Determinants of Poor Glycemic Control among People with Type 2 Diabetes in Selected Hospitals, in Dire Dawa City Administration, Eastern Ethiopia: Unmatched Case-Control Study

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Abstract

Background: Poor glycemic control often leads to diabetes-related morbidity and mortality. In Ethiopia, the magnitude of people with poorly controlled type 2 diabetes was 60.5%. However, there is little evidence on the factors contributing to poor glycemic control using the HbAc1 test. This study aimed to identify the determinants of poor glycemic control among people with type 2 diabetes in selected hospitals in Dire Dawa City Administration, Eastern Ethiopia.

Methods: A facility-based unmatched case-control study was conducted among people with diabetes in follow-up clinics of private and public hospitals in Dire Dawa City Administration. Cases were people with HbA1c > 7%, while people with HbA1c ≤ 7% were assigned as controls. A total of 190 patients (95 cases and 95 controls) were recruited in chronic follow-up diabetic clinics in the hospitals. The data was collected using structured questionnaire interviews and extracted from medical charts. The collected data were entered into EpiData and exported to Stata version 16.1 for analysis. A binary logistic regression model was fitted to identify the determinants of poor glycemic control.

Results: In the study, females were predominant, accounting for 72% of participants. The mean age of the participants was 56.11 ±13.75 years in cases and 53.74 ± 12.23 years in controls. The study showed that being females (AOR=2.73; 95% CI:1.10,6.79), smokers (AOR=14.85;95% CI:5.25,42.88), blood glucose monitoring ≤ 3 times per week (AOR= 4.87; 95% CI:1.42,16.71), overweight (AOR= 4.96;95% CI:1.82,13.52) and obese (AOR=5.19; 95% CI:1.76,15.56), more than 10 years or above on treatment (AOR= 3.56; 95% CI:1.17-10.82), and having coronary artery disease (AOR=2.47; 95% CI:1.01, 6.03), adherence to diabetic medication (AOR, 0.24; 95% CI: 0.10,0.63) were found predictors of poor glycemic control.

Conclusion: Smoking, being overweight or obese, poor medication adherence, low monitoring of blood glucose level, and having coronary artery disease were found to be predictors of poor glycemic control. Health promotion on the benefits of quitting smoking, maintaining a healthy weight, adhering to medication, and monitoring blood glucose levels.

Keywords: HbA1c, Poor glycemic control, T2DM, Ethiopia

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Introduction

Globally, diabetes affects 9.3% of the world's population (IDF, 2019; Arokiasamy *et al.*, 2021), and more than four million deaths occur each year, with half of those deaths occurring before the age of 70 years (Arokiasamy *et al.*, 2021). About 422 million people worldwide have diabetes, the majority living in low- and middle-income countries, and 1.5 million deaths are directly attributed to diabetes each year(Ye *et al.*, 2023). Both the number of cases and the prevalence of diabetes have been steadily increasing over the past few decades. According to the World Health Organization (WHO), diabetes will be the seventh leading cause of death in 2030, affecting approximately 62 million people by the end of 2045 (Saeedi *et al.*, 2019, Cho *et al.*, 2018, WHO, 2016). Furthermore, the total global healthcare spending on individuals with diabetes reached an estimated USD 850 billion (Cho *et al.*, 2018).

The challenge to combating diabetes in Sub-Saharan Africa (SSA) was the scarcity of funding, a shortage of diagnostic and management protocols and medications, and disparities between public and private sector

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healthcare (Atun and Gale, 2015). Diabetes affects 4 million adults aged 20 to 79 years in SSA, with a regional prevalence was 3.9% (Mbanya *et al.*, 2010; Ojuka and Goyaram, 2014). More than half (55.8%) of diabetes in the region live in one of these four countries namely South Africa (4.6 million), Nigeria (2.7 million), Democratic Republic of Congo (1.8 million), and Ethiopia (1.7 million) (Ojuka and Goyaram, 2014; Hall *et al.*, 2011; Azevedo and Alla, 2008). In Ethiopia, the pooled prevalence of diabetes was estimated at 6.5% (Zeru *et al.*, 2021). However, a community-based study in Dire Dawa town found that the prevalence of type 2 diabetes was 14.9%, with 41.5% undiagnosed (Ayele *et al.*, 2020).

Glycemic control is the optimal serum glucose concentration in diabetic patients. The American Diabetes Association's hemoglobin A1c (HbA1c) target of 7% for non-pregnant adults was considered a good control, while HbA1c levels of 8% and above were considered to have poor glycemic control (Marathe *et al*., 2017). Poor glycemic control is one of the most serious health issues in people with diabetes (Haghighatpanah *et al*., 2018). The pooled prevalence of good glycemic control in SSA was 30%, with a range of 10-60% (Fina Lubaki *et al.,* 2022). In Ethiopia, a meta-analysis revealed that 61.1% of individuals with Type 2 Diabetes Mellitus (T2DM) had poor glycemic control (Tegegne *et al*., 2024). Additionally, in Dire Dawa, the rate of poor glycemic control among individuals with T2DM was 45.2% (Nigussie *et al.,* 2021).

Factors such as older age, gender, lack of health insurance, low educational attainment, urban or rural residence, family history of diabetes, longer duration of diabetes, high pill burden, treatment plan, side effects, alcohol consumption, smoking, presence of other health conditions, and inadequate management were linked to poor glycemic control (Fina Lubaki *et al.,* 2022). Conversely, positive perceived family support, effective coping mechanisms, adherence to dietary guidelines, regular exercise, attendance at follow-up appointments, and compliance with medication were associated with achieving good glycemic control (Sahile and Bekele, 2020).

