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Factors Associated with Poor Glycemic Control in Type 2 Diabetic Patients Investigated at Ayder Referral Hospital, Mekelle, Ethiopia

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ABSTRACT

Background: Type 2 diabetes is the predominant form of diabetes with increasing prevalence all over the world. Inadequate glycemic control in type 2 diabetic patients contributes to increased rates of macrovascular and microvascular diabetic complications. **Objective:** This study was conducted to determine the factors associated with poorly controlled type 2 diabetes. **Methods:** The institution-based cross-sectional study was conducted among type 2 diabetic patients investigated at Ayder Referral Hospital, Mekelle town, Ethiopia in February 2015. Patients were studied consecutively. Data were collected through interview using structured questionnaires and data collection form to extract data from patients medical records. Data were analyzed using SPSS version 20.0. **Results:** Of the total 384 patients, 48.7% had HbA1c ≥7%, indicating poor glycemic control. In the multivariate model, being under age 60 (<50 years: OR = 2.99, 95% CI 1.20-7.4; 50-59 years: OR = 4.7, 95% CI 2.0-11.0) and hypertensive patients (OR = 2.2, 95% CI 1.1-4.4) were significantly associated with poor glycemic control. However, patients who followed diet plan as recommended (OR = 0.3, 95% CI 0.1-0.5), participated in regular exercise (OR = 0.1, 95% CI 0.1-0.2) and self-monitored blood glucose (OR = 0.3, 95% CI 0.2-0.6) were less likely to be poorly controlled. **Conclusions:** This study indicated that glycemic control in patients was generally poor. Younger age, hypertension, and non-adherence to diabetes self-management behaviors were independent predictors of poor glycemic control. Hence, educational programs that focus on diabetes self-management behaviors are encouraged to improve glycemic control and quality of life. Younger and hypertensive patients should be targeted with additional interventions to achieve optimal glycemic control.

INTRODUCTION

Type 2 diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia and impaired insulin action and/or insulin secretion. Its complex nature reflects the multifaceted genetic background and the varied genetic-environmental interaction [1]. Type 2 diabetes is the predominant form of diabetes with increasing prevalence all over the world steadily. It accounts for over 90% of diabetes in sub-Saharan Africa [2,3]. The estimated national prevalence of diabetes mellitus in an adult population of Ethiopia is 1.9% [4]. A three-year retrospective record review (2012-2014) revealed 1.3% prevalence of diabetes mellitus in patients attended Ayder referral hospital in Mekelle, Ethiopia while 82% of the diabetes were type 2 diabetic patients [5].

Type 2 diabetes mellitus being a chronic disorder requires multiple therapeutic approaches including dietary and lifestyle modifications [6]. Intensive glucose control in patients with diabetes provides strong benefits for microvascular complications. Canadian Diabetes Association has recommended therapy in diabetic patients should be targeted to achieve a glycated haemoglobin (HbA1c) ≤7.0%. A target HbA1c ≤6.5% may be considered in some patients with type 2 diabetes to further lower the risk of nephropathy and retinopathy [7]. The American Diabetes Association recommendation of optimal glycemic control in diabetic patients is a HbA1c level of <7% [8].

However, studies show that the percentage of patients with poor glycemic control was high. For instance, a hospital-based cross-sectional study conducted in southwest Ethiopia indicated 81.7% of the diabetic patients had fasting blood sugar (FBS) ≥126 mg/dl, indicating poor glycemic control as per American Diabetic Associations recommendations [9]. Similarly, high proportions of type 2 diabetic patients with poor glycemic control ranging from 50% to 78.6% were reported in different countries [10-16]. In addition, the proportions of adults with type 2 diabetes in the US from 1988 to 2002 who achieved the American Diabetes Association target of glycemic control (HbA1c <7%) remain unacceptably low [17]. Inadequate glycemic control in type 2 diabetic patients contributes to increased rates of macrovascular and microvascular diabetic complications, which may affect healthcare costs [18].

