Glycosylated Hemoglobin and Related Factors in Children With Type 1 Diabetes Mellitus Under 20 Years of Age

Zahra Razavi[1], Elham Kaviani[1], Javad Fredmal[2]

[1] *Department of Pediatrics, School of Medicine, Hamedan University of Medical Sciences, Hamedan, Iran*
[2] *Department of Biostatistics, Hamedan University of Medical Sciences, Hamedan, Iran*

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Abstract- The number of child and adolescence with type 1 diabetes mellitus (T1DM) is increasing. This study was conducted to assess glycemic control in child and adolescence with type 1 diabetes mellitus and its associated factors in Hamadan (Iran). This was a prospective observational study, dealing with 110 child and adolescence with type 1 diabetes mellitus, who referred to a pediatric diabetes clinic, affiliated to Hamadan University of Medical Sciences in 2012-2014. All blood tests were performed in a single laboratory. In this study, HbA1c levels of 6-7.9%, 8-9.9 and >10% were considered as good, moderate, and poor control. All collected data were recorded in the questionnaire. The number of male and female was equal. HbA1c level was equal to 6-7.9 in 48 patients (43.6%), 8-9.9 in 38 patients (34.5%), and more than 10 in 24 individuals (21.8%). Poor glycemic control was associated with: older age, duration of disease more than 5 years, less glucose monitoring, greater insulin dose, illiterate mothers, and more number of children, and residency in rural regions. Moreover, intensive insulin regimen and more times of insulin injection increased HbA1c level, though the difference was not significant. We concluded that in T1DM child and adolescence, the age, long duration of disease, number of glycemic control, insulin dose and living in urban regions are effective factors on the better control of the HbA1c levels. To improve glycemic control, we suggest more education and social support especially for mothers and rural patients and more blood glucose monitoring.

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Keywords: Type 1 diabetes mellitus; Hemoglobin A1c; Glycemic control; Child and adolescence; Glycosylated hemoglobin

Introduction

Currently, the number of child and adolescents with type 1 diabetes (T1D) is increasing. T1D in child and adolescence is generally associated with a 4% annual increase (1). A dramatic increase in T1D can be seen in the youngest age group (1-3). To avoid or delay complications such as nephropathy, retinopathy, neuropathy, and cardiovascular diseases associated with T1D, controlling the blood glucose is of great significance (4-6) and reaching the optimal HbA1c level is an important goal of therapy (7).

Sub-optimal control of blood glucose in children with T1D can negatively affect the performance of children at school and result in some behavioral problems (8-9).

Despite several investigations that have been conducted so far, in half of the child and adolescents with T1D, the HbA1c level has not been optimally controlled (10-11).

Achieving the optimal HbA1c level (<7.5%) in child and adolescents with T1D is a controversial issue among pediatricians (12). The parents of this child and adolescence are obliged to daily control diabetes, for instance through assessing blood glucose, injection of insulin as well as regulation of diet and physical activity for their children (13-14).

Understanding the relationship between parenting, demographic factors and outcomes of child and adolescence health are keys to optimally control the blood sugar and improve the quality of life in children with diabetes.

The existing differences in the ethnic and demographic factors and blood glucose control

Corresponding Author: E. Kaviani
Department of Pediatrics, School of Medicine, Hamedan University of Medical Sciences, Hamedan, Iran
Tel: +98 918 3199489, Fax: +98 81 32640064, E-mail address: kaviani_elham@yahoo.com

methods among different countries lead to different results. Since controlling blood glucose and maintaining glucose in the normal range can delay the onset or prevention of progression of diabetic complications such as retinopathy, nephropathy, neuropathy, and cardiovascular complications, this study was carried out to assess glycemic control in child and adolescents with T1DM and its associated factors in Hamadan (Iran).

Materials and Methods

This study was reviewed and approved by the local ethics committee and research of Hamadan University of Medical Sciences. Information about the trial was given generally both verbally and in written form to the parents of patients. All parents gave their written informed consent before the patients entered the study, according to the ethics board Committee of the university hospital. In this prospective observational study, we recruited 110 child and adolescents with T1DM referred to a pediatric diabetes clinic affiliated to Hamadan University of Medical Sciences during 2012-2014. Patients with T1DM confirmed by World Health Organization (WHO) criteria (15), history and clinical symptoms, aged 1-20 years, At least one year diabetes duration and with referral to the clinic for at least 3-4 times were included. Patients with irregular visits, no measure of the HbA1c level, incomplete information in their files, other auoimmune disorder, consumption of drugs affecting blood glucose and also acute illnesses were excluded. All blood tests were performed in a single laboratory. In this study, HbA1c levels of 6-7.9%, 8-9.9, and >10% were considered as good, moderate, and poor controls respectively.

