Audit of insulin prescription patterns and associated burden among diabetics in a tertiary health institution in Nigeria

Michael A Olamoyegun[1], Akinyemi T Akinlade[2], Oluwabukola A Ala[3]

1. Department of Internal Medicine, Endocrinology, Diabetes & Metabolism Unit, Ladoke Akintola University of Technology, & LAUTECH Teaching Hospital, Ogbomoso, Oyo State, Nigeria.
2. Department of Medicine, General Hospital Odan, Lagos Nigeria.
3. Department of Medicine, BOWEN University & BOWEN University Teaching Hospital, Ogbomoso.

Abstract

Background: Insulin is one of the most important anti-diabetic agents in the management of diabetes even among type 2 diabetic.

Objective: There was need to assess insulin adherence, mode of insulin delivery and burden of insulin usage among diabetics.

Methods: A cross-sectional, prospective questionnaire, orally administered at a Diabetes Clinic of a University Teaching Hospital, SouthWest, Nigeria. Participants were consecutive patients with diabetes who were 18 years or older presently on insulin either alone or in combination with other anti-diabetic agents for at least 3 months. Baseline demographic and insulin treatment information were obtained.

Results: Two hundred and thirteen (213) participants were studied. Of these, 21 (9.9%) had T1DM and 192 (90.1%) had T2DM, (means age, 58.6 ± 13.1 years, mean duration of diabetes, 7.0 ± 6.9 years). Insulin adherence was noted in 72.8% with better adherence among those who self-injected insulin compared to those who were injected by health care professionals (HCPs) or relations. Among the respondents, 80.8% were on human insulin and pre-mixed insulin was the most commonly used form of insulin (52.6%). Most participants (52.6%) were taking 10-20 units per day, only 22 (10.3%) were on >40units/day. Reuse of insulin needle was found in 74.6% of the participants. Major reasons for insulin omission were non-availability of insulin and patients being tired of insulin injection.

Conclusion: The insulin adherence among diabetics in this study was high. Non-availability of insulin, insulin injection pain and being tired of continual insulin usage were some of the reasons for non-adherent to insulin usage.

Keywords: Adherence, diabetes, burden, insulin injection, omission.

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Corresponding author:
Michael A Olamoyegun,
Department of Internal Medicine,
Endocrinology, Diabetes & Metabolism Unit,
Ladoke Akintola University of Technology,
& LAUTECH Teaching Hospital, Ogbomoso,
Oyo State, Nigeria.
Tel: +2348035755239
Email: dryemi@yahoo.com

Background

The burden of diabetes mellitus (DM) and its complication is increasing worldwide and more markedly in the sub-Saharan Africa including Nigeria. Diabetes mellitus is a significant contributor to global morbidity and mortality. The most recent statistics by the International Diabetes Federation (IDF) estimate that in 2015 there were 415 million people living with DM globally[1]. In Nigeria, the reported prevalence of DM ranges from 4.4 to 11.0%[2-6]. Out of this number, between 14.2% and 20.8% of persons with type 2 diabetes are treated with insulin therapy

either alone or in combination with oral or non-insulin anti-diabetic agents[7-9]. Furthermore, with recent introduction of insulin analogues into the Nigerian market and adoption of treatment-specific guideline along with the training of health care practitioners there would be a rise in the rate of insulin use among individuals with diabetes.

Insulin therapy is an integral part of diabetes management in both type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). In T1DM, insulin therapy is required from the time of diagnosis and continued to be required over the lifetime of an individual. In T2DM, insulin therapy is used either during acute illness associated with hyperglycaemia and hyperglycaemic emergencies, peri-operatively, or during pregnancy and lactation. Long-term insulin therapy in T2DM is indicated following the failure of combination anti-diabetic therapy with oral or non-insulin injectables to maintain optimal glycaemic control[10.] Insulin therapy is usually initiated gradually, progressing from once daily insulin regimens to premixed, basal-plus or basal-bolus insulin regimens while the patient is maintained on certain oral anti-diabetic therapies. Two types of insulin are currently in use in Nigeria i.e. human insulin derived by recombinant technology or insulin analogues which are genetically modified human insulin in which the amino acids sequence has been altered to change the pharmacokinetic profile.