The International Debates Federation suggests that the HbA1c test is a reliable indicator of long-term glycemic control (Nigussie *et al*., 2021). However, in Ethiopia, the practice of monitoring glycemic levels and long-term complications through the HbA1c test is uncommon. Instead, many studies in various regions of Ethiopia, such as Jimma (Mamo *et al*., 2019), Gondar (Legese *et al*., 2023), Dire Dawa (Ayele *et al.,* 2020; Nigussie *et al.,* 2021), Southern Ethiopia (Zekewos *et al.,* 2018; Dawite *et al.,* 2023), and Addis Ababa (Sahile and Bekele, 2020), rely on fasting blood glucose tests. Therefore, the present study aims to determine the factors contributing to poor glycemic control using the HbA1c test among individuals with type 2 diabetes in chronic care clinics at selected hospitals in Dire Dawa City Administration, Eastern Ethiopia.

Materials and Methods

Study Setting, Design, and Period

An unmatched case-control study was carried out on individuals with type 2 diabetes in Dire Dawa City Administration, situated 515 kilometers east of Addis Ababa, the capital city of Ethiopia. According to the 2012 GC data provided by the Central Statistical Agency (CSA) of Ethiopia, Dire Dawa City Administration is home to an approximate total population of 506,639, with 185,377 males and 184,264 females. About 32.5% of the population are rural residents, while 67.5% are urban dwellers. (Tusa *et al*., 2020, CSA, 2016). The administration has nine urban and thirty-eight rural kebeles (the lowest administrative unit in Ethiopia). According to the 2012 GC. Health and Health Related Indicators published by FMoH, Dire Dawa City has three public hospitals, three private hospitals as well as 15 health centers and 36 health posts. The research was carried out in Bilal Private and DileChora public hospitals from May to June 2022. These two hospitals were selected because they have separate clinic for diabetics' follow-up and HbA1c parameter test. Both hospitals are the largest in the administration offering comprehensive multispecialty care in a variety of disciplines. Patients served in the hospitals come from Dire Dawa City and surrounding regional states, Oromia, Somalia, Somaliland state, and Djibout.

Population, Inclusion/ Exclusion Criteria

People with poor glycemic control were cases and those with good glycemic control were the control. The study participants were selected from diabetes fol-

low-up clinics of private and public hospitals who presented during the data collection period and met the eligibility criteria. Adult people with diabetes (aged 18 and above) who had at least three consecutive follow-ups and who had at least one HbAlc parameter test were eligible for both cases and controls. However, pregnant women, and those who were mentally unstable or critically ill, and unable to respond were excluded from the study.

Sample size and Sampling Technique

The sample size was calculated using the software Open Epi software, version 3, by taking two population proportions and assuming a 95% significance level, 80% power. A case-to-control ratio of 1:1. The odds ratio (OR) and proportion of different predictor variables of glycemic control among cases controls were derived from a study conducted in Jimma, Ethiopia (Mamo *et al*., 2019). The largest sample size was considered (n=190), with 95 cases and 95 controls. There were 850 people with type 2 diabetes following at DilChora referral hospital outpatient follow-up clinic, and 156 people with T2DM in Bilal hospital during the study period (Amera *et al*., 2022), and enrolled glycated hemoglobin level. First, we developed a sample frame who have HbA1c parameter test in both hospitals. The sample size was allocated to each selected hospital based on the proportion of the study participants. The lists of sampling frames were obtained from the updated registration books of follow-up clinics. After establishing the sampling frames of respondents, a simple random sampling technique was used to identify the study unit to be included in the study.

Data Collection Instruments and Procedures

The questionnaires were developed after reviewing previously published literature (Nigussie *et al.*, 2021, Tegegne *et al.*, 2024). Face-to-face interviews were conducted using a structured questionnaire to collect socio-demographic information such as gender, age, marital status, educational status, occupation, residence, clinical and behavioral characteristics, duration of diabetes, family history of diabetes, lifestyle, and self-care (drug adherence, smoking, physical activity). Following the completion of the interview, information on the comorbid disease, weight, and height, type of drug treatment, recent HbA1c test, systolic blood pressure, diastolic blood pressure, lipid profiles, serum creatinine value, urine dipstick semi-qualitative protein level, and relevant to chronic complications of diabetes were abstracted from the participants' medical record.

Operational Definition/Definition of Terms

The glycated hemoglobin parameter test was used to measure the outcome variable.

Body mass index as weight in kilograms over height in meters squared, and were categorized according to WHO criteria (underweight: BMI<18.5 kg/m^2; normal: BMI=18.5–24.9 kg/m^2; overweight: BMI=25.0–29.9 kg/ m^2; and obese: BMI≥30.0 kg/m^2) (WHO, 2015).

Smoking status was categorized as never smoked, and lifetime smoker (WHO, 2015).

The alcohol drinking habits of the study participants during the survey period were classified as never, occasional, and frequent drinkers (WHO, 2015).

The total physical activity score was computed as the sum of all metabolic equivalent (MET)-minutes per week for vigorous-intensity physical activity, moderate-intensity physical activity, and walking. The sum of MET-minutes per week was categorized as high (3,000 MET-minutes or above) recorded as " high physical activity or yes", and low (<2999 MET-minutes) recorded as "low physical activity or no " (WHO, 2005).