Intensive insulin therapy was the regime with four injections per day of Aspart insulin before each meal and Glargine insulin at the bed time and conventional insulin therapy was twice daily injections of NPH and regular insulin.

The data extracted from these files were recorded in the questionnaire, and all demographical data required for the study were obtained through interview with parents or from medical files. These data were subsequently fed into the computer using SPSS software V. 19 and analyzed through *t*-test, Mann-Whitney test, and Wilcoxon signed-rank test. $P<0.05$ was considered as significant level.

Results

The participating child and adolescence population included 55 boys (50%) and 55 girls (50%). The education level of most fathers (35 individuals) was College-level, while the majority of mothers (31 individuals) had primary school to high school diploma.

No significant difference was found for HbA1c between sex, BMI, and parent education ($P>0.05$).

Significant differences were found for HbA1c between different groups of age ($P=0.027$). HbA1c levels in patients living in urban regions were significantly lower than those in rural regions ($P=0.028$).

In most of the child and adolescence, being 10-14 years old (40 individuals, 44.4%), the mean HbA1c levels was 7.87±1.76.

In child and adolescents with diabetes duration >5 yr., the mean HbA1c level was 9.07±1.81. In 42 patients with blood glucose control of 8-14 times per week, the mean HbA1c levels were 8.61±1.82.

Significant differences were found for HbA1c between disease duration <5 and >5 yr. ($P=0.014$), number of number of blood glucse measurement ($P=0.007$) and finally, insulin dose ($P=0.001$).

In the group receiving conventional insulin, HbA1c levels were less than the intensive insulin group, but this difference was not significant ($P=0.453$). HbA1c levels significantly increased with receiving higher doses of insulin ($P=0.001$).

No significant difference was found between number of insulin injections and HbA1c ($P>0.05$).

Based on the results, 48 children and adolescence (43.6%) with T1DM had good control (6-7.9%), 38 cases(34.5%) had moderate control (8-9.9%) and 24 cases (21.8%) had poor control diabetes (HbA1c >10%) (Figure 1).

With the increase in FBS, HbA1c levels showed a significant increase in the different level of control ($P=0.001$, Table 3).

The increase in the blood glucose was associated with significantly increased HbA1c levels in the different level of control ($P=0.001$, Table 4).

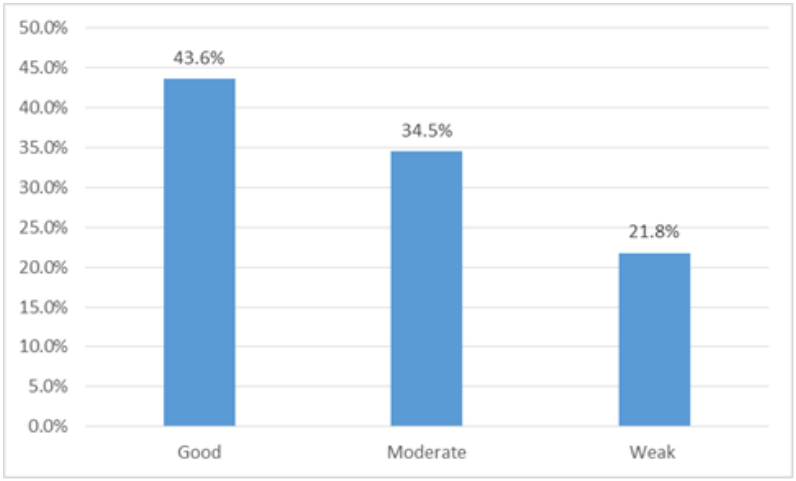

Figure 1. The frequency of different HbA1c control levels in the patients with T1DM

