

Glycemic control and its determinants among patients with type 2 diabetes mellitus at Menelik II Referral Hospital, Ethiopia

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Tadesse Alemu¹ , Tirhas Tadesse²
and Getasew Amogne³ 

Abstract

Objective: The objective of the study was to explore the level of glycemic control and its determinants among patients with type 2 diabetes mellitus at Menelik II Referral Hospital, Addis Ababa, Ethiopia.

Methods: Cross-sectional study design was employed. The sample size was determined using a single proportion formula and 245 patients with type 2 diabetes mellitus were involved in this study. Systematic sampling method was used to select the study subjects. Standard questionnaire was used to collect patient's biographic data, economic data, self-care activities, and patient compliance to medications. Summary statistics of a given data were calculated. Logistic regression model was used to measure the relationship between the outcome and predictor variable. Direction and strength of association was expressed using odds ratio and 95% confidence interval.

Result: More than three-fourth, 191 (80.3%) of diabetic patients had poor glycemic control. Poor glycemic control was found to be 7.03 times higher among diabetic patients with duration of 5–10 years (adjusted odds ratio = 7.03, 95% confidence interval = 2.7–18.6). Similarly, diabetic patients with a duration of above 10 years were poorly controlled their blood sugar level (adjusted odds ratio = 2.3, 95% confidence interval = 1.028–5.08) in comparison to diabetic patients with a duration of fewer than 5 years. It was also found that compliance with a specific diet was significantly associated with good control of blood sugar level (adjusted odds ratio = 3.7, 95% confidence interval = 1.24–11.13).

Conclusion: The magnitude of patients with poor glycemic control was high. Duration of diabetes and non-compliance with diets high in fruits, vegetables, and diets low in fat and sugar were significantly related to uncontrolled blood glucose levels. Therefore, developing strategies targeted toward improving blood glucose control with special attention to diabetes mellitus (DM) patients with a duration of ≥ 5 years and those who poorly comply with their diet was strongly recommended.

Keywords

Determinants, glycemic control, type 2 diabetes mellitus

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Introduction

The burden of chronic diseases (CDs) is rising alarmingly, and it is becoming a global challenge. Based on the projection of the World Health Organization (WHO),¹ by 2025 non-communicable disease (NCDs) will account for over 70% of all deaths globally, with 85% of these occurring in developing countries. Diabetes mellitus (DM) is one major segment of CDs. DM is a type of metabolic disease of sustained elevated blood glucose level due to either insulin deficiency or insulin resistance.²

Type 2 diabetes is the most common type of diabetes accounting for 85%–95% of all diabetes cases in developed

countries and with a higher proportion in developing countries. This is associated with fast social and cultural changes,

¹Public Health Department, Universal Medical and Business College, Addis Ababa, Ethiopia

²Public Health Department, Yekatit 12 Hospital Medical College, Addis Ababa, Ethiopia

³School of Pharmacy, Wollo University, Dessie, Ethiopia

Corresponding author:

Tadesse Alemu, Public Health Department, Universal Medical and Business College, Addis Ababa 13954, Ethiopia.

Email: talemu55@yahoo.com



an increase in life expectancy, rapid urbanization, sedentary lifestyle, and unhealthy behavioral patterns.³ It is a global problem affecting 366 million people, and this figure is forecasted to increase to 552 million by the year 2030.^{4,5}

Worldwide, 8.8% (415 million) people suffered from DM in 2015. By 2040, it is forecasted that more than 652 million people (10.4%).⁶ According to WHO⁷ report, DM is the third main cause of premature mortality next to hypertension and cigarette smoking. In low- and middle-income countries, three-fourth of deaths with type 2 DM occur as a result of inadequate metabolic control.⁸