The pattern of anti-diabetic treatment (especially in type 2 diabetes mellitus) tends to change markedly along with the duration of diabetes including use of Insulin in its treatment. Studies have reported the benefits of insulin in helping to achieve glycaemic control and reduce the risk of long-term diabetes complications[11,12]. However, studies have shown concerns and barriers to initiation and adherence to insulin therapy especially among type 2 diabetics[13]. These include errors or inaccuracies associated with the injections across the lifespan of people with diabetes[14]. The effectiveness of insulin therapy is related to adequate dosing, adherence, preservation of its potency through proper storage and good injection techniques among others.

The objective of this study was to report the pattern of insulin use, types, prescription, storage, common regimen used, adherence, sites of insulin injection and whether insulin use interferes with daily routines among other determinants in patients with diabetes..

Methodology

This was a descriptive, cross-sectional prospective study which was carried out at the Diabetic Clinic of the LAUTECH Teaching Hospital, Ogbomoso, Oyo State. Consecutive patients diagnosed of diabetes mellitus, aged at least 18 years old, that were on insulin for at least 3 months (either alone or in combination with oral or non-insulin injectables anti-diabetic agents) and fulfilled inclusion criteria were recruited over a period of 5 months (August to December 2016). Diabetic patients aged less than 18 years old, or those older than 18 years but not on any form of insulin use or on insulin for less than 3 months or those who were acutely ill were excluded. The physicians involved in the study were specially trained for the study.

The following variables were obtained from each of the participants: age, gender, type of diabetes, duration of diabetes, and current therapy for diabetes management. Other information obtained were types of insulin treatment, dosage of insulin used/day, number of daily injection, site of injection, devices used, rotation of injection areas, frequency of needle or syringe reuse, and adherence. Nature of occupation was also obtained with monthly income for those who earned salary. Clinical examination was carried out to determine anthropometric indices, level of blood pressure and insulin injection sites.

Burden of injections

Interference with eating and exercise was measured as the mean of two items asking, "How much does the way you inject insulin interfere with eating/exercising when you want?" (Response options: 1 = not at all, 2 = a little, 3 = a moderate amount, 4 = a great deal). The reliability of this scale was moderate ($\alpha = 0.80$). Interference with activities of daily living was measured as a count of the affirmative responses to the question, "Do your insulin injections have a negative effect on: social activities, recreational activities, sexual activity, work/career, family care-giving?" (Possible range = 0–5). Another measure of interference was whether the respondent plans daily activities around insulin injections (1 = yes, 0 = no).

Experience with insulin injections

There were four measures—dissatisfaction with injection time needed, ease of use, pain and embarrassment—each measured by a single item (response options: 1 = very satisfied, 2 = satisfied, 3 = somewhat satisfied, 4 = not at all satisfied).

Frequency of intentional/forgetting to take insulin omission

The dependent variable in this study was the response to the question, "How often do you skip insulin injections that you know you should take?" (Response options: 1 = never, 2 = rarely, 3 = sometimes, 4 = often). "How often do you forget to take insulin injection you were meant to take? (Response options: 1 = never, 2 = rarely, 3 = sometimes, 4 = often).

Definition of terms

The subjects were considered as having diabetes mellitus if diagnosis had been previously made by their physician as diabetics and were taking anti-diabetic agents.

Type 1 diabetes was defined by clinical criteria-onset before 30 years of age and using insulin since diagnosis[15].

Type 2 diabetes were classified as having type 2 diabetes mellitus using clinical criteria such as onset after 30 years of age and present/prior history of usage of oral anti-diabetic agents.

Levels of glycaemic control was determined using average of 3 most recent fasting plasma glucose (FPG) and good glycaemic control referred to FPG ≤ 126mg/dl (7.0mmol/L)

Statistical analysis

All statistical analyses were performed with the SPSS 18.0 software package (SPSS Inc., Chicago, Illinois, USA). Numerical variables are summarized as means ± standard deviation and categorical variables as percentage. The significance level was $p< 0.05$.

