

Glycemic Control, Diabetes Complications and Their Determinants Among Ambulatory Diabetes Mellitus Patients in Southwest Ethiopia: A Prospective Cross-Sectional Study

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Background: Over the past two decades, the prevalence of diabetes has increased faster in low- and middle-income countries than in high-income countries. Regardless of the instant growth in the prevalence of diabetes in Ethiopia, up-to-date data regarding glycemic control and related complications of diabetes is inadequate. This study aimed to identify glycemic control and chronic complications and their determinants among ambulatory diabetic patients at Mizan-Tepi University Teaching Hospital (MTUTH).

Methods: We conducted facility-based cross-sectional study from February 25 to March 25, 2019, at Mizan-Tepi University Teaching Hospital. Patients' demographic data, diabetes complications, and treatments were collected using pretested questionnaire and data abstraction format. Data was entered by using Epidata manager 4.0.2.101, and statistical analysis was done by SPSS version 21. Bivariate logistic regression was done to see the association between independent variables and glycemic control and complication. Multivariable logistic regression analyses using backward selection were done to identify the predictors of poor glycemic control and complication at a *P*-value of <0.05.

Results: One hundred ambulatory diabetic patients were included in this study. The mean duration of diabetes and the mean age of the participants were 3.95±5.85 and 46.66±15.53 years, respectively. About 71 (71%) of the studied diabetic patients had uncontrolled fasting blood glucose (FBG) level. More than half of the diabetic patients (59%) developed chronic complications of diabetes. Low medication adherence (adjusted odds ratio (AOR)=11.78, 95%CI: 1.09–17.17) and inappropriate doses in the first, second, and third clinic visits (AOR=7.70, 95%CI: 1.79–33.01; AOR=8.09, 95%CI: 1.90–34.33; AOR=4.34, 95%CI: 1.09–17.17), respectively, were independent predictors of uncontrolled FBG. No variable was found to be an independent predictor of chronic diabetic complication on multivariable logistic regression analyses.

Conclusion: Poor glycemic control and diabetes complications among ambulatory diabetic patients were high. Low medication adherence and inappropriate doses in the first, second, and third clinic visits were independent predictors of poor glycemic control.

Keywords: diabetes, glycemic control, complications, Ethiopia

Introduction

Diabetes mellitus (DM) is a group of metabolic disorders characterized by hyperglycemia resulting from absolute insulin deficiency, relative insulin deficiency, and/or peripheral insulin resistance. Untreated and long-term hyperglycemia secondary to DM

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may irreversibly damage vital organ and results in retinopathy, nephropathy, neuropathy, and failure of other organs like heart and blood vessels.¹ The overall global prevalence of DM is 8.8%. This infers that approximately 415 million people are living with diabetes. If this drift continues without any mediation, the number of diabetic patients is estimated to escalate to 642 million by 2040. Estimates by the International Diabetes Federation (IDF) propose about 29.3 million diabetic patients live on the continent of Africa. The projected global expenditure due to diabetes is about 673 billion dollars, of which, nearly 80% was attributed to rich countries while merely 20% was attributed to poor countries.² DM prevalence has risen faster in low- and middle-income countries than in high income countries over the last 10 years.³ Most of the diabetic patients are unaware that they have the disorder and the rate of undiagnosed DM is relatively high in sub-Saharan countries, so that the patients are high risk of developing chronic diabetic complications. In addition to the current challenges of resource limitation, poor countries face a double burden from both communicable and noncommunicable diseases and associated risks.⁴ Studies reported that >60% of patients with diabetes had poor glycemic control despite strict adherence to clinical practice guidelines.⁵ Likewise, a study done in primary health clinics of Malaysia shown that hemoglobin A1C (HbA1c) levels was not achieved among diabetic patients. Drug utilization pattern, age, drug adherence, and duration of diabetes were factors that influenced the outcome of glycemic control.⁶ Moreover, the study conducted at Jimma University Medical Center (JUMC) showed that a substantial number of diabetic patients did not achieve the glycemic target. Antidiabetic treatment, educational status, occupation, and drug adherence of the patients were factors affecting glycemic control.⁷ Any types of long-term hyperglycemia due to DM may result in permanent organ damage in many parts of the body and it can intensify the premature risk of dying. The potential long-term complication of DM includes renal failure, stroke, heart attack, amputation of lower extremities, loss of vision, and nerve damage.³ These chronic complications are two to fivefold more prevalent among patients with diabetes.⁸ The study done in Addis Ababa at Minilik II hospital indicated that about 37.5% of diabetic patients had chronic complications. Peripheral neuropathy and retinopathy were the two most commonly diagnosed chronic complications of DM and attributed 35.2% and 31.4% of the cases, respectively.⁹ The study carried out at JUMC indicated that types of DM, duration of diabetes, age and sex of the patients significantly affects the development of long-term

