Journal of Environment and Pollution

PRIME OPEN ACCESS

Volume 1, Issue 1

Research Article

Date of Submission: 28 March, 2025
Date of Acceptance: 21 April, 2025
Date of Publication: 29 April, 2025

Prevalence of Poor Glycemic Control and Associated Factors Among Adult Type 2 Diabetes Mellitus Patient at Alert Hospital, Addis Ababa, Ethiopia, 2022

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Citation: Ahmed, M. F., Abdella, A. A., Asefa, T. T. (2025). Prevalence of Poor Glycemic Control and Associated Factors Among Adult Type 2 Diabetes Mellitus Patient at Alert Hospital, Addis Ababa, Ethiopia, 2022. *J Environ Pollut, 1*(1). 01-15.

Abstract

Background: Over the last fifty years, type 2 diabetes have become a significant contributor to the global disease burden, and this trend is expected to continue. The Diabetes Prevention Program and the Finnish Diabetes Prevention Study showed the value of primary diabetes prevention, and many studies emphasized the significance of strict management of plasma glucose levels in reducing complications in both type 1 and type 2 diabetes. The aim of this observational study was to assess the prevalence and the associated factors for glycemic 31 control among adult type 2 DM patients at ALERT hospital, Addis Ababa, Ethiopia, 2022.

Method: An institutional based cross-sectional study was employed the study population were adult type 2 DM patients with or without other comorbidities who were on follow at follow up clinic at ALERT hospital. Using a single population proportion formula, the final sample size for this study was 371. A systematic random sampling technique was used to select a sample size of 174 pregnant women. The data was cleaned, entered and analyzed using SPSS version 37 26.0 statistical software and MS excel.

Result: From the 371 participants, 60.9% were male participants; 55.3% between 35 and 64 years of age and 49.1% of them were married. Overall prevalence of poor glycemic control was 89.5%. associated hypertension (p-value=0.049, AOR=5.850) was significantly associated with poor glycemic control. having history of hospital admission (p-value=0.028, AOR=0.212), recent Fast Blood Sugar of 70-130mg/dl (p-value=0.003, AOR=0.025) and access for Self-Monitoring of Blood Glucose p-value=0.021, AOR=0.046) were negatively associated with poor glycemic control.

Conclusion and Recommendations: The proportion of poor glycemic control among the type 2 diabetic patients was very high in this study. Educating and preparing methods on managing glycemic control and associated factors for diabetic patients.

Keywords: Type 2, Diabetes, Glycemia, ALERT, Addis Ababa and Ethiopia

List of Abbreviations

ALERT All Africa Leprosy Tuberculosis and Rehabilitation Training

- AOR: Adjusted Odds Ratio
- BMI: Body Mass Index
- CI: Confidence Interval
- CMI: Chronic Medical Illness
- COR: Crude Odds Ratio
- DM: Diabetes Mellitus
- EDA: Ethiopian Diabetic Association
- FBS: Fasting Blood Glucose
- Hb: Hemoglobin

- HbA1C : Hemoglobin A1C (Glycated Hemoglobin)
- HTN: Hypertension
- IDF: International Diabetic Federation
- JADE: Joint Asia Diabetes Evaluation Program
- OAD: Oral Anti-diabetic Drug
- P/A: Physical Activity
- SMBG: Self-Monitoring of Blood Glucose
- UAE: United Arab Emirates 483 WHO World Health Organization

Background

Hyperglycemia, a metabolic disease defined by diabetes mellitus (DM), happens when the pancreas stops making enough insulin or when the body is unable to use it [1]. It raises the chance of patient death because it is linked to numerous complications and final organ damage.

Globally, diabetes has become a significant public health issue. The majority of DM burden falls 54 on low- and middle-income countries [2].

The International Diabetes Federation (IDFDiabetes)'s Atlas estimated the prevalence of diabetes mellitus (DM) in adults aged 20 to 79 over the world at 8.3% in 2011, translating to 366.2 million cases. By 2030, 551.9 million individuals are expected to be living with DM [2]. Diabetes is a chronic condition with varying levels of complications that need for extensive self- care knowledge and administration. In low- and middle-income nations, extensive information, a positive mindset, and good practices may be the key to controlling and preventing the effects 61 of diabetes and implementing cost-effective solutions [3].

In 2011, the diabetes prevalence in Ethiopia was 3.5%. More than 90% of instances of diabetes mellitus is of type 2 (T2DM) origin. According to the 2020 meta-analysis study, Ethiopia has a 6.5% pooled prevalence of DM. Sedentary lifestyles and bad eating habits have been linked to 65 an increase in the prevalence and incidence of [4]. Poor glycemic control affects two thirds of 66 people with diabetes in Ethiopia, making it a crucial issue [5].

Other aspects of self-management, such as self-monitoring of blood glucose of self-management, regular foot care, and opthlmic examination, have all been shown to significantly reduce the incidence and progression of diabetes complications [5]. Diabetes control involves more than just taking medication. Previous research demonstrated a link between poor glycemic control and increased risks of kidney failure, cardiovascular disease, and visual impairment. The lack of suitable guidelines and diabetes education for caregivers and patients, as well as time constraints, lack of sufficient human resources, and poor adherence, were 74 additional potential causes [6].

A considerable percentage of patients still have poorly controlled diabetes, despite the data from major randomized controlled trials demonstrating the advantages of comprehensive diabetic management in lowering microvascular and macrovascular problems. Because the causes of poor glycemic control in T2DM are diverse, it is challenging to achieve adequate glycemic control over the long term in clinical practice. Poor glycemic control may be caused by reasons that are related to the patient and the healthcare practitioner. In earlier studies, there were relationships between poor blood glucose control among T2DM patients and factors like longer duration of diabetes, combination drug therapy with oral antihyperglycemic agents and insulin therapy, as well as poor drug adherence and some sociodemographic characteristics like age [7].