The glycemic level in patients with type 2 diabetes is affected by various factors. Lifestyle behaviors, demographic factors, clinical conditions, and treatment modalities significantly affect

HbA1c levels in type 2 diabetic patients [19]. Duration of diabetes, presence of co-morbidities, polypharmacy and non-adherence to medication are also the factors associated with poorly controlled diabetes [20,21]. Hence, this study was undertaken to determine factors associated with a poor glycemic control in type 2 diabetic patients attending Ayder Referral Hospital in Mekelle town, Ethiopia.

MATERIALS AND METHODS

Study design and setting

The institution-based cross-sectional study was conducted at Ayder Referral Hospital located in Mekelle, the capital city of Tigray region, northern Ethiopia in February 2015. Ayder Referral Hospital is a teaching hospital at College of Health Sciences, Mekelle University. It is the only referral hospital in the region and serving up to 8 million populations in its catchment areas of the Tigray, Afar and southeastern parts of Amhara regions. It has four major departments and other specialty units. Diabetic Mellitus ambulatory clinic unit is one of the specialty units of the hospital, which provides medical services for registered diabetic patients.

Study population and sampling

The target population was all type 2 diabetic patients attending diabetes clinic at Ayder Referral Hospital, aged ≥18 years and who had been on treatment for at least 3 months. Apart from these criteria, patients whose medical records had the necessary laboratory investigations and measurements were considered for the study. Patients with mental disorders, seriously ill patients, and pregnant women were excluded from the study.

The sample size was determined using a single population proportion formula based on the following parameters: prevalence of risk factors associated with poor glycemic control (50%) among type 2 diabetic patients in Ambo Hospital, Ethiopia [10], 5% margin of error and 95% confidence interval. Thus, a total sample size of this study was 384. Type 2 diabetic patients attending diabetes clinic during data collection were recruited consecutively.

Data collection

Data were collected through interview using structured questionnaire and data collection form to extract data from patients medical records. Data included socio-demographic characteristics, laboratory investigations and measurements, and self-management behaviors. The available last readings of laboratory investigations and measurements such as HbA1c and lipid profile (high-density lipoproteins, low-density lipoproteins, triglycerides, and cholesterol) were extracted from the patients records. Blood pressure, total body weight, and height were measured by nurses during the day of the study.

Body mass index was categorized as normal (<25 kg/m^2), overweight (25–29.9 kg/m^2), and obese (≥30 kg/m^2) [22]. Glycemic status was categorized as a good glycemic control if HbA1c was <7% and poor glycemic control if HbA1c was ≥7%. Patients with systolic/diastolic blood pressure >140/90 mmHg or who were on hypertensive treatment were referred to have hypertension [8]. Abnormal lipid profile levels were assessed as explained by the American Diabetes Association. Dyslipidemia was defined as a patient with one or more of the abnormalities for serum lipids [23].

Self-management behaviors were assessed during the past 7 days as follow. Following a diet plan as recommended: if follow diet plan ≥3 days; Engaged in physical exercise: if walk ≥3 days at least 30 minutes; Self-monitoring blood glucose: if test home blood glucose ≥5 days.

Data analysis

Data were analyzed using IBM SPSS, version 20.0. Categorical and continuous variables were described as proportions and mean (standard deviation, SD), respectively. Pearson's Chi-square test was employed to test associations between poor glycemic control and variables. All significant variables (P <0.05) were considered for a multivariate logistic regression model to determine independent factors associated with the poor glycemic control.

Ethical consideration

The study was approved by the Health Research Ethics Review Committee of College of Health Sciences, Mekelle University. Permission to conduct the study at diabetes clinic was sought from

the medical director of the hospital. Written informed consent was obtained from each respondent after explanation of the aim and objectives of the study.

RESULTS

Patients' characteristics

Most (40.1%) of the respondents were below 50 years of age with the mean (SD) age of 52.8 (10.1) years. The majority of the patients were males (54.7%), Orthodox Christianity followers (83.9%), married (93.2%), urban inhabitants (87.8%), and unemployed (66.7%) (Table 1).

