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Research Article

Knowledge and Practice of Glucose Self-Monitoring Devices among Patients with Diabetes

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Abstract

Background: With blood glucose self-monitoring, patients may assess how well their glucose level is controlled, and change their treatment plan as advised by their physicians. The development and increasing availability of different devices that are readily accessible plays a significant role in glycemic control and prevention of complications through early recognition with proper practice.

Methods: This observational cross-sectional study includes patients with diabetes attending Khartoum North Diabetes and Endocrinology Hospital and was carried out in April–July 2021 using convenient sampling via questionnaires obtained and filled by data collectors through interviews. Data analysis was done using SPSS software.

Results: Out of 125 total patients, 82 had prior basic knowledge about glucose self-monitoring devices. Twenty-four patients were using it regularly, and only seven were using it daily. Fifty-one patients had never used any device before. Fifty-five patients owned a device, and the rest borrowed or used devices available at healthcare centers or clinics, pharmacies, relatives' or neighbors' devices. Factors hindering the use of devices included financial difficulties and lack of education. Most frequent users had a stable occupation. Just below half of the patients using devices had good practice techniques with significant association with higher level of education. The rest had poor practice technique that was associated with lower level of education.

Conclusion: Utilization of glucose self-monitoring devices is prevalent among patients with diabetes. However, many challenges require attention to facilitate ongoing self-use with proper practice inline with education and access.

Keywords: Diabetes, glucometer, hyperglycemia, self-monitoring, glucose control

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1. Introduction

Type 2 diabetes has become more common in several regions. It is a lifelong condition that needs continuous medical care and lifestyle changes. It is expensive to manage diabetes and its consequences, especially in developing countries [1]. Numerous studies have demonstrated that controlling blood glucose levels can lower chances of developing complications [2]. Although many patients with diabetes have poor glycemic control,

it is possible to improve patients' knowledge, practice, and self-efficacy to obtain better glycemic control [3].

The effectiveness of patient education in enhancing patients' knowledge, attitude, practice, and self-efficacy is becoming more evident. With the help of blood glucose self-measurement, patients may keep a close watch on control of their condition and, in the case of blood glucose fluctuations, modify their therapy as advised [4]. Studies have shown a connection between self-monitoring frequency and positive changes in blood glucose levels [5]. Patients use many devices to check their blood glucose levels [6]. Unfortunately, most patients with diabetes find it unpleasant to check their blood sugar levels often. Traditional measurement devices employ electrochemical techniques, which utilize a small volume of blood to be drawn by a finger prick or a thin lancet inserted under the skin. The first differs from the last in that it just gives a single reading of the glucose level [7].

Large number of patients with diabetes have limited understanding of managing their condition and monitoring their blood sugar. Self-checking blood glucose levels at home can give patients and doctors useful information that helps in managing their diabetes, though the price of test strips may be a factor affecting regular monitoring [8].

Patients are generally interested in trying newer devices, and there is increasing acceptance of using self-monitoring devices, however, they do not necessarily use them regularly. In many populations, self-monitoring may not be associated with improved control [9]. Using the device may improve physical self-awareness, thus making patients less dependent on professionals. Therefore, proper techniques of self-monitoring should be taught and encouraged by healthcare providers [10].

Proper practice techniques of utilizing glucose self-monitoring devices is part of many key factors determining the accuracy of test readings, and treatment errors might result from inaccurate blood glucose levels [11]. Lack of education is a major contributor toward incorrect self-monitoring practice. Patients must be properly educated on how to measure their own blood sugar levels in addition to how to handle and store strips. Blood sugar values must be carefully interpreted as part of said education, since making wrong judgments might arise from inappropriately considering grossly atypical results [11]. Many patients either own or know how to use simple self-monitoring devices. However, many do not correctly practice their utilization. And a select number learn from neighbors and family members rather than healthcare professionals [12].

Diabetes treatment expenses are always rising in poor nations in which resources are scarce. However, greater financial and therapeutic benefits may come from patients' understanding of basic concepts of self-evaluation and follow-up. Thus being familiar

with and proficient in using self-monitoring devices help them become able to respond appropriately when encountering abnormal readings, which may indirectly reduce economic implications of disease complications.

Therefore, the objectives of the current study were to: identify prior knowledge about utilization of glucose self-monitoring devices; determine the prevalence of utilization of glucose self-monitoring devices; assess proper use of glucose self-monitoring devices; and assess challenges hindering use, and proper practice, of glucose self-monitoring devices.

