Glycaemic control and associated factors in adult patients with diabetes mellitus, South Sudan, 2021

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ABSTRACT

Introduction: Many patients with diabetes mellitus are not attaining optimal glycaemic control, although the rate is unknown in South Sudan. Maintaining adequate glycaemic control is the most effective means of preventing complications associated with diabetes. This record review assesses the proportion of patients with diabetes on follow-up not adequately controlled using glycated haemoglobin (HbA1c) and describes associated factors.

Method: This is retrospective cross-sectional review of electronic patient records from a private for-profit health facility in Juba, South Sudan. The study assesses follow-up HbA1c levels of type I (T1DM) and type II (T2DM) patients with diabetes 18 years and older. An HbA1c value of less than 7% was regarded as reflecting adequate control. Logistic regression was used to assess factors associated with inadequate control. From an unadjusted analysis, variables were retained for the adjusted analysis that were significant at the 95% confidence level. Crude and adjusted odds ratios (AOR) were reported.

Results: Of the 291 patients assessed, 62.2% were male, mean age was 54 (SD =12.6) years, and the median body mass index (BMI) was 27.2 (IQR=24.5-30). Those with hypertension were 28.5% and 35% had medical insurance. Overall, 60 patients (20.6%) achieved target HbA1c levels of <7%. One hundred patients had HbA1c levels between 7-10% and 131 had values of >10%. Independent predictors of non-achievement of target HbA1c were female gender, adjusted prevalence ratio, PR (95% CI) =1.18 (1.01-1.32); normal BMI, adjusted PR (95% CI) =1.41 (1.07-1.83) and having no medical insurance cover, adjusted PR (95%CI) =1.13 (1.10-1.29).

Conclusion: About 80% of patients did not attain target HbA1c levels. Diagnosis of diabetes, care and treatment of patients with diabetes is not well organised in South Sudan leading to poor outcomes even in private clinics. Women and those without medical insurance cover are at greater disadvantage. We recommend better diagnosis and classification of patients with diabetes as well as reorganisation of care and treatment. We also recommend initiatives that will increase coverage of services to women and putting more people on medical insurance cover.

Key Words: glycated haemoglobin, diabetes, South Sudan

INTRODUCTION

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycaemia resulting from defects in insulin secretion, action, or both. Chronic hyperglycaemia is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.[1] According to the World Health Organization (WHO), the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2021.

The International Diabetes Federation (IDF) estimates the age standardized prevalence of diabetes in South Sudan in 2021 at 6.5%.[2]

Intensive glycaemic control (keeping blood glucose as near to normal as possible) reduces the incidence and progression of microvascular complications (retinopathy, nephropathy and neuropathy) in Type I Diabetes Mellitus (T1DM).[3] Similarly, in patients with Type II Diabetes Mellitus (T2DM) the risk of diabetic complications is strongly associated with previous hyperglycaemia.[4] Any reduction in glycated haemoglobin (HbA1c) levels is likely to reduce the risk of complications, with the lowest risk being in those with HbA1c values in the normal range.[4]

Although the association between glycaemic control and risk of complications is established, many patients do not attain adequate control.[5,6] Factors associated with adequate glycaemic control include understanding of pharmacist's advice; younger age; treatment with oral anti-diabetic drugs plus insulin; absence of T2DM history in the family; obesity; absence of current alcohol consumption and presence of fewer comorbidities.[5,6] No study in South Sudan has documented the status of control of diabetic patients and associated factors. This study assessed glycaemic status of patients using HbA1c levels and describes associated factors.

METHOD

Design

A retrospective cross-sectional electronic record review of patients with diabetes.

Study setting

Juba, the capital city of South Sudan, has a population of over a million people and is in Juba County. The Ministry of Health Service Availability and Readiness Assessment (SARA) survey, (2018), found only 39% of facilities in this County offered diabetes services. Of these, the non-governmental organizations and the private for-profit sector were six times more likely to have diabetes services compared to government operated facilities. The SARA survey findings imply that patients with diabetes in Juba City are more likely to seek diabetes care and treatment in the non-governmental health facilities and private for-profit sector such as the Evidence Based Clinic (EB Clinic) where this study was undertaken.

Study population

The study participants were known cases of T1DM or T2DM, 18 years or older accessing care at the EB Clinic located in the suburb of Juba City. It provides services to a wide range of patients of various social classes. Most diabetes care in Juba is paid from patients'

personal resources because of the scarcity of services in the government facilities. The EB Clinic diabetes guidelines recommend follow-up HbA1c tests on all patients every three to six months. During a follow-up visit, case-based electronic records were updated. This study reviewed HbA1c results of patients who were confirmed cases of diabetes receiving treatment at the clinic at any point in time. Where more than one follow-up HbA1c readings were recorded in the electronic system, the first record was considered (first follow-up HbA1c). All HbA1c tests done during diagnosis of diabetes were excluded. Records were reviewed over 30 months (1st January 2019 to 30th June 2021).