Biochemical markers like serum creatinine with a normal range is 0.7 to 1.3 mg/dL (61.9 to 114.9 µmol/L) for men and 0.6 to 1.1 mg/dL (53 to 97.2 µmol/L) for women, blood lipid profile (total cholesterol, Low-Density Lipoprotein (LDL), triglyceride, High-Density Lipoprotein (HDL) values, the normal value LDL cholesterol was less than 100 mg/dL, HDL cholesterol more than 40 mg/dL, triglycerides less than 150 mg/dL, and total cholesterol less than 200 mg/dL(WHO, 2005).

A frequently healthy diet that's naturally rich in nutrients and low in fat and calories is fruits, vegetables, and whole grains three times and above per week (Sami *et al.*, 2017).

Data Quality Control

Experienced six BSc nurses were recruited for data collection who work at chronic disease follow-up clinics out of the study hospitals. The training was given by the principal investigator for two days on the data collection process and focused on the content of the

questionnaire, data collection techniques, ethical human research, and how to fill out the data provided. Before the data collection, a pre-test was conducted with 5% of the sample size in a similar setting at Hiwot Fana Specialized Comprehensive University Hospital in Harar, and amendments were made based on the pre-test results. The principal investigator oversaw and checked on a regular and timely for completeness and consistency of the questionnaire.

Data Processing and Analysis

Data were collected and entered to EpiData version 3.1 before being exported to the Stata 16.1 version for analysis. The data was checked for outliers, missing, and assumptions. Descriptive results were presented using frequency, proportion, and mean, and tables. In bivariable logistic regression analysis, p-values less than 0.25 were chosen as candidates for multivariable logistic regression analysis. The multicollinearity was checked. Model fitness was tested with the Hosmer-Lemeshow goodness of fit with a p-value of 0.7654. Finally, a multivariable logistic regression analysis was done to identify predictors of poor glycemic control. AOR with 95% CI was reported to show the degree of association between the independent and the outcome variable at P value < 0.05.

Ethical Consideration

Ethical clearance was obtained from the Institution Ethical Committee of Addis Ababa Medical and Business College on May 24, 2022 (AAMBC / DD / 01/14). A supportive letter was written from Addis Ababa Medical and Business College to Bilal and Dilchora hospitals' medical directors for cooperation to access the medical records. Confidentiality was maintained throughout the study period and informed consent was obtained before the data collection. Study participants who require treatment or modification of regimen were discussed with their clinicians during their follow-up visits.

Results

Socio-demographic characteristics of participants

A total of 190 study participants (95 cases and 95 controls) were included in the study. The mean age of the cases was 56 ±13.75 years, and the control group was 53 ± 12.23 years. The mean age difference between case and control was not statistically significant (p= 0.245). More than three-quarters of cases and controls were 45 years and above. Regarding marital status, 55% of cases and 44.6% of controls were married. about, 42.9% of cases and 57.1% of controls had no formal education. Almost half of the study participants were unemployed and had diabetes for 10 years or above (Table 1).

Table 1. Socio-demographic characteristics of adult people with type 2 diabetes at chronic follow-up at Dilchora and Bilal hospitals in Dire Dawa Administration, eastern Ethiopia, 2022 (n=190).

Variables	Category	Cases	Controls	Total
		Frequency (%)	Frequency (%)	Frequency (%)
Sex	Male	30(43.5)	39(56.5)	69(36.3)
	Female	65(53.7)	56(46.3)	121(63.7)
Age (years)	25-34	4(66.7)	2(33.3)	6(3.2)
	35-44	19(52.80)	17(47.2)	36(19.0)
	45-54	22(46.8)	25(53.2)	47(24.7)
	55-64	28(56.0)	22(44.0)	50(26.3)
	65+	22(43.1)	29(56.9)	51(26.8)
Marital status	Unmarried	6(46.2)	7(53.8)	13(6.8)
	Married	72(55.4)	58(44.6)	130(68.5)
	Widowed	11(32.4)	23(67.6)	34(17.9)
	Divorced	6(46.2)	7(53.9)	13(6.8)
Educational status	No formal education	33(42.9)	44(57.1)	77(40.5)
	Primary education	25(55.6)	20(44.4)	45(23.7)
	Secondary education	27(58.7)	19(41.3)	46(24.2)
	College and above	10(45.5)	12(54.5)	22(11.6)
Occupation	Employed	45(50.0)	45(50.0)	90(47.4)
	Unemployed	50(50.0)	50(50.0)	100(52.6)
Duration of Diabetes (year)	<5	55(52.4)	50(47.6)	105(55.1)
	5-10	25(45.4)	30(54.6)	55(29.1)
	> 10	15(50.0)	15(50.0)	30(15.8)

Behavioral and clinical characteristics

Of the 190 participants interviewed, 19 (20%) cases and 9 (9.5%) control were doing their blood glucose monitoring three times and above per week. In more than half of the cases, 54 (56.8%) and 10 (10.5%) of the control were cigarette smokers. One in five of the cases, 19 (20 %) and 9 (9.5%) control had alcohol consumption habits. Sixty-one of the cases (64.2%) and 43 (45.3%) of the control were hypertensive. Regarding adherence to diabetic medication 42 (44.2%) cases and 15 (15.8%) of the control had no adherence to their diabetic medication. It was found that 68.4% of cases, and 82.1% of control consume a healthy diet less than 3 times per week including fruit, vegetables, high fiber diet, and low unsaturated fat.

The study shows that 61(58.7%) cases and 43 (41.3%) of controls had high blood pressure during data collection or were already diagnosed as hypertensive. Of the study participants, 36 (37.9%) of the cases and 13(13.7%) of the controls had thyroid dysfunction (Table 2).