2. Materials and Methods

2.1. Study design

This study was an observational cross-sectional study.

2.2. Study population

The study included patients with diabetes attending Diabetes and Endocrinology Hospital, Khartoum North, Sudan, between April 2021 and July 2021. However, patients who were critically ill, lacked capacity, or refused to participate in the study were excluded.

2.3. Sampling Technique

A convenient random sampling method was used. The sample size was 125, and was calculated using standard statistical formula with a 95% confidence level, a 50% population proportion, a 5% margin of error, and a population size of 185.

2.4. Data Collection

Data were collected via structured questionnaire filled by data collectors through direct interviews after obtaining proper consent. The questionnaire was designed by the authors using related background information, with questions concerning proper practice technique being adopted, with modification, from a previous study [10]. Simple validation techniques were used including face validation in addition to qualified statistician approval, with no further validation before data collection.

3. Results

Data were analyzed using the SPSS statistical analysis software. Categorical variables were used to present the result as frequencies and percentages. Associations including cross tabulation was done using Chi-square testing and assessing statistical significance where the level of significance is set to be at *P*-value < 0.05. Total number of sample size was 125 patients. There were no incomplete responses nor lost data.

Moreover, 60% of the patients were males while 40% were females. Most (32.8%) were in their fifth decade; 24.8% in their fourth, 22.4% were >60 years of age, 8.8% were in their third decade, and 11.2% were <30 years old. In addition, 44 (35.2%) patients were unemployed, while the rest were either students (4.8%), employees (17.6%), free workers (33.6%), or retired (8.8%). While 21.6% of patients were illiterate, 28% were at primary school level, 23.2% at secondary school level, and 27.2% at collage level. Majority of patients (71, 56.8%) were diagnosed with diabetes <10 years ago (Table 1).

The study revealed that 82 patients (65.6%) had prior basic knowledge about glucose self-monitoring devices, while the rest (34.4%) had none. Sources of information were self-learning (6, 4.8%), physician education (38, 30.4%), pharmacists (7, 5.6%), and relatives (34, 27.2%) (Table 1). Overall, 67 (53.6%) patients used a glucose self-monitoring device before, while 58 (46.4%) had not. Most patients (32) who had used devices before were taught by their physicians, while others were taught by their relatives, neighbors, pharmacists, or had taught themselves through self-learning methods (Table 2).

Assessment of correct and proper technique when using glucose self-monitoring devices revealed that out of the total 125 patients, 47 (37.6%) properly disinfected their hands before using the device, while 37 (24.8%) did not. In addition, 61 (48.8%) patients measured glucose level using the first drop of blood from their fingers rather than the second drop (39.2%); 50 (40%) patients discarded the needle/lancet after using it once, 16 (12.8%) did not discard it, and only 8 (6.4%) patients reused the same needle after disinfecting it. Moreover, 31 (24.8%) patients punctured same finger every time rather than different fingers (44, 35.2%) and 39 (31.2%) patients measured the blood glucose both fasting and postprandial. Only 5.6% of patients used devices daily and 19.2% were used it regularly (Table 2). Patients who provided answers corresponding to proper practice technique in two or more out of four practice technique questions (hands disinfection before use, used needle discard, different finger puncture, and first blood drop avoidance) were 44.8%, while 55.2% had answered less than two questions correctly.

Regarding patients' access to devices, of the 125 patients, 55 (44%) owned a device, others gained access through healthcare centers or clinics (57, 45.6%), relatives or neighbors (12, 9.6%), and one patient through pharmacies. In total, 37 (29.6%) patients considered that financial reasons constitute a major challenge preventing them from gaining access to a glucose self-monitoring device, while others (19, 15.2%) chose lack of prior knowledge and education, and significant number of patients (52, 41.6%) could not provide a specific challenge (Table 2).

Assessing the relation of occupation to frequency of use and means of accessing devices revealed that 41.7% out of 24 regular users were independent workers, and 46.5% out of 43 non-regular users were unemployed (*P*-value = 0.017). Out of 55 patients who owned devices, 32.7% were independent workers and 36.4% were unemployed (*P*-value = 0.036) (Table 3). Assessing the relation of proper correct technique of device use with the level of education revealed that most college or higher educated patients disinfect their hands before using the device (44.70%, *P*-value = 0.019) and discard first blood drop (60.00%, *P*-value = 0.004,). However, a significant number of higher educated patients repeat same finger puncture during device practice (51.60%, *P*-value = 0.007; Table 4).

