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Quality of Life, Medication Adherence, and Glycemic Control in Type 1 Diabetes Mellitus Children with Basal Bolus Regimen During COVID-19 in Limited Resources Setting

Nur Rochmah [1], Yuni Hisbiyah [1], Rayi Kurnia Perwitasari [1], Jeny Rosaningrum [2], Garindra Wicaksono [1], Neurinda Permata Kusumastuti [1], Mahendra Tri Arif Sampurna [1], I Ketut Alit Utamayasa [1,*] and Muhammad Faizi [1]

[1]Department of Child Health, Faculty of Medicine Airlangga University, Dr. Soetomo General Hospital, Surabaya, Indonesia
[2]Department of Clinical Pharmacy, Faculty of Pharmacy Airlangga University, Surabaya, Indonesia

[*]*Corresponding author*: Department of Child Health, Faculty of Medicine Airlangga University, Dr. Soetomo General Hospital, Surabaya, Indonesia. Email: alit_tusari@yahoo.com

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Abstract

Background: Type 1 Diabetes Mellitus (T1DM) is a chronic disease that requires complicated therapies. The coronavirus disease 2019 (COVID-19) pandemic has caused lockdown restrictions, compromising access to medical care, including T1DM management. Poor medication adherence may affect the quality of life (QoL) and glycemic control.
Objectives: This study analyzed the association among QoL, medication adherence, and glycemic control in T1DM patients during the COVID-19 pandemic.
Methods: This study recruited T1DM patients aged 5 - 18 who regularly visited the pediatric endocrinology outpatient clinic. The PedsQL 3.2 and the diabetes management questionnaire (DMQ) were used to measure QoL and medication adherence. In addition, glycemic control was measured based on HbA1c levels. All data were analyzed using SPSS version 17, and correlations between variables were analyzed using Spearman or Pearson correlation tests.
Results: Twenty-five children and adolescents with a mean age of 141.1 months (± 36.7) were included in this study. The mean HbA1c level was 10.7 mg/dL (± 2.4). Around 19 (76%) participants had already experienced diabetic ketoacidosis (DKA). There was no significant correlation between QoL and medication adherence or HbA1c level (P = 0.220, r = - 0.254; P = 0.753, and r = - 0.066, respectively).
Conclusions: Our study's QoL and medication adherence of T1DM children was relatively good even though the HbA1c was still high. However, numerous factors affect QoL and medication adherence in T1DM children other than HbA1c level.

Keywords: Quality of Life, Medication Adherence, Glycemic Control, T1DM, COVID-19, Children

1. Background

Type 1 diabetes mellitus (T1DM) is a chronic immune-mediated disease caused by pancreatic β-cell destruction, resulting in partial or absolute insulin deficiency. The etiology of T1DM is multifactorial (1). The incidence of T1DM is increasing worldwide; it is estimated that nearly 90,000 children are diagnosed each year (2). In Indonesia, data from the Indonesian Pediatrician Association found 1,249 incidents of T1DM in children, with its prevalence increasing from 3.88 per 100 million in 2000 to 28.19 per 100 million population in 2010 (3). Type 1 diabetes is frequently misdiagnosed, and children with type 1 diabetes experience a phase of ketoacidosis due to delayed diagnosis, which can be fatal (4).

Diabetes is a chronic disease that significantly affects the lives of children, adolescents, and parents. The management of T1DM is, in fact, very complicated because young patients and their parents must adapt to new behaviors in addition to the child's psychological development (5). The management of T1DM children in Indonesia still uses an insulin basal-bolus regimen that requires the patient to inject and do self-blood glucose monitoring constantly. Poor T1DM management might result in macro- and microvascular problems impacting the patient's quality of life (QoL) (6). Children and adolescents with chronic illnesses deal with developmental changes, daily stressors, disease-related stressors, and maintaining health (7).

Quality of life is the most important outcome of diabetes management (8). Lower QoL is associated with psychological disorders and a negative family environment

(9). Several studies have shown that clinical symptoms of diabetes are related to QoL, which is affected by diabetes management (10).