Glycemic control is essential to managing diabetes because hyperglycemia is the hallmark of the disease. It has been demonstrated that reducing hemoglobin A1C to or below 7% will lessen the microvascular consequences of diabetes. Hemoglobin A1C (HbA1C) is assumed to reflect average glycemia over a period of several months and has good predictive value for diabetic complications. If started promptly after a diabetes diagnosis, it is linked to a long-term decline in macrovascular disease. Consequently, 7% is a fair HbA1C target for many non-pregnant adults [1,3].

HbA1C and microvascular problems have a curvilinear association, according to epidemiological research. According to these calculations, moving patients from extremely poor control to fair or good control will prevent the highest number of problems at the population level. Additionally, these results imply that lowering A1C from 7 to 6% is related with a further decrease in the risk of microvascular problems, even though the absolute risk is still high [1].

Intensive diabetes therapy has been shown to reduce microvascular and macrovascular consequences in large randomized controlled studies, although a significant number of patients 99 still have poorly managed blood sugar levels. Furthermore, inadequate and poor glycemic 100 controls in people with Type 2 diabetes is a significant public health issue and a significant risk 101 factor for the development of diabetes complications [1,3].

Studying the occurrence and associated factors will have a major impact on the prevention and prompt management of micro and macro vascular complications due to the strong impact of glycemic control in preventing complications. There are numerous studies on the evaluation of the glycemic control of T2DM in Ethiopia, but the majority of these studies relied on the FBS level of the participants. Therefore, this study is conducted to assess the glycemic control level using HbA1C results among T2DM patients at chronic follow up clinic of ALERT hospital of Addis Ababa, Ethiopia, 2022.

Objectives

General Objective

- To assess the prevalence and associated factors for poor glycemic control among adult type 2 diabetic patients at ALERT hospital, Addis Ababa, Ethiopia, 2022.

Specific Objectives

- To assess the prevalence of poor glycemic control among adult T2DM patients at alert hospital.
- To assess the associated factors for poor glycemic control at ALERT hospital.
- To assess self-monitoring practices of T2DM patients at ALERT hospital.

Methodology

Study Area

The study was conducted at All Africa Leprosy Tuberculosis and Rehabilitation Training (ALERT) hospital in Addis Ababa. ALERT hospital is one of the federal hospitals found in Addis Ababa with annual patient flow of more than 1 million of which almost one-third of them seen in chronic follow up clinic.

Study Design and Period

An institutional based cross-sectional study design was conducted from April to September of 2022.

Population

Source Population

All adult T2DM patients attending at chronic follow up clinic of ALERT hospital during the study period.

Study Population

All adult T2DM patients who were having more than one follow up visit at the chronic follow up clinic.

Eligibility Criteria

Inclusion Criteria

- All adult T2DM patients aged >18 years who have been visiting diabetic chronic follow up clinic at ALERT hospital.
- All adult T2DM patients aged >18 years and willing to participate in the study.

Exclusion criteria

- All T2DM patients who have no more than one visit to chronic follow up clinic.
- All T2DM patients who decline to participate in the study.
- All type 1 DM patients.
- Patients who were seriously ill.

Sample Size

The sample size for this study is calculated by using single proportion population formula. We took the prevalence of (64%) from previous study done at Northwest of Ethiopia [8]. We assumed a Z score at 95% CI (z = 1.96) with 5% margin of error. We added 5% for non-response rate and we found to be our final sample size.

$$N = \frac{21-\alpha/2 \times p \times (1-p)}{d_2}$$

Where N= sample size
P= incidence rate
Z = Z score corresponding to a 95% level of significance = 1.9
D= margin of error

Variables of the Study

Dependent Variable

- Glycemic Control (HbA1C level).

Independent Variables

- Scio demographic characteristics: age, sex, marital status, educational status, wealth, BMI.
- Life style: alcohol consumption, Cigarette smoking, physical exercise (PHA).
- Clinical and self-management: Self-Monitoring of Blood Glucose (SMBG).
- Co-morbidity other than diabetes.
- Duration of diabetes, medication adherence and drug utilization pattern.

Operational Definitions

- **FBS:** Blood glucose measured from venous blood after 8 hours of overnight fasting or longer [1].
- **Glycemic control:** It is managing blood glucose level of diabetic patients at optimum level.
- **Good glycemic control:** is defined as HbA1C < 7%) [1].
- **Poor glycemic control:** is defined as HbA1C > 7% [1].
- **Body Mass Index (BMI):** Height-for-height was used to classify adult T2DM patients into:

- Under-weight<18.5 kg/m2
- Normal 18.5-24.99 kg/m2
- Overweight 25-29.99 kg/m2
- Obese ≥ 30 kg/m2

- **Physical exercise:** Involve moderate-intensity activity that causes smaller increases in breathing or heart rate like for at least 10 minutes continuously [1].

Sampling procedure

The sampled participants in this study were enrolled through systematic random sampling method.

Data Collection Tools and Procedure

Data was collected using interviewer administered semi-structured and pre tested questionnaire initially prepared in English, then translated to Amharic and then translated back into English to check its consistency. The questionnaire of this study was developed from previous literature after a few amendments was done [9]. HbA1C records were extracted from the patients' cards and registration books. The data was collected by trained data collectors.

