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Original Work

Selfmonitoring of blood glucose practices by people living with diabetes who use their personal glucometers in Port Harcourt, Niger Delta Region, Nigeria

MO Nkpozi[ψ1], AU Chapp Jumbo[2], NN Unamba[3], CN Unachukwu[1], S Chinenye[1]

[1]Endocrine, Diabetes and Metabolism Unit, Department of medicine, University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Nigeria
[2]Department of Pediatrics, Abia State University Teaching Hospital (ABSUTH) Aba, Abia State, Nigeria
[3]Cardiology unit, Department of medicine, University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Nigeria

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ABSTRACT: Self-monitoring of blood glucose (SMBG) assists persons living with diabetes with the day-to-day behavioral and therapeutic adjustments to their diabetes care. It is a cheaper and more available alternative to glycated haemoglobin (HbA1c) in Nigeria for monitoring glycaemic control. Information on SMBG practices of Nigerians living with diabetes using their personal glucometers is scanty. The aim of the study is to assess the intensity and frequency of SMBG by glucometer owners, and the extent the patients and/or the health care providers (HCP) utilize SMBG to achieve personalized treatment goals via behavioral/treatment adjustments. This was a cross sectional study carried out among persons living with diabetes that accessed diabetes care at the diabetes clinic of the University of Port Harcourt Teaching Hospital (UPTH) and using their personal glucometers. They were consecutively recruited. Data obtained by using interviewer-administered questionnaires were analyzed using SPSS version 20.0, and pvalue <0.05 was considered significant. A total of 128 persons living with diabetes participated in the study of which 40 (31%) were males and 88 (69%) were females; the mean age of the subjects was 52.05 ± 11.24 years with a range of 26–70 years. The majority of the study subjects (72%) were in the active working age group (25–60years). The highest frequency of glucometer use was in the 26 subjects (20%) who checked their blood glucose every morning while 62 (48%) of the subjects checked their blood glucose any morning they felt like. Most of the subjects (60%) did not have any recording device. Glucometer owners were not just the insulin-requiring people living with diabetes as more than half of the subjects, 66 (52%) were on oral anti diabetic drugs (OAD) only. Glucometer ownership was mainly by those that were in the working age group. SMBG protocol (frequency) was variable and SMBG data were not maximally utilized.

KEY WORDS: ***Self-monitoring of blood glucose; Personal glucometer; Diabetes; Blood glucose***

INTRODUCTION

Diabetes mellitus (DM) is a leading cause of death worldwide and has reached epidemic proportions in developing countries[1,2]. Type 2 DM occurs in 85–99% of all diabetic populations[3]. The prevalence of DM is on the increase[4], especially in sub Saharan Africans[5] due to the ageing of the population, improving survival of people living with diabetes, obesity, increased urbanization and westernization, dietary changes and physical in-activity. WHO projected DM to rise to 552 million people worldwide by 2030 but it currently affects 371

ψCorrespondence at: University of Port Harcourt teaching hospital (UPTH), Port Harcourt, Nigeria. Email: marcelnkpozi@gmail.com

million people in the world with about 5 million affected Nigerians[6]. Prevalence of DM in Africans[4] is 3.2% of the adult population, with 12 million people affected and a projected increase to 24 million people by 2030.

Glycemic control in persons living with diabetes plays a significant role in reducing the development and progression of microvascular complications of diabetes. The Diabetes Control and Complications Trial (DCCT) demonstrated a direct correlation between glycemic control as indicated by the HbA1C and the likelihood of developing long-term diabetes-related complications[7,8].

In Nigeria[9], as in other developing countries, use of HbA1C to routinely monitor glycemic control is limited by cost and the unavailability of this testing technology to the increasing population of people living with diabetes. Self-monitoring of blood glucose (SMBG) with point of care glucose meter seems a cheaper and more available option among Nigerians living with diabetes. SMBG[4] objectively assesses the impact of daily lifestyle habits (diets and exercise), special situations (illness, stress, religious obligations) and medications on glycemic control. While it helps the diabetic patient to make necessary changes to their diabetic control measures, it helps HCP to provide individualized advice about lifestyle changes and glucose lowering medications. In other words, SMBG data are used by HCP to aid therapeutic decisions but is also used by patients to adjust medication dosages and lifestyle habits.

