from the Diabetes Control and Complications Trial and UK Prospective Diabetes Study. This is true for those with type 1 and type 2 diabetes. Finally, finding an important factor to reach an optimal glycemic control and avoid the burden of diabetes mellitus complications will reduce the morbidity and mortality of the disease. In view of the above circumstances, the present study was conducted to find the SMBG practice among the type 1 diabetes patients.

II. OBJECTIVES

- To estimate the frequency of routine self-monitoring of blood glucose among T1DM patients.
- To determine the relationship of self-monitoring of blood glucose and glycemic control.
- To find the compliance status in the study population and its association with SMBG.

III. LITERATURE REVIEW

According to this research, which focused on T2DM patients in the Al-Qassim Region, self-blood glucose monitoring (or SMBG) performance rates in Al-Qassim are on par with those reported in Western nations (around 78%). Compared to Najran (Saudi Arabia), which recorded a 1% rate, it's astronomical. Because of a lack of literacy and technical challenges in using the glucometer, poor self-care may be the result [10].

In the Qassim Region, patients who suffer from type 1 diabetes make frequent use of SMBG. However, both its regularity and its timing are less than ideal. Patients with diabetes who were younger (less than 50 years old), male, married, and had a higher level of education were more likely to perform SMBG. In Norway, a reported 71% of the population is obese. Over seventy-five percent of people with type 1 diabetes in France say they do at least two blood tests daily [11].

However, in Malaysian research, great number of people revealed that the percentage of SMBG participants varied from 6.9% among diabetes patients visiting private clinics to 26.8% among diabetic patients attending specialist clinics [12]. Men and those under the age of 50 were more likely to be SMBG participants in this study. Another research in Malaysia found that SMBG participants were more likely to be highly educated, had a higher total family income, had diabetes for a longer period of time, and were on an insulin treatment schedule [13].

IV. METHODOLOGY

- **Study design:** Cross-sectional study. A cross-sectional analytic research with a representative sample of diabetes patients in the Qassim Region of Saudi Arabia was done.
- **Data collection tool:** The study questionnaire included sociodemographic data, information on the patient's diabetes condition, therapy, the patient's assessment of his diabetes control level, patient's attitudes about SMBG, and the patient's current SMBG practices.
- **Study area/setting:** a specialized diabetic center at the major referral hospital in Qassim, King Fahad Specialist Hospital (KFSH) in Buraidah city.

A. Sampling:

- **Study population:** All type 1 diabetic patients in Buraidah city.
- **Sampling frame:** All type I diabetic patients who are visiting diabetic centre in Buraidah city. The average registered number was 1000 adults.
- **Sample size:** We used OpenEpi website to calculate the sample size. Using anticipating frequency from previous studies as 90%, precision of 5% and design effect of 1%, the calculated sample size was 122 patients.
- **Sampling method:** Due to time and Covid-19 constraints, we selected our sample in a convenient method. All patients visiting type 1 DM clinic in 2 weeks period were targeted. Ten to twenty patients completed the questionnaire.
- **Study duration:** From December 2020 to June 2022
- **Data Collection tool:** The questionnaires were distributed among type 1 diabetes mellitus patients who are fulfilling the criteria. Consent was taken at the beginning of the questionnaire. Hard copy of constructed self-administered questionnaires distributed to the patients visiting the diabetic center clinics. Questionnaire consists of demographic variables information and also other variables related to Self-Monitoring of Blood Glucose among Patients with Type I Diabetes Miletus.

B. Inclusion and exclusion criteria:

The inclusion criteria: all adult type 1 diabetes mellitus patients of both genders, Saudi nationality who agree to be part of the research.

