Original Article

Factors Affecting Glycemic Control in Type 1 Diabetes Mellitus among Children in Sulaimani Governorate, Iraq

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Abstract

Background and aim: Type 1 diabetes mellitus (T1DM) has been introduced as the second commonest chronic disorder in childhood. T1DM can lead to long-term complications which can be controlled through glycemic control which is under the influence of several factors such as age, lifestyle, family structure, duration of diabetes, and so forth. In this regard, the present study was carried out in order to specify and examine effective factors in glycemic control in type 1 diabetes mellitus among children in Sulaimani governorate, Iraq.

Methods: In a cross-sectional study, 104 children with T1DM were recruited and the required data on their sociodemographic characteristics and glycocyted hemoglobin (HbA1c) were collected. Afterwards, the association between different factors and glycemic control was examined through Chi-square test, Student's t-test, ANOVA, and Fisher's exact test using SPSS 25.0.

Results: The results of data analysis indicated that there was a significant relationship between the T1DM children's glycemic control and their age ($p=0.005$), while it had no significant association with other factors including sex, celiac disease, BMI, family economic status, father education level, and mother education level ($p>0.05$).

Conclusion: According to the results of the present study, glycemic control was significantly affected by the children's age. Therefore, this factorshould be paid more attention to while treating children with type 1 diabetes mellitus.

Keywords: type 1 diabetes mellitus (T1DM), glycemic control, children, glycated hemoglobin (HbA1c), Sulaimani

Introduction

As the second commonest chronic disorder of childhood, only to asthma (1), type 1 diabetes mellitus (T1DM) is characterized by chronic hyperglycemia resulted from insulin deficiency (2). Research has indicated that T1DM incidence is globally increasing by 3 to 5% (3). The lowest rate of T1DM incidence is reported to be in developing countries like China and Venezuela, and the highest rate in Finland (4). According to the review carried out by Mansour (2015) in Iraq, there was an increase from 5% in 1978 to 19.7% in 2012 (5). According to the relevant research, people type 1 diabetes mellitus have increased risks of developing autoimmune disorders such as celiac disease which is in turn associated with poorer glycemic control (6). Moreover, studies have shown that glycemic control is at a worse status among type 1 diabetic patients from minority groups, lower socioeconomic groups, and underinsured

families (7). Moreover, in their study, Haghighatpanah et al. (2018) indicated that poor glycemic control is significantly associated with the patients' demographic characteristics including gender, age, BMI, and occupation ($p<0.05$) (8). Glycemic control in type 1diabetes mellitus has also been reported to be associated with different complications caused by T1DM including nephropathy, retinopathy, neuropathy, cerebrovascular accidents, cardiovascular disease, and peripheral vascular disease (9). On the other hand, as shown in the study carried out by Nyström et al. (2015), appropriate glycemic control is associated with decreased risk of complications caused by type 1 diabetes mellitus (10).

Glycated hemoglobin (HbA1c) is a laboratory-based assessment that indicates the time-weighted average plasma glucose during the previous 8 to 12 weeks (11). According to the American Diabetes Association (ADA), HbA1c should be <7.5% for young individuals (<18 years) with T1DM (12). In addition, research has revealed a linear correlation between HbA1c and the initiation or progression of T1DM-related complications (13, 14); therefore, glycemic control and the risk of severe hypoglycemic episodes have been reported to be correlated inversely (15).

Studies carried out in Iraq have reported a low level of glycemic control at 10% (16) and 23% (17) which have been attributed to social and economic conflicts which have caused numerous problems to delivery of health care and supply of medicine. Moreover, different risk factors have been reported to be significantly associated with glycemic control in children, including low levels of HDL, treatment with oral anti-diabetes agents (18), medical status, sociodemographic status, lifestyle, lipid levels (19), family structure, age (20), duration of diabetes, and caregiver involvement (21). To the best of the authors' knowledge, no comprehensive study has ever focused on glycemic control and the factors that affect it in the Kurdistan Region of Iraq. In this regard, the present study was carried out in order to identify and examine the factors that affectglycemic control in type 1 diabetes mellitus among children in Sulaimani governorate, Iraq in 2018.