Results

Socio-demographic characteristics

The study included 213 participants, of which 114 (53.5%) were females. The mean age of the participants was 58.57 ±13.10 years, and at least half, 107 (50.2%) of the participants were 60 years old and above. Of the participants, 21 (9.9%) and 192 (90.1%) had T1DM and T2DM respectively. More than sixty percent of the participants, 136 (63.9%) had secondary and/or tertiary educations, and almost four-fifth, 175 (82.2%) were married. About sixteen percent (15.5%) of the participants were unemployed, while the rest are farmers, artisans, traders and civil servants. The mean fasting plasma glucose of the participants was 210.1 ±96.1mg/dl and 111 (52.1%) had hypertension (Table 1).

Table 1: Socio-demographic characteristics of the participants

Variable		N = 213	
		Frequency	Percentage
Age Group (Years)			
	< 40	16	7.5
	40 – 59	90	42.3
	≥ 60	107	50.2
	Mean ± SD	**58.57±13.10**	
Sex	Male	99	46.5
	Female	114	53.5
Religion			
	Christianity	149	70.0
	Islam	63	29.5
	Traditional	1	0.5
Education			
	None	23	10.8
	Primary	60	28.2
	Secondary	71	33.3
	Tertiary	59	27.7
Income			
	< 20,000	99	46.5
	20,000 – 50,000	65	30.5
	50,000 – 100,000	36	16.9
	> 100,000	13	6.1
Occupation			
	Unemployed	33	15.5
	Farming	16	7.5
	Trading	54	25.4
	Artisan	12	5.6
	Civil Servant	37	17.4
	Professional Job	3	1.4
	Others	58	27.2
Diabetes type			
	Type 1	21	9.9
	Type 2	192	90.1
History of Hypertension			
	Yes	111	52.1
	No	102	47.9
History of smoking			
	Yes	8	3.8
	No	205	96.2
History of Alcohol			
	Yes	16	7.5
	No	197	92.5
Good glycaemic control (FPG < 126mg/dl)			
	Yes	69	32.4
	No	144	67.6
Duration of Diabetes (years)	**Mean ± SD**	**7.04±6.94**	
	Median (Range)	**5.00 (0.10 – 54.0)**	
Duration of Insulin (years)	**Median (Range)**	**1.50 (0.10 – 40.0)**	
FPG (mg/dl)	**Mean ± SD**	**210.09 ± 96.14**	

**FPG= fasting plasma glucose, SD= standard deviation*

Patterns of insulin used

The number of insulin injected per day was one in 39 (18.3%), two in 159 (74.6%), three in 13 (6.1%) and more than three in 2 (0.8%). Insulin administration devices used were insulin syringes 118 (55.4%) and insulin pen 95 (44.6%). Majority of participants, 153 (71.8%) self-inject themselves, while spouses, relatives and health care providers assists others with insulin injection (Table 2).

Table 2: Insulin pattern

Variable		N = 213	
		Frequency	Percentage
Insulin Type			
	Rapid acting	28	13.1
	Soluble	47	22.1
	NPH	9	4.2
	Premixed	112	52.6
	Long-acting	13	6.1
	Soluble + NPH	3	1.4
	Soluble + NPH + Premixed	1	0.5
Insulin Frequency			
	Once	39	18.3
	Twice	159	74.6
	Thrice	13	6.1
	> 3 times	2	0.9
Device Type			
	Syringes	118	55.4
	Pen	95	44.6
Insulin Amount			
	<10 U	15	7.0
	10 – 20U	112	52.6
	21 – 40U	64	30.0
	> 40U	22	10.3
Location Insulin is kept			
	Refrigerator	179	84.0
	Beside clay water pot	3	1.4
	Inside cup of water	7	3.3
	Under the bed	4	1.9
	Others	20	9.4

**NPH= Neutral Protamine Hagedon*

Insulin injection technique & insulin storage

In this study, the most commonly used site for injection was thigh only in 75 (35.2%), then only arm 39 (18.3%) and least in buttock 6 (2.8%),and many participants used more than one site for injection (Figure 1A). However, significantly higher number of participants was rotating the injection site with each injection. A large proportion (43.1%) of patients reused the same needle for injecting for more than 3 times, and some (15.0%) reused needle for up to 10 times before discarding.

