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Original Research Article.

Rate and Predictors of Type 1 Diabetes Mellitus Poor Glycemic Control In Tabuk

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ABSTRACT

Background: Recently, great advances in the quality of care regarding type 1 diabetes have been achieved. Despite of that, glycemic control remains suboptimal for many patients with type 1 diabetes even in Western countries.

Objectives: To identify rate and predictors of glycemic control among type 1 diabetic patients in Tabuk Region, Saudi Arabia.

Subjects and Methods: A cross-sectional study was carried out in Tabuk city, Saudi Arabia. All type 1 diabetic patients attending the military hospital in Tabuk throughout the study period (December, 2018-February, 2019) constituted the target population for the study. Data collection questionnaire developed by the researcher and validated by three Diabetology consultants (face validity) was used. Glycosylated hemoglobin (HBA1c) Levels above 8%, independent of age was considered as poor control, and levels below or equal 8% were considered as acceptable control.

Results: The study included 150 type 1 diabetic patients. Their age ranged between 8 months and 27 years with a mean±standard deviation of 15.44±4.73 years. The prevalence of poor glycemic control among type 1 DM patients was 70.7%. Multivariate logistic regression analysis revealed that admission to the hospital twice or more than twice were associated with higher risk of poor glycemic control (Adjusted odds ratio (AOR) and their 95% confidence intervals (CI) were 2.19, 1.03-8.01 (p=0.046) and 3.02, 1.79-11.13 (p=0.009), respectively. With increase in age at diagnosis of type 1 DM by one year, there was a reduction in poor glycemic control by 38% (AOR=0.62, 95% CI=0.54-0.71, p<0.001) while with increase in the duration of diabetes by one year, the risk of poor glycemic control increased by 31% (AOR=1.31, 95% CI=1.09-1.98, p=0.001). Non availability of glucose test device was associated with almost 4-folds risk of poor glycemic control (AOR=4.12, 95% CI=2.23-5.03, p=0.007). **Conclusion:** Majority of type 1 diabetic patients in Tabuk Region, KSA had poor glycemic control. Many factors were associated with poor control, some of them are modifiable. Therefore, efforts must be done to overcome these factors.

Keywords: Type 1 Diabetes, Glycated Hemoglobin, Glycemic Control, Prevalence, Associated Factors.

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INTRODUCTION

Type 1 diabetes mellitus (T1DM) results from a cellular-mediated autoimmune destruction of beta cells of the pancreas.[1] On global level, It is one of the most common endocrine metabolic disorders in children and adolescents.[2] The follow-up study Epidemiology of Diabetes Interventions and Complications (EDIC) and The Diabetes Control and Complication Trial (DCCT) definitely found

that poor glycemic control over a prolonged period enhances the onset and fasts the progression of microvascular and macrovascular complications of type 1 diabetes.[3-5]

The prevalence of T1DM increased over the last three decades, and reach up to 109.5 per 100000 children in Saudi Arabia[6] with an annual incidence of 31.4 per 100000 according to the International Diabetes Federation's Diabetes Atlas.[7]

Recently, great advances in the quality of care regarding type 1 diabetes has been achieved including continuous subcutaneous insulin pump therapy, sophisticated blood glucose monitoring, and more physiologic insulins. Despite of that, glycemic control remains suboptimal for many patients with type 1 diabetes even in Western countries.[8-11]

Type 1 diabetic patients with poor glycemic control episodes were also at risk of in-hospital deaths.[12] Poor glycemic control was found to be a leading cause diabetic keto acidosis(DKA) in a study carried out in Jeddah (Kingdom of Saudi Arabia, 2015).[13]

Numerous factors have been associated with poor glycemic control in the literature. Elgerbi, et al (2014)[12] found an association between poor glycemic control and older age, a caregiver other than mother and poor compliance with insulin therapy. Also, there was a relationship between poor glycemic control and taking two injections per day with high insulin dose in another study carried out in Scotland.[14] In addition, glycemic control in T1DM patients is affected by duration of illness, type of insulin, parameters measurements, as well as family status.[12] This study aimed to investigate the rate and predictors of poor glycemic control among type 1 diabetic patients in Tabuk, Saudi Arabia

SUBJECTS AND METHODS

A cross-sectional study was carried out in Tabuk city, Saudi Arabia which located 2200 feet above sea level. It has a population of 534,893 (2010 census).[15] Military hospital in Tabuk city was the study setting. All type 1 diabetic patients attending clinics throughout the study period (December, 2018-February, 2019) constituted the target population for the study. For children, caregivers were responsible for filling the study questionnaire. Newly diagnosed cases (<12 months ago) as well as non-Saudi patients were excluded.