Table 1. Socio-demographic characteristics of type 2 diabetic patients, and their association with poor glycemic control.

Variable		n (%)	Poor glycemic control (%)	P value
Age	<50	154 (40.1)	63 (40.9)	
	50-59	118 (30.7)	66 (55.9)	**0.036**
	≥60	112 (29.2)	58 (51.8)	
Gender	Male	210 (54.7)	104 (49.5)	
	Female	174 (45.3)	83 (47.7)	0.722
Religion	Orthodox	322 (83.9)	156 (48.4)	
	Protestant	6 (1.6)	5 (83.3)	0.223
	Muslim	56 (14.6)	26 (46.4)	
Marital status	Single	3 (0.8)	2 (66.7)	
	Married	358 (93.2)	169 (47.2)	0.095
	Divorced/widowed	23 (6)	16 (69.6)	
Address	Rural	47 (12.2)	24 (51.1)	
	Urban	337 (87.8)	163 (48.4)	0.729
Educational level	Illiterate	20 (5.2)	13 (65.0)	
	Read & write	110 (28.6)	59 (53.6)	
	Primary School	83 (21.6)	41 (49.4)	0.235
	High School	72 (18.8)	33 (45.8)	
	Tertiary	99 (25.8)	41 (41.4)	
Occupation	Employed	127 (33.1)	54 (42.5)	
	Unemployed	256 (66.7)	132 (51.6)	0.147
	Student	1 (0.3)	1 (100.0)	

Clinical characteristics of type 2 diabetes mellitus patients, treatment modalities and co-morbidities are indicated in Table 2. The overall mean (SD) body mass index of the patients was

22.9 (2.9) and most (76.3%) of them were found to be normal. The most common co-morbidities observed in patients with type 2 diabetes mellitus were dyslipidemia (51.8%) and hypertension (40.4%) followed by peripheral neuropathy (32.6%). The mean (SD) duration of the diabetes was 6.9 (0.05) years with the majority (60.7%) of them had confirmed type 2 diabetes mellitus for <7 years. Oral antidiabetic agents (OAA) were prescribed to 62.8% of the patients while a combination of oral antidiabetic agents and insulin was prescribed in 10.2% of the patients.

Table 2. Association of clinical characteristics, treatment modalities and co-morbidities with poor glycemic control among type 2 diabetes mellitus patients

Variable		n(%)	Poor glycemic control (%)	P value
Body mass index (kg/m^2), mean (SD)=22.9(2.9)	Normal	293 (76.3)	119 (40.6)	**<0.0001**
	Over weight	81 (21.1)	62 (76.5)	
	Obesity	10 (2.6)	6 (60.0)	
Hypertension	Yes	155 (40.4)	95 (61.3)	**<0.0001**
	No	229 (59.6)	92 (40.2)	
Dyslipidemia	Yes	199 (51.8)	177 (58.8)	**<0.0001**
	No	185 (48.2)	70 (37.8)	
Peripheral neuropathy	Yes	125 (32.6)	74 (59.2)	**0.004**
	No	259 (67.4)	113 (43.6)	
Real disease	Yes	52 (13.5)	32 (61.5)	**0.046**
	No	332 (86.5)	155 (46.7)	
Diabetes ketoacidosis	Yes	35 (9.1)	23 (65.7)	**0.035**
	No	349 (90.9)	164 (47.0)	
Duration of disease (year), mean (SD)=6.9(0.05)	≥7	151 (39.3)	85 (56.3)	**0.017**
	<7	233 (60.7)	102 (43.8)	
Treatment modalities	OAA only	241 (62.8)	121 (50.2)	0.394
	Insulin only	104 (27.0)	51 (49.0)	
	OAA and insulin	39 (10.2)	15 (38.5)	

For self-management behaviors among type 2 diabetes mellitus patients, 42.4% did not follow healthy diet plans as recommended, 50.5% did not engage in regular physical exercise and 47.4% tested their blood glucose regularly at home. All study participants did not smoke a cigarette or chew khat during the study period (Table 3).