Methods

The present cross-sectional study was carried out on 104 type 1 diabetic children who referred to the governmental Pediatric Hospital located in Sulaimani, the Kurdistan Region of Iraq for their scheduled insulin injection from April to September, 2018. In order to select the study sample, a non-probability convenience sampling method was utilized. In order to collect the required demographic data, a questionnaire that was developed by a pediatric specialized physician was employed to interview all of the children and their families face to face while they referred to the hospital to receive insulin injection. The children and their families were also asked about the factors that are related to glycemic control in type 1 diabetes mellitus.

In order to determine the children's glucose level, HbA1c method was used. This method is a procedure high-performance liquid chromatographic (HPLC) method through a lab machine named BIO-RAD/D-10, and D-10 software was used for the purpose of analysis. Moreover, to quantify the HbA2/F/A1c, two-level calibration was

employed, and in order to calculate the A1c area, the exponentially modified Gaussian (EMG) algorithm was utilized.

The collected clinical data were recorded on an Excel (Microsoft) spreadsheet, and statistical analysis of the collected data was performed through SPSS version 25.0. The categorical variables were expressed as frequency distributions and single percentages, and the intergroup (i.e. age, sex, economic status, etc.) comparisons were carried out using Chi-square test and Student's t-test. Furthermore, when Chi-square test assumptions were violated. In addition, the collected quantitative variables were expressed as Mean ±SD. Also, ANOVA was utilized to assess significant differences between the means of three or more independent (unrelated) groups. Fisher's exact test was used for dichotomy of the variables. The level of statistical significance was set at $p<0.05$ in all statistical tests.

Results

According to the results of the present study indicated that the mean age of the children was 10.68 with a standard deviation of 3.49. It was also observed that 33.7% of the children were 4-8 years old, 29.8% were 8 to 12, and 34.6% were 12 to 16. With regard to their sex, 51% of the children were males and 49% were females. The children's mean BMI was 17.62±3.167, with a minimum of 11 and a maximum of 33 kg/m^2. In terms of their family economic status, almost half of them (46.2%) had a fair economic status, 14.4% a good status, and 39.4% a bad status (**Table 1**).

Measuring the children's HbA1c revealed that their mean blood glucose was 11.809 with a median of 11.600, standard deviation of 3.3165, minimum of 5.2, maximum of 23.4, 25^{th} percentile of 9.650, 50^{th} percentile of 11.600, and 75^{th} percentile of 13.200 (**Table 2**).

As the HbA1c distribution indicated in the following histogram, most of the participating children had a mean HbA1c of 11.81 (**Figure 1**).

According to the results of analyzing the T1DM children's HbA1c data, there was an increase in their HbA1c value with a rise in their age, and glycemic control was significantly worse in the older children with a significant difference level of 0.01. However, there was no significant difference between the boys and girls in terms of their HbA1c level (**Figure 2**).

Analyzing the relationship between different factors and glycemic control (HbA1c) in the participating T1DM children revealed that there was no significant difference between their glycemic control and sex (p=0.609), celiac disease (p=0.619), BMI (p=0.063), family economic status (p=0.995), father education level (p=0.259), and mother education level (p=0.186). As shown in Table 3, glycemic control was significantly associated only with age (p=0.005) (**Table 3**).

Although, it was observed reduced in the HbA1c level among patients who token the insulin regimen but the differences was not significant (p-value 0.754). (**Figure 3**).

Discussion

The results of the present study indicated that the children's mean HbA1c was 11.809, which is in agreement with the results of the study carried out by Hadi et

al. (2018) who reported a mean level of HbA1 as 11.3 (22). It was also observed that there was no significant association between the children's glycemic control and their sex (p=0.609). This finding is not in agreement with that of the study carried out by Setoodeh et al. (2011) who reported that girls had a higher level of HbA1c and a poorer level of diabetes control (23). This difference can be attributed to the difference in the samples of the two studies, one carried out in Iran and the other in Iraq. However, it was in line with the result of the study carried out by *Kadhim et al. (2016) in Baghdad (24).*

The results also indicated that glycemic control and celiac disease were not significantly correlated (p=0.619). This finding is rejected by other studies that have shown a significant correlation between celiac disease and T1DM and their coexistence in most type 1 diabetic patients (25-27). Also, the results proved no significant association between BMI and glycemic control (p=0.063). Similar findings have been reported by other researchers including Ashish et al. (2016) (28) and Vázquez et al. (2014) (29).