Persons living with diabetes accessing care at the diabetes clinic of UPTH are encouraged to perform SMBG. In Nigeria where there is no viable health insurance scheme and payment for medical services is largely 'out of pocket', the cost of SMBG such as strips, lancets and devices is challenging to the patients. In an earlier study in Port Harcourt, Nigeria, Unachukwu *et al*[10] noted that while knowledge of the use of glucose meter and urine for self-monitoring of glucose control was common among the participants, only 24 (27%) of the 90 subjects in their study owned their personal glucose meters. Out of the 24 participants, only 20 (23%) were actually using their glucometers for monitoring glycemic control. In a related study, 63 (89%) subjects studied practiced self-monitoring of urine glucose (SMUG)[11] while only 8 (11%) practiced self-monitoring of blood glucose. There is, therefore, a dearth of literature on SMBG practices by Nigerians living with diabetes who own their personal glucose meters. Hence, this study aims to bridge that gap.

METHODOLOGY

The study was carried out at the University of Port Harcourt Teaching Hospital (UPTH) Port Harcourt, Nigeria from January, 2015 to September, 2015. UPTH is a tertiary hospital in the Niger Delta region of Nigeria. The diabetes clinic of the hospital is run once a week and is designed to render care to patients with diabetes mellitus. Study subjects were recruited from patients accessing care at the diabetes clinic. It was a across sectional, descriptive study in which 128 persons living with diabetes that owned and used personal glucose meters were consecutively recruited and data were obtained via the use of an interviewer–administered questionnaire. Data obtained from the questionnaire included participants' age, sex, duration of DM, highest level of education attained, whether retired or active in service, duration of glucometer use, frequency of glucometer use, having ready-to-use glucose strips, history of post prandial blood glucose check, hypoglycemia history, medications, most recent fasting capillary blood glucose, ownership of a cord book, and actions in situations of hyperglycemia. Glycemic control was determined using the participants' fasting capillary blood glucose values at the time of recruitment.

The test statistics included unpaired student's t - test and chi square test. The student's t - test was used to compare the differences between quantitative variables while the chi-squared test was used to compare categorical variables. The Statistical Package for Social Sciences (SPSS Inc. Chicago IL, USA) version 20.0 statistical software was used for data analysis and the level of statistical significance was set at $p < 0.05$.

RESULT

A total of 128 people living with type 2 diabetes and who owned their personal glucometers participated in the study, of which 40 (31%) were males and 88 (69%) were females. The male-female ratio was 1:2. The mean age (SD) of the subjects was 52.05±11.24 years with a range of 26–70 years. The mean age (SD) of the males was 53.2±9.51 years (range of 34-70 years) while that of the females was 51.5±12.01 years (range of 26-70 years). With a p value>0.05 (t=0.584, p=0.21), the mean differences in the ages of the males and females were not statistically significant (**Table 1**).

The majority of the study subjects (72%) were in the age group (25–60 years) that is supposed to be actively working and earning income. With increasing level of formal education, there were more of the study subjects who owned and used their personal glucose meters. The majority of study subjects (56%) had tertiary level education while those with no formal education (4.7%) were in the minority. Similarly, the number of people living with diabetes that owned glucose meters and keyed into self-monitoring of blood glucose increased with more years of living with DM. For example, while 22% of the study subjects had lived

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with DM for <1 year, 42% had lived with DM for 1–5 years and 64% for> 5 years. (**Table1**)

Table 1: Socio-demographic characteristics of glucometer owners

	Number	**%**
Gender:		
Female	88	68.2
Male	40	31.2
Age (years):		
25 – 60	92	71.8
> 60	36	28.2
Formal Education:		
None	6	4.7
Primary	18	14
Secondary	32	25
Tertiary	72	56.3
DM Duration (years):		
< 1	22	17.2
1-5	42	32.8
> 5	64	50

There is no statistically significant association between glucometer users' gender and their age, level of education or DM duration prior to recruitment into the study (p>0.05) as shown in **Table 2**.

Table 2: Association between glucometer owners versus their age, level of education or duration of their DM

	M	F	Total	X2	P
Age:					
25-60 years	28	64	92	0.051	0.822
>60 years	12	24	36		
HLE:					
Nil	0	6	6		
Primary	2	16	18		
Secondary	10	22	32	4.836	0.31
Tertiary	18	34	52		
Postgraduate	10	10	20		
DM Years:					
< 1 year	6	16	22		
1-5 years	14	28	42	0.123	0.940
>5 years	20	44	64		

DM = Diabetes Mellitus; HLE = Highest Level of Education; DM years = Duration in years patient has lived with diabetes; M = Male; F = Female

The majority of the study subjects, 62 (48.4%) had owned their glucose meters for more than 12 months at the time of the study while 42 (32.8%) of them had owned theirs for less than 6 months. A small percentage of the subjects (15.6%) did not have glucose strips at the time of recruitment into the study. Glucose strips were either exhausted or expired (**Table 3**).