Assuming that the prevalence of poor glycemic control among type 1 diabetic patients was 9.5%, [1] and according to the formula of sample size calculation:

$$N=\frac{T^2 \times P(1-P)}{M^2}$$

Where: N = required sample size

T = confidence level at 95% (standard value of 1.96)

P = estimated prevalence of disease in the project area

M = margin of error at 5% (standard value of 0.05)

The sample size would be a minimum of 132 patients. This sample was increased to 150 in order to compensate for drop-out.

The patients were chosen from different clinics in the diabetic center by applying a systematic random sampling technique to select 15 patients daily. Thus a total of ten working days (almost two weeks) were needed to complete sample recruitment.

Data collection questionnaire developed by the researcher and validated by three Diabetology consultants (face validity). It is composed of three parts: Personal characteristics: Age and age at diagnosis, diabetes-related variables: Duration of the diseases, insulin type, dosage, history of hospitalization, ICU admission, carbohydrate count usage, diet usage, physician revisit interval, adherence to insulin therapy, knowledge about glucagon, glucagon injection, availability of diabetes educator, sufficiency of information from diabetes educator and availability of glucose test device. Glycosylated hemoglobin (HBA1c) Levels above 8%, independent of age was considered as poor control, and levels below or equal 8% were considered as acceptable control.[16]

Data were collected through interviewing of patients or their caregivers by the researchers. All ethical considerations were followed before conduction of the study.

Data Entry and Statistical Analysis

Statistical Package for Social Sciences (SPSS) software version 25.0 was used for computerized data entry and analysis. Descriptive statistics (number, percentage for categorical variables and mean, standard deviation (SD) and range for continuous variables) and analytic statistics using Chi Square tests (χ^2) to test for the association and/or the difference between two categorical variables were applied. P-value equal or less than 0.05 was considered statistically significant.

Poor glycemic control, based on (HBA1c% >7.5%) will be utilized as dependent variable in multivariate logistic regression analysis. All significant associated factors from bivariate analysis will be treated as independent categorical variables. The adjusted measure of association between associated factors and poor glycemic control among type 1 diabetic patients was expressed as the odds ratio (OR) with 95% Confidence Interval (95% CI). Adjusted or crude ORs with 95% CI that did not include 1.0 were considered significant.

RESULTS

The study included 150 type 1 diabetic patients. Their age ranged between 8 months and 27 years with a mean ± standard deviation of 15.44±4.73 years. Figure 1 shows that the prevalence of poor glycemic control among type 1 DM patients was 70.7%.

From table 1, it is shown that age at diagnosis of type 1 DM (p<0.001), duration of the diseases (p=0.013), history of hospital admission (p<0.001), history of ICU admission (p<0.001), history of hypothyroidism (p<0.001), bronchial asthma (p<0.001), retinopathy (p<0.001), renal complications (p=0.009), diabetic foot (p=0.001), family history of type 1 DM (p=0.034), history of familial genetic diseases (p<0.001), availability of glucose test device (p<0.001), frequency of monitoring blood glucose (p<0.001), availability of diabetes educator (p<0.001), frequency of taking to diabetes educators (p<0.001), sufficiency of information from them (p=0.004), awareness and usage of glucagon injection (p<0.001), use of herbal/traditional medicine (p<0.001)and usage of carbohydrate count (p=0.017) were significantly associated with DM type 1 control, presented as level of HbA1c.

Multivariate logistic regression analysis revealed that admission to the hospital twice or more than twice were associated with higher risk of poor glycemic control (Adjusted odds ratio (AOR) and their 95% confidence intervals (CI) were 2.19, 1.03-8.01 (p=0.046) and 3.02, 1.79-11.13 (p=0.009), respectively. With increase in age at diagnosis of type 1 DM by one year, there was a reduction in poor glycemic control by 38% (AOR=0.62, 95% CI=0.54-0.71, p<0.001) while with increase in the duration of diabetes by one year, the risk of poor glycemic control increased by 31% (AOR=1.31, 95% CI=1.09-1.98, p=0.001). Non availability of glucose test device was associated with almost 4-folds risk of poor glycemic control

(AOR=4.12, 95% CI=2.23-5.03, p=0.007). Also, never monitoring of blood glucose was associated with about 5-folds risk of poor glycemic control (AOR=5.13, 95% CI=2.02-9.03, p<0.001). Never talking to health educator was associated with higher risk of glycemic control (AOR=4.01, 95% CI=2.01-9.08, p=0.003). Consider usage of carbohydrate count as a reference category, none usage was associated with about 3-folds risk of poor glycemic control (AOR=3.22, 95% CI=1.69-6.28, p=0.016).