- **Exclusion criteria:** T1DM patients who have communication abnormalities, pregnancy, malignancies, bowel diseases, chronic renal failure, heart failure, or chronic obstructive pulmonary diseases (COPD) as they may have an influence on the accuracy and validity of the results.
- **Ethical approval:** Ethical approval of the study obtained from the Regional Research Ethics committee in Qassim. Before starting the study, permission was also obtained from the Diabetic center administration for the data collection.
- **Data management and confidentiality:** Data collected initially and were coded in the database excel sheet using a unique identification number. The data was stored on a password-protected laptop with PI and CI, and all data was maintained confidential manner. Only the researcher have access to the database for analyses purpose. In the publication, only present the summary statistics of participants and no identifying information was shared.

C. Statistical Analysis:

Data entered in Micro soft Excel, later data transferred to Statistical Package of Social Science (SPSS 24 version) and all values were analyzed. Descriptive statistics were presented in proportions, means, and standard deviation were calculated. For the categorical variables chi-square, Fisher exact tests were applied. Pearson correlation coefficient was used to assess the relationship between

continuous variables and independent T test was used to compare means for categorical variables. Probability (P) < or equal to 0.05 was considered as statistically significant.

V. RESULTS

We distributed the study questionnaire to 120 type 1 diabetic patients. Out of these, 113 completed the questionnaire, giving a response rate of 94.1%. Mean age of the study sample was 23.6 ± 7.62, range: 13-60 years, with 75% of them less than 30 years. Two thirds of the respondents reported an income of less than 5000 Saudi Riyals (SR), while only 8.8% had more than 10000 SR.

Table 1: Participants characteristics of patients with type I diabetes mellitus, Qassim.

Demographic variables	Number	Percentage
Gender		
Female	82	72.6
Male	31	27.4
Occupation		
None	32	28.3
Office employee	10	8.8
Student	64	56.6
Others	7	6.3
Marital status		
Married	20	17.7
Single	93	82.3
Nationality		
Saudi	112	99.1
Education		
Bachelor or higher	51	45.1
Diploma	10	8.8
High school	36	31.9
Elementary or middle school	16	14.2
Chronic diseases other than DM		
HTN	5	4.4
Hypothyroidism	11	9.7
None	91	80.5
Others	6	5.4
DM duration		
less than a year	4	3.5
1 to 5 years	32	28.3
6 to 10 years	20	17.7
More than 10 years	57	50.4
Type of Insulin		
Basal and bolus	112	99.1
Insulin pump	1	0.9
Pricking for SMBG		
Self-measuring	110	97.3
Family member	3	2.7

Table 1 shows that almost all of the participants were of Saudi nationality, majority (72.6%) were females, more than half (56.6%) were students and less than half (45.1%) had bachelor degrees. Only 17.7% of the study sample were married.

Besides being diabetic, 9.7% had hypothyroidism while 80.5% had no other chronic disease. Around half of the participants (50.4%) were diabetic for more than 10 years while around one third had been diabetic for less than 5 years. Almost all of the patients were using basal and bolus insulin and self-pricking themselves, 99.1% and 97.3% respectively.

Table 2: Type I diabetic patients compliance with management advices, Diabetic Center, Qassim.

Blood sugar characteristics	Number	Percentage
Home SMBG use		
No	1	0.9
Yes	112	99.1
Once every day	7	6.2
More than once daily	89	78.8
Once every week	6	5.3
More than once weekly	6	5.3
Once to three times a month	4	3.5
FBS readings last month		
less than 80 mg/dl	7	6.2
80 to 130 mg/dl	51	45.1
131 to 200 mg/dl	41	36.3
More than 200 mg/dl	13	11.5
RBS readings last month		
less than 80 mg/dl	4	3.5
80 to 200 mg/dl	92	81.4
More than 200 mg/dl	16	14.2
Hypoglycaemia within the last month		
None	35	31.0
1 to 4 times	46	40.7
5 to 10 times	22	19.5
More than 10 times	10	8.8
Positive attitude towards SMBG	103	91.2
Compliance to treatment		
0-3	10	8.9
4-5	103	91.1
Mean HbA1C level ± SD	9.28 ± 2.98	
Mean FBS level ± SD	144 ± 66.42	

Majority of patients (91.2%) had positive attitude towards SMBG. Almost all of patients practiced SMBG, with majority of them (85.0%) practiced it daily. Less than half (45.1%) reported having a FBS level within the acceptable range in the last month.

