

Research Article

Glycemic Control and Associated Factors Among Diabetics on Active Follow up at Public Hospitals of Harar, Eastern Ethiopia

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Abstract

Background: Poor glycemic control leads to medical consequences, whereas effective glycemic control minimizes acute and chronic complications and death due to Diabetes Mellitus. In some literatures, the prevalence of poor glycemic control approaches 80%. Considering the seriousness of the problem, there is a knowledge gap in the study area regarding the prevalence of poor glycemic control and the underlying causes. Therefore, this study aimed assess the status of poor glycemic control and associated factors among diabetics on active follow up at public hospitals of Harar, Eastern Ethiopia from February 1-28, 2023. **Methods:** Cross-sectional study design was employed. Proportionate stratified sampling technique was applied to obtain 405 diabetic patients on active follow. Data was entered in to EpiData software version 4.6, then exported to STATA software version 17 for analysis. Three consecutive months' average fasting blood glucose level was used to determine glycemic control. Explanatory variables with p value less than 0.20 in bivariate logistic regression analysis were entered into the multivariable logistic regression analysis model. Every variable with P-values less than 0.05 in the multivariable logistic model was considered as statistically significant. **Results:** Mean age of pediatric participants was 11.3 years $\pm$ 4.1 SD while the mean age of adult participants was 49.8 years $\pm$ 14.7 SD. Females made up 52.1% of the total. Overall prevalence of poor glycemic control was 73.6% (95%CI: 69-77.7). Age >50 years (AOR = 3.01; 95% CI: 1.10-8.24), being Unemployed (AOR = 6.06; 95% CI: 1.43-25.60), poor level of adherence to blood sugar testing (AOR = 3.95; 95% CI: 1.61-9.70), duration > 4 years on DM treatment (AOR) = 2.23; 95%CI: 1.001-4.98) and high level of total serum triglyceride (AOR = 10.37; 95%CI: 4.29-25.06) significantly increased the odds of poor glycemic control. **Conclusion:** There is high prevalence of poor glycemic control in the study area. The factors with statistically significant effects on poor glycemic control included age ≥ 50 years, unemployment, low blood sugar testing compliance, longer duration on treatment, and high levels of total serum triglycerides. I recommend especial attention to the elderlies, unemployeds and those with long duration on treatment.

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Keywords

Associated Factors, Diabetes Mellitus, Eastern Ethiopia, Glycemic Control, Harar

1. Introduction

Hyperglycemia is a defining feature of diabetes mellitus (DM), which is classified as a condition of improper carbohydrate metabolism [1]. One of the following criteria must be met in order to diagnose diabetes mellitus: symptoms of diabetes plus a random plasma glucose value of greater than 200 mg/dl, fasting plasma glucose greater than 126 mg/dl, OGTT 2-h value in venous plasma greater than 200 mg/dl, or HbA1c greater than 6.5% [2]. Based on the pathophysiology diabetes mellitus is broadly classified as type 2 (T2DM) and type 1 (T1DM). The former, accounts for more than 90% of the cases and it's more common in elderly whereas T1DM accounts around 5 to 10% and it's prevalent in children and adolescents [3, 4]. The genesis of T2DM is principally brought on by a confluence of two key factors: impaired insulin production by pancreatic β -cells and impaired insulin sensitivity of tissues [5]. It is thought that T1DM arises in genetically predisposed people when environmental factors prompt an immune response against pancreatic beta cells [5].

Diabetes mellitus is a rapidly accelerating worldwide health problem that contributes a lion share to the global health burden in terms of morbidity, mortality, and health expenditure. According to IDF 2021 data, 536.6 million people aged 20 to 79 years are living with diabetes mellitus worldwide. This figure is expected to rise to 783.2 million in 2045. Africa is expected to show the highest projection in 2045 (54.9 million). The low and middle income countries including Ethiopia shelters over 80% of the world diabetics. Although an estimated 1.3 million undiagnosed cases are expected [2], Ethiopia leads the African countries with over 3 million diabetics with highest projected proportional rise in 2045 [2].

In 2019 alone, 4.2 million people aged 20 to 70 years lost their lives due to DM. Out of this 285,600 of them occurred in Africa. Among the DM casualties in Africa, nearly 50% of them fall in the economically productive age group that is younger than 60 years. In 2019, approximately 760 billion USD went directly to diabetes mellitus and is expected to grow to 825 billion USD in 2030 (2). In 2013 about 34,262 deaths related to diabetes mellitus were reported from Ethiopia [2]. The country allocates around 32.7 USD per person for DM related health expenses [2].

To lead a quality life, delay the onset of complications and reduce health costs, a good glycemic control is recommended. Improved glycemic control, glycated hemoglobin (HbA1c) value less than or equal to 7% or FBG of 80 to 130 mg / dL and postprandial blood glucose level less than

180mg/dL are targeted in most patients. Slightly higher targets can be tolerated if the individual is elderly or have complications like hypoglycemia [6, 7].

In well-established setups HbA1c is the gold standard for measuring long-term glycemic control and a good indicator of long-term diabetic complications; since it is least affected by recent fluctuation in blood glucose (8). However due to the fact that it's not readily available in all setups, in most clinical follow ups FBG is measured. Too many nations still lack access to SMBG, and still more have little or no access to continuous glucose monitoring (CGM) [8]. Only 18.6% of the patients in a prior Ethiopian research had previously undergone a HbA1c test. According to other studies, none of the investigated diabetes patients had their HbA1c levels measured [8].

