



The Relationship between Glycated Hemoglobin Levels and the Quality of Life among Type 1 Diabetes Mellitus in Children

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Abstract

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BACKGROUND: Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia that occurs due to impaired both in insulin secretion and insulin action. Children with type 1 diabetes mellitus should be targeted to achieve a glycated hemoglobin (HbA1C) level $\leq 7.0\%$ to reduce the risk of complications and improve quality of life. The majority of children with type 1 diabetes mellitus exhibit poor self-care and Health-related Quality of life behavior.

AIM: The objective of the study was to determine the relationship between HbA1C level and the quality of life among type 1 diabetes mellitus in children.

METHODS: A cross-sectional study was conducted among 30 children with type 1 diabetes mellitus who attended at pediatric endocrine clinic Haji Adam Malik general hospital and Universitas Sumatera Utara hospital Medan. Sampling was carried out in April 2020–July 2020. HbA1C level and self-administered questionnaire were used to assess the quality of life. Spearman correlation test was conducted to assess the correlation between HbA1C levels and the quality of life.

RESULTS: The mean of HbA1C level was 10.35 ± 2.68 . No significant correlation between HbA1C level and the quality of life of children with type 1 diabetes mellitus ($r = 0.264$, $p > 0.05$)

CONCLUSIONS: There was no significant correlation between HbA1C levels and the quality of life of children with type 1 diabetes mellitus.

Introduction

Definition of diabetes mellitus is a systemic disorder resulting from a glucose metabolism disorder characterized by chronic hyperglycemia [1]. Diabetes mellitus type 1 (T1DM) is the most common diabetes disease in children, caused by autoimmune or genetic processes. Autoimmune processes result in damage to pancreatic beta cells resulting in decreased insulin production. These abnormalities in the pancreas are usually permanent [2], [3].

The incidence of DM has continued to increase in the last few years. Data from the Association of Hospitals throughout Indonesia (PERSI) explains that Indonesia is in the fourth rank after the United States, China, and India. The incidence of T1DM in children and adolescents based on data from the Indonesian Pediatrician Association (IDAI) has increased about sevenfold in the last 10 years with the number of T1DM sufferers throughout Indonesia as many as 1220 children in 2018. The prevalence of DM cases based on data from the 2018 Basic Health Research (RISKESDAS) shows an increase to 8.5% [4], [5].

Uncontrolled glycemic levels can cause death, disability and can indirectly reduce the quality of life due

to complications arising such as diabetic ketoacidosis, hypoglycemia, cardiovascular disease, cerebrovascular disease, neuropathy, nephropathy, retinopathy, and foot ulcers. Young age, puberty, and poor metabolic control are the factors that cause complications due to T1DM [6]. The Diabetes Control and Complications Trial (DCCT) states that 1% difference in glycated hemoglobin (HbA1C) reduces the risk of complications by 25–50% [7].

HbA1C is a standard metabolic control parameter and has a strong predictive value for diabetes complications. HbA1C will increase if there has been a non-enzymatic glycosylation process of hemoglobin. HbA1C formation is substantially irreversible and its concentration in blood depends on blood glucose concentration and the life span of red blood cells, which averages 120 days [8], [9]. HbA1C $< 7\%$ means good metabolic control; HbA1C $< 7\%$ was considered poor [10], [11].

Very few studies to assess the psychosocial effects of diabetes were carried out on children. Pediatric quality of life inventory (PedsQL) 4.0 is an instrument for measuring the quality of life in children that meet the standards recommended by WHO is an instrument to measure the quality of life for healthy children and adolescents and children with acute and

chronic diseases which include physical, emotional aspects, and psychosocial with validity and reliability standards [12], [13]. Previous studies reported that there was a relationship between HbA1C and quality of life of children with T1DM where children who achieved the HbA1C target of <7.5% reported higher quality of life; HbA1C >7.5 and <9.0% reported significantly lower quality of life; the worst control with HbA1C >9.0% reported significantly lower quality of life than each of the other two HbA1C groups [14].