The International Diabetes Federation (IDF) report showed that around 19.8 million people were estimated to have type 2 diabetes, and the proportion of DM is 4.9% in Africa. Half of the patients with DM in Africa live in the four highly populated countries of the continent including Ethiopia.⁹ Around 1.9 million people in the age category of 20–79 years were expected to have diabetes in the year 2013 and an additional 2.9 million people were living with impaired glucose tolerances (IGTs) that are at a greater risk of developing diabetes in Ethiopia. The prevalence of diabetes in Ethiopia was 4.36% with estimated deaths of 34,262 people in the same year.¹⁰

Different literature indicated that the major goal of diabetes patient treatment is maintaining adequate blood glucose control to prevent acute and chronic complications resulting from sustained hyperglycemia. However, a considerable proportion of patients fails to achieve adequate blood glucose control and the reasons are multifaceted and interwoven.¹¹ Blood glucose control is believed to be the chief management goal to prevent the complications of DM.¹² But literature from different parts of the world showed that the prevalence of poor glycemic control in DM patients is still high. The prevalence of poor blood glucose control in Malaysia is 75.3%,¹³ in Spain 45%,¹⁴ in Jordan 65.1%,¹⁵ and in Ethiopia 61.9%.¹⁶

Evidence shows that patients with diabetes benefited from the control of blood sugar levels; in Ethiopia, the prevalence of blood-adequate glucose control is still low. Besides, causes for poor glycemic control are multifaceted and interwoven.¹⁷ Hence, this study was aimed at assessing the level of glycemic control and its determinants in type 2 DM patients at Menelik II Referral Hospital, Addis Ababa, Ethiopia. The finding of this study is crucial for health policy planners and implementers for appropriate intervention and prevention of the problem. It will also be valuable to health planners and implementers of sub-city and Woreda level health offices to plan and design appropriate strategies for improving the management of type two DM. Moreover, the result of this study will provide baseline data for non-governmental organization (NGOs), researchers, and other concerned bodies working in the area.

Methods

Study design

Institutional-based cross-sectional study design was used to assess the level of glycemic control and its associated factors

among patients with type 2 DM at Menelik II Referral Hospital, Addis Ababa, Ethiopia.

Study setting and period

This study was undertaken at Menelik II Referral Hospital, a public hospital located in Addis Ababa, Ethiopia. It is among the referral hospitals under the administration of the capital of Addis Ababa. It is a referral and teaching hospital which serves more than 15 million people in its catchment area. The study was conducted from March to June 2019.

Study population

Type 2 diabetic patients attending the diabetes clinic at Menelik II Referral Hospital were the study population. The inclusion criteria for this study include type 2 DM patients, >18 years old, patients with at least three consecutive blood sugar measurements, and patients who are willing to participate. Patients with a major complication of type 2 DM, mentally ill patients, seriously ill, and medical records with incomplete data were omitted from the study.

Sample size determination

The sample size was determined using single population proportion formula by considering the following assumption: proportion of poor glycemic control 80% from a study done in Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia,¹⁸ 95% confidence interval (CI) with a 5% margin of error

$$n = \frac{(z_{\alpha/2})^2 * p (1-p)}{d^2}$$

$$= \frac{(1.96)^2 * 0.80(1-0.80)}{0.05^2} = 245$$

Hence, a total of 245 patients with type 2 DM who consented to participate were enrolled in this study.

Sampling method

A systematic sampling technique was used to select the study subjects. According to the hospital's chronic illness clinic registration book, an average of 530 patients with type 2 DM was enrolled at the clinic within 1 month. Hence, by dividing the total number of patients attending the clinic in 1 month (530) with the sample size (245), (N/n), a sampling interval (K) of 2 was obtained. The first patient was selected at random and consecutive participants were selected every second patient. The study participants were consulted in their waiting room.

Data collection method and instrument

Data collection format and structured interview questionnaire were prepared after reviewing different relevant literature and

used to collect data. A structured interview questionnaire that consists of close-ended questions was used to gather a patient's biographic, economic, and medical characteristics. A validated standard questionnaire for assessing the Summary of Diabetes Self-Care Activities (SDSCA) was used to gather data about the patient's self-care activity. Copyright permission was obtained before the use of the tool for data collection.¹⁹

Study variables

Glycemic control was the dependent variable. Biographic variables (*sex, age, marital status, residence, education, religion, family history of DM, income, and occupation*), behavioral characteristics, clinical characteristics (*duration of illness, treatment, diabetic complication, and co-morbid conditions*), self-care activities (*diet, exercise, medication, and foot care*), and medication adherence were the independent variables.