A good glycemic control reduces both acute and chronic DM related complications and death [9]. In practice, achieving and maintaining a good glycemic control for prolonged period in a patient is very difficult, if possible at all. This is because factors associated with glycemic control are multiple and complex.

Glycemic control requires a team effort among the patients, their families and the medical team. Studies shows the role of different factors in glycemic control. Educational status, type of employment, level of adherence to medication, duration with DM, duration on treatment, health education, exercise, body mass index, diet, smoking, gender, etc were found to be among the factors that play the major role in achieving and maintaining good glycemic control [10-15].

More than half of diabetic individuals have poor glycemic control [17]. Poor glycemic control is a widespread issue around the world. Global observational research showed that the percentage of people with poor glycemic control ranges from 50.1% to 91.8%. The proportion of adult and juvenile diabetics with poor glycemic control reaches 80% in certain parts of the world [17].

In Sub-Saharan Africa (SSA), a ten-year systematic study and meta-analysis revealed that between 40 and 90% of diabetic people have poor glycemic control. In Ethiopia, a thorough review and meta-analysis revealed that 65.6% to 66.8% of people had trouble maintaining appropriate glycemic control [17].

Patients should work to meet predetermined glycemic targets as there are a number of problems that can arise from poor glycemic control. Long-term uncontrolled hyperglycemia can affect several body organs and cause macrovascular

and microvascular problems such neuropathy, nephropathy, retinopathy, cardiovascular disorders, amputations, and even premature deaths [17].

Productivity is invariably hampered by poorly managed DM and its complications. Poor glycemic control increases the risk of death by 20%, myocardial infarction by 5%, stroke by 2%, clinical neuropathy by 50%, and retinopathy requiring laser therapy by 45% [17].

Several studies that were conducted on the prevalence of poor glycemic control and its associated factors among DM patients in Ethiopia have been published. The majority of these research, however, are narrowly focused on particular age groups and DM types. In addition, despite of the seriousness of the problem there is information gap regarding the prevalence of poor glycemic control and its associated factors in the study area.

This study intends to fill the knowledge gap on the prevalence of poor glycemic control and its contributing factors, by including both type 1 and type 2 diabetes and all age groups in Hiwot Fana Comprehensive Specialized University and Jugal Regional Hospitals of Harar, Eastern Ethiopia.

2. Materials and Methods

2.1. Study Settings, Design and Periods

The study was conducted in public hospitals in Harar town namely Hiwot Fana Comprehensive Specialized University and Jugal regional Hospitals. Harar is located in Harari region, about 526 Km away from Addis Ababa the capital city of Ethiopia. There are 4 hospitals in the city; these are a teaching, a regional, a police, and one private hospitals. In addition, there are eight health centers, 31 private clinics, 26 health posts, one fistula center and one regional laboratory.

HFCSUH is serving as a referral hospital for the entire eastern part of the country including Eastern Oromia, Dire Dawa city administration, Harari, and Somali regional states. Currently the hospital serves about 5.2 million people. It serves as a teaching center of Eastern Ethiopia. The hospital has five major department namely internal medicine, surgery, pediatrics, emergency (Harme-MEcare) and gynecology and obstetrics. There are also other specialty services such as ophthalmology, ENT, dermatology, anesthesiology, critical care and pain medicine (central ICU), and orthopedics and traumatology. The internal medicine and pediatrics departments have several follow up programs including ART, TB, cardiology, neurology, renal, GI, hypertension and diabetes mellitus.

Jugal hospital is one of the four governmental hospitals. Its administration is Harari health bureau. It serves as the general hospital of the region, mainly giving service to the society of Harar and Eastern Harerghe. It has four main departments; Gynecology/Obstetric, Internal Medicine, Surgery and Pediatrics. The internal medicine department has an ICU, emergency, inpatient, outpatient and follow up services. The

follow up services include anti-retroviral treatment (ART), hypertension and diabetes mellitus follow up.

This study was conducted in the diabetes mellitus follow up clinic of the two hospitals from February 1-28, 2023. A hospital based cross-sectional study design was used.

2.2. Source Population, Study Population and Eligibility Criteria

The source population were All diabetes mellitus patients who are on active follow up at DM follow up clinics of HFCSU and Jugal regional hospitals. The study population were Diabetes mellitus patients who are on active follow up at DM follow up clinics of HFCSU & Jugal regional hospitals and visits the follow up clinic during February 1 to 28, 2023.

Diabetic Patients with regular follow up and had at least 3 or more consecutive monthly measurements of fasting blood sugar level were included in the study. Critically ill diabetic patients and Pregnant women were excluded from the study.

2.3. Study Variables

2.3.1. Dependent Variables

Glycemic control status

2.3.2. Independent Variables

1) Sociodemographic status

- a. Age
- b. Sex
- c. Residence
- d. Educational status
- e. Religion
- f. Occupational status
- g. Marital status
- h. Insurance coverage

2) Diabetic self-care

- a. Diet adherence
- b. Physical activity adherence
- c. Foot care adherence
- d. Smoking
- e. Adherence to medication
- f. Adherence to BS testing

3) Clinical variables

- a. Body mass index
- b. Diabetic complication
- c. Comorbidity
- d. Duration of DM
- e. Duration per visit
- f. Type of DM
- g. Family history of DM

4) Knowledge and attitude

- a. Knowledge
- b. Attitude

5) Biochemical profiles

- a. Cholesterol level
- b. Serum triglyceride level
- c. Serum creatinine level
- d. Urine protein level

2.4. Sample Size Determination and Sampling Procedures

The sample size for prevalence of glycemic control was calculated by using the formula for single population proportion.

$$n = (Z_{\alpha/2})^2 P(1-P) / d^2$$

Where n is the sample size required; d, margin of error of 5% ($d = 0.05$); Z, the degree of accuracy required at 95% confidence level = 1.96; and P = 70.8% of prevalence of poor glycemic control (18). Replacing in the formula $n = (1.96)^2(0.708)(1-0.708)/(0.05)^2 = 318$.