Table 1: Factors associated with glycemic control among type 1 diabetes mellitus patients, Tabuk

		Glycemic control		p-value
		Acceptable n=44 N (%)	Poor n=106 N (%)	
Age at diagnosis (years) Mean±SD		13.18±3.40	7.88±2.67	<0.001ǂ
Duration of diabetes (years)		6.77±2.17	5.69±2.50	0.013
History of hospital admission	**No (n=82)**	41 (50.0)	41 (50.0)	<0.001*
	Once (n=22)	0 (0.0)	22 (100)	
	Twice (n=32)	3 (9.4)	29 (90.6)	
	>twice (n=14)	0 (0.0)	14 (100)	
ICU admission	**Yes (n=21)**	0 (0.0)	21 (100)	<0.001**
	No (n=129)	44 (34.1)	85 (95.9)	
History of other chronic diseases	**Hypothyroidism (n=46)**	2 (4.3)	44 (95.7)	<0.001**
	Wheat allergy (n=17)	2 (11.8)	15 (88.2)	0.074**
	Bronchial asthma (n=33)	21 (63.6)	12 (36.4)	<0.001*
Diabetes complications	**Retinopathy (33)**	0 (0.0)	33 (100)	<0.001**
	Renal complications (n=13)	0 (0.0)	13 (100)	0.009**
	Dental complications (n=58)	19 (32.8)	39 (67.2)	0.464*
	Diabetic foot (n=18)	0 (0.0)	18 (100)	0.001**
Family history of type 1 DM	**No (n=48)**	7 (14.6)	41 (85.4)	0.034*
	Yes, one (n=33)	12 (36.4)	21 (63.6)	
	Yes, two (n=30)	13 (43.3)	17 (56.7)	
	Yes, >two (n=39)	12 (30.8)	27 (69.2)	
History of familial genetic diseases	**No (n=104)**	40 (38.5)	64 (61.5)	<0.001**
	Yes (n=46)	4 (8.7)	42 (91.3)	
Availability of glucose test device	**No (n=67)**	2 (3.0)	65 (97.0)	<0.001*
	Yes, from the government (n=72)	34 (47.2)	38 (52.8)	
	Yes, on patient`s expense (n=11)	8 (72.7)	3 (27.3)	
Frequency of monitoring blood glucose	**Twice or more/day (n=51)**	35 (68.6)	16 (31.4)	<0.001*
	Once/day (n=49)	6 (12.2)	43 (87.8)	
	Once/week (n=29)	1 (3.4)	28 (96.6)	
	Never (n=21)	2 (9.5)	19 (90.5)	
Availability of diabetes educator	**Yes (n=104)**	44 (42.3)	60 (57.7)	<0.001*
	No (n=3)	0 (0.0)	3 (100)	
	Don`t know (n=43)	0 (0.0)	43 (100)	
Frequency of talking to health educator	**Once (n=66)**	29 (43.9)	37 (56.1)	<0.001*
	Twice/more (n=36)	15 (41.7)	21 (58.3)	
	Never (n=48)	0 (0.0)	48 (100)	
Sufficiency of information from diabetes educator (n=102)	**Yes (n=82)**	41 (50.0)	41 (50.0)	0.004**
	No (n=20)	3 (15.0)	17 (85.0)	
Awareness about Glucagon injection	**Yes (n=91)**	41 (45.1)	50 (54.9)	<0.001**
	No (n=59)	3 (5.1)	56 (94.9)	
Glucagon injection	**No (n=71)**	14 (19.7)	57 (80.3)	<0.001*
	Yes, once (n=35)	20 (57.1)	15 (42.9)	
	Yes, twice (n=30)	10 (33.3)	20 (66.7)	
	Yes,>twice (n=14)	0 (0.0)	14 (100)	
Usage of traditional/herbal medicine	**No (n=66)**	34 (51.5)	32 (48.5)	<0.001*
	Yes, once (n=25)	7 (28.0)	18 (72.0)	
	Yes, twice (n=40)	2 (5.0)	38 (95.0)	
	Yes,>twice (n=19)	1 (5.3)	18 (94.7)	
Diet usage	**Yes (n=35)**	2 (5.7)	33 (94.3)	0.583*
	No (n=136)	7 (5.1)	129 (94.9)	
Carbohydrate count usage (n=170)	**Yes (n=22)**	4 (18.2)	18 (81.8)	0.017*
	No (n=148)	5 (3.4)	143 (96.6)	
Physician revisit interval	**Once/month (n=8)**	0 (0.0)	8 (100)	0.514**
	Once/3 months (n=150)	9 (6.0)	141 (94.0)	
	Once/6 months (n=13)	0 (0.0)	13 (100)	
Adherence to insulin therapy	**Excellent (n=117)**	7 (6.0)	110 (94.0)	0.802**
	Good (n=52)	2 (3.8)	50 (96.2)	
	Bad (n=2)	0 (0.0)	2 (100)	
Type of insulin	**Multi-doses/day (n=105)**	6 (5.7)	99 (94.3)	0.866**
	Two doses/day (n=62)	3 (4.8)	59 (95.2)	
	Insulin pump (n=4)	0 (0.0)	4 (100)	