Data analysis

Statistical Package for Social Science (SPSS) version 23 computer software package was used to analyze the data. Summary statistics of a given data were calculated. Bivariate and multivariate logistic regression model was used to measure the relationship between the outcome and predictor variable. p -value < 0.05 was used to determine statistical significance. Direction and strength of association were expressed using odds ratio (OR) and 95% CI.

Operational definition

- Good/adequate blood glucose control: the blood glucose control was considered good if the fasting blood glucose (FBG) measurement on three consecutive visits falls in the normal range (70–125 mg/dL)
- Poor/inadequate glucose control: it is defined as patients whose one or more of FBG on three consecutive visits above or below the normal range (<70 mg/dL or >125 mg/dL).¹⁸
- Adherence: the degree of patient's habit of taking the prescribed drugs, adhering to a diet recommendation, and/or implementing lifestyle change corresponds with agrees recommendation from a clinician.

Diabetic patients' self-care practice was determined using a standardized SDSCA tool. It measures the frequency of self-care practice of the patients in the last 7 which includes a general and specific diet, physical activity, smoking, medication, blood glucose testing, and foot care. SDSCA was estimated by adding the average score for each component divided by the addition of the number of questions under each scale. After determining the overall mean score, it was categorized as desirable self-care if the average score is ≥ 3 or undesirable self-care if the average score is < 3 . Copyright

permission was obtained before the use of the tool for data collection.^{19,20}

Ethical approval and consent to participants

This research was undertaken in accordance with the Declaration of Helsinki. Ethical approval and clearance was obtained from the Institution Ethical Review Board (IERB) of Universal Medical and Business College (UMBC). Formal permission was obtained from the authorities of Menelik II Referral Hospital before approaching the study participants. The objective and purpose of the study were clearly explained to the study subjects to obtain written informed consent before data collection. Participants were also informed that they can discontinue or decline to participate in the study at any time. Confidentiality of the information was maintained, and the data were recorded anonymously throughout the study.

Result

Socio-demographic and economic-related characteristics of the study subjects

From 245 patients involved in this study, the data of 238 patients with type 2 DM were analyzed making a response rate of 97%. The majority of respondents 107 (45.0%) were in the age category of 45–64 years. The average age of the participants was 49.55 years (with standard deviation (SD) ± 13.5 years). More than half, 128 (53.8%) of the study subjects were females. Close to three-fourths 171 (71.8%) of them were single. About one-third of them, 76 (31.9%) attended secondary school education; 109 (45.8%) of participants were a private employee and the great majority of the respondent, 217 (91.2%) were urban residents (Table 1).

Disease-related characteristics of the patients

From the total of the study subjects, 92 (40.3%) were treated with anti-diabetic medication for <5 years, 97 (40.8%) were treated for 5–10 years, and 49 (20.6%) were treated for >10 years. Out of those who were on medication, 121 (50.8%) respondents were taking oral anti-diabetic medication (OAD), 12 (5.0%) were taking oral hypoglycemic agents (OHAs) and insulin (Table 2).

Self-care activity of the patients

Patients' adherence to self-care practice was measured by the SDSCA. About 66 (27.7%) of the study participants comply with their general dietary program. Only 21 (8.8%) were following their specific diet program correctly. Of the total respondents, 112 (47.1%) were exercising adequately and 119 (50.0%) were not practicing adequate foot care. Only 8 (2%) had ever smoked cigarettes (Table 3).

Table 1. Socio-demographic characteristics diabetes patients in Menelik II Referral Hospital, Addis Ababa, Ethiopia, 2019.

