

# Poor Glycemic Control and Its Contributing Factors Among Type 2 Diabetes Patients at Adama Hospital Medical College in East Ethiopia

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**Background:** Poor glycemic control is a major public health issue among patients with type 2 diabetes mellitus and a significant risk factor for the progression of diabetic complications. This study aimed to assess the magnitude and contributing factors of poor glycemic control among type 2 diabetes patients on follow-up at Adama Hospital Medical College (AHMC) in East Ethiopia.

**Methods:** A cross-sectional study was conducted among 245 type 2 diabetes patients on follow-up at AHMC from March 1 to 30, 2020. All type 2 diabetes patients on follow-up at AHMC and fulfilling the inclusion criteria were included in the study. The data were collected through face-to-face interviews using structured questionnaires and reviewing the patient chart. The data were entered and analyzed using SPSS version 21. The level of significance was declared at a p-value of <0.05.

**Results:** Of the 245 type 2 diabetes patients included in the study, 157 (64.1%) had poor glycemic control. The factors associated with poor glycemic control were being male (AOR = 2.28, 95% CI [1.24–4.21]), not attending formal education (AOR = 3.12, 95% CI [1.53–6.35]), monthly income of <136 USD (AOR = 2.14, 95% CI [1.17–3.91]), overweight (AOR = 2.60, 95% CI [1.32–5.10]) and obesity (AOR = 3.44, 95% CI [1.44–8.21]), and chewing khat (AOR = 2.77, 95% CI [1.04–7.33]).

**Conclusion:** The proportion of poor glycemic control among type 2 diabetes patients at AHMC was remarkably high. Therefore, more effort should be taken to strengthening and disseminating health education programs for diabetes patients at each follow-up visit on the importance of achieving optimal body weight, avoiding khat chewing, and maintaining regular physical exercise to prevent and mitigate the complications resulting from poor glycemic control.

**Keywords:** type 2 diabetes, glycemic control, AHMC, Ethiopia

## Introduction

Diabetes mellitus (DM) defined as a metabolic disorder characterized by a high blood glucose level (hyperglycemia).<sup>1,2</sup> DM is a universal public health problem, resulting in about 5 million deaths annually from related complications.<sup>3</sup> It is estimated that over 422 million adults are living with diabetes globally and this is anticipated to reach about 439 million adults by 2030 and 642 million by 2040.<sup>4,5</sup>

Diabetes mellitus is growing at an alarming rate throughout the world, and approximately 80% of diabetics live in developing countries.<sup>6</sup> Its burden is highest in resources limited countries, where screening and access to care and treatment are

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not readily available.<sup>5</sup> Type 2 DM is a heterogeneous group of disorders characterized by insulin resistance, impaired insulin secretion, and increased glucose production<sup>2</sup> and it accounts for 90% of total diabetes.<sup>1</sup> The occurrence of type 2 DM is rapidly increasing all over the world in which the number of adults with diabetes in the world will rise from 135 million in 1995 to 300 million in the year 2025.<sup>7</sup>

The burden of mortality and cardiovascular disease associated with uncontrolled diabetes is considerably high.<sup>8</sup> Glycemic control is a very important goal in the management of patients with diabetes<sup>9,10</sup> and it remains the main therapeutic target for the prevention of organ damage and other complications arising from diabetes.<sup>11</sup> Poor glycemic control is a major public health issue among patients with type 2 diabetes mellitus and a significant risk factor for the progression of diabetic complications.<sup>12–14</sup>

Poor glycemic control is a common problem in different parts of the world. Observational studies were conducted worldwide and revealed the magnitude of poor glycemic control ranges from 50.1% to 91.8%.<sup>13,15–20</sup> The magnitude of poor glycemic control among type 2 diabetes patients in Ethiopia was ranges from 50% to 80%.<sup>8,11,28–30,14 21–27</sup>

The factors associated with glycemic control were age, gender, marital status, residence, educational status, occupational status, monthly income, family history of DM, membership of diabetes association, type of diabetes, duration of diabetes, type of medication, body mass index, physical exercise, knowledge and attitude insulin self-administration, adherence to diet, and medication, follow-up, self-monitoring of blood glucose levels and family support.<sup>8,11,27–29,13–15,17,19,21,24,25,31,32</sup>