The aim of this study was to assess the relationship between HbA1C and the quality of life among type 1 diabetes mellitus in children at Central General Hospital Haji Adam Malik and Universitas Sumatera Utara hospital Medan.

Methods

Study design

The design of this study was an observational analytic study with a cross-sectional design in children who experienced T1DM at Central General Hospital Haji Adam Malik and Universitas Sumatera Utara hospital Medan.

Study setting and participant

The study was conducted from April 2020 to July 2020 at pediatric endocrine clinic Central General Hospital Haji Adam Malik and Universitas Sumatera Utara Hospital Medan. The participants were children who were fulfill the criteria of T1DM.

Instrument

Pediatric quality of life inventory (PedsQL) 4.0 which is a generic measurement scale consisting of 23 items that are designed according to the health dimensions recommended by WHO and have excellent internal PedsQL reliability, with a Cronbach alpha value of 0.9 for parent/guardian reports and 0.88 for children's self-reports. The items in the generic PedsQL 4.0 consist of 4 major groups – physical functions (8 questions), emotional functions (5 questions), school functions (5 questions), and social functions (5 questions).

This questionnaire consists of several subgroups of reports according to age groups – the reports of children: (1) Younger children (5–7 years); (2) older children (8–12 years); (3) adolescents (13–18 years), and parental reports; (1) toddlers (2–4 years); (2) younger children (5–7 years); (3) older children (8–12 years), and (4) adolescents (13–18 years). Each score received from the participants was transformed into a scale of 0–100 (0 = 100; 1 = 75; 2 = 50; 3 = 25; 4 = 0).

The calculation of the total score of 23 items is the average of all the number of items answered divided by the number of items answered. The higher score indicates a better quality of life with a cut point value for the quality of life of a good child 70 (healthy children have a score of about 83 with the lowest score of 70), whereas it is said to be affected if they have a score <70 (mean value 60 to <70).

Sample and data collection

Children aged 5–18 years who are diagnosed with T1DM and have been tested for HbA1C were included and those with mental retardation were excluded from the study. Once the subject was approached, the questionnaire was explained and guided by the researcher. Informed consent was obtained from their parent and assent from the patients before answering of the questionnaire. Basic data and anthropometric examinations were performed to determine nutritional status. Participants were allowed to opt-out from the study if they did not wish to participate in the study.

Statistical analysis

All data were entered using SPSS version 20.0 for Macintosh (SPSS Inc). Descriptive statistics were used to describe sociodemographic information. Categorical data were expressed in number and percentage. Numerical data were expressed in mean and standard deviation. Non-normally distribution data were described as median and interquartile range. Knowledge and attitude were expressed as frequency and percentages. Fisher's Exact test used to determine the association between two categorical variables. Pearson and Spearman correlation test analysis was conducted to assess the correlation between HbA1C levels and the quality of life of children with T1DM. The significance level and the confidence interval used were $p < 0.05$ and 95%, respectively.

Ethical approval

The study was approved by the Research and Ethics Committee, Faculty of Medicine, Universitas Sumatera Utara.

Results

Sociodemographic data

This study was attended by 30 participants. A total of 17 people (56.7%) were female patients with a mean age of 15.17-year-old. Most of the participants had good nutritional status (76.7%). Father of participants

had formal education up to university (66.7%) and the most occupations being private employees (26.6%). Maternal education level was mostly up to high school as many as 14 people (46.7%), whereas most occupations being housewives (56.6%). Fifty percent of the family has a monthly household income below the regional minimum wage.

More than half of the participants (56.7%) did not have a family history of diabetes with a mean length of suffering from diabetes were 2.63 years. All participants were received insulin injections at the age above 5 years with the highest frequency was more than 3 times a day. A total of 13 people (43.4%) did not do the regular blood sugar test every day. As many as 20 subjects (66.7%) did exercise <3 times a week. Sixty percent of the participants had never been hospitalized. Most of the participants (53.3%) were actively involved in a school activity (Table 1).