Characteristics	Category	Frequency	%
Age of respondents (years)	<25	6	2.5
	25–44	84	35.3
	45–64	107	45.0
	65+	41	17.2
Sex of respondents	Male	110	46.2
	Female	128	53.8
Marital status	Married	53	22.3
	Single	171	71.8
	Separated	4	1.7
	Widowed	10	4.2
Educational status of respondents	Illiterate	32	13.4
	Only can read and write	20	8.4
	Primary school ^{1–8}	59	24.8
	Secondary school ^{9–12}	76	31.9
	Above secondary school	51	21.4
Occupation of respondents	Housewife	52	21.8
	Farmer	5	2.1
	Governmental employee	55	23.1
	Private employee	109	45.8
	Daily laborer	8	3.4
	Trader	5	2.1
	Other	4	1.7
	Monthly income of respondents	<1000	67
	1000–1999	72	30.3
	2000–2999	40	16.8
	3000–4999	31	13.0
	≥5000	28	11.8
Place of residence	Urban	217	91.2
	Rural	21	8.8
Family history of DM	Yes	72	30.3
	No	166	69.7

DM: diabetes mellitus.

Table 2. Disease-related characteristics of diabetes patients in Menelik II Referral Hospital, Addis Ababa, Ethiopia, 2019.

Characteristics	Category	Frequency	%
Duration of illness	<5 years	92	38.7
	5–10 years	97	40.8
	>10 years	49	20.6
Regular follow-up	Yes	220	92.4
	No	18	7.6
Type of treatment	Oral anti-diabetic medication (OAD)	121	50.8
	Insulin	105	44.1
	OAD + insulin	12	5.0
Diabetic complication	Yes	45	18.9
	No	193	81.1
Comorbidities	Yes	61	25.6
	No	177	74.4
Hypertension	No (<130/80 mm Hg)	150	63.0
	Yes (130/80 mm Hg and above)	88	37.0

Table 3. Self-care behavior–related characteristics diabetes patients in Menelik II Referral Hospital, Addis Ababa, Ethiopia, 2019.

Characteristics	Category	Frequency	%
Compliance to general diet program the in last 7 days	>3 days (adequate)	66	27.7
	0–3 days (inadequate)	172	72.3
Compliance to specific diet program in the last 7 days	>3 days (adequate)	21	8.8
	0–3 days (inadequate)	217	91.2
Physical exercise in the last 7 days	>3 days (adequate)	112	47.1
	0–3 days (inadequate)	126	52.9
Foot care	>3 days (adequate)	119	50.0
	0–3 days (inadequate)	119	50.0
Compliance to blood sugar testing in the last 7 days	>3 days (adequate)	9	3.8
	0–3 days (inadequate)	229	96.2
Compliance medication in the last 7 days	7 days (adequate)	229	96.2
	<7 days (inadequate)	9	3.8
Cigarette smoking	Yes	8	3.4
	No	230	96.6
Diabetic medications adherence	High adherence	43	18.1
	Medium adherence	69	29.0
	Low adherence	126	52.9

The magnitude of glycemic control

The mean of three consecutive clinic visits FBG value was used to decide the level of blood glucose control. It was found that 80.3% of patients with type 2 diabetes had poor glycemic control (Figure 1).

Factors associated with glycemic control

Logistic regression analysis showed that a longer duration of type 2 DM was significantly related to poor glycemic control. Poor glycemic control was found to be 7.03 times higher among diabetic patients with a duration of 5–10 years (adjusted odds ratio (AOR) = 7.03, 95% CI = 2.7–18.6). Similarly, diabetic patients with a duration of above 10 years control their blood sugar level to a lesser extent (AOR = 2.3, 95% CI = 1.028–5.08) than diabetic patients with a duration of fewer than 5 years. Patients who adequately comply with a specific diet control their blood sugar level to a greater extent (AOR = 3.7, 95% CI = 1.24–11.13) than the rest (Table 4).