diabetic complications.¹⁰ Even though the prevalence of vision-threatening retinopathy is 7%, studies indicated that the prevalence of overall retinopathy is 35%. Diabetic patients with low socioeconomic status, type 1 diabetic patients, and those with longer duration of diabetes were associated with high prevalence of retinopathy. Adult diabetic patients are two to three times more likely to have cardiovascular diseases (CVD) than adults devoid of DM.³ Chronic diabetes complications can be delayed or prevented by controlling blood pressure, blood glucose and blood cholesterol to the normal level or as close as possible to the normal level.² Studies have showed that poor glycemic control was associated with both micro and macro vascular complications.¹¹ Among sub-Saharan African Countries, Ethiopia is in the top four countries where the prevalence of DM mellitus is relatively high. The rates of attendances and diabetic admissions in major hospitals have increased over the past two decades.¹² In Ethiopia, the prevalence of DM has escalated and is becoming the major economic problem in medical admissions and drug expenditure.¹³ Regardless of the instant growth of the prevalence of DM in Ethiopia, up-to-date data regarding glycemic control and related complications of diabetes is inadequate. Moreover, there is conflicting data with regard to factors affecting glycemic control and no research was done on diabetic complications and its determinants in Southwest Ethiopia. Hence, the aim of this study was to explore the level of glycemic control, chronic complications of diabetes and their determinants in resource constrained setting.

Patients and Methods

Study Setting and Study Design

The study was done in MTUTH in Benchi-Shako Zone, South-west Ethiopia. The hospital has an outpatient service where ambulatory diabetic patients have a regular follow-up every month and sometimes every three months. A facility-based cross-sectional study was conducted prospectively at MTUTH from February 25 to March 25, 2019.

We received ethical clearance from Mizan-Tepi University Ethical review board and letter of permission was received from the chief executive officer of the hospital to access patients' data. The ethical consideration involved Helsinki declaration statement of ethical principles for medical research involving human subjects. Accordingly, written informed consent was obtained from each study participant prior to data collection and the participants' right to withdraw at any time of the interview was maintained. Similarly,

generated scientific information does not pose any risk to the study participants. Patient charts were also handled properly and data was kept confidential and anonymous.

Patient Population

We undertook our study on 100 diabetic patients. The source populations were all adult diabetic patients who had regular follow-up at MTUTH while the study populations were all adult diabetic patients who attended diabetic clinics during study period and fulfill inclusion criteria. Diabetic patients with age ≥ 18 years, patients who were on antidiabetic medication and with at least three consecutive blood glucose measurements were included in our study. We excluded patients not willing to give written informed consent, patients who had active psychiatric diseases, and those patients who had incomplete medical records.

Data Collection and Outcome of the Study

The main outcomes of our study were glycemic control and chronic diabetes complications. Data abstraction format was used to extract relevant patient data on duration of illness, type of antidiabetic medication, type of diabetes, medication dose, blood glucose measurement, comorbid conditions, and chronic diabetes complications. We used a semi-structured questionnaire to collect patients' sociodemographic data and medication adherence. Morisky Medication Adherence Scale (MMAS-8) for chronic diseases¹⁴ was utilized to collect information regarding patient's medication adherence. MMAS is an eight-item questionnaire with dichotomous responses (yes/no) for the first seven questions and multiple choice for the last question. A numerical value of 1 was given for yes and 0 for no. If the patient answered never or rarely for the last question it was scored as 0 or 1 and if the patient replied other choices it was scored as 1. Adherence level was measured by taking the summation of the response of eight questions and categorized as high, medium or low, if the total score was 0, 1 to 2 and ≥ 3 respectively.