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has caused a global emergency. One of the most prevalent chronic conditions in SARS-CoV-2-infected patients is DM, worsened by the COVID-19 virus (11). As the World Health Organization declared a public health emergency of global concern, governments in most nations advised minimal activity to stop the spread of infection (12). Lockdown restrictions compromised access to medical care, and fear of potential exposure to COVID-19 has forced patients with chronic illnesses such as Type 1 Diabetes (T1D) to stay home (13). This situation may lead to irregular control of insulin treatment, resulting in rapid progression to diabetic ketoacidosis (DKA), increasing the risk of complications and lowering the quality of life of T1DM children (14, 15).

2. Objectives

To the best of our knowledge, studies about the correlation between the quality of life, medication adherence, and glycemic control, especially in developing countries that use insulin basal-bolus regimens as a treatment, are still limited. It is important to analyze the impact of the COVID-19 pandemic on T1DM patients. This study analyzed the association between quality of life, medication adherence, and glycemic control in T1DM patients during the COVID-19 pandemic.

3. Methods

This study was conducted at the pediatric endocrinology outpatient clinic of Dr. Soetomo General Hospital in Surabaya from January to June 2022. A consecutive random sampling method was used. The study population included children and adolescents aged 5 - 18 years who regularly visited the clinic and met the following inclusion criteria: Age of 5 - 18 years and T1DM diagnosis based on the ISPAD criteria for children, and ability to fill out the PedsQL 3.2 diabetes module questionnaire and DMQ independently and being consent for their children to participate in the study for parents. Patients with life-threatening conditions, pediatric intensive care unit admission, and refusal to complete the questionnaires were excluded from this study.

The sample calculation formula for a cross-sectional study was used to establish the sample size for this research (16). The glycemic control used was HbA1c. The laboratory measurements were performed in the Laboratory Centre, Dr. Soetomo Hospital, Indonesia. Then, HbA1c > 7% was categorized as high and indicated poor glycemic control (17). This research was authorized by the Ethics Committee of Dr. Soetomo General Hospital, Surabaya, Indonesia (0246/KEPK/VIII/2021).

3.1. Data Collection Tools

Data were collected via an online questionnaire on Google Forms. Participants filled out the questionnaire under the researcher's supervision during a Zoom meeting, so they could directly ask any questions about the items. Before this, informed consent forms were sent to the participants via text messages.

Participants' demographic and clinical data included sex, age, weight, height, duration of illness, family history of diabetes mellitus, and history of DKA. The patient's quality of life was assessed using the Indonesian version of PedsQL 3.2, a 5-point Likert scale scored from 0 to 4. The scores were linearly transformed into points ranging from 0 to 100 (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0). Lower scores indicated more diabetes symptoms, management issues, and a lower quality of life (12).

Medication adherence was evaluated using the DMQ, a 5-point Likert scale, and each item was scored from 0 - 4. The mean score of all completed items was calculated and then multiplied by 25 to standardize to a 0 - 100 scale to simplify the interpretation. A higher score implied better adherence to diabetes management (18). Parents filled out the DMQ questionnaire if the patient was < 13 years old, and the patient completed it if > 14 years old. Statistics of Airlangga University have tested the PedsQL and DMQ, which have been reported to be valid. Glycemic control was measured using the final HbA1c levels of the patients.

3.2. Data Analysis

Statistical analyses were performed using SPSS version. Descriptive statistics were used to describe the demographic characteristics of the participants, expressed as mean, standard deviation, and frequency (percentage). The Shapiro-Wilk test of normality was used to check the normal distribution of the data. Based on this, a comparison of parents' and patients' responses to the PedsQL questionnaire was conducted using either an independent *t*-test or a Mann-Whitney U test. Correlations between HbA1C, duration of illness, history of DKA and quality of life, and medication adherence were calculated using the Spearman or Pearson correlation test. Data were considered statistically significant if P-values were < 0.05.

4. Results

4.1. Subject's Characteristics

In total, 27 children and adolescents, consisting of 17 (68%) boys and 8 (32%) girls with T1DM, were included in this study. All patients used the Indonesian National Health Insurance (BPJS). The insulin regimen was basal-bolus (basal insulin was detemir, and bolus was short-acting insulin). The insurance paid for the insulin treatment, but patients needed to buy and strip the glucometer themselves. Over half of the participants had a normal BMI range (80%), and none were obese or overweight. Nevertheless, 8 (32%) patients had short stature. The mean duration of illness was 44 months (± 36.3), and 19 (76%) patients had already experienced DKA. The HbA1c levels were relatively high, with a mean of 10.7 (± 2.4). The demographic characteristics of the participants are presented in Table 1.

