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Original Research Article

Study factors associated with poor glycemic control in type 2 diabetes mellitus patients in tertiary care center

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ABSTRACT

Background: Poor glycemic control is a major public health issue among patients with type 2 diabetes mellitus and a significant risk factor for the progression of diabetic complications. This study aimed to assess the magnitude and contributing factors of poor glycemic control among type 2 diabetes patients.
Methods: A cross-sectional study was conducted among 150 type 2 diabetes patients a sample of 150 type 2 diabetics of both sexes was obtained diabetes in medicine OPD, any type 2 diabetes patient at the healthcare facilities over the age of 18 was eligible to participate in the study.
Results: Of the 150 type 2 diabetes patients included in the study, 118 had poor glycemic control. Mean age was 59.67 (SD = 9.617) years; 115 (76.9%) of them were men. Most patients [n = 62 (41%)] used insulin or oral anti-diabetics as monotherapy [n = 32 (21%)] to regulate their blood sugar levels. The glycemic control got worse the longer the patient had diabetes, from 5 to 10 years (OR = 1.74) to more than 10 years (OR = 2.55), compared to patients with less than 5 years of illness. In comparison to patients with co-morbidity, patients without co-morbidity had significantly better glycemic control (OR=1.56).
Conclusions: Gender, age, BMI, occupation, medical history, medication history, triglycerides, HDL, duration of diabetes, type and number of diabetes medications, and HbA1c were significantly associated. These factors can identify patients at risk of poor glycemic control, allowing targeted interventions for optimal outcomes. Adherence, physical activity, diabetes education, and training affect glycemic control, but this study did not.

Keywords: Co-morbidity, Glycemic control, Type 2 diabetes

INTRODUCTION

Diabetes is a 21st-century global health crisis. In 2040, 642 million adults will have diabetes.[1] Diabetics worry about complications. Hyperglycemia causes diabetes complications. Retinopathy, neuropathy, and nephropathy are the main long-term diabetes complications.[2] T2DM patients with tight blood glucose control have fewer complications.[3,4] Another study found that intensive glucose control reduced risk for nonfatal myocardial infarction in T2DM but not cardiovascular or all-cause mortality.[5] Diabetes mellitus was a major health and economic burden due to treatment costs and lost work hours.[6,7] Diabetes killed 5.0 million in 2015.[8] Diabetes is higher in many Sub-Saharan African cities than in most Western European countries.[9,10] Diabetes killed 5% of Addis Ababa adults.[11] Diabetes death and complications are determined by glycemic control.[12,13] Prior glucose

control levels affect type 2 DM complications. HbA(1c) levels were associated with lower risks of macrovascular events and death in type 2 diabetics down to 7.0% and 6.5%, respectively.[14] Poor glycemic control has many causes. Glycemic control is affected by delay and unnecessary insulin intensification, poor treatment adherence, diet, and exercise.[15] Another study found that short disease duration and few oral glucose-lowering drugs predicted blood glucose levels in type 2 diabetics. In developing nations, patients, doctors, and health services affect glycemic targets.[16] Another study found that age, duration of DM, monotherapy versus insulin and oral antidiabetics, and self- management behaviour did not affect glycemic control.[17] Several Ethiopian hospitals studied factors affecting glycemic control. Two showed that younger age, hypertension, and non- adherence to diabetes self-management behaviours independently predicted poor glycemic control.[18,19] Dyslipidemia, obesity, physical inactivity, and smoking were not well studied in Ethiopian diabetics. Dyslipidemia from cardiovascular risk factors has been studied in Addis Ababa and hypertension from adjustable cardiovascular risk factors in JUMC.[19,20] Ethiopian studies were cross-sectional [18–21]. This case-control study also examined modifiable cardiovascular risk factors linked to glycemic control.