Statistical Analysis

Data was entered by using EpiData manager 4.0.2.101 (EpiData Association, Denmark) and statistical analysis was done by SPSS version 21 (IBM Corporation, Armonk, NY, USA). Bivariate logistic regression was done to see the association between independent variables and glycemic control and complications. Variables with P -value ≤ 0.25 on bivariate logistic regression were entered into multivariate logistic regression. Multivariable logistic regression analyses using backward selection were done to

identify predictors of poor glycemic control and complications at P -value of <0.05 significant.

Operational Definitions and Definition of Terms

Comorbidity

The presence of other chronic diseases in addition to diabetic mellitus.

Fasting Blood Glucose

Blood glucose measured from venous blood after at least eight hours of overnight fasting.

Good Glycemic Control

Operationalized as if the patients had 70–130 mg/dL of fasting blood glucose (FBG) upon measurement of three consecutive visits.

Poor Glycemic Control

Operationalized as if the patients had >130 or <70 mg/dL of FBG upon measurement of three consecutive visits.

Results

Characteristics of Participants

Among 105 diabetic patients available during the study period, 100 of them fulfilled the inclusion criteria and were included in the study. The mean age of participants was 46.66 ± 15.35 with range of 11–76 years. Fifty-eight (58%) of them were male. More than half (51%) of the patients had attended secondary school and about one third of them (34%) were government employees (Table 1).

Clinical Characteristics of the Participants

Out of the entire 100 studied diabetic patients, 71 (71%) had poor glycemic control. The mean of FBG measured over three months was 158.75 ± 47.61 mg/dL. The majority, 76 (76%), of the participants were type 2 diabetic patients. The mean duration of diabetes was 3.95 ± 5.85 years. Approximately fewer than half of the patients (46%) were on antidiabetic medications for two to five years. Forty (40%) patients had at least one comorbidity, of which hypertension accounted 82.5% of total comorbidity. A majority, (59%) of the participants had developed chronic complications of diabetes. The most common chronic diabetes complication was peripheral neuropathy and accounted 69.5% of the cases (Table 2).

Table 1 Sociodemographic Characteristics of Ambulatory Diabetic Patients at MTUTH, February 25 to March 25, 2019

Variables	Variable Category	Frequency (%)
Sex	Male	58 (58)
	Female	42 (42)
Age category	<30	16 (16)
	30–44	16 (16)
	45–64	56 (56)
	≥65	12 (12)
Religion	Muslim	29 (29)
	Orthodox	57 (57)
	Protestant	14 (14)
Ethnicity	Amhara	47 (47)
	Bench	11 (11)
	Kaffa	19 (19)
	Oromo	13 (13)
	Other ^a	10 (10)
Marital status	Single	10 (10)
	Married	84 (84)
	Other ^b	6 (6)
Occupation	Unemployment	27 (27)
	Governmental employee	32 (32)
	Private employee	9 (9)
	Farmer	12 (12)
	Merchant	16 (16)
	Other ^c	4 (4)
Educational status	Illiterate	4 (4)
	Primary education	29 (29)
	Secondary education	51 (51)
	College and above	16 (16)

Note: ^aGurage, Silte, Yem and Tigre; ^bwidowed and divorced; ^cmechanic and driver.

Medication-related Factors

Twenty-nine (29%) of the participants were prescribed with insulin while metformin was prescribed for 27% of them. More than third (36%) of diabetic patients were taking the combination of glibenclamide and metformin. Fifty-nine (59%) diabetic patients were on monotherapy. Concerning the antidiabetic medications dose appropriateness in the last three clinic visits, nearly in two-thirds of the patients (63%) it was incorrect. Around half (48%) of the patients had medium level of medication adherence (Table 3).