4. Discussion

Most patients had prior knowledge about utilization of glucose self-monitoring devices. This might be due to the variation in sources of education either on individual level or the primary healthcare level, though relatives and neighbors played a significant role in patients' education and support alongside physicians. Significant number of patients have used a device previously whether by themselves or through assistance of relatives or healthcare centers. Despite that, significant number did either implement incorrect practice techniques or had no knowledge of how to properly utilize glucose self-monitoring devices. It is important to mention that physicians and healthcare providers did not appear to be the main reference in teaching for a number of patients, with relatives and neighbors may be appearing to be closer to patients' environment. Although having access to a device and knowing how to properly practice its use do not always equate to good glycemic control in some populations [9], it still plays a significant role in determining the frequency of monitoring which, in turn, helps in prevention of unfavorable outcomes. This has been demonstrated in previous studies [5].

Less than half of patients had their own self-monitoring device. This apparent low response may be due to financial difficulties and device availability, given the relatively

Table 1: Demographic data and device knowledge responses.

Parameter	Response	Frequency	Percentage
Gender	Male	75	60.00%
	Female	50	40.00%
Age (yr)	31–40	11	8.80%
	41–50	31	24.80%
	51–60	41	32.80%
	>60	28	22.40%
Educational level	Illiteracy	27	21.60%
	Primary school	35	28%
	Secondary school	29	23.20%
	College	34	27.20%
Occupation	Student	6	4.80%
	Employee	22	17.60%
	Independent worker	42	33.60%
	Retired	11	8.80%
	Unemployed	44	35.20%
Duration of diabetes (yr)	<5	31	24.80%
	5–10	40	32%
	>10	54	43.20%
Device prior knowledge	Yes	82	65.60%
	No	43	34.40%
Source of device knowledge	Self-learning	6	4.80%
	Physician	38	30.40%
	Relatives	34	27.20%
	Pharmacist	7	5.60%
	No one	40	32%

high cost of devices. Despite that, a significant number of patients could not provide a specific challenge preventing them from gaining access to a device. Furthermore, a number of patients reuse same needles during their practice, which can be explained by test strips cost and availability. These challenges were usually found more prevalent in rural environments, whereas urban populations were relatively affected to a lesser degree [8].

Just below half of the patients utilizing devices demonstrated overall proper practice of device use by providing proper responses to most questions. This is lower than expected given the level of background knowledge and source of practice education found, yet it differs from other populations that showed poor outcome to both basic knowledge and proper practice [8, 10]. However, this may be due to decreased participation of healthcare providers in the process of education and awareness of patients

Table 2: Practice technique responses and challenges hindering device utilization.

Parameter	Response	Frequency	Percentage
Prior use of devices	Yes	67	53.60%
	No	58	46.40%
Source of teaching practice techniques	Self-learning	9	7.20%
	Physician	32	25.60%
	Relatives or neighbors	28	22.40%
	Pharmacist	4	3.20%
	Nurses	9	7.20%
	No source	43	34.40%
Disinfecting hands before use	Yes	47	37.60%
	No	31	24.80%
	Do not know	47	37.60%
Using the first drop of blood	Yes	61	48.80%
	No	15	12%
	Do not know	49	39.20%
Discarding needle after single use	Yes	50	40%
	No	16	12.80%
	Reuse after disinfecting needle	8	6.40%
	Do not know	51	40.80%
Repeating same finger puncture	Yes	31	24.80%
	No	44	35.20%
	Do not know	50	40%
Timing of device use	Fasting	15	12%
	After meal (postprandial)	20	16%
	Both	39	31.20%
	Do not know	51	40.80%
Frequency of device use	Daily	7	5.60%
	Regular	24	19.20%
	Non regular	43	34.40%
	Rarely	51	40.80%
Means of access to devices	Own device	55	44%
	Pharmacy	1	0.80%
	Healthcare centers or clinics	57	45.60%
	Relatives or neighbors	12	9.60%
Challenges hindering device utilization	Financial difficulties	37	29.60%
	No prior knowledge	19	15.20%
	Availability of the device	11	8.80%
	Do not think it is important	6	4.80%
	Do not have a specific challenge	52	41.60%

Table 3: Relation between occupation vs means of access to devices and frequency of use.