METHODS

This was an Observational study conducted Department of Gen. Medicine at Sri Aurobindo Medical College and Mohak Superspeciality Hospital-Indore. Duration 18 Months July 2021 to December 2022. The Institutional Ethics Committee approved the study protocol, and permission from the hospital superintendent was obtained before the initiation of the study. The study participants were type 2 diabetics. A sample of 150 type 2 diabetics of both sexes was obtained diabetes endocrinology clinic, any type 2 diabetes patient at the healthcare facilities over the age of 18 was eligible to participate in the study. explaining the study were placed in the two healthcare facilities. Those patients who accepted the invitation were provided with the study questionnaire when they visited the healthcare facilities for physician appointments, hospital visits, and/or diabetes education sessions. Data from diabetic patients was collected retrospectively. Data was collected in terms of age, sex, BMI, duration of Diabetes, comorbidity and drug utilization pattern. Level of glycemic control was assessed with help of HBA1C and FBS levels. Levels of HbA1C <7% and FBS <110mg/dL were taken as good glycemic control. The outcome of HbA1C and FBS levels were collected from hospital information system. HbA1C was determined by high performance liquid chromatography using Bio-Rad D 10. Fasting blood sugar levels were measured by enzymatic reference method with hexokinase. Descriptive statistics are used to show the features and characteristics of the collected data. Association of categorical variables are analyzed using chi square test. Quantitative data - expressed as mean+/-SD. Student ‘t’ test are applied on quantitative data. If data found to be normal $p < 0.05$ will be considered statistically significant.

Exclusion criteria

Type 2 diabetic patients who did not visit physicians’ offices after being diagnosed with the disease. Individuals younger than 18 years old. Those who could not read and write in English were not included in the study. Individuals who were mentally incapacitated, prisoners, or others whose ability to give voluntary informed consent may be in question.

RESULTS

Out of 150 patients involved in the study, the average age was 59.67 (SD = 9.617) years; 115 (76.9%) of them were men, and 102 (68.3%) of them were between the ages of 51 and 70. The majority of the patients [n = 69 (46%)] were of normal weight, while 24 (16.1%) were obese (Table1). Different diabetic complications were plaguing the patients. Out of 150 patients, 33 (21.8%) and 117 (78.2%) had two diabetic complications, respectively. The majority of patients (n = 40, 26.6%) had diabetic peripheral neuropathy; of these, 34 (22.5%) men and 6 (4.1%) women suffered from the condition.

Male patients with diabetic retinopathy make up 25 (16.6%) and female patients make up 11 (7.3%). There were 70 patients (46.6% of the total population) with cardiovascular diseases like hypertension and dyslipidemia. Twenty participants in this study (13.1%) had infectious diseases, which were more prevalent and harmful in T2DM patients. 42 patients (26.7%) did not have a co-morbid condition.

The study was divided into 5 categories based on the type of work and physical activity that the patients engaged in. 46.6% and 21.5% of the patients, respectively, were physically demanding workers and housewives. The remaining individuals were employed in offices (18.7%), retired (7.5%), or jobless (5.8%). The majority of the study participants 98 (65.4%) and 116 (77.6%) were not smokers or alcoholics, and 108 (72%) of the participants covered their own medical expenses (Table 1).

Patients without a history of hypertension or hyperlipidemia made up 32.4% of the study's participants, with 81 (54.2%) having hypertension and 6 (4.0%) having hyperlipidemia. There were 64 patients (42.6%) who used insulin to manage their diabetes, 42 (27.5%) of whom had previously used combination therapy (insulin and an oral hypoglycemic medication), and 44 (29.5%) of whom had only used oral hypoglycemic medications. The majority of the study participants had no family history of diabetes, except for one patient who had just received a T2DM diagnosis with complications. The majority of the patients [n = 80 (53.4%)] had T2DM for more than 10 years prior to their diagnosis. The remaining patients (n = 37, 24.4%) had

T2DM for 5 to 10 years, and 33 (22.2%) had it for less than 5 years (Table 2). Three (2%) patients did not receive prescriptions for diabetes medication, according to an analysis of the drugs that were prescribed. For 54 (36%) of the patients, oral hypoglycemic medications and insulin were prescribed to control their blood sugar.

Table 1: Association of HbA1c levels with demographic factors.