To minimize the burden of diabetes mellitus, strictly maintaining a patient's blood glucose level in the normal or close to the normal range is crucial.<sup>31</sup> Despite many studies done in Ethiopia regarding this issue,<sup>8,11,29–31,14,21,22,24–28,33</sup> most of them were conducted in the Oromia and Amhara regions of Ethiopia, which did not truly reflect the magnitude in the Eastern parts of Ethiopia. Besides, this study done with the expectation of getting different results due to the presence of great variation in socioeconomic, cultural and lifestyle characteristics of the study populations compared to other studies in Ethiopia. Therefore, this study aimed to assess the magnitude and contributing factors of poor glycemic control among type 2 diabetes patients on follow-up at AHMC in East Ethiopia.

## Methods

### Study Design, Area, and Period

A hospital-based cross-sectional study was conducted in the chronic disease outpatient department clinic of AHMC from March 1 to 30, 2020. AHMC is one of the oldest public hospitals in the country and it is found in Adama city, which has 220,212 populations according to the 2007 census statistical of Ethiopia.<sup>34</sup> Adama city is located 90 km to the East of Addis Ababa, the capital city of Ethiopia. AHMC is a referral hospital and provides outpatient, inpatient, emergency, ambulatory, and other specialized services for the community living in the Eastern part of Ethiopia.

### Source and Study Populations

All type 2 diabetes patients on follow-up at AHMC were the source population. Randomly selected type 2 diabetes patients on follow-up and who fulfill the inclusion criteria were the study population.

#### Inclusion Criteria

- Age  $\geq 18$  years.
- Patients who were diagnosed to have type 2 diabetes.
- Patients with at least three consecutive blood glucose measurements for three months.
- Patients who have a willingness to participate in the study.

#### Exclusion Criteria

- Pregnant patients during the study period.
- Critically ill patients.
- If the patient chart will not be available during the data collection period.

### Sample Size Determination and Sampling Method

The required sample size was determined using the single population proportion formula with the assumption of taking a proportion of diabetes with poor glycemic control from a study in Addis Ababa to be 80%,<sup>30</sup> 5% margin of error, 95% confidence level, and adding 10% for non-response rate compensation. The final computed sample size was 271. The total numbers of type 2 diabetes patients who attend AHMC chronic follow-up clinic were 562. A systematic random sampling technique was employed to select the participants of every two patients ( $k = 562 / 271 = 2$ ) during their attendance. A random number from one and two were chosen as a random start then it was 2.

Hence, every two diabetic patients were studied until the total sample size was obtained.

## Study Variables and Measurements

The dependent variable was poor glycemic control. The independent variables were socio-demographic variables (age, sex, educational status, income, religion, ethnicity, marital status, occupational status, BMI), patient and clinical characteristics (duration of DM diagnosis, duration of DM treatment, specific type of drug regimen, comorbidity, DM complication, treatment adherence), and behavioral characteristics (smoking, alcohol consumption, khat chewing, drug use, physical activities, dietary, and knowledge of target blood glucose).

Glycemic control is the way of managing the blood glucose level of diabetic patients at optimum level.<sup>10</sup>

### Fasting Blood Sugar

Blood glucose measured from venous blood after at least 8 hours of overnight fasting.<sup>35</sup>

### Good Glycemic Control

If the patients had 70–130mg/dl of fasting blood glucose upon measurement of three consecutive visits, otherwise poor glycemic control.<sup>10,35,36</sup>

### Adherence to Blood Glucose Testing

If the patient was found to measure his/her blood glucose for more than or equal to 4 days in the last seven days.<sup>8</sup>

### Adherence to Physical Exercise

If the patient was followed recommended level of exercise for more than or equal to 5 days in the last seven days.<sup>37</sup>

### Alcohol Drinker

A patient who drinks alcohol every day or every other day basis whatever the amounts were considered alcohol drinker, otherwise not.