*Chi-square test ** Fischer exact test ǂ Student`s t-test

Table 2: Predictors of poor glycemic control among type 1: Results of multivariate logistic regression analysis

		Adjusted OR	95% CI	
History of hospital admission	No (n=82)[a]	1.0	---	---
	Once (n=22)	1.22	0.78-4.02	0.258
	Twice (n=32)	2.19	1.03-8.01	0.046
	>twice (n=14)	3.02	1.79-11.13	0.009
Age at diagnosis (years)		0.62	0.54-0.71	<0.001
Duration of diabetes (years)		1.31	1.09-1.98	0.001
Availability of glucose test device	Yes (n=83) [a]	1.0	---	---
	No (n=67)	4.12	2.23-5.03	0.007
Frequency of monitoring blood glucose	Twice or more/day (n=51) [a]	1.0	---	---
	Once/day (n=49)	1.09	0.29-1.31	0.459
	Once/week (n=29)	2.04	0.93-7.22	0.126
	Never (n=21)	5.13	2.02-9.03	<0.001
Frequency of talking to health educator	Twice/more (n=36) [a]	1	---	---
	Once (n=66)	1.19	0.24-5.02	0.389
	Never (n=48)	4.01	2.01-9.08	0.003
Carbohydrate count usage (n=170)	Yes (n=22) [a]	1.0	---	---
	No (n=148)	3.22	1.69-6.28	0.016

[a]: Reference category; OR: Odds ratio; CI: Confidence interval

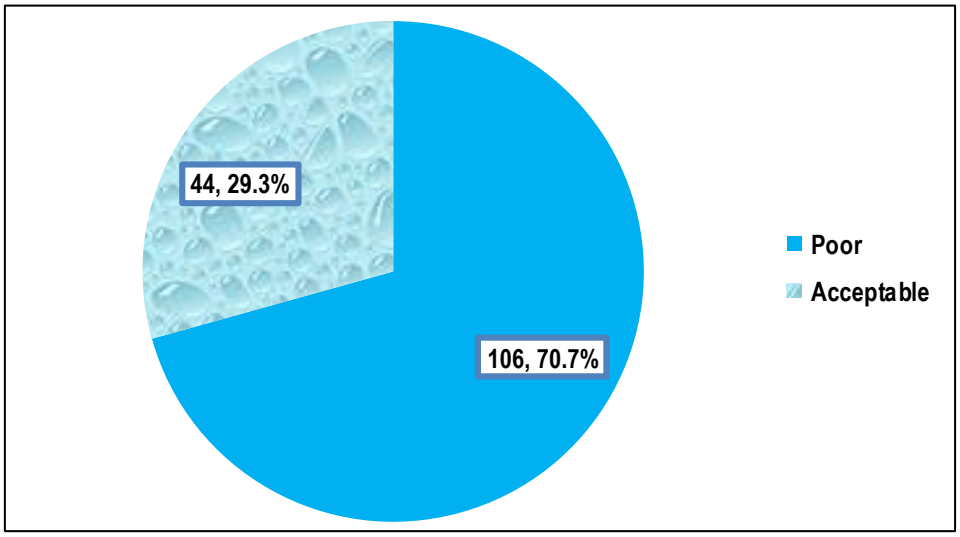

Figure 1: Prevalence of poor glycemic control among type 1 diabetes mellitus patients in Tabuk.