Biochemical and Anthropometric Characteristics

The mean of cholesterol was 202.02(±58.8) mg /dl among cases, and 179.24(± 51.3) mg/dl in the control (P-value=0.009). Also, the mean triglyceride was high 175.04 ±95.98 mg/dl in the cases and 149.61±62.27 mg/dl in the control (P=0.005). Moreover, the mean BMI was 28.41±6.33 kg/m2 among cases and 24.71±3.71 kg/m2 in the control (P < 0.001) (Table 3).

Table 2. Behavioral characteristics and clinical information of people with type 2 diabetes at Dilchora and Bilal hospitals in the Chronic diabetics' clinic, Dire Dawa City administration, Eastern Ethiopia, 2022 (n=190)

Variables	Categories	Cases	Controls	P-Value
Physical activity	Yes	79 (83.2)	80 (84.2)	0.844
	No	16 (16.8)	15 (15.8)	
Blood glucose monitoring (times/week)	≥3	19 (20.0)	9 (9.5)	0.041
	<3	76 (80.0)	86 (90.5)	
Life time smoking	Yes	54 (56.8)	10 (10.5)	0.001
	No	41 (43.2)	85 (89.5)	
Alcohol consumption	Occupational/Frequent	19 (20.0)	9 (9.5)	
	Not at all	76 (80.0)	86 (90.5)	0.041
Hypertension	Yes	61 (64.2)	43 (45.3)	0.009
	No	34 (35.8)	52 (54.7)	
Frequency of healthy diet (times/week)	≥ 3	30 (31.6)	17 (17.9)	0.029
	< 3	65 (68.4)	8 (82.1)	
Thyroid dysfunction	Yes	37 (38.0)	27 (28.4)	0.125
	No	58 (61.0)	68 (71.6)	
Healthy diet	Yes	37 (38.9)	22 (23.2)	0.019
	No	58 (61.1)	73 (76.8)	
Adherence to diabetic medications	Adhered	42 (44.2)	15 (15.8)	
	Non-adhered	53 (55.8)	80 (84.2)	0.001
Body Mass Index (Kg/m^2)	<25	26 (27.4)	57 (60.0)	
	25-29.9	36 (37.9)	24 (25.3)	0.001
	≥ 30	33 (34.7)	14 (14.7)	

Table 3. Biochemical and anthropometric characteristics among adults people with type 2 diabetes in Dilchora and Bilal hospitals, in Dire Dawa City Administration, Eastern Ethiopia, 2022 (n=190).

Clinical variables	HbA1c	Mean	Standard Deviation	T-test	P-value
Total cholesterol (mg/dl)	≥ 7 % (case)	202.24	58.78	-2.36	0.019
	< 7 % (control)	179.24	51.30		
Triglyceride (mg/dl)	≥ 7 % (case)	175.04	95.98	-2.45	0.005
	< 7 % (control)	149.61	62.27		
HDL (mg/dl)	≥ 7 % (case)	46.09	43.52	1.426	0.156
	< 7 % (control)	54.69	57.40		
LDL (mg/dl)	≥ 7 % (case)	116.84	47.66	-2.47	0.014
	< 7 % (control)	100.53	43.28		
BMI (kg/m2)	≥ 7 % (case)	28.41	6.33	-.4.49	0.000
	< 7 % (control)	24.71	3.71		

HbA1c; Hemoglobin A1c or glycated hemoglobin test, HDL; High Density Lipoprotein, LDL; Low Density Lipoprotein, BMI; Body mass Index

Diabetic Complications

Regarding on the diabetic complication, 51(53.7%) of the case and 29(30.5%) of the control had diabetic neuropathy, 8(8.4%) of the cases and 7(7.4%) of the control had diabetic retinopathy. In addition, 17(17.9) of cases and 10(10.5%) of control had nephropathy. Moreover, half of the cases 48(50.5% and 32 (33.2%) of the control had coronary artery disease (p_value= 0.019) (Table 4).

Table 4: Diabetic Complications among adult people with type 2 diabetes follow-up in DilChora and Bilal Hospitals, in Dire Dawa City Administration, eastern Ethiopia, 2022 (n=190).

Diabetic Complication	Category	Case	Control	P value
		Frequency (%)	Frequency (%)	
Diabetic neuropathy	Yes	51 (53.7)	29 (30.5)	0.788
	No	44 (46.3)	66 (69.4)	
Diabetic retinopathy	Yes	8 (8.4)	7 (7.4)	0.001
	No	87 (91.6)	88 (92.6	
Nephropathy	Yes	17 (17.9)	10 (10.5)	0.319
	No	78 (82.1)	85 (89.5)	
Coronary Artery Disease	Yes	48(50.5%)	32 (33.7)	0.019
	No	47(49.5%)	63 (66.3%)	

Prescribed medications

The study shows that 65 (68.4%) of the cases and 64 (67.4%) of the control had been prescribed Metformin drug, and 16(16.8%) of the cases and 7 (7.4%) of the control had been prescribed insulin. Most of the study participants, 51 (53.7%) of the cases and 60 (63.2%) of the control had been prescribed lipid-lowering agent statin. Angiotensin-converting enzyme inhibitor or angiotensin II blocker has been prescribed for 22 (23.2%) cases and 18 (18.9%) of control adults' people with type 2 diabetes.