Data Quality Control

The data collectors were trained for one day before data collection commencement and there were daily meetings to clear upany ambiguity during data collection. The data collection process was supervised by the principal investigator; and was performed on daily basis, defective questionnaires were rejected. All the questionnaires and documents were cross checked for completeness and consistency. Data was being cleaned on daily basis.

Data Analysis Procedure

The collected data were, checked for completeness, edited, cleaned and compiled accordingly. All data were coded and entered into SPSS version 26.0 statistical software and MS Excel for analysis. Descriptive analysis was done for Sociodemographic and clinical characteristics of the participants. Both simple and multiple logistic analyses were used to see the association between dependent and independent variables. Variables with a p-value of < 0.2 at simple binary logistic regression were taken into a multiple logistic regression so as to control confounding. And variables with a p-value of < 0.05 was considered to be statistically significant predictors of maternal anemia. The result presented using frequency tables (and percentage), and figures.

Ethical Consideration

An official written support letter was obtained from Addis Ababa University College of Health Science department of family medicine. The letter was submitted to the head of ALERT hospital. Verbal informed consents were obtained from respondents after explanation was given on the objective, benefits and potential risks of participating in the study and the right to withdraw from the study at any time throughout their interview. The participants were informed that there might not be direct benefit in participating in the study and were assured to keep confidentiality by removing personal identifications instead using codes and not sharing their information to anyone other than the study team.

Result Dissemination Plan

The study result was submitted to Addis Ababa University School of medicine. It will be presented to the health science community and disseminated to the concerned stakeholders and the result will be submitted on peer reviewed national and international scientific journal for possible publications.

Results

Response Rate

Three hundred and seventy-one self-administered questionnaires were distributed to type 2 diabetic patients who were visiting chronic follow up clinic for DM at ALERT hospital; all the questionnaires were completed and recollected. Therefore, the response rate of this study became 100%.

Sociodemographic and Diabetic Characteristics of Participants

From the total of 371 type 2 DM patients, majority (60.9%) of them were male participants. Only 25 (6.7%) of them were younger than 34 years of age while more than half (55.3%) of them fell on the age category between 35 and 64 years. Nearly, half (49.1%) of them were married unlike to the 95 (25.6%) of the participants who were singles in their marital status. A hundred and eighty-seven (50.4%) of the participants were Muslims while 148 (39.9%) of them were Orthodox in religion. Majority, 290 (78.2%), of the participants urban dwellers. A significant number, 127 (34.2%), of the respondents had not been to school at all but, on the other hand; a comparable number, 116 (31.3%), of them had been to at least college and above level academically. Upon their occupational information, only a quarter of them were employed in government or other organizations while 177 (47.7%) of them were not working currently (Table 1).

Variables		Frequency	Proportion (%)
Gender	Male	226	60.9
	female	145	39.1
Age-category			
	18-34	25	6.7
	35-64	205	55.3
	> 65	141	38
Marital Status			
	Married	182	49.1
	Single	95	25.6
	Divorced	43	11.6
	Widowed	51	13.7
Religion			
	Orthodox	148	39.9
	Muslim	187	50.4
	Protestant	35	9.4
	Other	1	0.3
Residence			
	Rural	81	21.8
	Urban	290	78.2
Education background			
	Not able to read and write	33	8.9
	Able to read and write	94	25.3
	1-8 grades	51	13.7
	9-12 grades	77	20.8
	College/University	116	31.3
Occupation			
	Farmer	13	3.5
	Employed	95	25.6
	No job	141	38
	Daily Laborer	45	12.1
	Merchant	41	11.1
	Retired	36	9.7
Years passed after diagnosis (years)			

	< 5	72	19.4
	5-10	213	57.4
	> 10	86	23.2
Family history of DM			
	Yes	211	56.9
	No	160	43.1
BMI			
	Underweight (<18.5)	1	0.3
	Normal Weight (18.5-24.9)	183	49.3
	Overweight (25-30)	160	43.1
	Obese (>30)	27	7.3
Follow up to diabetic chronic follow up clinic			
	No visit	198	53.4
	2-3 times visits	150	40.4
	> 3 visits	23	6.2

Table 1: Sociodemographic Characteristics of Type 2 Dm Patients at Chronic Follow Up Clinic of 233 Alert Hospital, Addis Ababa, Ethiopia, 2022

More than four-fifth, 299 (80.6%), of the diabetic patients responded as it had been at least five years since they were diagnosed with DM and 211 (56.9%) of them reported associated family history of diabetes. The Body Max Index (BMI) of most, 183 (49.3%), of the diabetic patients was in the normal range (18.5-24.9) while more than half, 188 (50.7%), of the participants had out of normal range BMI index. On the contrary, 198 (53.4%) of them did not have either a single visit to or had only one chance of visiting the diabetic chronic follow up clinic while only 23 (6.2%) had more than three times visits to chronic follow up clinic. A hundred and fourteen (30.7%) of the patients gave one time history of hospital admission since diagnosis while 183 (49.3%) of them had history of hospital admission more than once. The majority, 357 (96.2%) of participants stated as they have social and family support (Table 1).

Other Comorbidity and Diabetic Complications

Two and thirty-eight (64.2%) of the type 2 DM patients reported to have associated comorbidity of hypertension (HTN) while more than two-third (67.7%) of the diabetic patients had associated Dyslipidemia. The rest 133 (35.8%) and 120 (32.3%) did not have associated hypertension and dyslipidemia, respectively. Two and six-two (70.6%) and 336 (90.6%) of the participants were non-smokers and non-alcohol drinkers, respectively; while 13 (3.5%) of them were both smokers and drinkers (Figure 1).