The results of the present study revealed no significant relationship between the children's family economic status and their glycemic control. This finding is in agreement with those of the studies conducted by Ashish et al. (2016) (28) and Al-Odayani et al. (2013) (30). Moreover, as revealed by the results of the present study, glycemic control and education level of the children's parents were not significantly correlated (p>0.05). A similar finding was reported by Majidi et al (2014) (31).

However, the results of the present study showed that there was a significant association between glycemic control and the children's age (p=0.005). This finding is in line with those of studies carried out by Ashish et al. (2016) (28), Haugstvedt et al. (2011) (32), and Fisher et al. (2018) (33).

Conclusion

The results of the present study revealed that age was among the factors that had a significant effect on glycemic control. Therefore, while treating children with type 1 diabetes mellitus (T1DM), this should be taken into careful consideration, such that treatment of children with T1DM should be started early because as they grow older, glycemic control declines and becomes more difficult.

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Tables and Figures

Table 1. Demographic characteristics of the study sample (T1DM patients)

Characteristics of patients	N (%)
Patients	104 (100%)
Mean age (year)±(standard deviation)	10.68±(3.49)
4-8	35 (33.7)
8-12	31 (29.8)
12-16	36 (34.6)
Total	102 (98.1)
Sex	
Male	53 (51)
Female	51 (49)
Total	104 (100)
Mean BMI±(standard deviation)	17.62±(3.167) kg/m^2
Minimum	11 kg/m^2
Maximum	33 kg/m^2
BMI classification	
Under weight	75 (72.1)
Normal weight	25 (24)
Over weight	3 (2.9)
Obese	1 (1)
Family economic status	
Good	15 (14.4)
Fair	48 (46.2)
Bad	41 (39.4)

Table 2. HbA1c of the sample

Current HbA1c	
N	
Valid	104
Missing	0
Mean	11.809
Median	11.600
Std. Deviation	3.3165
Minimum	5.2
Maximum	23.4
Percentiles	
25	9.650
50	11.600
75	13.200

Table 3. Distribution of effective factors in glycemic control (HbA1c) in the children with T1DM

Factors		N (%)	Mean±SD	p-value
Sex	Male	53 (51.0)	11.645±3.768	0.609
	Female	51 (49.0)	11.98±2.799	
Age	4-8 year	35 (33.7)	10.426±2.481	0.005
	8-12 year	31 (29.8)	11.706±2.881	
	12-16 year	36 (34.6)	12.850±3.649	
Celiac disease	Present	4 (4.6)	13.700±7.021	0.619
	Not present	82 (95.3)	11.754±3.274	
Body mass index	Under weight	75 (72.1)	11.744±3.164	0.063
	Normal weight	25 (24.0)	11.336±3.178	
	Over weight	3 (2.9)	16.567±5.923	
	Obese	1 (1.0)	14.200	
Family economic status	Good	15 (14.4)	11.760±3.442	0.995
	Fair	48 (46.2)	11.844±3.226	
	Bad	41 (39.4)	11.785±3.456	
Father education level	Illiterate	28 (26.9)	12.454±4.096	0.259
	Primary	24 (23.1)	11.854±2.347	
	Secondary	34 (32.7)	11.874±3.081	
	College	17 (16.3)	10.359±3.368	
	Other	1 (1.0)	15.100	
Mother education level	Illiterate	40 (38.5)	12.362±3.702	0.186
	Primary	34 (32.7)	11.241±2.504	
	Secondary	21 (20.2)	12.362±3.548	
	College	9 (8.7)	10.200±3.290	