Predictors of Poor Glycemic Control

In bivariable logistic regression analysis, adherence to diabetes medication, blood glucose monitoring, smoking, alcohol consumption, hypertension, diabetes sensory neuropathy, coronary artery diseases, high body mass index, and duration of diabetes were found to be associated with poor glycemic control. However, in multivariable logistic regression analysis being female, smoking, adherence to diabetic medication, self-blood glucose monitoring, coronary artery diseases, high body mass index, and duration of diabetes were significantly associated with poor glycemic control. The study shows that being females were 2.7 times more likely to have poor glycemic control compared with their counterpart (AOR = 2.73; 95% CI = 1.10, 6.79). Study participants who were practicing self-monitoring blood glucose less than three times per week were 4.9 times more likely to have poor glycemic control (AOR=4.87; 95% CI=1.42, 16.71) than their counterparts. Furthermore, being a smoker (AOR=14.85; 95% CI=5.21, 42.28), having coronary artery diseases (AOR=2.4; 95% CI=1.01, 6.03), being overweight (AOR=4.69; 95% CI=1.82, 13.52) and obese (AOR=5.19, 95% CI=1.76, 15.16), and long duration of diabetes (AOR=3.56; 95 % CI=1.17, 10.82) were significantly associated with poor glycemic control. Study participants who had taken diabetic medication five and above days per week had 76% lower blood glucose levels (AOR=0.24; 95%CI=0.10, 0.63) as compared to those who took less than five days per week) (Table 5).

Table 5. Determinants of poor glycemic control people with type 2 diabetes in a follow-up clinic in DileChora and Bilal hospitals, in Dire Dawa administration, Eastern Ethiopia, 2022 (n=190).

Variables	Category	Case	Control	COR (95 % CI)	AOR (95 % CI)
Sex	Male	30	39	1	1
	Female	65	56	1.50 (0.83-2.74)	2.73 (1.10-6.79)*
Adherence to diabetic medications (days/ week)	<5	42	15	1	1
	≥5	53	80	0.24 (0.12-0.47)	0.24 (0.10-0.63)*
Blood glucose monitoring(times/week)	<3	70	86	2.39 (1.02-5.59)	4.87 (1.42-16.71)*
	≥3	19	9	1	1
Smoking	Yes	10	54	11.19 (5.18-24.20)	14.85 (5.21-42.28)*
	No	85	41	1	1
Alcohol consumption	Yes	89	76	3.71 (1.41-9.76)	1.41 (0.37-5.37)
	No	6	19	1	1
Hypertension	Yes	61	43	2.17 (1.21-3.88)	0.51 (0.22-1.21)
	No	34	52	1	1
Diabetes sensory neuropathy	Yes	16	10	2.63 (1.46-4.78)	0.50 (0.21-1.19)
	No	78	75	1	1
Coronary artery diseases	Yes	48	32	2.01 (1.12-3.61)	2.47(1.01-6.03)*
	No	47	63	1	1
Total cholesterol (mg/dl)	<200	46	59	1	1
	≥ 200	49	36	1.75 (0.98-3.11)	1.19 (0.43-3.25)
Triglyceride(mg/dl)	<150	42	52	1	1
	≥ 150	53	43	1.53 (0.86-2.70)	1.67 (0.73-3.82)
HDL (mg/dl)	≥ 40	67	57	1	1
	<40	28	38	0.63 (0.34-1.15)	0.86 (0.34-2.19)
LDL(mg/dl)	<100	34	42	1	1
	≥ 100	61	53	1.42 (0.79-2.55)	2.50 (0.54-4.14)
Body Mass Index(kg/m2)	< 25	26	57	1	1
	25-29.9	36	24	3.29 (1.64-6.58)	4.96 (1.82-13.52)*
	≥ 30	33	14	5.17 (2.37-11.26)	5.19 (1.76-15.16)*
Duration of Diabetes (year)	<10	64	87		
	≥ 10	31	8	5.27 (2.27-12.22)	3.56 (1.17-10.82

HDL, High-Density Lipoprotein, LDL, Low-Density Lipoprotein

Discussion

The purpose of this study was to determine predictors of glycemic control using the Hb1Ac parameter test and the study found that being female, smoking, non-adherence to diabetic medications, having low self-blood glucose monitoring, having coronary artery diseases, being overweight and obese, and long duration of diabetes were significantly associated with poor glycemic control.

The age group of 60 and above had a higher proportion of poor glycemic control, which is in line with a study conducted in Dares Salaam(Kamuhabwa and Charles, 2014). The study shows that more than two-thirds (69%) of participants were on oral metformin alone (with no insulin as a component of their drug therapy). This finding was consistent with the finding reported by Weng et al.(Weng *et al.*, 2017).

This study revealed that being female was significantly associated with poor glycemic control supported by a study conducted in India (Haghighatpanah *et al.*, 2018), Tanzania (Kamuhabwa and Charles, 2014), and Ethiopia (Demoz *et al.*, 2019). This might be because women are responsible for family care, and neglect their health care (Haghighatpanah *et al.*, 2018;Kautzky-Willer *et al.*, 2015). Hence, they might be more obese and accumulate bad cholesterol than men with diabetes to achieve the intended glycemic target(Demoz *et al.*, 2019). Literature has shown that women have more adverse effects on lipid profiles than men due to estrogen effects (Motuma *et al.*, 2020; Kamuhabwa and Charles, 2014).The other possible justification Female in Ethiopian might not attend their follow-up therapy as needed as males due to the

workload at home and are less likely to follow their drug therapy attentively (Demoz *et al.*, 2019; Dawite *et al.*, 2023) and less adherent to their lifestyle modification like regular physical activity (Demoz *et al.*, 2019; Motuma *et al.*, 2020, 2021). A previous study by Motuma et al. reported that more physical inactivity and obesity were observed in Ethiopian females than males(Motuma *et al.*, 2020). Thus, many women in the Sub-Saharan countries had poor access to treatment, care, and education (Fina Lubaki *et al.*, 2022).