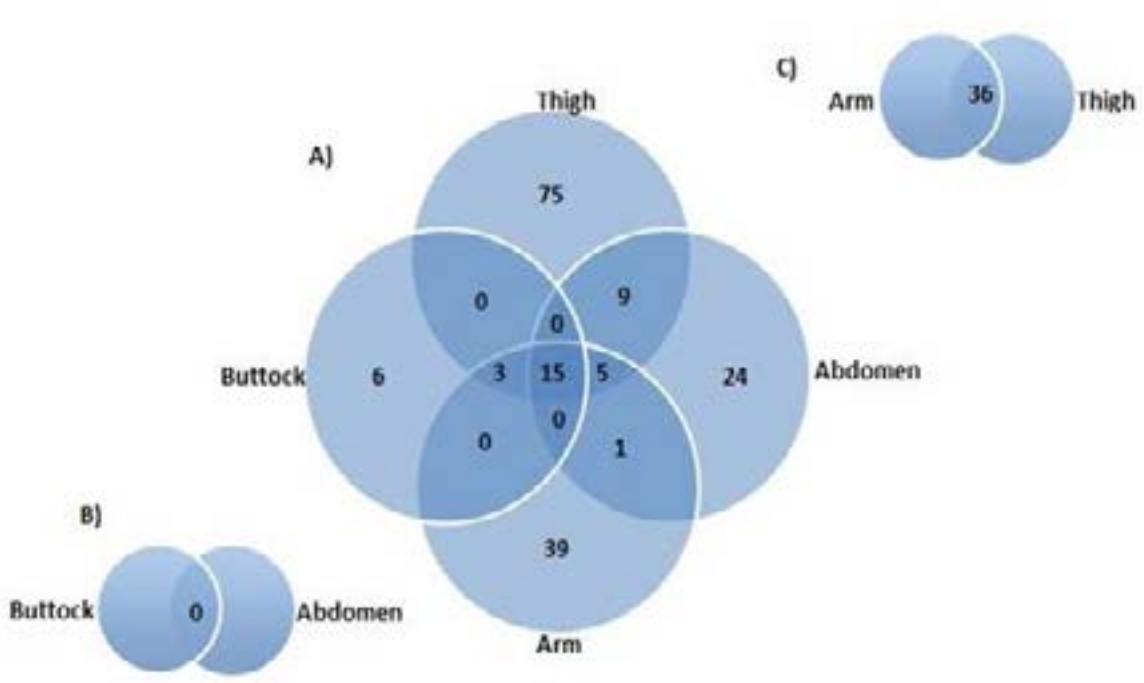


Figure 1.A. Venn diagram showing the frequencies of and overlap between different sites of insulin injection in the patients. B. Representation of abdomen and buttock. C. Representation of arm and thigh.