## Data Collection Tools and Procedure

The data were collected through a face-to-face interview using a structured questionnaire and by reviewing patient charts using a checklist. The structured questionnaire incorporates information about socio-demographic characteristics, behavioral profiles, comorbidity, complication, and drug-related profiles. The questionnaire was developed by reviewing relevant literature in English and then translated into the local language, and back-translated into English to check the consistency by an independent translator. Fasting blood sugar records of

the last three clinic visits (3 months) were obtained from patients' medical cards and the mean was used to determine the level of glycemic control. The body mass index of the study participants was measured using a DHM-15A standardized scale (BMI height and weight body fat scale) at their arrival at the follow-up clinic of the hospital. BMI was categorized as underweight if BMI was  $<18.5$  kg/m<sup>2</sup>, normal if BMI was 18.5–24.9 kg/m<sup>2</sup>, overweight if BMI was 25–29.9 kg/m<sup>2</sup>, and obese if BMI was  $\geq 30$  kg/m<sup>2</sup>. The training was given to data collectors and supervisors concerning the objective and process of data collection and to discuss the presence of an ambiguous question in the questionnaire.

## Data Processing and Analysis

The data were entered and analyzed using SPSS version 21. The results are presented in tables and numerical summary measures such as mean and standard deviation (SD). Bivariate and multivariable logistic regression analyses were used to identify independent variables associated with poor glycemic control. Independent variables with a p-value of less than 0.25 in bivariate logistic regression were included in the multivariable logistic regression model. The Hosmer-Lemeshow goodness-of-fit test indicated ( $P = 0.522$ ) that the model was good enough to fit the data well. The level of significance was declared at a p-value of  $<0.05$ .

## Results

### Sociodemographic Characteristics

Of the 271 total sample sizes, 245 study participants have completed the interview, giving a response rate of 90.4%. The mean age of the participants was 48.6 ( $\pm 14.9$  SD) ranging from 18 to 85 years old. One hundred sixty (65.3%) and 112 (45.7%) of the participants were married and Orthodox in religion, respectively. The average monthly income was 136, ranges from 80 to 165 USD. The average body mass index was 24.95 ( $\pm 3.99$  SD) ranging from 18.6 to 41.2 kg/m<sup>2</sup> (Table 1).

### Behavioral Profiles

Of the 245 interviewed, 6 (2.4%) and 19 (7.8%) of the respondents were cigarette smokers and alcohol drinkers respectively. Forty (16.3%) of the study participants were khat chewer. Two hundred nineteen (89.4%) and 223

**Table 1** Sociodemographic Characteristics of the Respondents at AHMC in East Ethiopia

Variables	Categories	Frequency	Percent
Sex	Male	135	55.1
	Female	110	44.9
Age	< 20	9	3.7
	21–40	71	29
	41–60	108	44.1
	≥ 60	57	23.3
Religion	Orthodox	112	45.7
	Protestant	75	30.6
	Muslim	58	23.7
Marital status	Single	34	13.9
	Married	160	65.3
	Divorced	28	11.4
	Widowed/ widower	23	9.4
	Educational status	No formal education	76
	Formal education	169	69
Monthly income (USD)	< 136	127	51.8
	≥ 136	118	48.2
Body Mass Index (BMI in kg/m <sup>2</sup> )	18.5–24.9	112	45.1
	25–29.9	86	35.1
	≥ 30	47	19.8

(91%) of the participants had no adherence to exercise and no adherence to blood glucose testing, respectively (Table 2).

**Table 2** Behavioral Profiles of the Respondents at AHMC in East Ethiopia

Variables	Categories	Frequency	Percent
Smoking cigarette	Yes	6	2.4
	No	239	97.6
Alcohol drinking	Yes	19	7.8
	No	226	92.2
Khat chewing	Yes	40	16.3
	No	205	83.7
Adherence to physical exercise	No	219	89.4
	Yes	26	10.6
Eating plan	≤ 4 days	193	78.8
	≥ 5 days	52	21.2
Adherence to blood glucose testing	No	223	91
	Yes	22	9

**Table 3** Comorbidity, Complication, and Drug-Related Profiles of the Respondents at AHMC in East Ethiopia

Variables	Categories	Frequency	Percent
Comorbidity	Yes	175	71.4
	No	70	28.6
Number of comorbidities	One disease	71	40.6
	Two disease	104	59.4
DM complications	Yes	112	45.7
	No	133	54.3
Group drug regimen	Diet only	9	3.7
	Oral hypoglycemic agents (OHA)	160	65.3
	OHA + Insulin	43	17.5
	Insulin	33	13.5
Duration of diabetes treatment	≤ 7 years	189	77.1
	8–14 years	35	14.3
	≥ 15 years	21	8.6
Glycemic control	Poor	157	64.1
	Good	88	35.9

## Comorbidity, Complication, and Drug-Related Profiles

One hundred thirty-five (55.1%) and 112 (45.7%) participants had comorbidity and diabetes complications, respectively. The majority (65.7%) of the participants was used oral hypoglycemic agents and 210 (85.7%) participants were treated for seven years or more. The magnitude of poor glycemic control among type 2 diabetes patients at AHMC was 64.1% (n = 157) (Table 3).