The finding revealed that being overweight or obese was significantly associated with poor glycemic control. This study is consistent with previous reports (Kamuhabwa and Charles, 2014; Weng *et al.*, 2017; Sendekie *et al.*, 2022). This might be due to the exacerbation of insulin resistance due to increased fat mass and visceral adiposity, which affect insulin sensitivity and cause insulin resistance(Demoz *et al.*, 2019)

In line with a study conducted by Demoz et al. and Kamuhabwa and Charles, poor medication adherence was also found as an important predictor of poor glycemic control (Demoz *et al.*, 2019). Participants who had non-adherence to diabetic medication are associated with increased levels of HbA1c (Kamuhabwa and Charles, 2014). This finding is consistent with other reports in Ethiopia and Jordan (Abebe *et al.*, 2015; Khattab *et al.*, 2010). Similarly, studies have shown that people with inadequate knowledge of their status might not regularly attend clinics and are less likely to have adherence (Miras *et al.*, 2014). Lack of continuous education affects motivation to cultivate healthy lifestyles and maintain poor treatment adherence (Raum *et al.*, 2012; Letta *et al.*, 2022). Medication adherence supposed as the patient's problem alone (Demoz et al., 2019, Mamo et al., 2019), but it might be due to frustration to agree on the prescription entirely with the patient and/or failure to provide continuous support that the patient needs once the drug has been dispensed.

In the current study, a higher proportion of poor glycemic control was reported in study participants who lived with DM for a long duration of period. The result is consistent with previous findings in the South of the Sahara and Dilchora Hospital Dire Dawa (Camara *et al.*, 2015; Tekalegn *et al.*, 2018; Nigussie *et al.*, 2021). However, a study conducted at the Gondar University Hospital revealed a high proportion of poor glycemic control in patients with diabetes for less than seven years (Fasil *et al.*, 2018). This is possibly due to reduced insulin secretion or excessive insulin resistance in those patients (Haghighatpanah *et al.*, 2018).

In this study participants who were not self-monitored their blood glucose were identified as predictors of poorly controlled blood glucose This finding is consistent with studies in Jimma University and Jordan (Mamo *et al.*, 2019 ;Khattab *et al.*, 2010).Similarly, the study conducted in Mekelle indicated that patients who were adherent to self-monitoring blood glucose had good glycemic control(Eticha *et al.*, 2016). A patient who does not self-monitor their blood glucose may not visit health facilities, not consult health care providers, not adjust their diabetic medication and modify their lifestyle. This probably contributes to poor glycemic control.

In the current study, participants who had coronary artery diseases were found to have poorer glycemic control than those who had no coronary artery disease. Our results are consistent with previous studies on the relation of type 2 diabetes with endothelial dysfunction (Chen *et al.*, 2021). Poor glycemic control exerts an adverse effect on endothelial function and aggravates coronary atherosclerosis in type 2 diabetes. These observations, at least partly provide substantial insight into the management of type 2 diabetic patients with coronary artery disease.

Strength and limitation

The study's strengths lie in its inclusion of both private and public hospitals, as well as its use of the HbA1c test, which is well-regarded for effectively predicting long-term glycemic control. However, limitations such as potential recall and social desirability biases among participants, the risk of measurement bias from single weight and height measurements, and a disproportionate sample size with underrepresentation of men were noted. Furthermore, the study's focus solely on type 2 diabetes patients in outpatient clinics may limit its generalizability to the broader diabetes population. The reliance on medical records data and the absence of control for factors like managing clinician

experience, medication types, and comorbidities further highlight areas for improvement in future research.

Conclusion

According to this study, being female, smoking, self-monitoring blood glucose three or fewer times per week, coronary artery diseases, a longer duration of diabetes mellitus (≥ 10 years), and being overweight or obese were independent predictors of poor glycemic control. Healthcare providers should encourage people with type 2 debates on lifestyle modification, take their diabetes medication regularly and frequent monitoring of their blood glucose level. We recommend scholars and researchers to conduct logitudinal study with representative sample to guide policy makers and public health interventions.

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Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AMT conceived the research idea, developed the proposal, and conducted fieldwork, data processing, and analysis. AMT drafted the manuscript, with HL and AM providing critical feedback and discussing the results and interpretation. All authors have read and approved the final manuscript.

List of abbreviations

CSA, Central Statistical Agency; IDF, International diabetics Federation; BMI, Body Mass Index; HbA1,HemoglobinA1c; HDL, High-Density Lipoprotein ; LDL, Low-Density Lipoprotein; MET, Metabolic Equivalent -Minutes; SSA, Sub-Saharan Africa; T2DM, Type 2 Diabetes Mellitus; WHO, World Health Organization

References

Abebe, S. M., Berhane, Y., Worku, A., Alemu, S. & Mesfin, N. 2015. Level of sustained glycemic control and associated factors among patients with diabetes mellitus in Ethiopia: a hospital-based cross-sectional study. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy***,** 65-71.

Amera, T. G., Tefera, Y. M., Menberu, T. & Yassin, A. M. 2022. Determinants of Type 2 Diabetes Mellitus Among Adults in Dill-Chora Referral Hospital, Dire Dawa, East Ethiopia. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 3565-3576.

Arokiasamy, P., Salvi, S. & Selvamani, Y. 2021. Global burden of diabetes mellitus. *Handbook of Global Health.* Springer.

Atun, R. & Gale, E. A. 2015. The challenge of diabetes in sub-Saharan Africa. *The lancet Diabetes & endocrinology,* 3**,** 675-677.