Predictors of Poor Glycemic Control

On multivariate logistic regression analysis, low adherence to medication (AOR=11.78, 95%CI: 1.09–17.17), inappropriate doses during the first clinic visit (AOR)=7.70,

Table 2 Disease-related Characteristics of Ambulatory Diabetic Patients at MTUTH, February 25 to March 25, 2019

Variable Category		Frequency (%)
Level of glycemic control	Good	71 (71)
	Poor	29 (29)
Type of diabetes	Type 1 diabetes	24 (24)
	Type 2 diabetes	76 (76)
Duration of diabetes (years)	≤1	32 (32)
	2–5	46 (46)
	>5	22 (22)
Comorbidity	Yes	40 (40)
	No	60 (60)
Type of comorbidity	Hypertension	30 (30)
	Asthma	2 (2)
	Hypertension plus Asthma	3 (3)
	Peptic ulcer disease	5 (5)
Complication	Yes	59 (59)
	No	41 (41)
Types of complications	Peripheral neuropathy only	41 (69.5)
	Impotency only	5 (8.5)
	Retinopathy	5 (8.5)
	Diabetic foot ulcer	4 (6.8)
	Peripheral neuropathy + retinopathy	3 (5.1)
	Peripheral neuropathy + impotency	1 (1.7)

95%CI: 1.79–33.01), inappropriate doses during second clinic visit (AOR=8.09, 95%CI: 1.90–34.33) and inappropriate doses during third clinic visits (AOR=4.34, 95%CI: 1.09–17.17) were independent risk factors of poor glycemic control among participants (Table 4).

Predictors of Complications

Even if numerous variables were associated with diabetic complications on univariate analysis, no variable was found to be an independent predictor of complications on multivariable analysis (Table 5).

Discussion

This study set out the level of glycemic control and diabetes-related complications. Moreover, we have assessed the factors associated with poor glycemic control and diabetes-related chronic complications. Our study showed that the majority (71%) of patients had poorly controlled DM. The mean FBG was 158.75±47.61 mg/dL. This result

Table 3 Medication-related Characteristics of Ambulatory Diabetic Patients at MTUTH, February 25 to March 25, 2019

Variable Category		Frequency (%)
Type of antidiabetic medications	Insulin	29 (29)
	Metformin	27 (27)
	Glibenclamide	3 (3)
	Metformin + glibenclamide	36 (36)
	Insulin + metformin	5 (5)
First clinic visit dosage appropriateness	Inappropriate dose	70 (70)
	Correct dose	30 (30)
Second clinic visit dosage appropriateness	Inappropriate dose	60 (60)
	Correct dose	40 (40)
Third clinic visit dosage appropriateness	Inappropriate dose	59 (59)
	Correct dose	41 (41)
Medication adherence level	High	9 (9)
	Medium	48 (48)
	Low	43 (43)

is comparable with the study done at Jimma University Teaching Hospital⁷ where 70.9% of patients had poorly controlled diabetes. Our finding is higher than the Iranian study¹⁵ in which 56.3% of diabetic patients had poorly controlled diabetes and the findings of University of Gondar Hospital, Ethiopia¹⁶ where 60.5% of patients had poor glycemic control. This difference might be due to variations in the study settings, urbanization, the method of glucose measurement and study populations. For instance, in the Iranian study, all the participants were female diabetic patients.

Conversely, our result is lower than the findings in India¹¹ and Kenya¹⁷ in which uncontrolled DM presented in 78.6% and 81.6% of diabetic patients. This discrepancy might be due to inconsistencies in the way of investigating blood glucose levels. HbA1C was used as assessment tool for glycemic control in former studies whereas FBG was used to assess glycemic control in present study.

Low level of medication adherence and inappropriate dose in the first, second, and third clinic visits were independent predictors of poorly controlled DM. This study showed that low level of adherence to the prescribed antidiabetic medications has a deleterious impact on glycemic control. The finding of this study was consistent with findings in research done in Malaysia,⁶ which indicated that glycemic control was higher among patients who adhered to their antidiabetic medications. This can be elucidated since effectiveness of drug treatment depends principally on the efficacy of the prescribed medication and adherence of the patient to the treatment. In our study, individuals taking inappropriate doses of antidiabetic medications were more likely to have uncontrolled DM compared to their counterparts.