Measurement of HbA1c: Glycated haemoglobin was measured using a point of care test machine that uses Fluorescence Immunochromatographic Analysing (FIA) System. The clinic uses the Finecare™ FIA Meter II Plus SE (FS-114) system which has a built-in quality control mechanism.

Glycated haemoglobin reflects average glycaemia over approximately the previous three months and has a strong predictive value for diabetes complications.[7] The American Diabetic Association (ADA) recommends HbA1c goal of < 7% for non-pregnant adults and <8% in patients with a history of severe hypoglycaemia or in those with limited life expectancy.[8] The test however, is of limited value in conditions that affect red blood cell turnover.[9]

Data Collection

The EB Clinic uses a password-protected electronic patient record system. Patient data were exported from the software to an Excel spreadsheet. Patients' names were removed before data were shared with the statistician.
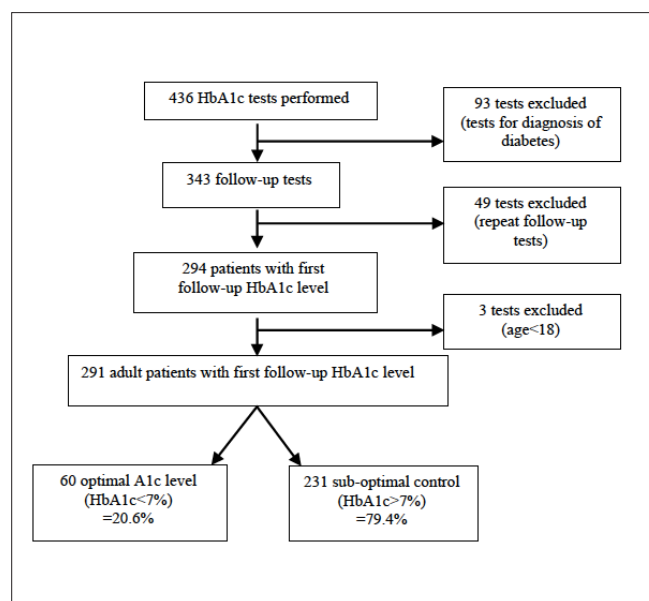

Figure 1. Study flow chart

Data Analysis

Participant characteristics were described using summary statistics (means, standard deviation and percentages). Binary logistics regression was used to assess factors associated with HbA1c level. The stepwise backward elimination technique was used to remove variables of no significance, one variable at a time, starting with the most non-significant p-value. From an unadjusted analysis, variables were retained for the adjusted analysis that were significant at the 95% confidence level. Since uncontrolled HbA1c level was common in this study population (Prevalence >10%), the odds ratios were corrected to obtain prevalence ratios as the adjusted odds ratios tend to overestimate the association when the prevalence of the outcome of interest is greater than 10 percent.[10] We corrected the crude and adjusted odds ratios to obtain corresponding crude and adjusted prevalence ratios (PR) using the expression: $PR = OR / ((1 - P) + (P \times OR))$, where P is the prevalence of uncontrolled AIC level in the reference group.

Ethical consideration

The clinic administration provided approval for the study. All diagnostic tests in the clinic were conducted voluntarily after explanation. All data extracted did not include participants' identifiers.

RESULTS

A total of 436 HbA1c tests were performed during the 30-month period. Of these, 93 tests were excluded because they were performed for diagnosis of diabetes, 49 tests were repeat follow-up tests. The remaining 291 tests were analysed after excluding three children. Figure 1.

Study participants' characteristics

Of the 291 patients assessed, 62.2% were male, mean age 54 (SD =12.6) years and the median body mass index (BMI) was 27.2 (IQR=24.5 -30). Those with hypertension were 28.5% (Table 1).

Distribution of HbA1c levels

Sixty (20.6%) patients achieved target HbA1c levels of <7%; 100 patients (34.4%) achieved intermediate levels 7-10% and 131 (45.0%) had HbA1c levels >10%. Those under 40 years old were more successful (25.6%) than other age groups at achieving target levels, as were males than females (24.3 % versus 14.5%), obese (39.5%) than overweight (23.6%) or normal weight (15.5%) and having medical insurance cover than without (29.4% versus 15.9%) (Table 2).