Table 1. Demographic characteristics of the patients with T1DM and their parents

		Mean HbA1C (±SD)	*P*
Sex	**Boy**	8.68±1.98	0.905
	Girl	8.64±1.68	
Age group	**5-9 yr**	7.51±1.73	0.027
	10-14 yr	7.87±1.76	
	15-20 yr	9.30±1.92	
BMI	**<5**	9.24±1.88	0.210
	5-85	8.66±1.81	
	>85	7.82±1.86	
Father's education	**Illiterate**	8.91±2.08	0.596
	Primary and secondary	8.83±1.69	
	High school	8.49±1.79	
	Collegiate	8.27±1.69	
Mother's education	**Illiterate**	9.56±1.98	0.082
	Primary and secondary	8.22±1.60	
	High school	8.29±1.86	
	Collegiate	8.59±1.54	
Address	**Urban**	8.33±1.69	0.028
	Rural	9.23±1.83	

Table 2. Clinical characteristics of the patients with T1DM

		Mean HbA1C (±SD)	*P*
Duration of Diabetes	**<5 yr**	8.13±1.76	0.014
	>5 yr	9.07±1.81	
Times of glycemic control in week	**< 7**	8.96±1.67	0.007
	8-14	8.61±1.82	
	>15	7.41±1.41	
Insulin dose (u/kg)		0.87±0.30	0.001
Insulin Regimen	**Conventional**	8.59±1.90	0.453
	Intensive	8.91±1.51	
Number of insulin injections	**1**	8.64±1.41	0.259
	2	8.56±1.94	
	3	9.65±1.19	
	4	9.02±1.56	

Table 3. Fasting blood glucose in different HbA1c control levels in the patients with T1DM

HbA1c control	Fasting blood sugar	*P*
Good	135.10±43.05	
Moderate	161.18±55.50	0.001
Poor	239.45±56.42	

Table 4. Random blood glucose in different HbA1c control levels in the patients with T1DM

HbA1c control	Random blood glucose	*P*
Good	170.08±43.05	
Moderate	161.18±55.50	0.001
Poor	239.45±56.42	

Discussion

In our study, HbA1c level in 43.6% of patients was in the range of 6-7.9%, being indicative of a well-controlled T1DM. In a previous study in china, HbA1c level in 27.5% of patients was 8.6% (16), and in Kashan (Iran), HbA1c level less than 8% was reported in less than 8% of patients (17).

In this research, no significant difference was found between sex and HbA1c, in agreement with the results of previous studies in Wales (18), Scotland (19), Kashan (Iran) (17), Egypt (12), and Japan (20).

Based on the present study, age was influential on glycemic control, consistent with the findings of a similar study previously performed in Wales (18). Furthermore, disease duration >5 yr was effective on glycemic control, similar to the results of a study in Kashan (Iran) (17).

In the present study, BMI had no effect on glycemic control, in contrast with the results of previous researches in Wales (18) and United States (21), although because of the low number of patients in <5 and >5 groups, such difference cannot be fully explained

We found a significant difference between number of blood glucse measurement and HbA1c, confirmed by the findings of Aschner *et al.,* (22).

Moreover, a significant difference between insulin dose and the HbA1c level was observed, similar to the findings of O'Hagan (18). In the group receiving conventional insulin, HbA1c levels were less than those in the intensive insulin group, but this difference was not significant, in agreement with the data reported by Cardwel (23).

No significant effect of the number of insulin injections on the HbA1c level was observable, consistent with the findings of Razavi (24).

In our study, HbA1c levels were significantly higher in children with uneducated mothers, but there was no significant difference between father's education and HbA1c levels, similar to the results reported in a study in Kashan (17).

In another investigation in Saudi Arabia, good glycemic control has been reported in diabetic children of mothers with higher education levels (25). Moreover, another study in Portugal indicated a significant correlation between poor glycemic control and low education of parents (26).

Compared to less educated parents, parents with higher education are more aware of the symptoms and complications of T1DM, which can result in better disease control.

HbA1c levels in patients living in urban regions were significantly lower than those in rural regions, in agreement with the results of a study in Brazil (27).

In this research, with the increase in the FBS and random blood glucose, HbA1c levels showed a significant increase in the different level of control.

In summary, we concluded that in T1DM child and adolescence, age, long duration of disease, number of blood glucose measurement, insulin dose, and living in urban regions are effective factors on the better control of HbA1c levels. To improve glycemic control, we suggest more education and social support, especially in mothers and rural patients and more blood glucose monitoring.

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