Insulin adherence

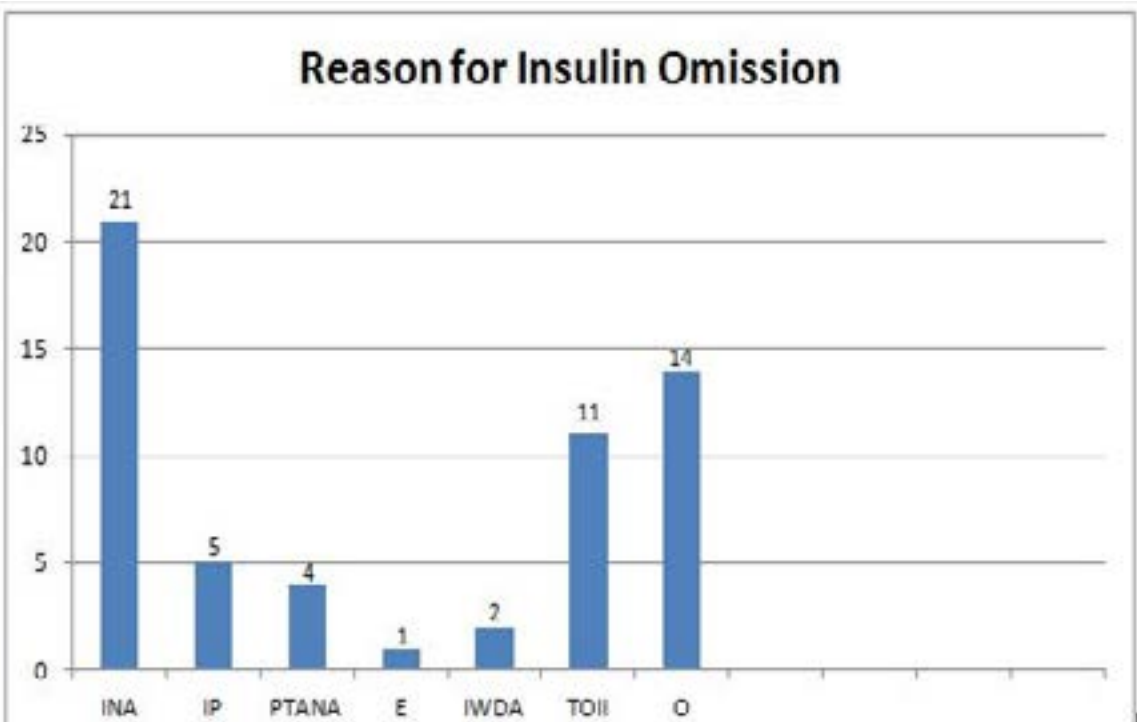
Adherence to insulin administration was noted in 72.8% of the study participants. Short time glycaemic control i.e. FPG ≤126mg/d; (7.0mmo/L) was achieved in 69 (32.4%). The mean FPG was significantly higher (p=0.03) in those who admitted to non-insulin adherence compared to those who adhered to their insulin regimens. More than a quarter (27.2%) of participants reported skipping insulin injections they should take; out of which 14.6% of these reported skipping insulin sometimes or often. A greater proportion of persons who self-injected insulin adhered to insulin prescription compared to those whose injections are administered by others (Table 3).

Table 3: Insulin Injection techniques and practices

Variable		N = 213	
		Frequency	Percentage
Do you rotate site?			
	Never	18	8.5
	Rarely	9	4.2
	Sometimes	61	28.6
	Often	125	58.7
Do you swab site?			
	Never	177	83.1
	Rarely	34	16.0
	Often	2	0.9
Swab substance			
	Water	29	13.6
	Methylated Spirit	169	79.3
	Water + Methylated Spirit	13	6.1
	Others	2	0.9
Do you reuse your needles?			
	Yes, *how often?*	159	74.6
	1 – 3 times	*67*	*31.5*
	4 – 6 times	*40*	*18.8*
		20	*9.4*
		32	*15.0*
	No	54	25.4
Do you know how to inject?			
	Yes	164	77.0
	No	49	23.0
Do you inject yourself?			
	Yes	153	71.8
	No, *but who administers*	60	28.2
	Spouse	*30*	*14.1*
	Relative	*19*	*8.9*
	Health Care Workers	*11*	*5.2*
Do you forget to take your Insulin?			
	Yes, *how often?*	43	20.2
	Rarely	*23*	*10.8*
	Sometimes	*14*	*6.6*
	Often	*6*	*2.8*
	No	170	79.8
Do you sometimes refuse to take Insulin?			
	Yes, *how often?*	58	27.2
	Rarely	*27*	*12.7*
	Sometimes	*20*	*9.4*
	Often	*11*	*5.2*
	No	155	72.8

Reasons forinsulin omission

All of the 7 major reasons for insulin omission are as shown in Figure 2; the commonest cause of insulin omission which occurred in 42 (20.2%) was insulin not available.



INA= Insulin not available, IP= Insulin pain, PTANA= Person to administer not available, E= Embarrassment, IWDA= Interference with daily activities, TOII= Tired of insulin injection, O= Others.