## Factors Associated with Good Glycemic Control

After adjusting for confounding variables, being male (AOR = 2.28, 95% CI [1.24–4.21]), not attending formal education (AOR = 3.12, 95% CI [1.53–6.35]), monthly income of <136 USD (AOR = 2.14, 95% CI [1.17–3.91]), overweight (AOR = 2.60, 95% CI [1.32–5.10]) and obesity (AOR = 3.44, 95% CI [1.44–8.21]), chewing khat (AOR = 2.77, 95% CI [1.04–7.33]), and not adherence to exercise (AOR = 3.71, 95% CI [1.44–9.58]) were factors significantly associated with poor glycemic control (Table 4).

## Discussion

An important strategy for the management of patients with type 2 diabetes to prevent or delay disease progression and

**Table 4** Factors Associated with Poor Glycemic Control of the Respondents at AHMC in East Ethiopia

Variables	Categories	Glycemic Control		COR (95% CI)	AOR (95% CI)	P-value
		Poor	Good			
Sex	Male	97	38	2.13(1.25–3.62)	2.28(1.24–4.21)	0.008
	Female	60	50			
Education	No formal education	58	18	2.28(1.24–4.20)	3.12(1.53–6.35)	0.002
	Formal education	99	70			
Monthly income (USD)	< 136	91	36	1.99(1.17–3.38)	2.14(1.17–3.91)	0.014
	≥ 136	66	52			
Body mass Index (Kg/m <sup>2</sup> )	18.5–24.9	60	52			0.006
	25–29.9	63	23	2.37(1.30–4.35)	2.60(1.32–5.10)	
	≥ 30	34	13	2.27(1.08–4.75)	3.44(1.44–8.21)	
Chewing khat	Yes	33	7	3.08(1.30–7.29)	2.77(1.04–7.33)	0.041
	No	124	81			
Adherence to physical exercise	Yes	9	17			0.007
	No	148	71	3.94(1.67–9.27)	3.71(1.44–9.58)	
Comorbidity	Present	113	62	1.08(0.61–1.92)	1.61(0.80–3.22)	0.180
	Absent	44	26			
Diabetes Health education at HI	Yes	74	49			0.532
	No	83	39	1.41(0.83–2.38)	1.21(0.67–2.18)	

**Abbreviations:** AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio; HI, health institution; USD, United States Dollar.

reduce the risk of developing diabetes complications is maintaining good glycemic control.<sup>15</sup> This study aimed to assess the magnitude and contributing factors of poor glycemic control among type 2 diabetes patients on follow-up at AHMC in East Ethiopia.

The magnitude of poor glycemic control among study participants at AHMC was 64.1%, 95% CI (58.1–70.1%). This finding was in line with 59.2%,<sup>11</sup> 63.8%,<sup>24</sup> and 64.9%<sup>26</sup> at Oromia region hospitals, Ethiopia, and 68.3% at Tikur Anbessa Specialized Hospital in Ethiopia.<sup>27</sup> It was higher than 50%,<sup>25</sup> 55.3%,<sup>22</sup> and 57.1%<sup>23</sup> prevalence at Oromia and Amhara regional hospitals in Ethiopia. But, it was lower than 70.8%,<sup>28</sup> 70.9%,<sup>21</sup> 71.4%,<sup>14</sup> 72.7%,<sup>8</sup> and 73.5%<sup>29</sup> prevalence at Oromia and Amhara regional hospitals in Ethiopia. The discrepancy observed between this and other studies was due to the difference in sample size, and operational definition used (this study uses fasting blood glucose level to categorized glycemic control, while other studies use hemoglobin A1c to categorized glycemic control). Besides, the presence of great variation in socioeconomic, cultural and lifestyle characteristics of the study populations across different studies may play a great role in the observed difference.