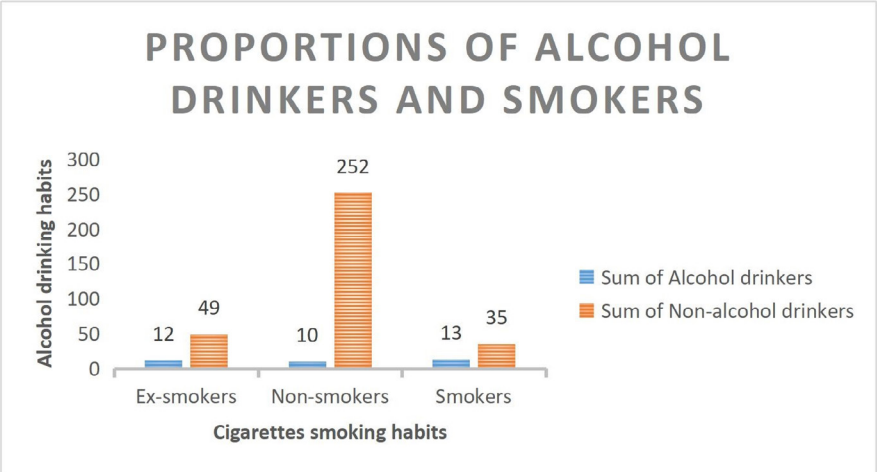

Figure 1: Proportions of Alcohol Drinking and Cigarettes Smoking Habits Among Type 2 dm Patients at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

Two hundred and thirty-six (63.6%) participants responded as they did not have any other chronic medical illness (CMI) while 35 (9.4%), 7 (1.9%) and 3 (0.8%) of them had associated infectious, renal and liver chronic diseases, respectively (Table 2).

Variables		Frequency	Proportions (%)
CMI	Renal disease	7	1.9
	Liver disease	3	0.8
	Infectious diseases	35	9.4
	Others	90	24.3
	None	236	63.6
Total		**371**	**100**

Table 2: Proportions of Associated CMI Among Type 2 DM Patients at Chronic Follow Up Clinic of ALERT Hospital, Addis Ababa, Ethiopia, 2022

Two hundred and forty-three (65.5%) of the diabetic patients developed at least one diabetic complication and the most common complication reported being diabetic nephropathy with frequency of 111 (29.9%). It was followed by diabetic neuropathy and retinopathy with frequencies of 97 (26.1%) and 65 (17.5%), respectively. Only 128 (34.5%) of them did not 265 reported to have any diabetic complications (Table 2).

Thirty-six (9.7%) participants reported to have two or more diabetic complications, of which47.2% (17 out of 36) of them had combined diabetic complications of neuropathy plus nephropathy, while 33.3% (12 out of 36) had both diabetic retinopathy plus nephropathy. Two patients had combined diabetic complications of retinopathy and neuropathy while another two participants had combined complications of diabetic nephropathy plus cardiac complication. One patient had diabetic retinopathy plus cardiac complication and one patient had diabetic neuropathy plus cardiac complication while another one had three diabetic complications (retinopathy, neuropathy plus nephropathy) (Figure 2).

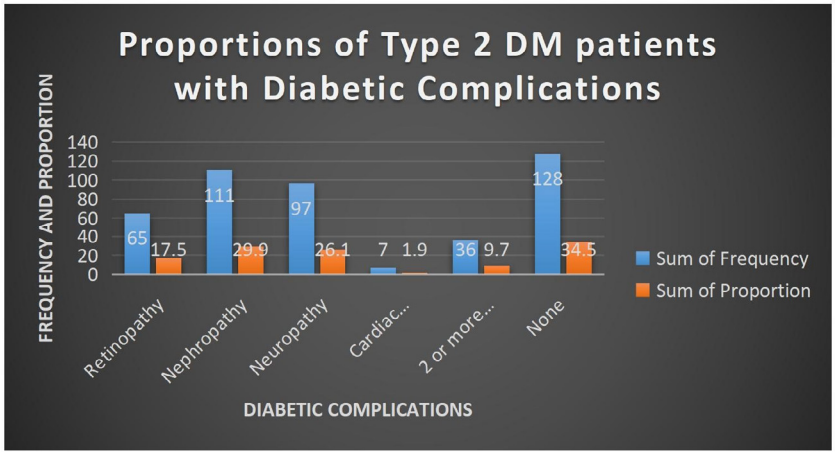

Figure 2: Proportions of Type 2 DM Patients with Diabetic Complications at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

Use of Preventive Measure

Upon assessing their preventive measures and activities, only 199 (53.6%) of the diabetic patients had the habits of doing exercise and physical activities. Most of the patients, 157 (42.3%), were taking a combination of oral anti-diabetic (OAD) drugs and insulin, and followed by two OAD and a single OAD for their diabetic control with a frequency of 126 (34%) and 81 (21.8%), respectively. Two hundred and twenty-three (60.1%) of the participants were paying to get the medication but 130 (35%) of them were not adherent to it. Two hundred and thirty284 five (63.3%) of them did not have access for self SMBG level (Table3).