Figure 2: Reason for omitting insulin.

Hypoglycaemia and self-monitoring of blood glucose (SMBG)

While a total of 158 (74.2%) of the study participants had glucometers, but 128 (69.4%) do self-monitoring of blood glucose (SMBG). The number of participants who checked their blood glucose everyday was 64 (30%) while 84 (39.4%) checked their blood glucose 3-10 times/ months. Almost a third (31.9%) of participants have had at least an episode of hypoglycaemia within the last 3 months but only 17 (7.9%) had ≥3 episodes of hypoglycaemia in the last 3 months. Of the 21 participants who had been managed in the hospital on account of hypoglycaemia within the last 3 months, 20/21 (95.2%) had admission only 1-2 times (Table 4).

Table 4: Pattern of Hypoglycaemia/SMBG.

Variable		N=213	
		Frequency	Percentage
Possess glucometers			
	Yes	158	74.2
	No	55	25.8
SMBG frequency			
	Never	12	5.6
	Rarely (1 – 2)	53	24.9
	Sometimes (3 – 5)	45	21.1
	Often (6 – 10)	39	18.3
	Everyday	64	30.0
Experience of hypoglycaemia			
	Yes, *how often?* *Rarely (1 – 2)* *Sometimes (3 – 5)* *Often (6 – 10)* *Everyday*	68 *51* *12* *5* *0*	31.9 *23.9* *5.6* *2.3* *0.0*
	No	145	68.1
Hypoglycaemia admission			
	Yes, *how many times?* *1 – 2 times* *3 – 5 times* *> 5 times*	21 *20* *0* *1*	9.9 *9.4* *0.0* *0.5*
	No	192	90.1

Insulin injection sites examinations

Figure 3 showed the distribution of adverse skin reactions noted at the insulin injection sites. The commonest skin lesion noted was hyperpigmentation found in 21.1% of participants and lipohypertrophy present in 13.2% of the participants.