4.2. Quality of life, Medication Adherence, and Glycemic Control

There were no significant differences in PedsQL scores between the patients' and parents' responses, indicating that the QoL values were not significantly different (Table 2). Responses to the DMQ demonstrated that adherence to insulin had the highest score among the items (Table 3). The total mean medication adherence (DMQ) score was 55.85 (± 11.44). Our study showed no significant correlations between QoL and medication adherence and HbA1c level, illness duration, and DKA history (Table 4).

5. Discussion

In this study, we found that correlations between QoL and HbA1c levels were not significant. In contrast to our findings, lower HbA1c levels were associated with a better QoL (17-19), evidenced by previous studies from Kuwait, Indonesia, and Spain. However, QoL encompasses all facets of life, and numerous factors, other than HbA1c levels, influence it. Some examples include the presence of acute or chronic complications, level of disease management, psychosocial response to the disease, self-efficacy for self-management, family support, and acceptance of the disease (20).

Our study reported no correlation between medication adherence and HbA1c level, which aligns with previous research. For instance, Rochmah et al. found no correlations between medication adherence and glycemic control (21). Also, HbA1c is an essential biomarker of long-term metabolic control, as it represents the cumulative glycemic history and average blood glucose levels during the previous two or three months (22). Numerous factors affect HbA1c levels besides medication adherence, such as education, dietary intake, and physical activity (23).

This study demonstrated that the QoL of T1DM children does not correlate with the duration of their illness. However, existing research is mixed; for example, one study found contrasting evidence that the duration of illness strongly correlated with QoL (24). However, another study conducted in Ethiopia demonstrated a negative correlation between them (25). The mixed findings may be explained by the fact that many other variables, besides the duration of illness, also affect QoL (25). When first diagnosed, children and parents typically face difficulty adjusting to the unfamiliar health condition, but over time, they adapt to it (26). Acceptance grows in proportion to the length of the disease, denoted by a good understanding of it. This improves disease management; thus, total acceptance of the disease has been found to benefit QoL (20). Parental involvement in diabetes management boosts a child's compliance. However, the transitional period in which parents' involvement in managing the disease decreases as the child grows can worsen the quality of life (26). Therefore, it is important to enable a gradual transition to independence and reduce parental control during the middle and high school years.

A study conducted by Aleqeel found that lockdown adversely affected the health of children with T1DM and increased comorbidities such as DKA (27). However, this study found no correlations between QoL, medication adherence, and having a history of DKA. This could be due to our frequent online health education campaigns during the COVID-19 pandemic. According to our prior report, health education promotes a better quality of life for children with T1DM (28). The patients in this study used an insulin basal-bolus regimen that required them to constantly inject insulin by themselves up to three to four times a day and do self-blood glucose monitoring up to seven times daily. The distribution of insulin bolus regimen during the pandemic in our hospital was still sufficient. The Indonesian government health insurance also covered the monthly insulin needed for T1DM patients. However, the glucometer strips must be paid out of pocket even though the insulin is covered. This condition is troublesome because most patients come from lower to middle socioeconomic statuses. It is similar to other settings in Kenya, where a lack of financial means resulted in a limited supply of insulin and a nearly complete absence of self-blood glucose monitoring (29).

The QoL scores were not significantly different between the children's and parents' reports. Of the five aspects evaluated, worries had the lowest score. Previous findings that demonstrate lower QoL scores among children with T1DM could result from variations in T1DM management (30). In contrast, other studies have stated no differences between the QoL of children with T1DM and

Table 1. Demographic Characteristics of Subjects [a]

Characteristics	T1DM Children (N = 27)
Gender	
Male	18 (66.7)
Female	9 (33.3)
Age (m)	136.48 ± 39.02
Bodymassindex	
Underweight	5 (18.5)
Normal	22 (81.5)
Obese	0
Overweight	0
ShortStature	
Normal	17 (63)
Short Stature	10 (37)
Family history of diabetes mellitus	
Yes	15 (55.6)
No	12 (44.4)
History of ketoacidosis	
Yes	19 (70.4)
No	8 (29.6)
Duration of illness (m)	41 ± 36.48
HbA1c	10.79 ± 2.43
HbA1c (2019, before COVID-19)	9.20 ± 1.86

[a] Values are presented as No. (%) or Mean ± SD.