Table 3: Association of glucometer owners and gender

	M	F	T	XP2	P
Glucometer ownership:					
<6 months	10	32	42		
6-12months	10	14	24	1.162	0.559
>12 months	20	42	62		
Glucose Strips Available:					
Yes	36	72	108	0.215	0.642
No	5	15	20		

The mean (SD) fasting capillary blood glucose was in poor glycemic range and this was 9.25±4.30mmol/l. The mean fasting capillary blood glucose for the males was 9.65±5.07 and that for the females was 9.07±3.96mmol/l; there were no statistically significant differences in the mean fasting capillary blood glucose of the males and females (p=0.62) as shown in **table 4**.

Table 4: Mean age and fasting capillary blood glucose of the subjects

	M	**F**	**Total**	**Statistics**
Mean Age ± SD	53.2 ± 9.51	51.1 ± 12.01	52.05 ± 11.24	T=0.58 p=0.21
Mean FPG ± SD	9.65 ± 5.07	9.07 ± 3.96	9.25 ± 4.30	T=0.21 p=0.62

The frequency of use of glucose meters varied (**table 5**). While 62 (48%) of the subjects checked their blood glucose any morning they felt like, the highest frequency of use was in the 26 subjects (20%) who checked theirs every morning. Similarly, while 14 (11%) checked their blood glucose only on their clinic appointment dates, 16 (12.5%) checked theirs once a week and 10 (8%) checked once in two weeks.

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Only 36 (28%) of the subjects had sometimes in the past checked their blood glucose after a meal, while 92 (72%) had never done that. Fifty-two subjects (41%) had sometimes in the past measured capillary blood glucose of more than 250 mg/dl and 24 (46%) of them took no action and only waited till the next diabetes clinic visit. Twenty-four subjects (46%) of them adjusted their diabetes medications or went to hospital that same day while 4 (8%) adopted lifestyle changes (dietary modifications).

Only 14 (11%) of the subjects had measured a hypoglycemic reading prior to being recruited into the study. Seventy subjects (60%) did not have any recording device (notebook, logbook, etc.) and did not know the importance of the data recordings to the diabetes care team.

Glucometer owners were not just the insulin requiring people living with diabetes (**table 6**). More than half of the subjects, 66 (52%) were on oral anti diabetic drugs (OAD) only, 30 (23%) were on insulin only, 30 (23%) were on a combination of insulin and OAD while 2 (1.6%) were on diet only.

Table 5: Intensity and outcome of glucometer use

	Glucometer users N (%)
Pre-breakfast frequency of glucometer use:	
Every morning	26 (20%)
Once a week	16 (12.5%)
Once in two weeks	10 (7.8%)
Only on diabetes clinic appointment dates	14 (10.9%)
Any morning patient feels like	62 (48.4%)
Post-prandial blood glucose check:	
Yes	36 (28%)
No	92 (72%)
Ever-measured blood glucose > 250mg/dl?	
Yes	52 (40.6%)
No	76 (59.4%)
Action when blood glucose was >250mg/dl:	
Waited till next diabetes clinic visit	24 (46.2%)
Sought treatment same day	8 (15.4%)
Adjusted diabetes medication	16 (30.8%)
Dietary changes	4 (7.7%)
Ever measured a hypoglycemic reading before?	
Yes	14 (10.9%)
No	114 (89.1%)
Have a glucose record device	
Yes	52 (40.6%)
No	76 (59.4%)

Table 6: Distribution of anti-diabetic medications among the subjects

Diabetes medications	**Glucometer users, N (%)**
Oral anti-diabetic drugs (OAD) only	66 (52)
Insulin only	30 (23)%
Combination of insulin and OAD	30 (23%)
Diet only	2 (1.6%)

DISCUSSION

The main findings of this study include the observation that many people living with diabetes in Port Harcourt, not just the insulin requiring patients, are keying into self-monitoring of blood glucose as a diabetes self-care tool. Secondly, the frequency of glucometer use is quite low and sub-optimal for a comprehensive personalized diabetes care tool. Finally, the majority of the glucometer

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owners did not understand how the data generated by SMBG could help them or their HCP modify their behavior, diet, medications or lifestyles with a view to achieving an optimal glycemic control.

The mean age of the subjects in this study was in keeping with the finding that in developing countries, the majority of people living with diabetes are aged 45–65 years[12,13]. The implication is that most of the subjects belonged to the working class age group (25–60 years) who are empowered to buy their glucose meters and strips. Retirees living with diabetes who practice SMBG are in the minority probably because of low life expectancy in Nigeria or due to financial challenges as most of them are dependent on their extended family members for their Medicare.