There are about 500 diabetics on active follow up at the two public hospitals. In addition to this there is a pediatric DM follow up clinic at HFCSUH. Therefore proportionate stratified sampling technique was employed as depicted in the table below. To calculate the required sample size from each stratum the following formula was used. (sample size/population size)*(stratum size) (Table 1). The calculated samples from each stratum were then collected using a simple random sampling technique.

Table 1. Sample size procedures.

Average number of Diabetics on active follow up (N= 500)	Follow up clinic	Required sample size from each strata
370 Adult	Adult clinic	$(405/500)*(370) = 300$ (n _{HA})
130 (N _{HP})	Pediatrics clinic	$(405/500)*(130) = 105$ (n _{HP})

2.5. Data Collection Tool and Procedures

The data collection instrument is developed after several similar literatures were reviewed thoroughly. It is arranged in three parts.

Part 1: Questionnaire on socio demographic variables.

Part 2: Tools to assess self-care activities of the patients: Summary of diabetes self-care activities (SDSCA) scale was used. This scale was developed by Toobert and Glasgow; it has acceptable reliability and validity. It contains 12 questions about the diet, exercises, blood sugar test and foot care [17]. Adherence to medication was assessed using the revised SDSCA which has three questions on medication adherence.

Part 3: Tools to assess knowledge and attitude towards glycemic control. This tool is adopted from a scholarly article prepared in university of Gondor. It has 16 items on knowledge and 12 items on attitude [17].

Part 4: A and B: Checklist to review patient's medical record about their last three fasting blood glucose, type of treatment regimen patient are receiving, duration with DM, duration per visit, comorbidity, DM complication, family history, BMI, serum cholesterol level, serum creatinine level and urine protein level.

2.6. Operational Definition

- 1) *Good glycemic control* is defined as patients' average fasting blood glucose measurement of three consecutive visits which is between 70 and 130 mg/dL. Any

measurement which is above 130 or below 70 mg/dL is defined as poor glycemic control [17].

- 2) *Adherence to diet*: If the study participant had followed the recommended diet for 3 or more days in last seven days [17].

- 3) *Adherence to exercise*: If the study participant had followed the recommended level of exercise/activity for 5 or more days in last seven days [17].

- 4) *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 [17].

- 5) *Adherence to medication*: If the study participant took all his/her anti diabetic medication in the last seven days will be taken as adherence and failure to do so as none-adherence [17].

6) Knowledge

Adequate knowledge: Refers to participants who correctly responded to more than 50% of knowledge questions. If it is less than or equal to this it is referred as inadequate knowledge [17].

- 7) *Foot-care adherence*: Summary value marking 75% percentile and above represented a good adherence anything less than that poor adherence [17].

8) Attitude

Good attitude: Refers to participants who positively responded more than 50% of attitude assessing questions. positively answering less than 50% of the questions is termed as poor attitude [17].

2.7. Data Quality Control

The data collection tool is first prepared in English and then was translated to Amharic and Afan Oromo. Then again it was translated back to English by different expert to ensure validity of translation. Necessary training was given for data collectors on the contents of the data collection tool, data collection procedures and ethical considerations during data collection by the principal investigator (PI).

A pretest was conducted on randomly selected 20 (5% of the calculated sample size) DM patients who are on active DM follow up at Dilchora hospital, Dire Dawa, a week before the actual data collection. Then, adjustments were made on the tool for final data collection. Close supervision was carried out on daily basis by the supervisor and the PI during the data collection time. Data from each questionnaires was checked for completeness, clarity, consistency, and accuracy by the PI. Any missed or incorrectly filled questionnaire were sent back to the respective data collector for correction. Data clean up was done before analysis.

2.8. Data Processing and Analysis

After categorization is completed, each variables were checked for missed values and any inconsistencies. The data was coded and entered in to EpiData software version 4.6, which was then exported to STATA software version 17 for additional data cleaning and analysis. Descriptive statistics such as mean, midian, frequency and percentage were used to describe the independent variables. A bivariate logistic regression analysis was done to select the variables to be entered into the final logistic multivariable analysis.

Explanatory variables with p value less than 0.20 in bivariate logistic regression analysis were entered into the multivariate logistic regression analysis model using forward stepwise regression analysis approach and association between the independent variables and glycemic control was assessed using adjusted odds ratio at a 95% confidence interval.

The model's fitness was evaluated based on Hosmer and Lemeshow's goodness-of-fit statistics, the p-value was 0.95 indicating a fitted model. In addition, multicollinearity was assessed using the variance inflation factor, which was 2.69. The variables with a P value below 0.05 were used to declare statistical significance.

3. Results

3.1. Socio Demographic Characteristics of Participants

A total of 405 children and adult diabetic patients were included in the study. There were 105 children (age <18 years) and 300 adults (age ≥ 18 years) in the study. The mean age of pediatric participants was 11.3 years ± 4.1 SD while the mean age of adult participants was 49.8 years ± 14.7 SD. More than half of the respondents 211 (52.1%) were females. Two hundred seventy two (67.2%) of them were urban dwellers. Most of the adult participants (52.86%) were married. 119 (29.4%) had no formal education. Over two third, 273 (67.4%), of them had health insurance coverage (Table 2).