Variables	Sub-Variable	Total patients *N* = 150 *N* (%)	HbA1c ≤ 7% (≤53 mmol/mol) *N* (%)	HbA1c > 7% (>53 mmol/mol) *N* (%)	*p*
Gender	Male	115 (76.9)	28 (18.4)	88 (58.4)	0.013*
	Female	35 (23.1)	5 (3.3)	30 (19.8)	
Age (y)	40-50	28(18.6)	6 (4)	22 (14.6)	<.001*
	51-60	52 (34.6)	10 (6.5)	42 (28)	
	61-70	50 (33.7)	11 (7.3)	40 (26.4)	
	71-80	17 (11.3)	4 (2.6)	13 (8.7)	
	> 80	3(1.8)	2 (1.4)	1 (0.7)	
BMI (kg/m^2)	Underweight	4 (2.7)	1 (0.7)	3 (2.3)	0.014*
	Normal	69 (46.0)	16 (10.5)	53 (35.3)	
	Overweight	53 (35.2)	14 (9.0)	39 (26.2)	
	Obese	24 (16.1)	3 (1.7)	22 (14.5)	
Occupation	House work	32 (21.5)	5 (3.2)	27 (18.3)	0.042*
	Office work	28 (18.7)	6 (4)	22 (14.7)	
	Physical labor	70 (46.6)	16 (10.4)	54 (36.2)	
	Retired	11 (7.4)	4 (2.6)	7 (4.8)	
	Unemployed	9 (5.8)	3 (1.7)	6 (4.1)	
History of alcohol consumption	No	98 (65.4)	21 (14.3)	77 (51.1)	0.935
	Reformed	52 (34.6)	11 (7.5)	41 (27.1)	
	Regular	0	0	0	

*p <0.05 (significant). BMI = body mass index

Table 2: Association of HbA1c levels with patient history and therapy.

Variable	Sub-Variable	Total patients *N* = 150	HbA1c ≤ 7% (≤ 53 mmol/mol)	HbA1c > 7% (> 53 mmol/mol)	*p*
Medical history	HTN	81 (54.2)	21 (14.3)	60 (39.9)	0.003*
	Hyperlipidemia	6 (4.0)	1 (0.7)	5 (3.2)	
	HTN + hyperlipidemia	14 (9.4)	1 (0.7)	13 (8.8)	
	No HTN or hyperlipidemia	49 (32.4)	9 (6.1)	39 (26.3	
Medication history	Insulin OHA	64 (42.9)	12 (8.1)	52 (34.9)	0.007*
	Insulin + OHA	44 (29.5)	13 (8.5)	32 (21)	
	No drug	41 (27.4)	8 (5)	34 (22.4)	
	Insulin OHA	1 (0.7)	1 (0.7)	0	
Familyhistory	No	77 (51.4)	18 (12.1)	59 (39.3)	0.097
	Yes	72 (48.1)	14 (9.1)	59 (39)	
Duration of diabetes illness (y)	< 5	33 (22.2)	11 (7.5)	22 (14.7)	<0.001*
	5-10	37 (24.4)	8 (5.5)	28 (18.9)	
	> 10	80 (53.4)	13 (8.8)	7 (44.6)	
Antidiabetic drugs at discharge	OHA	32 (21.3)	11 (7.3)	21 (14.0)	<0.001*
	Insulin	63 (42.1)	12 (7.8)	51 (34.3)	
	Insulin+ OHA	55 (36.6)	8 (5.4)	47 (31.2)	
Numberof antidiabetic drugs at discharge	No drug	3 (2)	3 (1.7)	1 (0.7)	<0.001*
	1-2	116 (77)	26 (17.2)	90 (60)	
	3-4	30 (20.2)	4 (2.9)	26 (17)	
	> 4	1 (0.7)	0	1 (0.5)	

*p <0.05 (significant). HTN = hypertension; OHA = oral hypoglycemic agent

Table 3: Univariate analysis of demographic factors associated with poor glycemic control.

Variable	Sub-Variable	OR	CI (95%)	*p*
Gender	Male	1	1.13-3.06	0.014*
	Female	1.86		
Age (y)	> 65	1	1.01-2.25	0.044*
	≤ 65	1.51		
BMI (kg/m^2)	< 30	1	1.414-5.23	0.003*
	≥ 30	2.72		
Occupation	House work	3.04	1.44	0.004*
	Office work physical labor retired			
	Unemployed	1.98	0.95	0.066
	House work office work physical labor retired	1.86	0.97	0.060
	Unemployed	1		
	House work office work physical labor retired	1.30	0.52-3.26	0.570
Family history	No	1	0.94-2.00	0.097
	Yes	1.37		

*p < 0.05 (significant).BMI = body mass index; CI = confidence interval; OR = odd ratio

Table 4: Univariate analysis of clinical variable associated with poor glycemic control.