Our study found that 59% of study participants had diabetes-related complications. This finding is considerably higher when compared to those from Minilik II hospital, Ethiopia⁹ where 37.45% of diabetic patients had one or more chronic complications of diabetes. Moreover, the finding of the present study is higher than that from the University of Gondar Hospital, Ethiopia¹⁶ in which chronic diabetes complications were found in 31.33% of diabetic patients. The variation in the sample size and level of care given to diabetes patients might have contributed

Table 4 Predictors of Poor Glycemic Control Among Ambulatory Diabetic Patients at MTUTH, February 25 to March 25, 2019

Variable Category	Appropriateness of Antimedication	Glycemic Control		AOR (95%CI)
		Good	Poor	
Dose appropriateness during first clinic visit	Inappropriate dose	11	59	7.698 (1.791–33.007)*
	Correct dose	18	22	1.0
Dose appropriateness during second clinic visit	Inappropriate dose	6	54	8.083 (1.904–34.328)*
	Correct dose	23	17	1.0
Dose appropriateness during third clinic visit	Inappropriate dose	7	52	4.338 (1.090–17.172)*
	Correct dose	22	19	1.0
Medication adherence level	High	7	2	1.0
	Medium	14	34	3.074 (0.382–24.593)
	Low	8	35	11.770 (1.383–99.334)*

Notes: P value <0.05 was considered statistically significant. *Statistically significant.

Abbreviation: AOR, adjusted odds ratio.

Table 5 Predictors of Complications Among Ambulatory Diabetic Patients at MTUTH, February 25 to March 25, 2019

Variable Category		Complication		Multivariable Analysis	
		No	Yes	COR(95%CI)	AOR (95%CI)
Age	<30	11	5	1.0	1.0
	30–44	6	10	3.667 (0.849–15.844)	0.194 (0.024–1.448)
	45–64	17	39	5.047 (1.519–16.777)*	0.295 (0.028–2.786)
	≥65	7	5	1.571 (0.330–7.481)	0.362 (0.036–3.645)
Type of DM	Type 1	13	11	0.496 (0.195–1.249)	0.340 (0.055–2.111)
	Type 2	28	48	1.0	1.0
Duration of diabetes (years)	≤1	15	17	1.0	1.0
	2–5	20	26	1.147 (0.463–2.840)	0.983 (0.355–2.648)
	>5	6	16	2.353 (0.732–7.560)	0.513 (0.138–1.879)
Comorbidity	Yes	11	29	2.636 (1.117–6.224)*	0.503 (0.195–1.314)
	No	30	30	1.0	1.0
Glycemic control	Good	11	18	1.197 (0.494–2.903)	1.296 (0.134–12.553)
	Poor	30	41	1.0	1.0

Note: *Statistically significant.

to this discrepancy. In our set up, patients are often given care by general practitioners and nurses. It is a fact that the most beneficial approach in preventing complications of diabetes is optimal treatment of hyperglycemia. Apart from that, the discrepancy might be attributed to the differences in the study settings. Conversely, our finding is comparable with the report in Jimma University Specialized Hospital¹⁰ where 52.5% of diabetic patients had one or more chronic complication.

Limitation of the Study

The main limitation of this study was the use of FBG in place of HbA1c to determine the glycemic status. In addition, the cross-sectional nature of the study and the small sample size to oversimplify the findings to the general population.

Conclusions

The prevalence of poor glycemic control and DM complications was noticeably high among diabetes patients. Low medication adherence level and inappropriate doses in the first, second, and third clinic visits were found to be independent predictors of poor glycemic control among diabetic patients. None of the variables were significantly associated with the development of diabetic complications.

Abbreviations

DM, diabetes mellitus; FBG, fasting blood glucose; HbA1C, glycated hemoglobin; IDF, International Diabetes Federation;

MMAS, Morisky Medication Adherence Scale; SNNPR, Southern Nations Nationalities and Peoples Region.

Data Sharing Statement

The supporting documents for this study can be available from the corresponding author upon request.

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Author Contributions

All authors contributed to data analysis, drafting and revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests.

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