The mean level of HbA1C was 10.35% + 2.65%, with minimal score was 5.60% and maximal score was 14.9. The mean score of the quality of life was 87.72 + 3.59, minimal score was 77 and maximal score was 95 (Table 2).

Table 1: Sociodemographic characteristics of the study subjects (n = 30)

Karakteristik demografi Subyek	n = 30
Gender, n (%)	
Male	13 (43,3)
Female	17 (56,7)
Age (SD), year	15,1 (1,64)
Nutritional status, n (%)	
Malnutrition	5 (16,7)
Well nourished	23 (76,7)
Overweight	2 (6,7)
Education level, n (%)	
Junior high school	12 (40,0)
Senior high school	18 (60,0)
Father's education level, n (%)	
Junior high school	3 (10,0)
Senior high school	7 (23,3)
University	20 (66,7)
Father's employment status n (%)	
Working	30 (100)
Not working	0 (0)
Mother's education level, n (%)	
Junior high school	5 (16,7)
Senior high school	14 (46,7)
University	11 (36,6)
Mother's employed status, n (%)	
Working	13 (43,3)
Not working	17 (56,6)
Family income, n (%)	
Above UMR	15 (50,0)
Below UMR	15 (50,0)
Family history of DM, n (%)	
Yes	13 (43,3)
No	17 (56,7)
Disease onset (SD), year	2,6 (1,30)
Frequency of insulin SC, n (%)	
<3 times perday	9 (30,0)
≥3 times per day	21 (70,0)
Frequency of blood sugar monitoring, n (%)	
1 time per day	10 (33,3)
>1 time per day	7 (23,3)
Not everyday	13 (43,3)
Frequency of exercise, n (%)	
<3 times per week	20 (66,7)
≥3 times per week	8 (26,7)
Everyday	2 (6,7)
School activity, n (%)	
Never	5 (16,7)
Sometimes	9 (30)
Active	16 (53,3)

DM: Diabetes mellitus.

Table 2: The mean of HbA1C level and quality of life score from 30 respondent

Variable	minimal score	Maximal score	Mean ± SD
HbA1C	5.60	14.9	10.35 ± 2.68
Quality of Life	77	95	87.72 ± 3.59

HbA1C: Glycated hemoglobin.

The relationship between HbA1C and The quality of life of children with T1DM

In this study, the bivariate statistical analysis only could be carried out between HbA1C and emotional function. Since other components function, such as physical, social, and school functions as well as the total quality of life was not affected (Table 3). **Table 3: Hubungan Antara HbA1C Terhadap Kualitas Hidup Fungsi Emosi Anak dengan DMT I**

HbA1C	Fungsi Emosi		p
	Terganggu	Tidak Terganggu	
>7%	4 (16.7)	20 (83.3)	0.571*
≤7%	2 (33.3)	4 (66.7)	

*Uji Fisher's exact. HbA1C: Glycated hemoglobin.

Based on the correlation analysis, it can be concluded that there was no significant correlation between HbA1C levels and all components of the quality of life function and the total quality of life score (p > 0.05) (Table 4).

Table 4: Correlation of HbA1C and quality of life of children with T1DM

HbA1C	p	r
Physical functions	0.944 ^a	0.013
Emotional function	0.138 ^b	0.277
Social functions	0.225 ^a	0.228
School functions	0.899 ^a	-0.024
Total quality of life score	0.159 ^a	0.264

^aSpearman, ^bPearson. HbA1C: Glycated hemoglobin, T1DM: Type 1 diabetes mellitus.

Discussion

The characteristic of research subjects

The incidence of DM has continued to increase in recent years. The incidence of T1DM in children and adolescents based on data from the IDAI has increased about seven times in the last 10 years with the number of diabetes mellitus cases throughout Indonesia as many as 1220 children in 2018 [4].