In this study, we found out that as the level of education increased, the more the number of glucometer owners increased. The explanation for this is not clear but considering that SMBG[4] is a diabetes-self care skill, the more literate a person is, the more likely he/she will appreciate the usefulness/need of a glucometer. That people living with diabetes are more likely to buy and own their glucose meters with increasing duration of DM as shown in this report could be a follow up to the fact that diabetes self-management education (DSME) is an on-going event in their life, so that with more years of living with the condition, more people see reasons to own their glucose meters.

A large proportion of the subjects (32.8%) acquired their glucose meters in the six months before recruitment into the study, which suggests an increasing acceptance by people living with diabetes. This could, also, suggest that diabetes self-management education (DSME) is making the expected impact on the people living with diabetes.

It is note-worthy in this study that a considerable number of the subjects (16%) had no glucose strips despite owning their glucose meters. Reasons could be financial constraints, lack of a strong conviction or misplacement of priority. Without glucose strips, the glucose meters were useless. This finding is comparable to the report by Unachukwuetal *et al*[10] where, of the 24 people that owned their glucometers, only 20 were actually using their glucometers.

In this study, the highest frequency of use of glucometer (once every morning by 20% of the study subjects) was fewer than the IDF guideline[4]. None of the subjects checked blood glucose more than once per day, not minding that 25% of them were on insulin only. The latter could have been T1DM (latent autoimmune diabetes of adult (LADA) or insulin requiring T2DM patients who, according to IDF guideline[4] should check their blood glucose four times per day.

SMBG data generated from the blood glucose checks done any morning the patient felt like, once a week, fort-nightly or only on the patient's diabetes clinic appointment day may not assist the persons living with diabetes or their HCP to make the necessary adjustments to their diet, behavior and medications aimed at optimal glycemic control. However, one may argue that the varying frequency of glucometer use may be a form of personalized management in diabetes.

The majority of the subjects (72%) had never checked their postprandial glucose level with their glucose meters and this means that they missed the opportunity of dietary modifications (type and quantity) based on SMBG data. The reason for not checking their postprandial blood glucose is not obvious but may not be unconnected with the mass poverty in Nigeria by 2015 due to the economic recession then. With the massive devaluation of the local currency, glucose meters and accessories became so expensive that owners economized their use, thereby accounting for the low frequency of glucometer use.

SMBG should be used by people living with diabetes to adjust medication dosages and to optimize anti-diabetic therapy[12]. However, in our study, 46% of the subjects who measured blood glucose > 250mg/dl sometime in the past just did nothing about their anti-diabetic medications. That they waited till their next diabetes clinic visit day could be due to inadequate diabetes education. In the same way, SMBG helped 7% of the subjects who had hypoglycemia to confirm the diagnosis with their glucose meters. These patients contained the situation (hypoglycemia) with diet and drug adjustments.

SMBG data are used by healthcare providers to aid therapeutic decisions. However, the majority of the subjects (60%) had no recording devices such as notebook or logbook. The diabetes care team needed to review the SMBG data trend of each patient to help the physician assess glycemic control and optimize therapy. The absence of a recording device could also be due to inadequate diabetes education. Financial constraints cannot be an adequate explanation for this as a simple exercise book, which costs very little could serve as a recording device.

The participants in this study who were on oral anti- diabetic drugs, insulin and a combinations of both show that SMBG is no longer reserved for type 1 DM or insulin requiring type 2 DM patients only. SMBG is a diabetes self-care tool for all persons living with diabetes, and awareness and utilization of SMBG by persons living with diabetes in Nigeria may have improved in recent years probably due to increased prevalence of DM nation-wide and or DSME. Poverty, however, has been a strong limiting factor.

Limitation of study

Our small sample size is an obvious limitation of the study and the conclusions of the study can only

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apply to Port Harcourt city, Niger Delta region of Nigeria and not to Nigeria as a whole. A Nigerian multicenter study can minimize this limitation. Recall bias is also a possible limitation of this study and may have influenced the observations and conclusions reached.

CONCLUSION/RECOMMENDATIONS

The increasing number of persons living with diabetes is keying into SMB Gin urban Port Harcourt, Niger Delta region of Nigeria. The figures are increasing with the duration of DM and level of education. Frequency and intensity of SMBG practices varies and both the HCP and persons living with diabetes do not utilize application of SMBG maximally.

Government should subsidize the cost of glucose meters and accessories to make them accessible and affordable to all persons living with diabetes. People living with diabetes should be encouraged to follow the IDF guidelines specifying frequency and intensity of glucometer use for all types of diabetes. Diabetes education should be intensified and used to clarify all aspects of SMBG in the developing countries. Locally, there is a need for a national guideline specifying the frequency of SMBG check for persons living with diabetes who have a stable control and those with poor control. Finally, bringing SMBG notebook/logbook for review by the diabetes care team should be mandatory for all persons living with diabetes who use personal glucose meters.

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