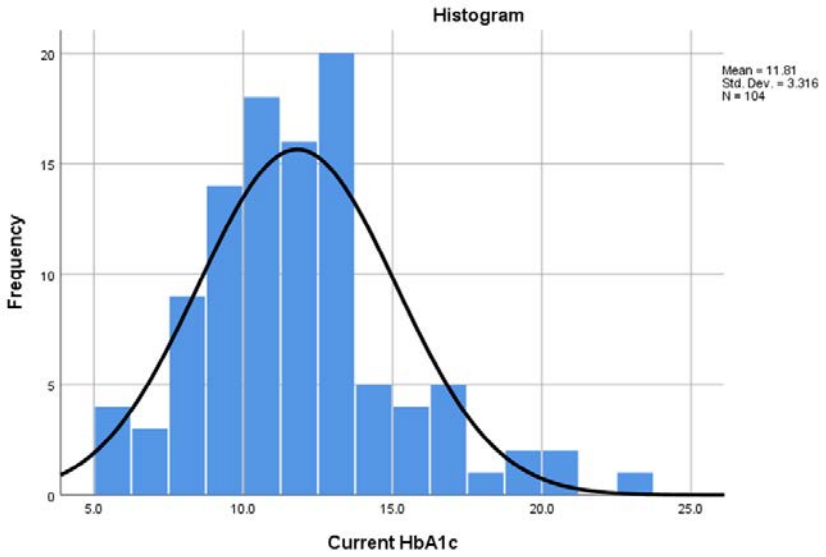

Figure 1. Histogram of the HbA1cdistribution in the study population

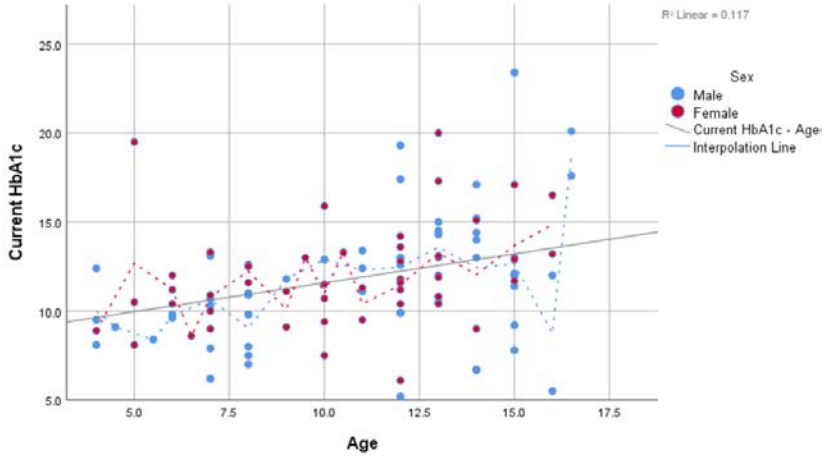

Figure 2. The correlation between the participants' age and HbA1c level

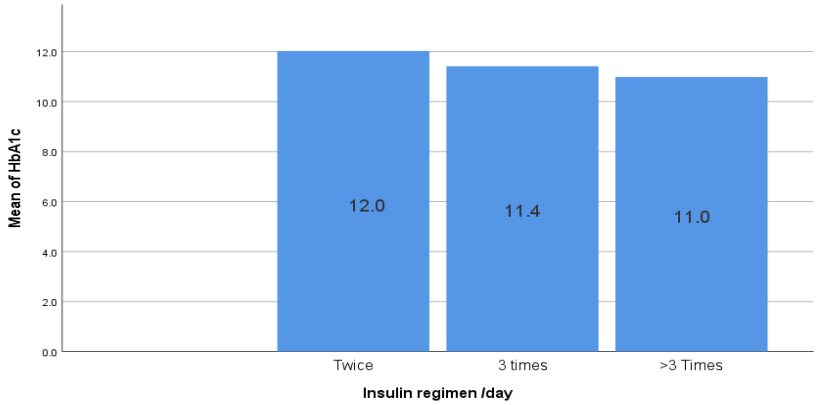

Figure 3. The relation between insulin regimen and HbA1c level