Table 2. Socio demographic characteristics of DM patients on active DM follow up at public hospitals of Harar, Eastern Ethiopia, February 2023 (N=405).

Variables	Categories	Frequency (%)
Sex	Female	211 (52.10)
	Male	194 (47.90)
Age (mean=11.3 for pediatrics and 49.8 for adult)	1-11 years	46 (11.36)
	12-17 years	62 (15.31)
	18-49 years	124 (30.62)
	≥ 50 years	173 (30.62)
Current residence	Urban	272 (67.16)
	Rural	133 (32.84)
Religion	Orthodox	140 (34.57)
	Muslim	216 (53.33)
	Protestant	38 (9.38)
	Catholic	11 (2.72)

Variables	Categories	Frequency (%)
Marital status	Single	133 (32.84)
	In relationship	17 (4.20)
	Married	164 (40.49)
	Divorced	45 (11.11)
	Widowed	46 (11.36)
Educational status	Can't read and write	119 (29.38)
	Can read and write	51 (12.59)
	Primary	163 (40.25)
	Secondary	72 (17.78)
Occupational status	Unemployed	122 (30.12)
	Private	61 (15.06)
	Government /NGO	27 (6.67)
	House wife	75 (18.52)
	Students	120 (29.63)
Insurance coverage	Insured	273 (67.41)
	Uninsured	132 (32.59)
Distance to HF*	Near by	214 (52.84)
	Far away	191 (47.16)

*Distance from the health facility where the follow up is taking place.

3.2. Clinical and Biochemical Characteristics of Participants

There were a total of 149 (36.79%) type 1 and 256 (63.21%) type 2 diabetic patients. More than four-fifth of the respondents 348 (85.93%) had no family history of DM. Majority, 239 (59.01), of the participants were diagnosed within the last 5 years. More than half of respondents, 250 (61.7%), had no diabetic complications. About two-third (64.7%) respondents had no comorbid diseases. Out of the total participants, 219 (54%)

respondents were taking insulin only (s had no albuminuria).

The median (IQR) duration since diagnosis was 5 years $\pm$ 5 with the a minimum 1 year and a maximum of 32 years. Similarly, the median (IQR) duration since treatment started was 4 years $\pm$ 5 with the a minimum 1 year and a maximum of 32 years.

Nearly three-fourth, 299 (73.83), of the participants had normal level (<150mg/dl) of total serum cholesterol. On the other hand, about half 200 (49.38) of the participants had elevated level (>0.55mg/dl) of serum creatinine. Around 328 (81%) of the study participants had no albuminuria (Table 3).

Table 3. Clinical characteristics of DM patients on active DM follow up at public hospitals of Harar, Eastern Ethiopia, February 2023 (N=405).

Variables	Categories	Frequency (%)
Type of DM	Type I	149 (36.79)
	Type II	256 (63.21)
Family history of DM	Yes	57 (14.07)
	No	348 (85.93)
Current medication type	Single oral	38 (9.38)

Variables	Categories	Frequency (%)
Initial regimen	Combined oral	123 (30.37)
	Injection only	219 (54.07)
	Combined oral and injection	25 (6.17)
	Single oral	18 (7)
	Combined oral	30 (7.41)
DM complication	Injection only	160 (39.51)
	Combined oral and injection	20 (4.94)
	Yes	155 (38.27)
DM comorbidity	No	250 (61.73)
	Yes	143 (35.31)
Duration since diagnosis (midian = 5 years)	No	262 (64.69)
	< 5 years	239 (59.01)
Duration on treatment	> 5 years	166 (40.99)
	< 4 years	206 (50.86)
Frequency of HF visiting	>4 years	199 (49.14)
	Every month	286 (70.62)
	Every two month	117 (28.89)
Time spent per a single visit	Others*	2 (0.49)
	< One day	228 (56.30)
	>One day	177 (43.7)
Total serum cholesterol	Normal	299 (73.83)
	High	106 (26.17)
Total serum triglyceride	Normal	215 (53.09)
	High	190 (46.91)
Serum creatinine	Normal	205 (50.62)
	Elevated	200 (49.38)
Urine albumin	Negative	328 (80.99)
	Positive	77 (19.01)

*every week and every two week

3.3. Diabetic Self-care Characteristics of Participants

Table 4. Diabetic self-care characteristics of DM patients on active DM follow up at public hospitals of Harar, Eastern Ethiopia, February 2023 (N=405).

Variables	Categories	Frequency (%)
Adherence to diet	Good	102 (25.19)
	Poor	303 (74.81)

Variables	Categories	Frequency (%)
Adherence to exercise	Good	147 (36.30)
	Poor	258 (63.70)
Adherence to BS testing	Good	91 (22.47)
	Poor	314 (77.53)
Adherence to foot care	Good	137 (33.83)
	Poor	268 (66.17)
Adherence to medication	Good	211 (52.10)
	Poor	194 (47.90)
Smoking	Yes	18 (4.44)
	No	387 (95.56)

Well over three quarters of the subjects, totaling 303 (74.8%), exhibited poor dietary adherence. Exercise was adhered to by 258 (63.7%) people, blood sugar monitoring by 314 (77.5%), and foot care by 268 (66.2%). Nonetheless, over 50% of the individuals had good levels of adherence to 211 (52.1%) DM medications (Table 4)

3.4. Knowledge and Attitude of Participants

359 diabetics and 46 caregivers of diabetic children under the age of 12 were interviewed regarding their knowledge and attitudes towards glycemic control. Four hundred of the respondents (98.8%) knew the effect of sugar intake on DM.