		Occupation										
		Student		Employee		Independent worker		Retired		Unemployed		
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Means of access to devices	Own device	3	5.50%	10	18.20%	18	32.70%	4	7.30%	20	36.40%	**P-value 0.036**
	Pharmacy	1	100.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	
	Health centers or clinics	2	3.50%	9	15.80%	21	36.80%	6	10.50%	19	33.30%	
	Relatives or neighbors	0	0.00%	3	25.00%	3	25.00%	1	8.30%	5	41.70%	
Frequency of device use	Daily	1	14.30%	1	14.30%	1	14.30%	3	42.90%	1	14.30%	**P-value 0.017**
	Regular	3	12.50%	5	20.80%	10	41.70%	2	8.30%	4	16.70%	
	Non regular	1	2.30%	9	20.90%	12	27.90%	1	2.30%	20	46.50%	
	Rarely	1	2.00%	7	13.70%	19	37.30%	5	9.80%	19	37.30%	

Table 4: Relation between level of education vs proper practice technique responses.

		Level of education								
		Illiteracy		Primary school		Secondary school		College		
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Disinfecting hands before use	Yes	7	14.90%	9	19.10%	10	21.30%	21	44.70%	**P-value 0.019**
	No	6	19.40%	9	29.00%	8	25.80%	8	25.80%	
	Do not know	14	29.80%	17	36.20%	11	23.40%	5	10.60%	
Using the first drop of blood	Yes	11	18.00%	14	23.00%	16	26.20%	20	32.80%	**P-value 0.004**
	No	1	6.70%	4	26.70%	1	6.70%	9	60.00%	
	Do not know	15	30.60%	17	34.70%	12	24.50%	5	10.20%	
Repeating same finger puncture	Yes	5	16.10%	3	9.70%	7	22.60%	16	51.60%	**P-value 0.007**
	No	8	18.20%	14	31.80%	10	22.70%	12	27.30%	
	Do not know	14	28.00%	18	36.00%	12	24.00%	6	12.00%	

who may rather reach out toward their closer environment, namely their neighbors and relatives. Furthermore, different challenges may contribute indirectly toward improper practice, whether financial or environmental, through insufficient patient education.

Significant number of patients measured their glucose levels before and after meals which is considered a better frequency for close monitoring of blood glucose. Few were regular users and more were non-regular users. The majority of those regular users

were independent workers, while a number of non-regular users were unemployed with statistically significant relation (*P*-value = 0.017). This indicates that either employment or working may help patients become more regular in self-monitoring and that may be partly due to the cost of test strips which are required for ongoing use. These findings support consistent demonstrations of occupation as a predictor of ongoing use of self-monitoring devices [10].

When assessing the relation of correct practice to patients' level of education, there appeared to be a statistically significant relation between proper practice techniques and higher education level. While the majority of patients with prior knowledge about self-monitoring devices had previously achieved college level of education, those with no prior knowledge were illiterate. This reflected the prominent effect of education on knowledge and awareness (*P*-value = 0.002). It may be explained by background knowledge that helps drive seeking expert advice in any health-related issues, which appears to be consistent in other populations [10].

5. Conclusion

Utilization of glucose self-monitoring devices is prevalent among patients with diabetes. However, many factors facilitating ongoing regular use require special attention, such as variation in occupation. Multiple challenges, related to level of education and financial difficulties, are involved in, and significantly affect, proper practice techniques. Furthermore, lack of direct involvement of healthcare services practice-related education as well as awareness may indirectly affect glycemic control in patients with diabetes.

Impact

Wide incorporation of glucose self-monitoring devices into national health insurance institutions would be beneficial in overall diabetes control and complications prevention while alleviating financial-related challenges. Provision of healthcare personnel education for patients' understanding of proper utilization alongside awareness programs encouraging promotion of self-measurement of blood glucose would impact proper practice.

Limitations

Direct observation of patients live practicing glucose self-measurement using devices would further confirm proper practice and eliminate doubts or bias that might accompany data collection from plain interviews utilizing patients' responses, which may limit accuracy of information obtained. Furthermore, advanced analytical techniques including binary logistic regression assessing association between different parameters in larger populations would provide additional statistically significant information.

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Ethical Considerations

An informed verbal consent was obtained from each patient before data collection while ensuring clear confidentiality and anonymity during data collection from both patients and collectors. Ethical clearance and approval was obtained from relevant authorities and study area as appropriate.

Competing Interests

Authors declare no conflict of interest.

Availability of Data and Material

Data available within submitted article.

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