Only 31.0% reported being free from any hypoglycaemic events during the past month, while 28.3% reported having 5 or more hypoglycaemic attacks. The mean FBS level during the day of visit was 144 ± 66.42 and mean glycosylated haemoglobin level was 9.28 ± 2.98. Most of patients (91.2%) consider themselves compliant with management plan, Table 2.

Table 3: HbA1C compared to other variables using T-test

Variable		Mean HbA1C (%)	P-value
Gender	Male	8.8	0.28
	Female	9.5	
Marital Status	Single	9.5	0.16
	Married	8.4	
Education	Bachelor or higher	8.5	0.007
	Less than bachelor	10.0	
Duration of DM	≤ 5 years	9.5	0.62
	≥ 6 years	9.2	
Other chronic diseases	Yes	8.7	0.3
	No	9.4	
SMBG frequency	Daily	9.1	0.054
	Less than daily	10.5	
Reported compliance level	Good	9.2	0.22
	Poor	10.4	

Mean HbA1C was negatively associated with age. The relationship was weak but significant, Pearson correlation -0.278, (p=0.003). On the other hand, there was a weak positive association between HbA1C and FBS, Pearson correlation 0.230, (p=0.014).

There was 1.4% difference between those who check their blood sugar daily compared to those with less frequent blood sugar checking, but the difference could not pass the statistical level (p=0.054). Similarly, the difference between mean HbA1C among those who perceived their compliance as good compared to those who perceived their compliance as poor, mean difference: 1.2% and the difference was not significant (p=0.22). The education level was found to have a statistically significant mean HbA1C difference between those who had higher education compared to those with less educational level, mean HbA1C difference 1.5%, (p=0.007). However, there was no significant association between mean HbA1C and other studied independent variables, gender, marital status, diabetes duration, and having other chronic diseases. The mean HbA1C difference between items of each variable was less than 1%, Table 3.

VI. DISCUSSION

The current study was conducted at Diabetic centre, Buraidah among the type 1 diabetes patients during the period from December 2020 to June 2022. In our study, the mean age of the population was 23.6 and standard deviation (SD) was ± 7.62. Compared with our study which has a younger age group, a study conducted by Kuenen JC, Borg R et al among the type 1 diabetes patients, the mean age in their study revealed as 44.1 ± 12.9. This difference of mean age could be due to demographic situations in the country [14].

In our study, about 9.7% were presented with hypothyroidism as a chronic disease and 80.5% of type 1 diabetes does not have other chronic diseases based on patients self-report. This hypothyroidism prevalence was close to three times (8/11) more among females than that of males (3/11) type 1 diabetes patients in our study. Similar findings were observed with longitudinal study conducted in United States of America (USA) by Umpierrez GE, Latif KA et al in the year 2003 and stated that hypothyroidism was observed more than 2 times among the females than that of males in type 1 diabetes patients [15].

Other studies conducted at western world through screening programs in their cross sectional studies among the type 1 diabetes patients in the late 80s, 90s and after the year 2000 found that hypothyroidism disease was more among the type 1 diabetes as these two entities from the autoimmune nature and moreover hypothyroidism disease was more among the females than that of males and also expressed the gravity of hypothyroidism in 12–24% of female and 6% of male patients with type 1 diabetes [15-19].