Discussion

The study explored the level of blood glucose control and its determinants in type 2 diabetic patients. The proportion of type 2 DM patients with poor blood glucose control was 80.3%. The duration of the disease and the inability to comply with specific diet therapy were significantly related to inadequate blood sugar control.

This study identified that the magnitude of poor blood glucose control among the study participants was high (80.3%). This finding was similar to the study conducted in Addis Ababa where 80% of patients with type 2 DM had poor glycemic control.¹⁸ Whereas, the magnitude of poor

glycemic control in this study was high compared to studies conducted in Tanzania 69.7%,²⁰ Jordan 65.1%,²¹ and Saudi Arabia 74%.²² It is also higher than studies from Shanan Gibe Hospital, Southwest Ethiopia (59.2%),²³ Gondar Referral Hospital, and North Ethiopia (64.7%).²⁴ The dissimilarity might be explained by the difference in the design of the study and the difference in patients' characteristics.

The finding of this study showed that the prevalence of poor blood glucose control was 80.3% which was higher than a study done in Malaysia where the prevalence of poor glycemic control was 69%.²⁵ The discrepancy in those studies may also be explained by the fact that this study used Fasting Blood Sugar (FBS) for measuring glycemic control, whereas in other studies, they used hemoglobin A1c (HbA1c) test for measuring glycemic control. Furthermore, it may be due to differences in study participants' social and economic class which may in turn influence access to health care, drug, and balanced nutrition.

In this study, inadequate blood sugar control was significantly related to the duration of the disease since diagnosis. Poor glycemic control was found to be 7.03 times higher among diabetic patients with a duration of 5–10 years (AOR = 7.03, 95% CI = 2.7–18.6). Similarly, diabetic patients with a duration of above 10 years control their blood sugar level to a lesser extent (AOR = 2.3, 95% CI = 1.028–5.08) than diabetic patients with a duration of fewer than 5 years. This result was in line with the studies done in Black Lion Hospital, Ethiopia,¹⁸ Jordan,²¹ and Shanan Gibe Hospital, Southwest Ethiopia.²³

A study done in Malaysia showed that a longer duration of DM was a predictor of poor glycemic control.²⁵ The finding is similar to the finding of this study in which inadequate blood sugar control was significantly associated with a longer duration of the disease. The negative relationship

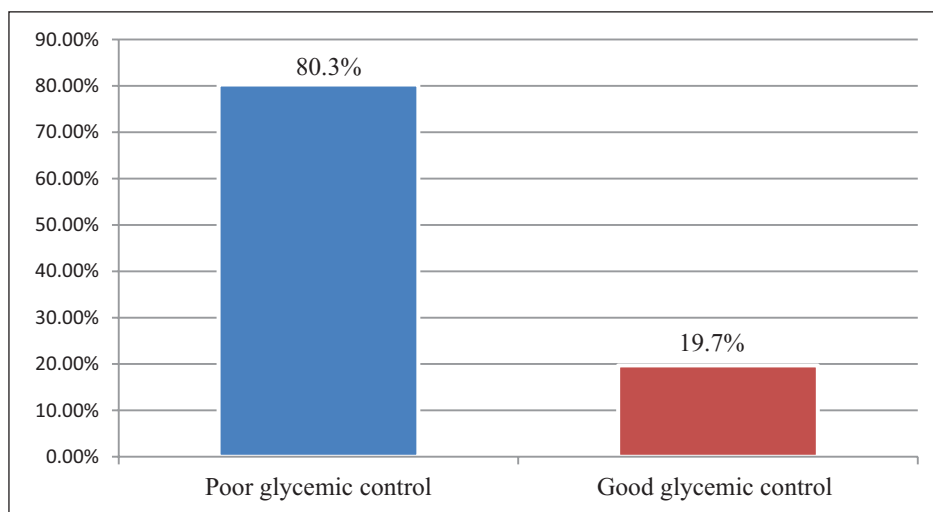


Figure 1. Glycemic control of diabetes patients in Menelik II Referral Hospital, Addis Ababa, Ethiopia, 2019.