In this study, the sex of the respondents had a significant association with glycemic control. Being male had 2.3 times higher odds of having poor glycemic control than females. This finding was supported by a study conducted in Nigeria.<sup>13</sup> But, some studies revealed that being female is more associated with poor glycemic control.<sup>19,27</sup> This could be because males have higher insulin resistance compared to females.<sup>38</sup>

Not attending formal education was statistically associated with poor glycemic control. Respondents who are not attending formal education were 3 times more likely to have poor glycemic control than those who attend formal education. This finding was supported by studies conducted in Ethiopia<sup>14,21,24,28</sup> and Nigeria.<sup>15</sup> This could be due to the low diabetes knowledge and its treatment resulted in the low practice of recommended diabetes treatment, application of diabetes-friendly lifestyles, and poor adherence to diabetes medication.<sup>39</sup>

In this study, low monthly income showed a significant association with poor glycemic control. Respondents who had a monthly income <136 USD were 2 times higher odds of having poor glycemic control than those who had a monthly income of 136 USD or more. This finding was

supported by Bayisa et al<sup>24</sup> revealed that low monthly income was significantly associated with poor glycemic control. This could be due to the inability to afford diabetes self-monitoring devices and diabetes-friendly diets that help to achieve good glycemic control.<sup>26</sup> Since frequent self-monitoring of blood glucose levels may enable patients to better control glycemic levels as this could guide on how to respond and adjust their treatment regimen in line with blood glucose levels.<sup>31</sup>

Body mass index was associated with glycemic control. Respondents who were overweight and obese were 2.6 and 3.4 times respectively more likely to have poor glycemic control than those who had normal body mass index. This finding was supported by several studies.<sup>8,15,27</sup> A study done by Borgharkar et al revealed that for every one-unit increase in the patient BMI, the HbA1c of the patient increases by 0.1%.<sup>40</sup> Chewing khat was significantly associated with poor glycemic control. Respondents who chewed khat were 2.8 times higher odds of having poor glycemic control than those who did not chew khat. This could be due to the association of khat chewing with higher fasting blood glucose levels.<sup>36</sup>

In this study, lack of adherence to physical exercise was significantly associated with poor glycemic control. Respondents who did not adhere to physical exercise were 3.7 times more likely to have poor glycemic control than those who adhere to physical exercise. This finding was supported by a study conducted in Ethiopia.<sup>31</sup> This could be due to the effect of exercise on the reduction of hemoglobin A1c either by increasing insulin secretion from the beta cells or decreasing insulin resistance from the cell of our body.<sup>41</sup>

## Limitations of the Study

First, the cross-sectional nature of the study design does not allow ascertaining the causal association between the outcome variable and potential contributing factors. Second, the smaller sample size may limit the generalization of the study findings to a larger population of type 2 diabetes patients in the country. The last and foremost, the use of fasting blood glucose to assess the level of glycemic control (failure to use glycated hemoglobin due to the lack of laboratory facility), since measurement of fasting blood glucose does not show the true level of glycemic control over 3 months like that of glycated hemoglobin (HbA1c).

## Conclusion

The proportion of poor glycemic control among type 2 diabetes patients at AHMC was remarkably high. Therefore, more effort should be taken to strengthening and disseminating health education programs for diabetes patients at each follow-up visit on the importance of achieving optimal body weight, avoiding khat chewing, and maintaining regular physical exercise to prevent and mitigate the complications resulting from poor glycemic control.

## Abbreviations

AHMC, Adama Hospital Medical College; AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval; COR, crude odds ratio; DM, diabetes mellitus; HbA1c, hemoglobin A1c; SPSS, Statistical Package for the Social Sciences; SD, standard deviation; USD, United States Dollar.

## Data Sharing Statement

The data set is handled by the corresponding author and can be provided upon request.

## Ethics Approval and Consent to Participate

Ethical approval was obtained from Mizan-Tepi University-Institutional Review Board (MTU-IRB). Permission was obtained from AHMC. The study participants were informed about the purpose of the study, their right to deny participation, anonymity, the confidentiality of the information, and this study was conducted following the Declaration of Helsinki. Written informed consent was obtained from participants who participated in the study.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Disclosure

The authors declare no conflicts of interest in this work.

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