Variables	Frequency	Proportion (%)
Exercise/physical activities		
Yes	199	53.6
No	172	46.4
Types of Treatment		
Dietary alone	7	1.9
One OAD	81	21.8
Two OAD	126	34
Combination of OAD and Insulin	157	42.3
Medication Adherence		
Non-adherent	130	35

Adherent	241	65
Access for drug		
Free	148	39.9
Paid	223	60.1
Recent FBS levels (mg/dl)		
< 70	3	0.8
70-130	133	35.8
> 130	235	63.3
HbA1C (past 3 months)		
< 7%	39	10.5
> 7%	332	89.5
Access for SMBG		
Yes	235	63.3
No	136	36.7

Table 3: Practices of Preventive Measures Among Type 2 DM Patients at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

Prevalence of Poor Glycemic Control

Most of the participants, 235 (63.3%) had a recent FBS level of >130 mg/dl while 133 (35.8%) of them had recent FBS records ranging between 70-130 mg/dl (Figure 3). Upon assessing their sugar level (glycemic control) over the past three months based on their recent HbA1C results, 332 (89.5%) of them had HbA1C records of > 7% and, therefore; the overall prevalence of poor glycemic control in this study became 89.5%.

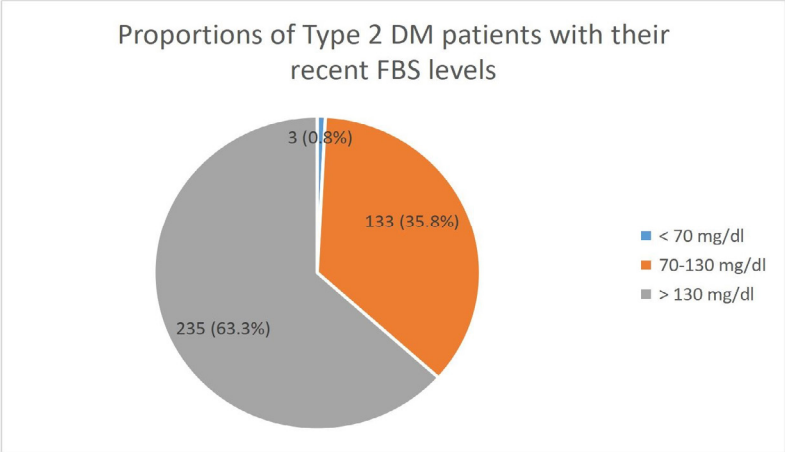

Figure 3: Proportions of Type 2 DM Patients and Their Recent Fbs Records at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

Upon assessing their glycemic control based on participants' sociodemographic information, majority, 86.3% (177 out of 205), of the participants in the age-category 35-64 years and all participants in the age-category > 65 years (141 out of 141) had poor glycemic control while 91.7% (206 out of 226) and 86.9% (126 out of 145) of male and female respondents, respectively; had also poor glycemic control (table 4).

Variables		**Glycemic Control (HbA1C level)**		
		Good (%)	**Poor (%)**	**Total**
Age Category	18-34 years	11 (44)	14 (56)	25
	35-64 years	28 (13.7)	177 (86.3)	205
	≥ 65 years	___	141 (100)	141
Gender	**Male**	**20 (8.8)**	**206 (91.2)**	**226**
	Female	19 (13.1)	126 (86.9)	145
BMI	**Underweight**	**___**	**1 (100)**	**1**
	Normal Weight	25 (13.7)	158 (86.3)	183
	Overweight	12 (7.5)	148 (92.5)	160
	Obese	2 (7.4)	25 (92.6)	27

Occupation	**Farmer**	**___**	**13 (100)**	**13**
	Employed	18 (18.9)	77 (81.1)	95
	No Job	13 (9.2)	128 (90.8)	141
	Daily Laborer	7 (15.6)	38 (84.4)	45
	Merchant	1 (2.4)	40 (97.6)	41
	Retired	___	36 (100)	36
Marital Status	**Married**	**14 (7.7)**	**168 (92.3)**	**182**
	Single	21 (22.1)	74 (77.9)	95
	Divorced	4 (9.3)	39 (90.7)	43
	Widowed	___	51 (100)	51
Family History DM	**Yes**	**27 (12.8)**	**184 (87.2)**	**211**
	No	12 (7.5)	148 (92.5)	160
Educational Background	**Not able to read/ write**	**___**	**33 (100)**	**33**
	Able to read & write	7 (7.4)	87 (92.6)	94
	1-8 Grades	10 (19.6)	41 (80.4)	51
	9-12 Grades	8 (10.4)	69 (89.6)	77
	College/University	14 (12.1)	102 (87.9)	116
Residence	**Rural**	**3 (3.7)**	**78 (96.3)**	**81**
	Urban	36 (12.4)	254 (87.6)	290
Religion	**Orthodox**	**15 (10.1)**	**133 (89.9)**	**148**
	Muslim	19 (10.2)	168 (89.8)	187
	Protestant	5 (14.3)	30 (85.7)	35
	Other	___	1 (100)	1
Years passed after diagnosis	**< 5 years**	**28 (38.9)**	**44 (61.1)**	**72**
	5-10 years	11 (5.20	202 (94.8)	213
	> 10 years	___	86 (100)	86
Follow up	**No visit**	**13 (6.6)**	**185 (93.4)**	**198**
	2-3 visits	23 (15.3)	127 (84.7)	150
	> 3 visits	3 (13)	20 (87)	86
History of hospital admission	**Once**	**7 (6.1)**	**107 (93.9)**	**114**
	More than once	___	183 (100)	183
	None	32 (43.2)	42 (56.8)	74
Social/family support	**Yes**	**39 (10.9)**	**318 (89.1)**	**357**
	No	___	14 (100)	14

Table 4: Comparing Glycemic Control Based on Sociodemographic Characteristics of Type 2 DM Patients at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

Significant number of participants whose BMI showed overweight and obese had poor glycemic control with proportions of 92.5% (148 out of 160) and 92.6% (25 out of 27), respectively. All retired participants (36 out of 36) by occupation and all widowed participants (51 out of 51) had poor glycemic control. Significant number of respondents who were rural inhabitants, 96.3% (78 out of 81) and who had less than or equal to a single visit to diabetic chronic follow up clinic,93.4% (185 out of 198) had also poor glycemic control levels. Similarly, all participants who are not able to read and write (33 out of 33), who had history of hospital admission more than once (183 out of 183), and who responded as they did not have social/family support (14 313 out of 14) (Table 4).