Table 4. Bivariate and multivariate logistic regression showing factors associated with poor glycemic control among diabetes patients in Menelik II Referral Hospital, Addis Ababa, Ethiopia, 2019.

Characteristics		Glycemic control		COR (95% CI)	AOR (95% CI)	p-value
		Good	Poor			
Duration of DM	<5 years	9	83	1	1	
	5–10 years	19	78	5.8 (2.38–14.3)	7.03 (2.7–18.6)	0.001
	>10 years	19	30	2.6 (1.2–5.6)	2.3 (1.028–5.08)	0.043
Compliance to general diet	Adequate	20	46	1	1	
	In adequate	27	145	2.3 (1.1–4.6)	1.8 (0.87–3.8)	0.109
Compliance to specific diet	Adequate	8	13	1	1	
	In adequate	39	178	2.8 (1.09–7.2)	3.7 (1.24–11.13)	0.019

COR: crude odds ratio; CI: confidence interval; AOR: adjusted odds ratio; DM: diabetes mellitus.

between longer duration of DM and blood glucose control may related to the resistance of insulin production over time which resulted from β -cell dysfunction. As the duration of the disease increases, patients need a raise dosage of their treatment to maintain glycemic control.

Adherence to recommended diet has long been associated with good glycemic control and better quality of life. In this study, patients who adequately comply with a specific diet controlled their blood glucose to a greater extent (AOR = 3.7, 95% CI = 1.24–11.13) than the rest. This result was similar to a study conducted in Black Lion Hospital, Ethiopia.²¹

Anti-diabetic medications are used to lower blood glucose levels in patients with DM. This study found that compliance with medication was not associated with blood glucose control to a significant level. The finding of this study contradicts a study done in the United States, Texas, where good medication adherence was a predictor of good glycemic control,²⁶ and a study done in Jordan where poor blood glucose control was common among those patients with medication non-adherence.²¹ In this study, it was also found that compliance with exercise and smoking was not

associated with glucose control. This difference may due to the use of relatively smaller sample size in this study.

Limitation of the study

This study used FBG to assess the level of glycemic control as there was no laboratory facility to measure glycosylated hemoglobin. Measurement of glycosylated hemoglobin would show the rate of glycemic control over 3 months better while fasting blood sugar may have a drawback to show the true level of glycemic control. Besides, this was a cross-sectional study and assessed cause and effect simultaneously. Hence, causal links may not be established due to the lack of temporal connection.

Conclusion

Although there was a diabetic clinic that provides services for diabetic patients in the hospital, a large proportion of patients had poor glycemic control. The percentage of type 2 DM patients with poor glycemic control was higher (80.3%).

It was found that the duration of the disease and the inability to comply with specific diet (diets high in fruit and vegetables but low in fat and sugar) therapy seem to be significantly related to inadequate blood sugar control.

Recommendations

Based on the finding, it was recommended that authorities and experts should design and implement strategies for improving glycemic control of diabetic patients with special attention to patients who lived with type 2 DM for a longer period (≥ 5 years) and those with poor compliance to a specific diet. Scientific communities are recommended to conduct prospective studies using large-scale samples to identify the determinants of blood glucose control among diabetic patients.

Accessibility of data and materials

The result of this article was extracted from the data gathered and analyzed for use in this research. The data supporting the finding of this study will be made available upon request.

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Author contributions

The authors contributed to the planning of the study, data analysis, drafting or revising the article, provided the last consent of the version to be in print, and agree to be responsible for all aspects of this research article.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

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Informed consent

The objective and purpose of the study were clearly explained and written informed consent was obtained from all participants before data collection. Participants were also informed that they can discontinue or decline to participate in the study at any time. Confidentiality of the information was maintained, and the data were recorded anonymously throughout the study.

ORCID iDs

Tadesse Alemu  <https://orcid.org/0000-0002-4649-7054>

Getasew Amogne  <https://orcid.org/0000-0002-3363-0688>

Supplemental material

Supplemental material for this article is available online.

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