Variable	Sub-Variable	OR	*CI (95%)*	*p*
SBP (mmHg)	≤ 130	1	0.83-1.76	0.315
	>130	1.21		
DBP (mmHg)	≤ 80	1	0.71-1.51	0.829
	> 80	1.04		
Duration ofdiabetes (years)	< 5	1		
	5 - 10	1.74	1.0-2.89	0.032*
	> 10	2.55	1.64-3.98	< 0.001*
Total cholesterol (mg/dL)	< 200	1	0.73-2.30	0.369
	≥ 200	1.30		
Triglyceride (mg/dL)	<150	1	1.03-2.48	0.036*
	≥ 150	1.60		
HDL (mg/dL)	> 45	1	1.03-2.67	0.036*
	≤ 45	1.66		
Type of diabetes medication	OHA	1		
	Insulin	2.31	1.45-3.68	< 0.001*
	OHA + insulin	3	1.81-4.96	< 0.001*
Number of complication	2 complication	1	0.79-1.89	0.375
	1 complication	1.22		
Presence of comorbidity	Yes	1	1.08-2.27	0.019*
	No	1.56		

*p < 0.05 (significant).

Most patients [n = 62 (41%)] used insulin or oral anti-diabetics as monotherapy [n = 32 (21%)] to regulate their blood sugar levels (Table 2).

HbA1c levels were significantly correlated with gender, age, BMI, and occupation among other demographic variables. The majority of the patients had HbA1c levels above 7% (>53 mmol/mol), which indicates that these patients have poor glycemic control (Table 1). 60 (39.9%) of the patients with poor glycemic control had a history of hypertension, and 34 (22.4%) had received prescriptions for insulin and oral anti-diabetic medications in the past. Patients in this study had poor glycemic control, whether they had a family history of diabetes or not. HbA1c levels and the length of diabetes were significantly correlated; 67 (44.6%) of the patients with poor glycemic control had had the disease for longer than ten years. 51 (34.3%) patients used only insulin to control their blood sugar levels, 47 (31.2%) used combination therapy (OHA and insulin), and 90 (60.3%) used one or more diabetes medications (Table 2).

The abbreviations CI, DBP, HDL, LDL, OR, OHA, and SBP stand for confidence interval, odd ratio, oral hypoglycemic agent, and systolic blood pressure,

respectively. Patients who were obese (OR = 2.72) and females (OR = 1.86) who were 65 years of age or younger. When compared to retired patients, housewives had a higher risk (OR = 3.04). Patients were more likely to have poor control if they had a family history [OR = 1.37 (Table 3)]. Patients were more likely to have poor glycemic control if their systolic blood pressure was greater than 130 mmHg (OR =1.21), as well as if their diastolic blood pressure was higher than 80 mmHg (OR =1.04).

The glycemic control got worse the longer the patient had diabetes, from 5 to 10 years (OR = 1.74) to more than 10 years (OR = 2.55), compared to patients with less than 5 years of illness. In comparison to patients with co-morbidity, patients without co-morbidity had significantly better glycemic control (OR=1.56). Glycemic control was also significantly influenced by other variables such as total cholesterol, triglyceride level, and the type of diabetes medications (Table 4).

Table 5: Multivariate analysis of variable associated with poor glycemic control.

Variable	Sub-variable	OR	CI (95%)	P
Gender	Male	1	1.12-3.82	0.021*
	Female	2.07		
Age (y)	> 65	1	1.0-2.81	0.049*
	≤ 65	1.67		
BMI (kg/m^2)	< 30	1	0.97-4.15	0.062
	≥ 30	2		
Triglyceride (mg/dl)	< 150	1	0.84-2.19	0.219
	≥ 150	1.35		
HDL (mg/dl)	> 45	1	1.01-2.95	0.048*
	≤ 45	1.72		
Duration of diabetes illness (year)	< 5	1		
	5-10	1.35	0.78-2.50	0.344
	> 10	2.53	1.46-4.40	0.001*
Diabetes medication	OHA	1		
	Insulin	2.03	1.15-3.58	0.014*
	OHA + insulin	2.41	1.35-4.28	0.003*
Presence of comorbidity	Yes	1	0.91-2.27	0.125
	No	1.43		

*p < 0.05 (significant).

Body mass index (BMI), confidence interval (CI), high-density lipoprotein (HDL), odd ratio (OR), and oral hypoglycemic agent (OHA) are some of the terms used. Poor glycemic control was significantly associated with patients under the age of 65 (OR = 2.07), patients with abnormal high-density lipoprotein (HDL) levels (OR = 1.72), diabetes duration (more than 10 years), and type of diabetes medication (Table 5). Significant variables that are linked to inadequate glycemic control were included in the developed logistic regression model (HbA1c as reference line). Area under the ROC curve for the created model was 0.683 (p 0.001).