Participants' glycemic control levels based on the information gained on the presence of associated other comorbidity showed that poor glycemic level was identified among the majority of participants who had associated HTN, 97.9% (233 out of 238), associated dyslipidemia, 97.2% (244 out of 251) and associated infectious CMI, 91.4% (32 out of 35). The majority of diabetic patients who were alcohol drinkers, 97.1% (34 out of 35) and all patients who were smokers (48 out of 48) had poor glycemic control (Table 5).

Variables		Glycemic Control (HbA1C level)		
		Good (%)	**Poor (%)**	**Total**
HTN	**Yes**	**5 (2.1)**	**233 (97.9)**	**238**
	No	34 (25.6)	99 (74.4)	133
Smoking habit	**Smoker**	**_____**	**48 (100)**	**48**
	Non-smoker	37 (14.1)	225 (85.9)	262
	Ex-smoker	2 (3.3)	59 (96.7)	61
Alcohol drinking	**Drinker**	**1 (2.9)**	**34 (97.1)**	**35**
	Non-drinker	38 (11.3)	298 (88.7)	336
Dyslipidemia	**Yes**	**7 (2.8)**	**244 (97.2)**	**251**
	No	32 (26.7)	88 (73.3)	120
Other CMI	**Renal disease**	**2 (28.6)**	**5 (71.4)**	**7**
	Liver disease	1 (33.3)	2 (66.7)	3
	Infectious disease	3 (8.6)	32 (91.4)	35
	Others	2 (2.2)	88 (97.8)	90
	None	31 (13.1)	205 (86.9)	236

Table 5: Comparing Glycemic Control Based on the Associated cmi of Type 2 DM Patients at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

Based on the information collected on participants' use of preventive strategies, all participants who were on dietary management alone had good glycemic control. On the contrary, higher proportions of poor glycemic control were identified on participants who were on two OAD, 326 97.6% (123 out of 126) and on combination of OAD with insulin, 99.4% (156 out of 157). Higher proportion of poor glycemic control was also identified among type 2 DM patients who were not performing regular exercise (physical activity), 98.8% (170 out of 172); who were non- adherent to their medication, 99.2% (129 out of 130) and who did not have access for SMBG, 330 99.3% (135 out of 136), at home (Table 6).

Variables		Glycemic Control (HbA1C level)		
		Good (%)	**Poor (%)**	**Total**
Exercise/phy sical activity	**Yes**	**37 (18.6)**	**162 (81.4)**	**199**
	No	2 (1.2)	170 (98.8)	172
Types of treatment	**Diet**	**7 (100)**	**___**	**7**
	One OAD	28 (34.6)	53 (65.4)	81
	Two OAD	3 (2.4)	123 (97.6)	126
	OAD & Insulin combination	1 (0.6)	156 (99.4)	157
Medication Adherence	**Non-adherent**	**1 (0.8)**	**129 (99.2)**	**130**
	Adherent	38 (15.8)	203 (84.2)	241
Drug Access	**For free**	**11 (7.4)**	**137 (92.6)**	**148**
	Paid	28 (12.6)	195 (87.4)	223
Recent FBS level	**< 70 mg/dl**	**2 (66.7)**	**1 (33.3)**	**3**
	70-130 mg/dl	36 (27.1)	97 (72.9)	133
	> 130mg/dl	1 (0.4)	234 (99.6)	235
SMBG	**Yes**	**38 (16.2)**	**197 (83.8)**	**235**
	No	1 (0.7)	135 (99.3)	136
Any diabetic	**Retinopathy**	**___**	**49 (100)**	**49**
complication	Neuropathy	___	76 (100)	76
	Nephropathy	___	79 (100)	79
	Cardiac complication	___	3 (100)	3
	None	39 (30.5)	89 (100)	128
	> 2 complication	___	36 (100)	36

Table 6: Comparing Glycemic Control with Practice of Preventive Measures of Type 2 DM Patients at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

The proportion of poor glycemic control was also higher among participants who were getting medication for free, 92.6% (137 out of 148) and who's recent FBS records were above 130mg/dl, 99.6% (234 out of 235). All the type 2 DM patients participated in this study with at least one (or more) diabetic complications were identified to have poor glycemic control unlike to the participants without any diabetic complications (Table 6).

Factors Associated with Poor Glycemic Control

All the independent variables were analyzed using simple binary logistic regression and those variables with significance level (p-value) of less than 0.2 were considered to have associations and then, those were further subjected to multiple binary logistic regression analysis for possible of confounding factors. Variables with p-value of less than 0.05 under multiple binary logistic regression analysis were considered to have significant associations with poor glycemic control. After analyzing each independent variables turn by turn using simple logistic regression analysis, variables identified to have p-value of less than 0.2 were: participant's residence area; participants having history of hospital admission; participants having history of associated HTN; participants having habits of cigarettes smoking; participants having history of associated dyslipidemia; participants having history of associated comorbidity; participants 350 performing exercise/physical activity; types of anti-diabetic treatment participants were taking; participant's adherence level to their medication; level of participants' recent FBS records; and participants' having access for SMBG.