Table 3. Association between self-management behavior and glycemic control among type 2 diabetic patients

Variable	n(%)	Poor glycemic control (%)	P value
Follow diet plan as recommended			
Yes	221 (57.6)	57 (25.8)	**<0.0001**
No	163 (42.4)	130 (79.8)	
Participate in physical exercise			
Yes	190 (49.5)	31 (16.3)	**<0.0001**
No	194 (50.5)	156 (80.4)	
Self-monitoring blood glucose			
Yes	182 (47.4)	48 (26.4)	**<0.0001**
No	202 (52.6)	139 (68.8)	
Alcohol use			
Yes	33 (8.6)	19 (57.6)	0.286
No	351 (91.4)	168 (47.9)	
Smoking habits			
No	384 (100)	-	-
Khat use			
No	384 (100)	-	-

Glycemic control

Of the total 384 respondents, 48.7% had HbA1c ≥7%, which is categorized as a poor glycemic control. Possible interaction between poor glycemic control and variables is shown in Tables 1, 2 and 3. Poor glycolic control was found to be associated with age, body mass index, hypertension, dyslipidemia, peripheral neuropathy, renal disease, diabetes ketoacidosis and duration of diabetes mellitus. Similarly, the glycemic level of the patients was possibly affected by self-management behaviors such as diet, exercise, and glucose testing.

In the multivariate logistic regression analysis, being under age 60 (<50 years: OR = 3.0, 95% CI 1.2-7.4; 50-59 years: OR = 4.7, 95% CI 2.0-11.0) were significantly associated with increased odds of being poorly controlled. Likewise, hypertensive type 2 diabetic patients were significantly associated with poor glycemic control (OR = 2.2, 95% CI 1.1-4.4) compared to non-hypertensive patients. On the other hand, patients who followed diet plan as recommended by health professional (OR = 0.3, 95% CI 0.1-0.5), participated in physical exercise (OR = 0.1,

95% CI 0.1-0.2) and self-monitored blood glucose at home (OR = 0.3, 95% CI 0.2-0.6) were less likely to be poorly controlled (Table 4).

Table 4. Multivariate logistic regression analysis of independent factors and poor glycemic control among patients with Type 2 diabetes

Variable		OR (95% CI)	P value
Age	<50	**3.0 (1.2, 7.4)**	**0.019**
	50-59	**4.7 (2.0, 11.0)**	**<0.0001**
	≥60	1	
Body mass index (kg/m^2)	Normal	0.3 (0.1, 1.8)	0.182
	Over weight	0.8 (0.1, 4.6)	0.760
	Obesity	1	
Hypertension	Yes	**2.2 (1.1, 4.4)**	**0.021**
	No	1	
Dyslipidemia	Yes	1.5 (0.8, 2.8)	0.235
	No	1	
Peripheral neuropathy	Yes	1.1 (0.5, 2.2)	0.817
	No	1	
Real disease	Yes	0.9 (0.4, 2.2)	0.728
	No	1	
Diabetes ketoacidosis	Yes	2.6 (0.9, 7.1)	0.071
	No	1	
Duration of disease (year)	≥7	0.8 (0.4, 1.6)	0.430
	<7	1	
Follow diet plan as recommended	Yes	**0.3 (0.1, 0.5)**	**<0.0001**
	No	1	
Participate in physical exercise	Yes	**0.1 (0.1, 0.2)**	**<0.0001**
	No	1	
Self-monitoring blood glucose	Yes	**0.3 (0.2, 0.6)**	**<0.0001**
	No	1	

DISCUSSION

HbA1c is one of the primary techniques to assess the effectiveness of the management plan on glycemic control. It reflects average glycemia over several months and has strong predictive value for diabetes complications. The American Diabetes Association recommendation of HbA1c value in diabetic patients is <7% since it is associated with a long-term reduction of microvascular complications of diabetes [8].