Factors associated with non-achievement of target glycaemic levels

Table 1. Characteristics of study participants

Characteristic		n (%)
Sex	Female	110 (37.8)
	Male	181 (62.2)
Hypertensive¥	No	208 (71.5)
	Yes	83 (28.5)
Health insurance	No	189 (65)
	Yes	102 (35)
	Mean (SD)	
Age – years	54 (12.6)	
	Median (IQR)	
BMI	27.2 (24.5 -30)	

SD = Standard Deviation; IQR=Interquartile range
¥ hypertensive: definition based on diagnosis of hypertension logged on the electronic patient record system but not BP at clinic visit.

The independent predictors of non-achievement of target HbA1c were being female, adjusted PR (95% CI) = 1.18 (1.01-1.32); having normal BMI, adjusted PR (95% CI) = 1.41 (1.07-1.83) and having no medical insurance cover, adjusted PR (95%CI) = 1.13 (1.10-1.29). Table 3.

DISCUSSION

Glucose control among follow-up diabetic patients

In this review of 291 patients with diabetes on follow-up, we found only a fifth (20.6%) attained HbA1c levels of <7%. Nearly half (45%) had HbA1c values >10% and one third (34.4%) had intermediate values between 7-10%.

The ADA recommends goal HbA1c levels of <7%. The basis for the recommendation is the finding that intensive glycaemic control significantly decreases rates of microvascular complications. The relationship between HbA1c levels and microvascular complications is curvilinear.[4] When such a relationship is applied to the population level, it suggests that the greatest number of complications will be averted by taking patients from very poor control to fair/good control. It also suggests that further lowering of HbA1c levels from 7% to 6% is associated with further reduction in the risk of microvascular complications, although the absolute reductions become much smaller.

The findings in our study of 80% of patients not attaining goal HbA1c levels are worse when compared to those from similar studies conducted in Ethiopia[5] and Brazil[6] that showed 45% and 49% of patients respectively not attaining goal values. The findings of this study are from patients attending a private health facility, it is likely that the proportion of patients with inadequate glycaemia attending public health facilities is worse given the limited services in the public sector.

Table 2. Distribution of glycated haemoglobin (HbA1C) levels of diabetic patients on follow-up by participants characteristics

Characteristic		n	HbA1c range			p-value
			<7 n (%)	7 to 10 n (%)	>10 n (%)	
Age (years)						
	<40	39	10 (25.6)	11 (28.2)	18 (46.2)	0.928
	40 - 49	61	12 (19.7)	19 (31.1)	30 (49.2)	
	50 - 59	90	18 (20.0)	32 (35.6)	40 (44.4)	
	60 +	101	20 (19.8)	38 (37.6)	43 (42.6)	
Sex						
	Male	181	44 (24.3)	58 (32.0)	79 (43.7)	0.128
	Female	110	16 (14.5)	42 (38.2)	52 (47.3)	
Hypertensive						
	No	208	44 (21.1)	63 (30.3)	101 (48.6)	0.059
	Yes	83	16 (19.3)	37 (44.6)	30 (36.1)	
BMI						
	≥30	38	15 (39.5)	13 (34.2)	10 (26. 3)	0.007
	25 - <30	72	17 (23.6)	26 (36.1)	29 (40.3)	
	<25	181	28 (15.5)	61 (33.7)	92 (50.8)	
Health insurance						
	Yes	102	30 (29.4)	36 (35.3)	36 (35.3)	0.010
	No	189	30 (15.9)	64 (33.8)	95 (50.3)	
Overall		291	60 (20.6)	100 (34.4)	131 (45.0)	

Factors associated with inadequate control of glycaemic level

Independent predictors of non-achievement of target HbA1c were being female, a normal BMI and no medical insurance cover.

We found patients of normal BMI (<25) were 41% more likely to have inadequate control compared to obese patients (BMI≥30). These findings are consistent with those from the US National Health and Nutrition Examination Survey.[11] In the US survey, Nguyen et al. found that the mean fasting glucose and HbA1c levels were highest for patients with diabetes whose BMI was less than 25.0, suggesting a state of higher severity of disease.[11] They also found that mean insulin and C-peptide levels were highest for patients with diabetes with BMI equal to 35.0, suggesting a state of insulin resistance. The authors concluded that many of the patients with diabetes falling within normal weight range (BMI<25) had T1DM classification and those in the obese range were mostly T2DM.

Based on these finding, it is possible that most of the patients with lower BMI in our study are T1DM or patients with Latent Autoimmune Diabetes in Adults (LADA) but misclassified as T2DM and put on inappropriate treatment regimen resulting into inadequate control. The diagnosis of T1DM in this private clinic, as is the case in South Sudan, is made clinically and not based on measurement of C-peptide or insulin levels. This differs from the findings from similar studies in the Brazil and the US.[6,12] It is likely that the diagnosis of T1DM is more accurately made in the US and Brazilian settings.