Ayele, B. H., Roba, H. S., Beyene, A. S. & Mengesha, M. M. 2020. Prevalent, uncontrolled, and undiagnosed diabetes mellitus among urban adults in Dire Dawa, Eastern Ethiopia: A population-based cross-sectional study. *SAGE open medicine,* 8**,** 2050312120975235.

Azevedo, M. & Alla, S. 2008. Diabetes in sub-saharan Africa: kenya, mali, mozambique, Nigeria, South Africa and zambia. *International journal of diabetes in developing countries,* 28**,** 101.

Camara, A., Baldé, N. M., Sobngwi-Tambekou, J., Kengne, A. P., Diallo, M. M., Tchatchoua, A. P., Kaké, A., Sylvie, N., Balkau, B. & Bonnet, F. 2015. Poor glycemic control in type 2 diabetes in the South of the Sahara: the issue of limited access to an HbA1c test. *Diabetes research and clinical practice,* 108**,** 187-192.

Chen, S., Shen, Y., Liu, Y.-H., Dai, Y., Wu, Z.-M., Wang, X.-Q., Yang, C.-D., Li, L.-Y., Liu, J.-M. & Zhang, L.-P. 2021. Impact of glycemic control on the association of endothelial dysfunction and coronary artery disease in patients with type 2 diabetes mellitus. *Cardiovascular diabetology,* 20**,** 1-9.

Cho, N. H., Shaw, J., Karuranga, S., Huang, Y., Da Rocha Fernandes, J., Ohlrogge, A. & Malanda, B. 2018. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes research and clinical practice,* 138**,** 271-281.

Dawite, F., Girma, M., Shibiru, T., Kefelew, E., Hailu, T., Temesgen, R. & Abebe, G. 2023. Factors associated with poor glycemic control among adult patients with type 2 diabetes mellitus in Gamo and Gofa zone public hospitals, Southern Ethiopia: A case-control study. *PloS one,* 18**,** e0276678.

Demoz, G. T., Gebremariam, A., Yifter, H., Alebachew, M., Niriayo, Y. L., Gebreslassie, G., Woldu, G., Bahrey, D. & Shibeshi, W. 2019. Predictors of poor glycemic control among patients with type 2 diabetes on follow-up care at a tertiary healthcare setting in Ethiopia. *BMC research notes,* 12**,** 1-7.

Eticha, T., Mulu, A., Gebretsadik, H., Kahsay, G. & Ali, D. 2016. Factors associated with poor glycemic control in type 2 diabetic patients investigated at Ayder Referral Hospital, Mekelle, Ethiopia. *Ijppr Human,* 6**,** 160-171.

Fasil, A., Biadgo, B. & Abebe, M. 2018. Glycemic control and diabetes complications among diabetes mellitus patients attending at University of Gondar Hospital, Northwest Ethiopia. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy***,** 75-83.

IDF. 2019. IDF diabetes atlas. 2013. https://diabetesatlas.org/upload/resources/material/20200302_133351_IDFATLAS9e-final-web.pdf

Fina Lubaki, J.-P., Omole, O. B. & Francis, J. M. 2022. Glycaemic control among type 2 diabetes patients in sub-Saharan Africa from 2012 to 2022: a systematic review and meta-analysis. *Diabetology & Metabolic Syndrome,* 14**,** 134.

Haghighatpanah, M., Nejad, A. S. M., Haghighatpanah, M., Thunga, G. & Mallayasamy, S. 2018. Factors that correlate with poor glycemic control in type 2 diabetes mellitus patients with complications. *Osong public health and research perspectives,* 9**,** 167.

Hall, V., Thomsen, R. W., Henriksen, O. & Lohse, N. 2011. Diabetes in Sub Saharan Africa 1999-2011: epidemiology and public health implications. A systematic review. *BMC public health,* 11**,** 1-12.

Hammack, D. C. 2006. American debates on the legitimacy of foundations. *The legitimacy of philanthropic foundations: United States and European perspectives***,** 49-98.

Kamuhabwa, A. R. & Charles, E. 2014. Predictors of poor glycemic control in type 2 diabetic patients attending public hospitals in Dar es Salaam. *Drug, healthcare and patient safety***,** 155-165.

Kautzky-Willer, A., Kosi, L., Lin, J. & Mihaljevic, R. 2015. Gender-based differences in glycaemic control and hypoglycaemia prevalence in patients with type 2 diabetes: results from patient-level pooled data of six randomized controlled trials. *Diabetes, obesity and metabolism,* 17**,** 533-540.

Khattab, M., Khader, Y. S., Al-Khawaldeh, A. & Ajlouni, K. 2010. Factors associated with poor glycemic control among patients with type 2 diabetes. *Journal of Diabetes and its Complications,* 24**,** 84-89.

Letta, S., Aga, F., Assebe Yadeta, T., Geda, B. & Dessie, Y. 2022. Self-care practices and correlates among patients with type 2 diabetes in Eastern Ethiopia: A hospital-based cross-sectional study. *SAGE open medicine,* 10**,** 20503121221107337.

Mamo, Y., Bekele, F., Nigussie, T. & Zewudie, A. 2019. Determinants of poor glycemic control among adult patients with type 2 diabetes mellitus in Jimma University Medical Center, Jimma zone, south west Ethiopia: a case control study. *BMC endocrine disorders,* 19**,** 1-11.

Mbanya, J. C. N., Motala, A. A., Sobngwi, E., Assah, F. K. & Enoru, S. T. 2010. Diabetes in sub-saharan africa. *The lancet,* 375**,** 2254-2266.