Yet, just 50 (12%) of them knew the causes of DM (Table 5).

Three hundred ninety five, (98%) of the respondents thought regular exercise can help in glycemic control. On the other hand only ninety (22%) of them thought regular blood sugar testing is important for glycemic control (Table 7). Over all two hundred thirty eight (58.77%) of the participants had gave positive response for at least 7 seven of the attitude questions (Table 6).

More than half of respondents, 217 (53.582%) had inadequate knowledge towards glycemic control. On the other hand less than half of the respondents, 167 (41.23%) had poor attitude towards glycemic control (Table 7).

Table 5. Frequency of responses to glycemic control knowledge assessment questions among DM patients on active DM follow up at public hospitals of Harar, Eastern Ethiopia, February 2023 (N=405).

S.no	Knowledge questions	Correct response n (%)	Incorrect response n (%)
1	What is DM?	170 (42)	235 (58)
2	What type of DM you had?	131 (32)	274 (68)
3	What is/are the causes of DM?	50 (12)	355 (88)
4	What kind of medications are used to treat DM?	222 (55)	183 (45)
5	What do you do when you become hypoglycemic?	219 (54)	186 (46)
6	How to inject insulin? (if on insulin)	201 (50)	204 (50)
7	Is that DM hereditary?	72 (18)	333 (82)
8	What does lipidemic/obesity/hypertension mean?	180 (44)	225 (56)
9	What is/are the risk factors of DM?	67 (17)	338 (83)
10	How is DM be detected?	210 (52)	195 (48)
11	Could DM affect other organs?	150 (37)	255 (63)
12	Can complications occur due to DM?	227 (56)	178 (44)

S.no	Knowledge questions	Correct response n (%)	Incorrect response n (%)
13	What is/are the effect of regular exercise on DM?	245 (60)	160 (40)
14	What is/are the effect of extra salt intake on DM?	200 (49)	205 (51)
15	What is/are the effect of sugar intake on DM?	400 (98)	5 (2)
16	What is/are the effect of smoking on DM?	151 (37.3)	254 (62.7)

Table 6. Frequency of responses to attitude towards glycemic control assessment questions among DM patients on active DM follow up at public hospitals of Harar, Eastern Ethiopia, February 2023 (N=405).

S.no	Attitude Questions	Positive response n (%)	Negative response n (%)
1	Do you think glycemic control is necessary for DM?	350 (86)	55 (14)
2	Do you think regular exercise can help to control DM?	395 (98)	10 (2)
3	Do you think smoking causes poor glycemic control?	150 (37)	255 (63)
4	Do you think blood pressure control is necessary for glycemic control?	250 (62)	155 (38)
5	Do you think glycemic control prolonged life expectancy?	100 (25)	305 (75)
6	Do you think that alternative treatments are good?	200 (49)	205 (51)
7	Do you think regular blood sugar testing is important for DM?	90 (22)	315 (78)
8	Do you think diet alone glycemic control is better than medication with diet glycemic control?	150 (37)	255 (63)
9	Do you believe fruits and vegetables are good for glycemic control?	350 (86)	55 (14)
10	Do you think alcohol can increase the complication of DM?	350 (86)	55 (14)
11	Do you think insulin (metformin) drug has harmful effects to the organs of the body?	100 (25)	305 (75)
12	Do you think traditional treatments are better than modern medicines for DM?	320 (79)	85 (21)

Table 7. Knowledge and attitude of DM patients on active DM follow up at public hospitals of Harar, Eastern Ethiopia, February 2023 (N=405).

Variables	Categories	Frequency (%)
Knowledge level	Adequate	188 (46.42)
	Inadequate	217 (53.58)
Attitude level	Good	238 (58.77)
	Poor	167 (41.23)

3.5. Prevalence of Poor Glycemic Control Among Participants

The median (IQR) fasting blood sugar was 167 mg/dl $\pm$ 99 with the a minimum 60 mg/dl and a maximum of 452 mg/dl.

The overall prevalence of poor glycemic control was 73.6% (95%CI: 69-77.7). The highest prevalence of poor glycemic control 145 (83.8%) was seen among patients who are 50 and more years of age. Among the participants, around one hundred sixty six (78.7%) of the females, one hundred eighty (69.9%) of the urban dwellers and one hundred four

(63.4%) of the married ones had poor glycemic control. The majority of respondents who had poor glycemic control were unemployed 108 (88.5%).

Out of all the participants, one hundred fifteen (77%) of T1DM and one hundred eighty three (71.5%) of T2DM patients had poor glycemic control. Two hundred fifty (71.8%) of participants who had no family history of DM had poor glycemic control. One hundred seventy four (66.4%) subjects who had no comorbid disease had poor glycemic control. Poor glycemic control was predominant, thirty one (81.6%), in the participants who are on single oral regimen.

Two hundred fifty six (84.5%) of participants with poor dietary adherence, two hundred twenty one (85.6%) of participants with poor exercise adherence and two hundred seventy one (86%) of participants with poor blood sugar testing adherence exhibited poor level of glycemic control. Further more, two hundred thirty three (86.9%) of participants with poor foot care adherence and one hundred seventy two (88.7%) of participants with poor DM medication adherence had poor glycemic control. Two hundred eighty two (72.9%) non-smokers had poor glycemic control.