Self-monitoring blood glucose monitoring is very essential modality for the prevention of hypoglycaemic tendencies especially in the type 1 diabetes patients and also gives warning signals for the prevention of short term and long term complications in the patients. In our study, positive attitude towards SMBG was noted and reflected by having almost all patients (99.1%) were practicing SMBG, though 15% were infrequently practiced it. But about 48% had more than 130mg/dl FBS level on the day of visit and 6.2% had FBS of less than 80mg/dl level. Similarly, for the reported RBS level, about 14.2% had > 200mg/dl and 3.5% had < 80 mg/dl.

Near to our study findings observed a study conducted in a Spain in the year 2000 among type 1 Diabetes patients revealed that about 11.1% of study group were showing > 250mg/dl and these variations could be due to during the COVID period and post pandemic COVID period and also some variations could be due to classification range of the sugars that is some authors prefers 200mg/dl and some prefers >250mg/dl, SMBG use in his study was 95.7% [20]. Another study conducted in the year 2000 by Varma et al and classified the hypo and hyperglycaemic as < 70mg/dl and >180mg/dl respectively [21].

In the present study, the mean glycosylated haemoglobin level was 9.28, a similar finding was observed in the study conducted at King Fahad Armed Forces hospital, Jeddah where mean HbA1C level among type 1 diabetes patients was 9.4% ± 2.3 [22] and another study conducted in Jeddah found mean HbA1c level of 8.8% [23].

In contrast, few international studies reported better mean HbA1C among type 1 diabetics. A study conducted in Belgium found surprisingly much lower mean HbA1C level of 6.6±1.2 among < 18 years of age and also stated that HbA1C level was low in first 2 years of T1DM patients [24]. An international multi-centre study conducted in Europe, Japan and United states of America reported a mean HbA1C level of 8.6±1.7 [25]. Similarly, another study conducted among 81 type 1 diabetes patients in United Arab Emirates (UAE) during 2014 and 2015 found a mean HbA1c level of 8.6±1.9 [26].

Age and education were the only patient demographic variables that showed significant association. Those who have higher education are expected to be of older age compared to those with less education but we have not looked at the confounding effect between those two factors. As expected, there was positive correlation, however weak, between FBS and HbA1C. Of note, only 8.8% of our participants reported poor compliance with management plan. Patients tend to overestimate their compliance level. This was probably behind weak association between compliance level and mean HbA1C level, as good compliance should result in overall better glycemic control. Similarly, the difference between those who reported frequent SMBG, though clinically sound, could not reach statistical significance. Small sample, recall bias, and patient self-misclassification explain our study failure to find statistically significant differences.

VII. STUDY STRENGTHS

Our study, to our knowledge, is the first one studying SMBG practices among type 1 diabetics in Qassim region. Our data completeness, including the most objective variables, i.e. FBS and HbA1C, were good.

VIII. STUDY LIMITATIONS

Our sample excluded those who are below 14 years of age as those are managed at paediatric hospital. The study sample was relatively small and was a convenient one. Multiple obstacles were faced during the data collection. This survey was conducted during Covid-19 pandemic period. Low participants show up for their outpatient visits and their frequent perceived unwillingness to participate in our survey were the most hindering factors. Males were under represented in this study possibly due to better female patients willingness to participate and female staff to collect data. It may be difficult to generalize our finding to other institutes or to diabetic patients community, as this study was conducted in a specialized centre and during a difficult circumstances.

IX. CONCLUSIONS

Majority of reviewed type 1 diabetic patients at KFSH diabetic center have positive attitude towards SMBG and frequently practiced it. Their overall mean FBS and mean HbA1C levels were below targeted levels, but there were association, however weak, between frequent SMBG and mean HbA1C level. Age and education level were also associated with better blood sugar control.

X. RECOMMENDATIONS

Type 1 diabetics at diabetic centre, KFSH compliance with management and lifestyle advices need to be addressed. Health care team provision of medical management and staff recommended health promotion measures need to be assessed for possible improvement programs. Further studies to widely assess diabetic patients compliance including SMBG practice are suggested. Periodic practice and compliance assessments at each institute are also recommended.

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