DISCUSSION

Diabetes can cause many serious health issues. Diabetes-related morbidity, mortality, and long-term complications can cause significant healthcare issues for families and society.[25] Gender, age, BMI, duration of illness, medication, lipid profile, and blood pressure all affect glycemic control.[26,27] This study used HbA1c, the gold standard for glycemic control. Diabetes patients with HbA1c values of 7% or less have good glycemic control.[25-27] In this study, 657 patients had poor glycemic control (78.2%), males predominated, and females had a significantly higher risk (p <0.001). Roy et al described male suboptimal control.[28]

Age correlated with glycemic control in this study. Similar to Huang et al and Woldu et al, most patients with poor glycemic control were 50-60 or 60-70.[29,30] Similar to Lee et al and Kassahun et al, this study found a significant relationship between glycemic control in diabetics and BMI (p = 0.014) and occupation (p = 0.042).[31,32] Non-glycemic control was also associated with hypertension or hyperlipidemia (p = 0.003) and diabetes duration (p <0.001). Other studies by Khattab et al and Salonen et al found that insulin metabolism disturbance and poor glycemic control were linked to longer diabetes duration, hypertension, and dyslipidemia.[33,34] Glycemic control was significantly associated with patients' medication histories and discharge medications (p = 0.007). Glycemic control was also associated with diabetes medication and number of diabetic drugs prescribed at discharge (p <0.001). Roy et al, Agarwal et al, Esposito et al, and Schweizer et al found similar results.[28,35-37] Glycemic control was not affected by smoking, alcohol use, family history, or medical insurance in this study. Juarez et al found that insurance type did not affect glycemic control.[38] As reported by Kirk et al and Zhao et al, this study found that male patients had better glycemic control than female patients, especially those who were responsible for family care and neglected their health.[39,40] Poor glycemic control was more common in younger patients. Age significantly affects glycemic control, according to Harrabi and Eid.[41,42] BMI affects HbA1c, according to Adham et al.[43] Obesity was linked to poor glycemic control in this study due to insulin resistance and secretion. Bays et al also found that obesity increases diabetes risk.[44] This study found that retired patients had better glucose control than housewives and others. Retirees may have enough time to manage their therapy and lifestyle changes. Kassahun et al found that farmers had poorer glycemic control than unemployed respondents.[32] Self-paying patients had better glycemic control than insured patients, but this effect was not significant. In contrast, Juarez et al found that insurance coverage did not affect glycemic control.[38] Except for low-density lipoprotein cholesterol levels, family history did not affect the clinical characteristics of diabetes patients, according to Papazafiropoulou et al and Bo et al.[45,48] In this study, patients with a family history of diabetes had poorer glycemic control, but this effect

was not statistically significant. Khattab et al and Eid et al found that T2DM duration strongly correlated with poor glycemic control.[33,42] This study found that longer diabetes duration worsened glycemic control, possibly due to insulin secretion or insulin resistance in those patients. Juarez et al also found that patients with diabetes for 6 to 7 years or 10 years or more had wider glycemic variability than those with diabetes for 3 years or less.[38] Poor glycemic control is linked to diabetes duration.[38] Diabetics have lipid abnormalities. In this study, dyslipidemia was linked to poor glycemic control, especially for triglycerides over 150 mg/dL. Lower total cholesterol, low-density lipoprotein cholesterol, and triglycerides were linked to better glycemic control by Adham et al and Benoit et al.[43,47] In this study, patients on insulin + OHA or insulin monotherapy were more likely to have poor glycemic control than those on oral diabetes medication. Implementing an insulin regimen or having an optimal glycemic level that oral medication cannot achieve may cause this. Khattab et al and Benoit reported similar findings.[33,47] El-Kebbi et al found that T2DM patients with co-morbidities can achieve good glycemic control.[48] Patients with more than one diabetes complication had better glycemic control, but the difference was not statistically significant. Poor glycemic control was associated with female gender, age, HDL level, diabetes duration, and medication type in multivariate analysis.

This study has some limitations. This study did not examine adherence, physical activity, diabetes education, or training programmes, which affect glycemic control.

CONCLUSION

Demographic factors like gender, age, BMI, occupation, and clinical variables like medical history, medication history, triglyceride level, HDL level, duration of diabetes illness, type and number of prescribed diabetes medications, and HbA1c level were significantly associated. These factors can identify patients at risk of poor glycemic control, allowing targeted interventions for optimal outcomes.

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