DISCUSSION

It is essential to Identify type 1 diabetic patients at high risk for poor glycemic control in order to adopt aggressive interventions and management for the disease, and prevent further deterioration of glycemic control. Unfortunately, treating physicians lack the tools to identify those patients, making it difficult to provide preventative care.[17] Therefore, this study was conducted to identify rate and predictors of glycemic control among type 1 diabetic patients in Tabuk Region, Saudi Arabia.

Generally speaking, in agreement with other investigators[18-22], the glycemic control, evidenced by level of HBA1c in the current study was poor among majority of patients (70.7%).

Several predictors for poor glycemic control were identified in the bivariate analysis in this study. However, after control for the confounding effect in multivariate logistic regression analysis, nine factors remained. In this study and in accordance with others[18], the duration of type 1 diabetes was significantly associated with glycemic control as the level of poor glycemic control increased significantly with each year increase in the duration of diabetes. This is called "a phenomenon of honeymoon period" as the residual beta cell function may deliver intrinsic insulin for months to few years after the onset of diagnosis.[23] In the present study, age at diagnosis of type 1 DM was associated with poor glycemic control. This finding coincides with that observed Yazidi et al (2016) in Tunisia who reported that the young age at diagnosis was associated with higher HbA1c during follow-up and attributed this to the faster autoimmune β cell destruction.[18] Similarly, Clements et al recorded in a large cohort of type 1 diabetic patients that age at diagnosis was significantly associated with glycemic control as there was deterioration in glycemic control with advancing age.[17]

Studies had documented that females with type 1 diabetes had a worse glycemic control than males and attributed this to a higher prevalence of eating disorders, higher insulin resistance, and insulin misuse for weight-control purpose, particularly in young age.[23,24] however, in the present study and in accordance with others[18], gender difference was not observed.

In this study, the frequency of talking to diabetic health educators was significantly associated with better glycemic control. The same has been reported by others, However, among type 2 diabetic patients.[25,26] Also, in previous studies carried out in Brazil[20], Australia[27] and Saudi Arabia[28], participation in a diabetes education program was significantly associated with better glycemic control. This finding enforces the role that could played by diabetic health educator in improving the level of glycemic control among type 1 diabetic patients.

Regarding the observation that carbohydrate count usage was significantly associated with better glycemic control in the present survey; the same has been documented by others. Laurenzi et al (2011) in their randomized clinical trial concluded that patients with type 1 diabetes treated with continuous subcutaneous insulin infusion with carbohydrate counting showed a reduction in HbA1c level.[29] Mehta et al (2009) reported that carbohydrate count usage was significantly associated with better glycemic control among type 1 diabetic patients and hypothesized that usage of carbohydrate counting would allow for proper calculation of insulin doses and improve glycemic control.[3] Also, other older studies reported that usage of carbohydrate counting was independently associated with lower A1C.[31,32] Tascini et al (2018)[33] concluded that usage of carbohydrate counting may reduce HbA1c concentration. However, it should be integrated with the counts of fats and proteins, in order to improve the calculation of the insulin dosage. A systematic review and meta-analysis was recently performed to evaluate the effectiveness of carbohydrate counting usage on glycaemic control in people with T1D and concluded that usage of carbohydrate counting, compared with usual diabetes diets or other diabetes diet methods improved values of HbA1c.[34]

In accordance with others,[35,36] the availability and frequent application of glucose test device was associated with better glycemic control of diabetic patients in the present study.

In the current study, more frequent hospitalized patients were less likely to achieve appropriate glycemic control. The same has been proved by Wei NJ et al who concluded that hospitalized diabetic patients with poorly controlled diabetes were less likely to achieve optimum glycemic control at one year compared to non-hospitalized patients.[37] So, there is a need to improve long-term glycemic control in hospitalized diabetic patients.

This study has important limitations that should be addressed. The cross-sectional design of the study does not allow establishing a temporal relation between HbA1c and possible predictors. Carrying out the study in one region of KSA could influence the generalizability of results over other regions. Finally, information used in this study with the exception of t HBA1c level, were collected through interviewing caregivers with the possibility of information bias.

In conclusion, majority of type 1 diabetic patients in Tabuk Region, KSA had poor glycemic control. Many factors were associated with poor control, some of them are modifiable. Therefore, efforts must be done to overcome these factors.

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