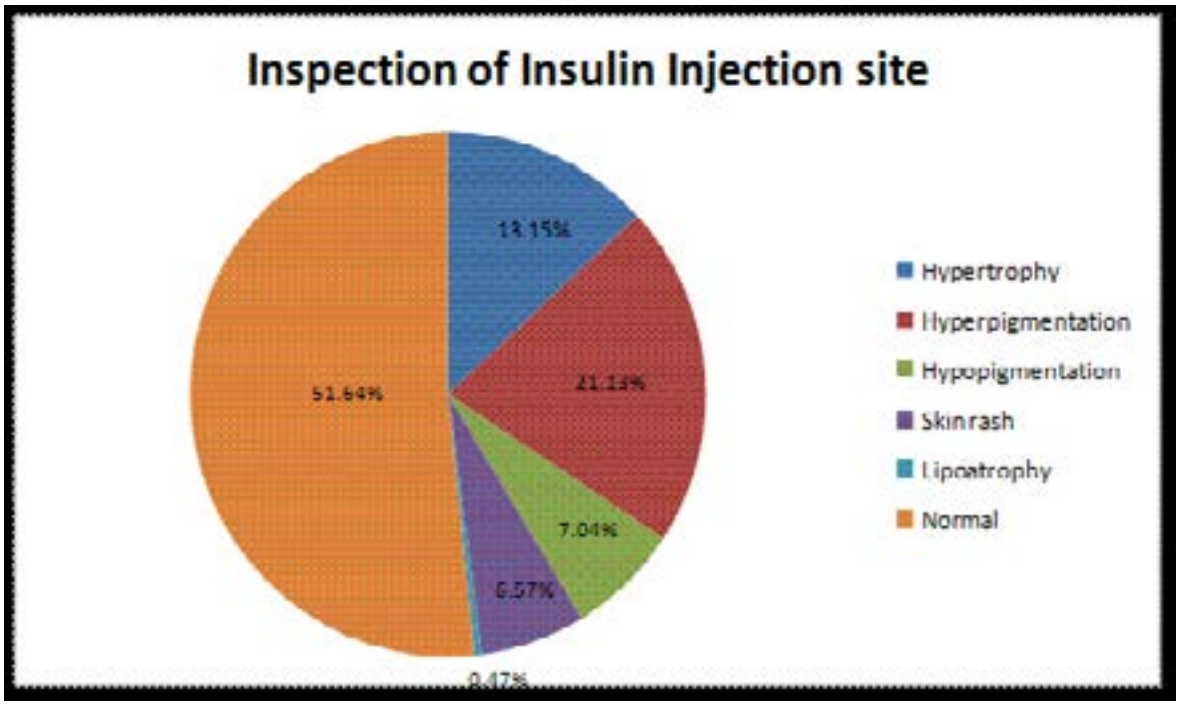


Figure 3: Inspection of the insulin injection sites.

Insulin burden

A substantial number of participants (40.4%) said they planned their daily activities around their insulin injections and (20.2%) reported that insulin injections interfered with their eating/exercise. Almost one-fifth (20.2%) of the participants said that insulin injections had a negative effect on their social activities. A significant proportion of participants (71.9%) reported moderate levels of non-satisfaction with the insulin pain. Ease of insulin used noted only in (44.1%) of the study participants (Table 5).

Table 5: Burden of insulin injection

Burden	Not at all	Little amount	Moderate amount	Great deal
	N (%)	N (%)	N (%)	N (%)
Interference with eating/exercise	170 (79.8)	30 (14.1)	12 (5.6)	1 (0.5)
Negative effect on social activities	169 (79.3)	28 (13.1)	14 (6.6)	2 (0.9)
Daily activities around injection	127 (59.6)	48 (22.5)	17 (8.0)	21 (9.9)
	Very satisfied	**satisfied**	**Somewhat satisfied**	**Not at all satisfied**
Ease of Insulin used	94 (44.1)	82 (38.5)	27 (12.7)	10 (4.7)
Pain	60 (28.2)	74 (34.7)	56 (26.3)	23 (10.8)

Discussion

Despite the importance of adhering to prescribed insulin regimens, little is known about the degree to which patients are adhering. In this study, 69.0% of the participants practiced SMBG. The proportion of patients who performed SMBG in our study was slightly lower than 70-80% reported by workers in developed countries[16,17] but significantly higher than 40% reported by Iwuala et al[18] in Nigeria. Although the issue of cost as a possible barrier to SMBG amongst Nigerians with DM is already stated, because the expenses are mostly borne out-of-pocket[19]. However, diabetic patients on insulin are usually encouraged by their health care providers to monitor their blood glucose, hence the relatively high number of diabetics that owned glucometers and monitored their blood glucose in this study. The American Diabetes Association (ADA) has statutory recommendations for SMBG on use of glucometer in all diabetic patients on insulin[20]. Approximately 30% of our patients did not have access to glucometer, although they are on insulin. Other studies from developing countries like Kenya reported a lower utilization of glucometers and adherence[21,22].

Insulin syringes were used by 55.4% of our participants, whereas 44.6% used insulin pen device. This finding is similar to the 45% of diabetic patients on insulin pen device in the USA, but higher than 33% reported in Mexico[23] and 29% by Ogbera et al[24] in Lagos. Our findings were different from that of the DiabCare India Study where 65.6% used pen device, 32.0% used syringes[25]. Also findings from multinational MOSA1C revealed that majority used pen device over syringes in countries like China (100%), Germany (95%), Russia (93%) and Saudi Arabia (63%)[23]. Data from a recent large worldwide survey indicated that insulin pen alone was used by 85.6% of patients, while 9.6% used a syringe device, 2.8% used both, and 1.4% used a pen and another device (usually insulin pumps)[26]. Insulin syringes remain the commonly used delivery device due to its accessibility. Insulin pens which are more convenient to use, more accurate, take less time to teach patients and its needle less painful are at present not as readily available as insulin syringe to most patients with diabetes at the study centre. Also noted in this study, was the relatively low use of insulin analogues. In the study reported by Ogbera et al[24] in 2012, the percentage of insulin analogue use was 29% compared to

19.2% in this study. The reasons for the lower use of insulin analogue may be partly due to lower disposable income among our participants. Insulin analogues are more expensive than human insulin and also less accessible in our study centre.