Miras, A. D., Risstad, H., Baqai, N., Law, S., Søvik, T. T., Mala, T., Olbers, T., Kristinsson, J. A. & Le Roux, C. W. 2014. Application of the International Diabetes Federation and American Diabetes Association criteria in the assessment of metabolic control after bariatric surgery. *Diabetes, obesity and metabolism,* 16**,** 86-89.

Marathe, P. H., Gao, H. X. & Close, K. L. 2017. American D iabetes A ssociation S tandards of M edical C are in D iabetes 2017. Wiley Online Library.

Motuma, A., Gobena, T., Roba, K. T., Berhane, Y. & Worku, A. 2020. Metabolic Syndrome Among Working Adults in Eastern Ethiopia. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy,* 13**,** 4941-4951.

Motuma, A., Gobena, T., Roba, K. T., Berhane, Y. & Worku, A. 2021. Sedentary Behavior and Associated Factors Among Working Adults in Eastern Ethiopia. *Frontiers in Public Health,* 9.

Nigussie, S., Birhan, N., Amare, F., Mengistu, G., Adem, F. & Abegaz, T. M. 2021. Rate of glycemic control and associated factors among type two diabetes mellitus patients in Ethiopia: a cross sectional study. *PloS one,* 16**,** e0251506.

Ogurtsova, K., Guariguata, L., Barengo, N. C., Ruiz, P. L.-D., Sacre, J. W., Karuranga, S., Sun, H., Boyko, E. J. & Magliano, D. J. 2022. IDF diabetes Atlas: Global estimates of undiagnosed diabetes in adults for 2021. *Diabetes research and clinical practice,* 183**,** 109118.

Ojuka, E. O. & Goyaram, V. 2014. Increasing prevalence of type 2 diabetes in sub-Saharan Africa: not only a case of inadequate physical activity. *Diabetes and Physical Activity,* 60**,** 27-35.

Raum, E., Krämer, H. U., Rüter, G., Rothenbacher, D., Rosemann, T., Szecsenyi, J. & Brenner, H. 2012. Medication non-adherence and poor glycaemic control in patients with type 2 diabetes mellitus. *Diabetes research and clinical practice,* 97**,** 377-384.

Saeedi, P., Petersohn, I., Salpea, P., Malanda, B., Karuranga, S., Unwin, N., Colagiuri, S., Guariguata, L., Motala, A. A. & Ogurtsova, K. 2019. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes research and clinical practice,* 157**,** 107843.

Sahile, A. T. & Bekele, G. E. 2020. Prevalence of diabetes mellitus and associated factors in Addis Ababa public health facilities, Addis Ababa, Ethiopia, 2016. Diabetes, Metabolic Syndrome and Obesity, 501-508.

Sami, W., Ansari, T., Butt, N. S. & Ab Hamid, M. R. 2017. Effect of diet on type 2 diabetes mellitus: A review. *International journal of health sciences,* 11**,** 65.

Sendekie, A. K., Teshale, A. B. & Tefera, Y. G. 2022. Glycemic control in newly insulin-initiated patients with type 2 diabetes mellitus: A retrospective follow-up study at a university hospital in Ethiopia. *Plos one,* 17**,** e0268639.

Tegegne, K. D., Gebeyehu, N. A., Yirdaw, L. T., Yitayew, Y. A. & Kassaw, M. W. 2024. Determinants of poor glycemic control among type 2 diabetes in Ethiopia: a systematic review and meta-analysis. *Frontiers in Public Health,* 12**,** 1256024.

Tekalegn, Y., Addissie, A., Kebede, T. & Ayele, W. 2018. Magnitude of glycemic control and its associated factors among patients with type 2 diabetes at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. *Plos one,* 13**,** e0193442.

Tusa, B. S., Weldesenbet, A. B. & Kebede, S. A. 2020. Spatial distribution and associated factors of underweight in Ethiopia: an analysis of Ethiopian demographic and health survey, 2016. Plos one, 15, e0242744.

CSA 2016. Central Statistical Agency (CSA)[Ethiopia] and ICF. Ethiopia Demographic and Health Survey, Addis Ababa. Central Statistical Agency.

Weng, W., Tian, Y., Kimball, E. S., Kong, S. X., Bouchard, J., Hobbs, T. M. & Sakurada, B. 2017. Treatment patterns and clinical characteristics of patients with type 2 diabetes mellitus according to body mass index: findings from an electronic medical records database. *BMJ Open Diabetes Research and Care,* 5**,** e000382.

Ye, J., Wu, Y., Yang, S., Zhu, D., Chen, F., Chen, J., Ji, X. & Hou, K. 2023. The global, regional and national burden of type 2 diabetes mellitus in the past, present and future: a systematic analysis of the Global Burden of Disease Study 2019. *Frontiers in Endocrinology,* 14**,** 1192629.

WHO 2016. WHO Diabetes Country Profiles https://cdn.who.int/media/docs/default source/ncds/ncd-surveillance/diabetes_ profiles _explanatory_notes.pdf?sfvrsn=f2a2083c_5

WHO, 2005. WHO STEPS surveillance manual: the WHO STEPwise approach to chronic disease risk factor surveillance. Geneva: World Health Organization.

Zekewos, A., Loha, E., Egeno, T., Wubshet, K. & Merga, Z. 2018. Prevalence of diabetes mellitus and associated factors in Southern Ethiopia: a community-based study. Ethiopian journal of health sciences, 28.

Zeru, M. A., Tesfa, E., Mitiku, A. A., Seyoum, A. & Bokoro, T. A. 2021. Prevalence and risk factors of type-2 diabetes mellitus in Ethiopia: systematic review and meta analysis. *Scientific reports,* 11**,** 21733.