In this study, 48.7% of the patients had HbA1c ≥7% resulting in poor glycemic control. This finding was consistent with the study conducted among patients with type 2 diabetes mellitus in Ambo Hospital, Ethiopia, which showed 50% of the patients had a mean FBG level of >126mg/dl [10]. However, other studies reported higher proportion of patients with poor glycemic control in Cameroon and Guinea (74% had HbA1c ≥7%) [13], Jordan (65.1% had HbA1c ≥7%) [11], Malaysia (77% had HbA1c ≥6.5%) [14], India (78.6% had HbA1c ≥7%) [16], Saudi Arabia (78% had >7%) [15], Tanzania (69.7% had FBG of ≥7.2 mmol/L) [12] and southwest Ethiopia (81.7% had FBS ≥126 mg/dL) [9]. This could be explained that there may be a great effort to improve glycemic control and treatment outcomes among diabetic patients at the study area.

This investigation indicated that younger age was significantly associated with poor glycemic control like other studies [24-26]. Self-management behaviors among younger patients might be low compared to older patients who could be more motivated in taking care of their diabetes and more compliant with their diet and medications [26]. It was investigated that younger individuals were more likely to have more barriers to self-management behaviors such as healthy low-fat diet, glucose testing, regular physical exercise and compliance with medications [27]. Diabetes self-management intervention may help these target patients to maintain their health and quality of life since effective self-management and quality of life are the key outcomes of diabetes self-management education and support. Effective self-management behaviors among patients with diabetes should be measured and monitored as part of care [8].

Co-morbidities such as hypertension [20], neuropathy, retinopathy, renal failure, coronary heart disease and neurological disorders were associated with poorly controlled diabetes [28]. In the present study, hypertensive patients were more likely to be poorly controlled unlike a number of

studies [10-12,16]. Hypertension is a common co-morbidity in type 2 diabetes mellitus patients and a major risk factor for both cardiovascular disease and microvascular complications. Therefore, diabetic patients with hypertension should be treated to less than 140/90 mmHg [8] and many of them require combination therapy with multiple antihypertensive medications [29], which may lead to poor medication adherence. It was investigated that non-adherence was significantly associated with multiple medications in the prescription [6]. Feldman *et al.* reported poor adherence to medications as an independent determinant of poor glycemic control among patients with diabetes [30]. Therefore, the findings of this study suggest that interventions focusing on patients with co-morbidities, mainly hypertension, could improve medication adherence to achieve optimal glycemic control.

Self-management behaviors such as diet, exercise, and glucose testing were independent predictors of poor glycemic control among type 2 diabetic patients in this investigation like other studies [9,11,28]. Lifestyle and behavioral factors play an important role in the development and successful management of type 2 diabetes. However, patients and healthcare professionals often find lifestyle change as the most challenging aspect of care, and patients report that changing diet patterns and exercise prescriptions are often impracticable to follow long-term [31]. Lifestyle intervention is important to reduce cardiovascular disease risk factors through increased physical activity, weight loss and smoking cessation [8]. A highly personalized intervention is the key feature of the intervention, which addresses diabetes self-management issues. The intervention can potentially be incorporated into routine patient care in general practice [31].

This study was limited by cross-sectional study, which could not provide a well-established association between glycemic control and its potential predictors, unlike a longitudinal design. Selection bias can also occur as the study only included patients with information on the laboratory examination.

CONCLUSION

The findings of this study revealed that the glycemic control among type 2 diabetes mellitus patients in Ayder Referral Hospital is found to be poor though it was relatively better than that reported in many regions. Independent predictors of poor glycemic control in these patients were younger age, hypertension, and non-adherence to diabetes self-management behaviors. Hence,

diabetes self-management education is critical to improving glycemic control and quality of life. Younger and hypertensive patients should be targeted with additional interventions to achieve optimal glycemic control. Further study with more rigorous study design over time is recommended to provide substantial evidence of causality.

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