This study showed that only 38.5% of the participants had adequate glycaemic control (FPG< 126mg/dl) and it is consistent with other studies[27,28] who reported similar low glycaemia control. Glycated haemoglobin (HbA1C) which is considered as gold standard to assess levels of glycaemic control was not used among our participants; hence, the use of FPG levels (average of 3 most recent FPG tests) was used to assess and monitor glyceamic control. The ADA position statement with the standard of diabetic care recommend that a patient with good glycaemic control, at least HbA1C test be done twice per year while in patients with poor glycaemic control, HbA1C test should be done 3-4 monthly[20].

Also noted in this study is the high rate of insulin needle reuse (74.6%) among our patients; 9.4% reused needle 7-10 times and 15.0% reused insulin needle more than 10 times. In a study by Frid et al[26], they found needle reuse in approximately half of the patients worldwide, almost a third using the same needle up to 6 times. Also, Baruah et al[29] found 72.2% of their patients reused insulin needle and 98.9% in the South Indian Study[30]. In contrast, more than 80% of patients avoid needle reuse in developed nations like Italy[31]. Recent guidelines have strongly discouraged needle reuse although optimal cutoff for maximum number of injection reuse has not been set[32]. Major reasons thought to be responsible for the high rate of needle reuse in our study are cost and inadequate education of the patients by the health care providers. As previously reported by Olamoyegun et al[14], even health care practitioners (HCPs) had poor knowledge of insulin use, hence may not be able to give patients adequate assistance, when they raise the issue with them.

In the present study, the storage condition of insulin was appropriate as majority of participants stored their insulin in the refrigerator. Vials of insulin not in use should be refrigerated. Excessive temperatures (<2^{0}C or 28^{0}C) and excessive shaking should be avoided to prevent loss of potency, clumping, frosting and precipitation. Insulin in use may be kept at room temperature, behind local water pot and in cool places away from direct sunlight in the absence of refrigerator so as to maintain potency.

Adherence to anti-diabetic agents including insulin is one of the important determinants of optimal glycaemic control among diabetics. Insulin adherence rate in this study of 79.8% is comparable to 77% reported by Ogbera et al[24] in a previous study in Nigeria. Majority of our patients practiced self-insulin injection, hence positively affected their insulin adherence. In contrast to other studies that found evidence of poor adherence to insulin therapy among patients with diabetes[33] they noted that only 28% of their patients were adherent to insulin therapy.

We noted that some patients deliberately omitted or forgot to inject the insulin they were meant to take. In this study, pain, ease of insulin use and embarrassment associated with insulin injection resulted in insulin omission. This is similar to findings by Peyrot et al who reported pain and embarrassment as some of the reason for insulin omission among both type 1 and type 2 diabetic patients[33]. Our study also suggests that insulin omission is affected by the perceived burden of insulin therapy including having to plan one's life around insulin injections and feeling that the insulin regimens interfere with activities of daily living such as social activities. Measures to reduce this perceived burden of insulin injections may require repeated health education by health care providers emphasizing adherence. Also, a finding in this study suggests that insulin omission may be affected by previous or perceived experience that injecting insulin is painful and uncomfortable. However, adopting alternative ways to deliver insulin like insulin pens, finer gauge needles are some of the ways to reduce pain, reduce inconvenience and ameliorate embarrassment. Measures adopted to address pain and embarrassment due to insulin injection may also help to lessen the emotional burden of injections, thereby improving psychological well-being and adherence.

Limitations of the study include the fact that measure of insulin adherence was based on patients' admittance rather than objective means like pharmacy records or frequency of drugs refill. Also, long-term glycaemic control was assessed with average of three most recent FPG rather than with glycated haemoglobin which is the usual measure of long-term glycaemic control[25].

Authors' contributions

OMA & AAT, were involved in the conception, and design of this study. OMA analyzed the data, drafted the manuscript. All authors were involved in revising the manuscript critically for intellectual content and provided a final approval of the version to be published.

Conflict of interest

Nil.

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