Table 2. Comparison Between Child's and Parent's PedsQL Scores

Pedsql Aspects	Child's Answers	Parent's Answers	P-Value
Diabetes symptoms	73.83 ± 15.85	71.97 ± 12.57	0.637
Treatment barrier	76.30 ± 17.02	74.26 ± 20.51	0.889
Treatment adherence	82.71 ± 13.21	80.40 ± 16.57	0.673
Worries	68.52 ± 26.49	68.82 ± 20.36	0.923
Communication	71.99 ± 27.10	76.39 ± 23.21	0.615
Total score	75.15 ± 15.13	74.10 ± 12.94	0.786

that of the general population (9, 31). Various factors can account for these mixed findings. Low levels of conflict within a family play a role in treating T1DM in children and improving their QoL (9). However, the latter is also affected by complications, including impaired cognitive function, decreased intellectual power, and neurological disorders (30), which require intensive therapy to prevent or slow the occurrence of complications (30).

Returning to this study's finding that worry had the lowest score out of the QoL aspects, a previous cross-sectional study showed that fear could reduce QoL, as it can increase HbA1c levels. This incident is increasingly evident in older T1DM children between 13 - 18 years old (32). Older adolescents tend to have a higher sense of worry and a lower QoL, while teenagers undergo a maturation phase between 12 and 18 (33). Adolescents also tend to worry about complications more, feel dissatisfied with social and school life, and feel like a burden on their families because of their illness (31).

This study also found that adherence to insulin use was

Table 3. Medication Adherence Score Based on Diabetes Management Questionnaire in Each Category

DMQ Category	Mean ± SD
Adherence to physical activity	36.42 ± 28.32
Adherence to diet management	61.23 ± 17.79
Adherence to glycemic monitoring	54.78 ± 21.30
Adherence to Insulin use	66.67 ± 12.45
Total DMQ Score	56.39 ± 11.64

Table 4. Correlation Between HbA1c, Duration of Illness, and History of DKA and Quality of Life (PedsQL) and Adherence (DMQ)

Variable	Quality of Life		Medication Adherence	
	P-Value	r	P-Value	r
HbA1c	0.125	- 0.303	0.867	0.034
Duration of Illness	0.905	0.024	0.741	- 0.067
History of DKA	0.218	0.245	0.796	- 0.052

reported to have the highest score, whereas adherence to physical activity had the lowest score. The sufficient availability of an insulin regimen covered by Indonesian national health insurance in our hospital might be the reason for a good score in adherence to insulin use. However, lockdown restrictions imposed during the COVID-19 pandemic may have contributed to the low score for physical activity because children might be unable to engage in daily sports and recreational activities (34). Even though it is not considered a treatment per se, regular physical activity plays an essential role in managing children with T1DM (35); physical activity can increase insulin sensitivity, resulting in optimal HbA1c levels (3).

This study had some limitations, which can be addressed through future research. First, the population size was relatively small. Second, the PedsQL and DMQ were used to measure the patient's quality of life and adherence, but their application is restricted to people with poor language proficiency, and memory bias may have affected the results. Third, the data collection format through online questionnaires was a primary limitation due to the COVID-19 pandemic. Therefore, connection issues and misunderstandings caused by the inability to interpret the questionnaire items virtually could have affected the results. Lastly, it is necessary to consider additional potential variables that might influence adherence and QoL in children with T1DM, such as complications, psychosocial response, and disease acceptance.

5.1. Conclusions

This study found that the correlations between QoL, medication adherence, and HbA1c levels were insignificant during the COVID-19 pandemic. However, numerous factors affect QoL and medication adherence in T1DM children other than HbA1c levels. Further studies must evaluate other predisposing factors that may influence these variables.

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Footnotes

Authors' Contribution: N. R. and I. K. A. U. participated in making the concept, designing the manuscript, and as a supervisor in drafting the manuscript. Y. H. and R. K. P. drafted the manuscript and helped with administrative, technical, and material support. J. R. and G. W. collected the data, performed statistical analysis, and interpreted the data. N. P. K. and M. T. A. S. re-evaluated the clinical data, reanalyzed statistical data, and revised the manuscript. M. F. revised the manuscript for important intellectual content and helped with administrative and material support.

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Data Reproducibility: The dataset presented in the study is available on request from the corresponding author during submission or after publication. The data are not publicly available due to privacy and ethical considerations.

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