Variables		COR (95% CI)	AOR (95% CI)	P-value
Residence	Rural	3.685 (1.105, 12.294)	0.553 (0.079, 3.885)	0.552
	Urban			1.000
History of hospital admission	Once	0.086 (0.035, 0.210)	0.212 (0.053, 0.847)	0.028 **
	More than Once		_____	0.994
	None			1.000
HTN	yes	16.004 (6.080,42.123)	5.850 (1.008, 33.957)	0.049 **
	No			1.000
Smoking habits	Smoker		_____	0.997
	Non-smoker	4.851 (1.136, 20.711)	6.012 (0.672, 53.758)	0.109
	Ex-smoker			1.000
Alcohol-drinking habits	Drinker	4.336 (0.577, 32.586)	0.102 (0.004, 2.373)	0.155
	Non-drinker			1.000
Dyslipidemia	Yes	12.675 (5.399, 29.756)	_____	0.999
	No			1.000
Other associated CMI	Renal disease	2.645 (0.492, 14.232)	8.862 (0.304, 58.312)	0.205
	Liver disease	3.306 (0.291, 37.557)	____	0.999
	Infection	0.620 (0.179, 2.147)	1.393 (0.025, 76.962)	0.871
	Other	0.150 (0.035, 0.642)	0.328 (0.024, 4.559)	0.407
	None			1.000
Exercise or PHA	Yes	0.052 (0.012, 0.217)	0.532 (0.079, 3.529)	0.517
	No			1.000
Types of treatment	Diet alone		____	0.999
	One OAD	82.415(10.945, 620.558)	____	0.998
	Two OAD	3.805 (0.391, 37.031)	____	0.841
	OAD & Insulin		1.000	
Medication Adherence	Nonadherent	24.148 (3.275, 178.039)	____	0.838
	Adherent			1.000
Drug Access	For free	1.788 (0.861, 3.714)	0.601 (0.081, 4.435)	0.617
	Paid			1.000
Recent FBS (mg/dl)	70-130	0.022 (0.005, 0.094)	0.025 (0.002, 0.293)	0.003 **
	<70 or >130			1.000
SMBG	Yes	0.038 (0.005, 0.283)	0.046 (0.003, 0.633)	0.021 **
	No			1.000
Footnote: ** are significant factors (p-value < 0.05)				

Table 7: Factors Affecting Glycemic Control Among Type 2 DM Patients at Chronic Follow Up Clinic of Alert Hospital, Addis Ababa, Ethiopia, 2022

Those, the above variables; with p-value of less than 0.2 under simple logistic analysis were further treated using multiple logistic regression for controlling the confounding factors. On multivariate logistic analysis, participants having history of hospital admission; participants having history of associated hypertension; level of participants' recent FBS records; and participants' having access for SMBG were significantly associated with poor glycemic control. Participants having history of associated HTN [p-value=0.049, AOR (95% CI) =5.850 (1.008, 33.957)] was the only positively (significantly) associated variable identified to have poor glycemic control. Participants' having history of hospital admission once [p-value=0.028, AOR (95% CI) =0.212 (0.053, 0.847)], participants' having preferable recent FBS (70-130mg/dl) levels/records [p-value=0.003, AOR (95% CI) =0.025 (0.002, 0.293)]; and participants' having access for SMBG [p-value=0.021, AOR (95% CI)= 0.046 (0.003, 0.633)] were variables identified to have negative (significant) association with poor glycemic control (Table 7).

Discussion

Hyperglycemia defines diabetes, and glycemic control is fundamental to the management of diabetes [1]. The ultimate and main goal in the management of DM is to maintain good glycemic control, which is very important for controlling diabetes and preventing and delaying diabetes complications [3]. Glucose measurement is the main tool for assessing glycemic control. The best investigation modality to assess the relatively long term (over 3 months period) glycemic control of diabetic patients is determining and checking their HbA1C at least twice a year [1,3]. This study was carried out to assess the glycemic control and its associated factors among type 2 diabetic patients at ALERT hospital, Addis Ababa, Ethiopia. The study found that the majority of the study participants had poor glycemic control based on the A1C level recommended by ADA [1].

All of the participants in this study had HbA1C determination unlike to most previous studies which were done in different parts of the country. Unlike to the current study, none of their participants had HbA1C determination according to the previous studies done different parts of the nation: in the capital city (Addis Ababa), North (Suhul Shire), Southwest (Jimma), Northwest (Gonder), West (Ambo) and East (Dire Dawa) parts of Ethiopia [8-16]. This might be due to 384 unavailability of the laboratory service for the HbA1c determination in the public health 385 institutions of Ethiopia.

The overall poor glycemic control among the study subjects was 89.5% which is far above the recommended level by the ADA [1]. This finding is comparable to the previous studies conducted in different parts of Ethiopia: Addis Ababa (80%) and Jimma (82 and 81.7%) [9,12,17]. In the contrary, this finding was higher than the findings of the previous studies done in Dire Dawa (45.2%), Ambo (64.7%), Tigray (37%), Gondar (50%, 60.5% and 64.7%) towns of Ethiopia [9,11,14-16]. This similarities and differences could be due to the differences in the geographic locations, methods of glycemic control measurements and the study period of the studies. It might also be partly explained by the fact that HbA1C is better estimator than FBS in assessing the glycemic control (blood glucose level) in the past [1].