Females were about 18% more likely to have inadequate control compared to males. Many studies have documented a similar relationship.[13] Possible explanations for this difference include socioeconomic status, psychological factors, differences in treatment response and glucose homeostasis. Salcedo-Rocha et al.[14] suggested that women have several social and economic disadvantages that might decrease their ability to achieve glycaemic control compared to men. This is possible in South Sudan where literacy rates in females above 15 years

Table 3. Factors Associated with non-achievement of Target HbA1c level

Variable	COR (95% CI)	p-value	Crude PR (95%CI)	AOR (95% CI)	p-value	Adjusted PR (95%CI)
Sex						
Male	ref		ref	ref		ref
Female	1.89 (1.01 - 3.54)	0.048	1.13 (1.01-1.68)	2.54 (1.28 - 5.03)	0.008	1.18 (1.01-1.32)
BMI						
≥30	ref		ref	ref		ref
25 - <30	2.11 (0.90 − 4.92)	0.084	1.26 (1.00-1.64)	2.16 (0.88 - 5.27)	0.091	1.25 (0.94-1.66)
<25	3.56 (1.66 - 7.66)	0.001	1.40 (1.24 1.75)	4.02 (1.72 − 9.34)	0.001	1.41 (1.07-1.83)
Health insurance						
Yes	ref		ref	ref		ref
No	2.21 (1.24 − 3.93)	0.007	1.19 (1.11-1.28)	1.78 (1.02 -3.22)	0.044	1.13 (1.10-1.29)
Age						
<40	ref	0.483				
40 - 49	0.70 (0.54 - 3.66)	0.476				
50 - 59	0.71 (0.57- 3.34)	0.452				
60 +	0.75 (0.59 - 3.33)					
Hypertensive						
No	ref					
Yes	1.12(0.59- 2.13)	0.721				

COR, *crude odds ratio;* **PR**, *Prevalence ratio,* **AOR**, *adjusted odds ratio*

is only 28.9% compared to men at 40.3%.

Patients without medical insurance cover were nearly 13% more likely to have inadequate glycaemic control. It is likely that medical insurance cover is a proxy for factors favorable for glycaemic control such as better access to medical care. However, our findings are inconsistent with similar reviews.[15] The study setting where there was no correlation between medical insurance cover and glycaemic control status was Switzerland. It is likely that patients in Switzerland without insurance can still access better medical care.

We found no correlation between hypertension and glycaemic control, although multiple comorbidities were associated with poor control.[6]

Implications for diabetes care in South Sudan.

South Sudan has a growing burden of diabetes. In 2021, the IDF estimated the age standardised prevalence of diabetes to be 6.5%.[2] Most patients with diabetes receive treatment and care from non-governmental organizations including private for-profit clinics. There is a limited supply of anti-diabetic medication and trained teams in the public sector. The organisation of diabetes care in the private facilities is largely by a single clinician rather than system run by care teams. Disadvantages of such a system

include, fragmented delivery of care, poor coordination and limited clinical information.

An effective framework for improving quality of diabetes care that can be adapted in South Sudan is the Chronic Care Model (CCM). This model has the following key elements: team based where scheduled visits are organised; self-management and decision support is offered; patient registers are maintained; resources for healthy lifestyle are offered such as leaflets and other health education materials; and it is focused on quality-oriented care.[16, 17] Implementation of this model has shown better patient outcomes and individual healthcare cost savings.

Additionally, there is need for use of better diagnostic tests to classify patients with diabetes. Current clinical means of classifying patients into T1DM and T2DM could lead to T1DM patients or patients with LADA being treated with oral anti-hyperglycaemic agents as T2DM thus, leading to inadequate control.

Limitations: We did not assess conditions associated with false HbA1c readings like anaemia. This was a single private for-profit centre study and may not truly represent the population of patients with diabetes in South Sudan. We did not assess additional factors that might influence HbA1c levels such as insulin treatment and duration of diabetes.

CONCLUSION AND RECOMMENDATIONS

About 80% of patients did not attain target HbA1c levels. Diagnosis of diabetes, care and treatment of patients with diabetes is not well organised in South Sudan leading to poor outcomes even in private clinics. Women and those without medical insurance cover are at greater disadvantage. We recommend better diagnosis and classification of patients with diabetes as well as reorganisation of care and treatment. We also recommend initiatives that will increase coverage of services to women and putting more people on medical insurance cover.

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