Two hundred nine (96%) and 164 (98%) of participants who had inadequate knowledge and poor attitude towards glycemic control respectively had poor glycemic control. One hundred two (96%) and 181 (95%) of participants with high serum level of total cholesterol and triglyceride had poor glycemic control.

3.6. Factors Associated with Poor Glycemic Control Among Participants

The following variables were all included in the multivariate logistic regression with a p value of less than 0.2 during the bivariate logistic regression. This includes sociodemographic factors like age, sex, residence, distance from a

health facility, employment status, education status, and insurance coverage; self-care traits like adherence to a diet, exercise, blood sugar testing, foot care, and medication; knowledge and attitude toward glycemic control; duration since diagnosis, duration on treatment, duration per single visit, frequency of health facility visits, family history, complications and comorbidities, history of medication adverse effect, current and initial medication regimen; and biochemical factors like serum cholesterol, serum triglyceride and urine protein levels.

In multivariable logistic regression analysis, the variables with significant effects on poor glycemic control include age >50 years, unemployed occupational status, poor adherence to blood sugar testing, duration > 4 years on DM treatment and high level of total serum triglyceride. Participants who were >50 years old had nearly three times the likelihood of having poor glycemic control than those who 18-49 years old: adjusted odds ratio (AOR) = 3.01; 95% confidence interval (CI): [1.10-8.24; p = 0.03]. The odds of poor glycemic control in participants who were unemployed was approximately six times higher than in those who were Government/NGO employed: AOR = 6.06; 95%CI: [1.43-25.60; p = 0.01]. Patients with a poor level of adherence to blood sugar testing were nearly four times more likely to have poor glycemic control than those who had a good level of adherence: AOR = 3.95; 95% CI: [1.61-9.70; p = 0.003]. Participants who had stayed more than 4 years on DM treatment had nearly double the likelihood of having poor glycemic control than those who stayed less years: adjusted odds ratio (AOR) = 2.23; 95% confidence interval (CI): [1.00-4.98; p = 0.049]. The odds of poor glycemic control in participants who had high level of total serum triglyceride was approximately ten times higher than in those who had normal level: AOR = 10.37; 95% CI: [4.29-25.06; p = 0.00] (Table 8).

Table 8. Factors Associated with Poor Glycemic Control among patients on active DM follow up at public hospitals of Harar, Eastern Ethiopia, February 2023 (N=405).

Factors	Categories	Glycemic status		COR (95%CI)	AOR (95%CI)	P value
		Poor (%)	Good (%)			
Age	18-49 years	70 (56.5)	54 (43.5)	1	1	
	1-11 years	32 (69.6)	14 (30.4)	1.76 (0.86-3.63)	1.45 (0.25-8.37)	0.68
	12-17 years	51 (82.3)	11 (17.7)	3.58 (1.7-7.5)	1.65 (0.24-11.16)	0.61
	>50 years	145 (83.1)	28 (16.9)	3.99 (2.33-6.84)	3.01 (1.10-8.24)	0.03*
Sex	Male	132 (68)	62 (32)	1	1	
	Female	166 (78.7)	45 (21.3)	1.73 (1.11-2.71)	2.20 (0.95-5.08)	0.07
Current residence	Urban	190 (70)	82 (30)	1	1	
	Rural	108 (82.2)	25 (17.8)	1.86 (1.12-3.09)	1.77 (0.67-4.67)	0.25

Factors	Categories	Glycemic status		COR (95%CI)	AOR (95%CI)	P value
		Poor (%)	Good (%)			
Distance to HF	Near by	139 (60.7)	75 (39.3)	1	1	0.34
	Far away	159 (85)	32 (15)	2.68 (1.67-4.3)	1.55 (0.64-3.76)	
	Government /NGO	12 (44.4)	15 (55.6)	1	1	
Occupational status	Unemployed	108 (88.8)	14 (11.2)	9.64 (3.76-24.72)	6.06 (1.43-25.60)	0.01*
	Private	32 (52.5)	29 (47.5)	1.38 (0.55-3.42)	2.92 (0.76-11.20)	0.12
	House wife	53 (70.7)	22 (29.3)	3.01 (1.21-7.46)	4.58 (0.74-28.29)	0.10
	Students	93 (77.5)	27 (22.5)	4.3 (1.8-10.29)	2.63 (0.91-7.66)	0.08
Educational status	Secondary	35 (48.8)	37 (51.2)	1	1	0.21
	Can't read and write	106 (89.1)	13 (10.9)	8.62 (4.12-18.04)	4.16 (0.94-18.39)	
	Can read and write	44 (86.7)	7 (13.7)	6.64 (2.64- 16.70)	1.80 (0.36-9.05)	
Insurance	Primary	113 (69.3)	50 (30.7)	2.39 (1.35-4.22)	2.06 (0.67-6.35)	0.06
	Insured	183 (77)	90 (33)	1	1	0.89
	Uninsured	115 (87.1)	17 (12.9)	3.33 (1.88-5.80)	1.06 (0.44-2.55)	
Adherence to diet	Good	42 (41.2)	60 (58.8)	1	1	0.16
	Poor	256 (84.5)	47 (15.5)	7.78 (4.71-12.86)	1.97 (0.76-5.08)	
Adherence to BS testing	Good	27 (29.7)	64 (70.3)	1	1	0.003**
	Poor	271 (86.3)	43 (13.7)	14.94 (8.59-25.97)	3.95 (1.61-9.70)	
Duration on treatment	< 4 years	128 (62.1)	78 (37.9)	1	1	0.049*
	>4 years	170 (85.4)	29 (14.6)	3.57 (2.20-5.80)	2.23 (1.001-4.98)	
Total serum TG	Normal	117 (54.4)	98 (45.6)	1	1	0.00**
	High	181 (95.3)	9 (4.7)	16.85 (8.19-34.65)	10.37 (4.29-25.06)	

Note * p value <0.05, **p value <0.01, COR= crude odds ratio, AOR= adjusted odds ratio, BS blood sugar, HF=health facility.