This proportion of poor glycemic control (89.5%) in the current study is also comparable to the study which was done in Mumbai, India (91.8%) [18]. The present study's proportion of poor glycemic control was also comparable also higher than the findings of studies conducted in other countries, previous studies from Kenya (60.5%), Sudan (71.9%), Jordan (65.1%), United Arab Emirates -UAE (69%), Riyadh -Kingdom of Saudi Arabia (67.7%), Venezuela (76%), Brazil (47.34%), and Hawaii (68.5%) [19-26]. This variation could have been due to the difference in the method of glucose measurement, glycemic level's cutoff points, socioeconomic status, culture, genetics, environmental factors, urbanization, and lifestyle, which can predispose individuals to different risk factors of poor glycemic control among the study participants.

The proportion of poor glycemic control was higher among patients who were not practicing SMBG (99.3%) at home. The practice of SMBG level at home in this study (63.3%) was comparable to previous study done in Addis Ababa (57.5%), but it was by far higher than the findings of the other studies done in Addis Ababa (5.5%) and Jimma (5%) towns of the country [9,10,12]. This could be explained by the differences in study subjects and period, and their financial capacity of the patients to afford purchasing glucometer and strips at the study areas. All the type 2 DM patients with diabetic complications in the current study were identified to have poor glycemic control unlike to the participants with out any diabetic complications. This was comparable to the finding of the study done in Gonder and Arbaminch towns of the nation where the majority of their participants with diabetic complications had poor glycemic control [16,27]. This could be explained by the fact that poor glycemic control in diabetic patient can result in its complications [1,3].

The present study revealed that Participants having history of associated HTN (p-value=0.049, AOR=5.850) was significantly associated with poor glycemic control. Hypertension is a common comorbidity of diabetes, affecting the majority of patients. The choice of anti-hypertensive medications also matters when coexists with diabetes [1]. The fact that the presence of comorbidity increases pills burden on the patient and increases the risks of complications which further aggravate sugar level in the blood and decrease patient compliance. Hence, these all can result in derangement of the glycemic level in diabetic patients. Evidence also shows that use of multiple medications associated with poorly controlled blood glucose [1,21,28].

The other significantly associated factor identified was participants' having history of hospital admission only once (p-value=0.028, AOR=0.212). Though it seems irony, admitted patients can possibly have increased time of contacts

with physicians. Patients having contact with health professionals will have a better chance of getting to know their diseases. Studies have shown that the, type 2 DM patients who have good knowledge on their disease will have good diabetic 431 controls [1,3,11-13].

The study also identified that participants' having preferable recent FBS (70 130mg/dl) levels/records (p-value=0.003, AOR = 0.025) and participants' having access for SMBG (p- value=0.021, AOR=0.003) were variables identified to have negative (significant) association with poor glycemic control. It is straight forward that good FBS results are associated with good glycemic control and patients having access for SMBG have better chances of controlling their 437-blood sugar level. Evidence shows that SMBG reduces HbA1C level of type 2 DM patients [1].

Limitation of the Study

This study was conducted with the intention of assessing the prevalence of poor glycemic control and its associated factors among type 2 diabetic patients. Despite this good intention, the study was not free of limitations. It was hospital-based study at follow up clinic of single government hospital and hence, the current findings might not be possibly generalized to the entire type 2 DM patients of Addis Ababa. The other limitation is the cross-sectional nature of the study design; which could not reveal the exact causal association between poor glycemic control and its risk factors. The study tried to address some of the important factors related to poor glycemic control but it lacks in depth identifications of factors related complicated diabetes for their poor glycemic control and qualitative part (like, their diabetic knowledge levels) which in-depth explores patients' perception on controlling their blood sugar levels.

Recommendation

- Health professionals working in the hospital should provide better patient advice about 451 medications and should design treatment strategies for T2DM.
- Educating and preparing methods on managing glycemic control and associated factors for diabetic patients using easily understandable methods.
- All responsible government and non-government partners should be involved on the importance of the determinants of glycemic control to achieve the targeted glycemic 456 control for the diabetic patients.

A future cohort study participating diabetic patients from different government and private hospitals is recommended to infer substantial evidence of causality.

Conclusion

The proportion of poor glycemic control among the type 2 diabetic patients was very high in this study. Participants having history of hospital admission; participants having history of associated hypertension; level of participants' recent FBS records; and participants' having access for SMBG were significantly associated with poor glycemic control.

Declarations

Ethical Approval and Consent to Participate

An official written support letter was obtained from Addis Ababa University College of Health Science department of family medicine. The letter was submitted to the head of ALERT hospital. Verbal informed consents were obtained from respondents after explanation was given on the objective, benefits and potential risks of participating in the study and the right to withdraw from the study at any time throughout their interview. The participants were informed that there might not be direct benefit in participating in the study and were assured to keep confidentiality by removing personal identifications instead using codes and not sharing their information to anyone other than the study team.

Consent for Publication

The study result was submitted to Addis Ababa University School of medicine and presented to the health science community and disseminated to the concerned stakeholders and the result will be submitted on peer reviewed national and international scientific journal for possible publications.

Availability of Data and Materials

The datasets used and analyzed for this study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

Funding

The research was conducted for academic purpose as a requirement of speciality degree in Family Medicine from Addis Ababa University. It was funded by the university.

Author's contributions

Protocol preparation and literature review: MFA, AA. Data analysis and interpretation: MFA. Drafting of the manuscript

and revision of manuscript: MFA, AA. All authors read and approved the final manuscript.

Acknowledgment

We would like to acknowledge the Addis Ababa University, School of Medicine, Department of Family Medicine for letting us accomplished with this paper, and ALERT Hospital which provide us the data and other necessary documents during the patients' data review, analysis and summary preparation process. We want to extend our sincere gratitude to the research team members who helped us from data collections to everything.

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