A total of 30 pediatric patients who came for treatment at the Pediatric Endocrinology Clinic at the Haji Adam Malik Central General Hospital and the Universitas Sumatera Utara Hospital Medan were involved with the mean age 15.17-year-old and predominantly were female with an average length of suffering from diabetes were 2.6 ± 1.30 years. Similar with the previous study by Nansel *et al.* was found that the mean age of the children in the study was 11.5 years [15]. Ozyazicioglu *et al.* showed that the mean age of children with diabetes was 14.96-year-old [16]. Children with T1DM in this study mostly had good nutrition status and only 5 children had

malnutrition. Other study also found that the majority nutritional status of children and adolescents were involved in the study was good [17].

The rate of HbA1C formation is directly proportional to the concentration of glucose in the blood. HbA1C is the integrated value for glucose during the previous 8–12 weeks. Based on the DCCT results, a 1% HbA1C difference reduces the risk of complications by 25–50% [7]. HbA1C has a strong predictive value for diabetes complications [8], [9]. Measurement of HbA1C levels should be performed routinely in all patients with diabetes as an initial assessment and as part of ongoing care. Measurements of the indicator of glycemic control are HbA1C. Majority of the mean level of HbA1C from our study was more than 7%. In line with other studies conducted in Turkey, Egyptian as well as research in Khartoum also reported similar finding that was reflected that the most of the children that involved in the studies had poor glycemic control [18], [19], [20]. Low parental education levels, low economic income, and limitation of the health care service were postulated as the cause of poor glycemic control in children with T1DM [20].

The relationship between HbA1C and The quality of life of children with T1DM

This study was shown that from physical, emotional, social, and school function only emotional function was affected in six children. However, when the Spearman correlation test was conducted, none of the functions and the quality of life were statistically had a significant correlation with HbA1C level ($r = 0.264$, $p > 0.05$). This is in line with the research conducted by Ali *et al.* (Egypt) which states that the PedsQL domain shows no significant difference between children with good controls and poor controls T1DM ($p > 0.05$ for all domains) [21]. Consistent with previous research, Emmanouilidou (Greece) conducted a study on 89 children with T2DM also explained that there was no difference between HbA1C and the quality of life of children with T1DM [22]. Although there is no physical activity limitation for children with T1DM, emotional problems such as anger and psychosocial problems can arise [22]. On the other hand, it is known that once children and adolescents were diagnosed, they find it difficult to get used with their conditions.

Contrary with Linear multivariate studies conducted by TEENS in several countries on children aged 8–25 years with T1DM indicated that there was a linear relationship between HbA1C and quality of life [14]. Low parental education levels, low economic income, and thus incapacity providing optimal health care may be the cause of poor glycemic control of children with T1DM [21]. In keeping with research by Rasoul showed that there was a significant relationship between the total PedsQL score and the mean HbA1C level, where all age groups with good metabolic control

had higher total emotional and social scores [17].

In a study conducted by Ozyazicioglu *et al.*, it was stated that adolescents have an increased risk of psychosocial problems. The relationship between HbA1C levels in adolescents of 13–18-year group and the total PedsQL score had a significant correlation to emotional function, social function, school function, and total PedsQL. The presence of diabetes makes a person feel different and isolated, reduced efforts to be independent, effect on family control, and causes a decline in a person's metabolic control. Adolescents as a result of the conflict in the family [16]. The initial manifestations of complication T1DM are due to ignorance of early symptoms of the disease, infection, lack of glucose control, psychological problems, and medical costs that are not covered by insurance or the government [23].

Conclusions

This study was shown that the majority of the children had poor glycemic control. However, only few children had emotional function affected. Domain physical, social, and school function were not affected. The lack of association between HbA1C level and the quality of life may be related to the number of sample since the study was conducted during pandemic COVID-19, this condition was affect the number of patients who attended to our clinic. Our study also did not used the generic and diabetes-specific PedsQL modules which more specific for children with diabetes, since the questionnaire still not available in Indonesian. Further research with a larger sample size and specific PedsQL modules for diabetes children is indicated.

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