4. Discussion

This study was carried out to assess the prevalence of glycemic control and associated factors among diabetic patients on active follow up at public hospitals of Harar, Eastern Ethiopia. Poor glycemic control was observed in 73.6% (95%CI: 69-77.7) of the participants. Age >50 years, unemployed occupational status, poor adherence to blood sugar testing, poor attitude towards glycemic control, duration > 4 years on DM treatment and high level of total serum triglyceride were significantly associated with poor glycemic control.

In this study poor glycemic control was observed in 73.6% of the participants. The proportion of poor glycemic control was comparable to the studies done in Saudi Arabia (74.9%) [19], Cameroon & Guinea (74%) [20], Sudan (71.9%) [21] and China (70.8%) [16].

The sociodemographic characteristics of the study participants could be used to explain the observed resemblance. Similar to the current study, the majority of participants in the Saudi Arabia study were women, urbanites, and relatively young. In contrast, the studies from Cameroon, Guinea, Sudan, and northeast Ethiopia all had low socioeconomic status, which is associated with subpar healthcare.

In studies, conducted in Iraq (86.2%) [23], South and South East Asia (78.2%) [24], Egypt (80.4%) [17], Addis Ababa (80%) [25] and Hawassa (83.6%) [26], the prevalence of poor glycemic control was higher than the current study. This discrepancy may have occurred because all of this studies were done on adult participants only.

On the other hand, the proportion of poor glycemic control in our area was higher than studies carried out in Iran (37%) [27], Thailand (54.8%) [28], western Ethiopia (64.1%) [29], Nekemte Referral Hospital (64.9%) [30] and Southwest Ethiopia (64.2%) [31]. This discrepancy may be due to the test used to measure glycemic control. All of the aforemen-

tioned research employed HbA1c, whereas the current study used FBS as a tool for measuring glycemic control. Since HbA1c is the gold standard, measurements can be made with greater accuracy [31].

In this study, participants who were ≥ 50 years old had nearly three times the odd of having poor glycemic control than those who were 18-49 years old. This finding is lined with studies conducted in Northern Ethiopia and in referral hospitals of Amhara region [18].

This could be due to the fact that older diabetics experience co-morbidities and DM problems more frequently than their younger counterparts. The most common are cardiovascular problems brought on by aging and by DM-specific premature atherosclerosis. While the most distressing problems are visual and cognitive deficits [23]. Frailty, cognitive decline and dementia, urinary incontinence, traumatic falls and fractures, disability, and side effects of polypharmacy are among the common geriatric syndromes that older patients with diabetes are more likely to experience. These conditions have a significant negative impact on quality of life and may interfere with anti-diabetic treatment [23].

The body's natural ability to regulate blood glucose levels diminishes over time, making it harder for elderly people to maintain stable blood glucose levels. Additionally, chronic inflammation and changes in physical activity due to aging can also contribute to poorer glycemic control in older age. Poor dietary choices and a lack of exercise can worsen glycemic control as well. Age-related health issues such as diabetes, stroke, and kidney disease may also worsen glycemic control with age [23]. This suggests that as people get older, it gets harder to manage their illnesses as well as the risk of having poor glycemic control.

But the odds of poor glycemic control was higher in younger age group as evidenced by a study from South Africa [32]. Other studies done in Dire Dawa [18] and Adama [18] say there is no significant association between glycemic control and age.

The odds of poor glycemic control in participants who were unemployed was approximately six times higher than in those who were Government/NGO employed. This was comparable to a study from west Ethiopia [33]. Unemployed individuals often lack access to health care and medical supplies necessary to effectively monitor and manage their diabetes, leading to an increased risk of complications and health issues related to poor glycemic control [23]. Additionally, unemployed individuals may suffer from financial stressors which can increase the risk of poor health outcomes such as high blood pressure, which can in turn increase the risk for poorly controlled diabetes. Finally, unemployed individuals might not have the time or resources required for regular physical activity, food planning, and stress management that are essential for proper diabetes management [23].

However, our finding was in contrast to a study from north-east Ethiopia where being merchant showed higher odds of having poor glycemic control than being government employee [22].

Patients with a poor level of adherence to blood sugar testing were nearly four times more likely to have poor glycemic control than those who had a good level of adherence. This was supported by a study from western Ethiopia [29]. It is impossible to adjust the treatment of a condition, including diabetes, if one does not have an understanding of where his or her current blood sugar level stands in relation to previous readings and expected levels [29]. Regular measurements give healthcare providers the opportunity to observe a patient's progress and make changes as necessary for better glycemic control. Even when patients take their medication correctly, failure to monitor their levels adequately can cause them to go undetected until it is too late [23].

Related to this there are questions about the use of SBGM as compared to Continuous Blood Glucose Monitoring [23]. Therefore the use of SBGM may need further evidence from comparative studies.

In the current study, participants who had stayed more than 4 years on DM treatment had nearly double the odds of having poor glycemic control than those who stayed less years. In a study conducted in Egypt among child diabetics, after adjusting for other variables, duration of disease were significant independent risk factors of poor glycemic control [17].

These similarities could be a result of the disease process lasting longer, endogenous insulin production steadily declining, an increase in diabetes complications that place a burden on medications, an increase in drug-drug and food-drug interactions that could lead to poor medication adherence, and finally an increase in blood glucose levels [23]. The body often becomes less sensitive to the medications over time. As a result, higher doses or more medications may be needed in order to gain the same degree of glucose control [23]. Furthermore, long-term use of certain medications can cause side effects which can further reduce their effectiveness in aiding with glucose control. It is also possible that prolonged treatment may lead to decreased patient compliance with dietary changes, insufficient exercise and medication regimens. All of these issues can contribute to poorer glycemic control over time [23].

The odds of poor glycemic control in participants who had high level of total serum triglyceride was approximately ten times higher than in those who had normal level. This was in line with studies from South Africa [32], Iraq [23] and Egypt [17]. Triglycerides are deposited in the cells in the form of fatty acids which can interfere with insulin response and make it difficult for insulin to regulate blood glucose levels. This can lead to high glucose levels and ultimately poor glycemic control [23]. Further more, it has been proven that patients with DM benefit from intensive therapy and lifestyle changes that are largely designed to lower serum lipid profiles in terms of glycemic control [17].

5. Conclusions and Recommendations

In general, there was a high frequency of poor glycemic

control in the study area. The factors with statistically significant effects on poor glycemic control included age ≥ 50 years, employment status, low blood sugar testing compliance, a longer duration of treatment, and high levels of total serum triglycerides.

To health professionals

- 1) Should provide especial attention to the elderly, unemployed and those with long duration on treatment and create case specific approach.
- 2) Should ensure that regular blood sugar monitoring is taking place and that readings are being taken accurately and consistently.
- 3) Should advise utilization of technology to make it easier for elderly people and those with longer duration on treatment to track their condition regularly, such as with mobile apps or remote glucose monitors.
- 4) Should educate patient about the importance of understanding their condition, adjusting their diet accordingly, and maintaining glycemic control through lifestyle modifications including regular exercise (activity level) and proper compliance with doctor's orders.
- 5) Should encourage goal setting and accountability when managing diabetes, especially for those with poor adherence towards standard care practices.
- 6) Should recommend specialist care if needed, such as nutrition counseling or endocrinology care to assist in better management of diabetes particularly in those with high serum triglyceride levels and compliance issues.

To health institutions

- 1) Should offer incentives for individuals who adhere to their blood sugar monitoring regimen, such as discounts or rewards for medical supplies and services.
- 2) Should invest in health literacy and sound nutrition education programs for elders and those with poor attitudes, targeting the low-income demographic specifically.
- 3) Should expand public education programs in the community targeting at-risk populations that emphasizes proper nutrition and exercise guidelines for people with diabetes.
- 4) Should provide diabetes self-management education resources tailored to address specific needs, such as lifestyle changes, proper monitoring techniques, and communication strategies with health care professionals for optimal control.
- 5) Should utilize evidence-based comprehensive treatment plans for patients with diabetes, focusing on lab results, physical activity goals, nutrition counseling and overall wellness instead of just pharmacological solutions.
- 6) Should increase access to insulin and other medications which can be critical for controlling blood sugar levels among diabetics who may not have reliable sources of income or transportation to regular doctor's visits or pharmacies where these options are available.

- 7) Should establish and expand access to patient assistance programs which provide resources such as free medication refills, dietary consultation and referrals to specialists (including mental health) should they be needed too.

To researchers

Should use HbA1c as a measure of glycemic control instead of the fasting blood sugar which is a good predictor of glycemic control over a long period of time.

6. Strengths and Limitations

The strengths of this study are that, unlike other researches done on related topics, it included all age groups and both types of diabetes mellitus. Some important factors which were not available in patient chart were collected by interview.

The average FBS over three months was employed in this study as a gauge of glycemic status. Nonetheless, it would have been preferable to have used HbA1c. The study used a cross-sectional study design, hence temporal relationship of the observed associations can't be told.

Abbreviations

AOR	Adjusted Odds Ratio
BMI	Body Mass Index
DM	Diabetes Mellitus
FBG	Fasting Blood Glucose
FBS	Fasting Blood Sugar
HbA1c	Glycated Hemoglobin
HFCSUH	Hiwot Fana Comprehensive Specialized University Hospital
IDF	International Diabetes Federation

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Ethical Approval

The study was carried out under consideration of the Helsinki Declaration of medical research ethics.

Ethical clearance (Ref. No. IHRERC/005/2023) was obtained from the Institutional Health Research Ethics review Committee of Haramaya University, College of Health and Medical Science. After explaining the aim and the benefit of the study informed, voluntary written and signed consent was obtained from each study participant and heads of public hospitals.

For children written informed consent was obtained from their parents. For those aged 12 to 17 years additional assent was obtained from themselves. All the information retrieved is and will be kept in a way that it could not interfere in personal confidentiality. Confidentiality of the information was maintained by omitting participants' names and personal identification. Participants found to be on poor glycemic control, poor adherence to medication or diet, the individual cases were communicated with the focal nurse in order to initiate an appropriate intervention.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request via (dawitabdibeka@gmail.com).

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Conflicts of Interest

The authors declare no conflicts of interest.

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