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The Relationship Between Physical Activity and Body Mass Index with Hemoglobin A1c in Children with Type 1 Diabetes Mellitus

Yunita Putri Ragil Pratiwi[1], Nur Rochmah[2,3]*, Rio Wironegoro[4,5], Azwin Menghindra Putra[2,3]

[1]Faculty of Medicine, UNIVERSITAS AIRLANGGA, Surabaya, Indonesia

[2]Faculty of Medicine, Department of Child Health, UNIVERSITAS AIRLANGGA, Surabaya, Indonesia

[3]Department of Child Health, Dr. Soetomo, General Academic Hospital, Surabaya, Indonesia

[4]Faculty of Medicine, Department of Internal Medicine, UNIVERSITAS AIRLANGGA, Surabaya, Indonesia

[5]Department of Internal Medicine, Dr. Soetomo, General Academic Hospital, Surabaya, Indonesia

E-mail: yunita.putri.ragil-2021@fk.unair.ac.id ; nur-r@fk.unair.ac.id; rio18378@gmail.com ; azwin-m-p@fk.unair.ac.id

*Corresponding author details: Nur Rochmah; nur-r@fk.unair.ac.id

ABSTRACT

Background*:** In children with type 1 diabetes mellitus (T1DM), extensive destruction of pancreatic β-cells is observed, primarily mediated by autoimmune processes. Physical activity functions to increase insulin sensitivity, thereby aiding in the maintenance of good glycemic control and body mass index (BMI) in T1DM patients. Glycemic control in children with T1DM is commonly monitored through hemoglobin A1c (HbA1c) levels. ***Objective*:** This study aims to analyze the relationship between physical activity and BMI with HbA1c levels in children with T1DM. ***Methods*:** This research employs an observational analytic method to assess the association of physical activity and BMI with HbA1c levels in children with T1DM in a cross-sectional design at a specific sample and time frame. Sampling was conducted using the consecutive random sampling method, in line with the research criteria, followed by distributing questionnaires to the parents or caregivers of children with T1DM at the Pediatric Endocrinology Clinic of Dr. Soetomo Regional General Hospital. Physical activity was measured using the Physical Activity Questionnaire for Children (PAQ-C) and the Physical Activity Questionnaire for Adolescents (PAQ-A). ***Results*:** A total of 37 samples were obtained for this study, with the following details: The range of HbA1c among respondents was 6.8%–13.6%, with an average HbA1c of 9.44% (high risk). The range of physical activity levels, as measured by the PAQ-C and PAQ-A, was between 1 and 5, with an average activity level of 2. The respondents' BMI ranged from 8.44 to 26.02, with an average BMI of 18.81 (underweight). The study results showed no significant association between physical activity ($p = 0.373$) and BMI ($p = 0.230$) with HbA1c levels in children with T1DM, with a significance level of $p < 0.05$. ***Conclusion: No significant association was found between physical activity and BMI with HbA1c levels in children with T1DM.

Keywords: children; physical activity; T1DM; HbA1c; BMI.

INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a metabolic disease caused by an autoimmune process that attacks pancreatic β-cells, resulting in minimal or no insulin production [3]. Clinical symptoms typically arise when pancreatic cell damage reaches ≥90%. Several factors contribute to the pathogenesis of T1DM, including genetic, epigenetic, environmental, and immunological factors [6]. In children, classic symptoms of hyperglycemia may appear, such as polyuria, polydipsia, polyphagia, unexplained weight loss, fatigue, and blurred vision. Electrolyte imbalances can also be detected [6].

Globally, there are an estimated 8.75 million individuals living with T1DM, of whom 1.52 million are under 20 years of age. In the Western Pacific region alone, 14,000 deaths are attributed to T1DM [3]. In Indonesia, 1,249 cases of T1DM were reported among children from 2017-2019 [7].

Management of T1DM involves five key pillars, including physical activity and glycemic control. Optimal glycemic control can help to monitor the risk of complications arising from T1DM, thereby improving patient quality of life, extending life expectancy, and reducing healthcare costs.

Glycemic control can be assessed through monitoring HbA1c levels, fasting blood glucose levels, and 2-hour postprandial glucose (2HPP) levels [13]. HbA1c reflects glycemic status over the preceding 8 - 12 weeks, with a target of <7.5% (5.8 mmol/L) for all age groups [12]. Physical activity increases insulin sensitivity, which helps to maintain good glycemic control and a healthy body mass index (BMI) in T1DM patients [1]. To date, no specific studies have examined the relationship between physical activity and BMI with HbA1c levels in children with T1DM. Thus, this study aims to analyze whether there is an association between physical activity and BMI with HbA1c levels in children with T1DM.

METHODS

This study employed an observational analytic method to investigate the association between physical activity and BMI with HbA1c levels in children with T1DM over a specific time period and sample. Sampling was conducted using a consecutive random sampling method, in alignment with the study criteria, and questionnaires were distributed to the parents or guardians of children with T1DM at the Pediatric Endocrinology Clinic of Dr. Soetomo Regional General Hospital. This study utilized primary data obtained through interviews via questionnaire responses from parents or guardians of children with T1DM, as well as secondary data from the medical records of children with T1DM. Physical activity was measured using the Physical Activity Questionnaire for Children (PAQ-C) and the Physical Activity Questionnaire for Adolescents (PAQ-A), with a score of 1 indicating low physical activity levels, whereas a score of 5 indicates high physical activity levels. The collected data were analyzed using Pearson and Spearman correlation tests with Statistical Product and Service Solutions (SPSS) software.

RESULT AND DISCUSSION

The basic characteristics of the patients in Table 1 show that out of 37 samples, 35.14% were male and 64.86% were female, with 56.76% of the children aged 8-14 years and 43.24% aged 14-19 years.

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TABLE 1: Basic Characteristics.

Characteristics	Number (%)
Gender	
Male	13 (35,14%)
Female	24 (64,86%)
Ages	
8-14 years	21 (56,76%)
14-19 years	16 (43,24%)

In Figure 1, HbA1c levels in children with T1DM indicate that 51.35% have high-risk HbA1c levels, 29.73% have suboptimal HbA1c, 18.92% have optimal HbA1c, and none have ideal HbA1c levels. This finding aligns with Wicaksono (2021) who reported an average HbA1c level of 9.2% (high-risk) in T1DM patients [2].

Rochmah (2021) in Dr. Soetomo General Academic Hospital reported that the average HbA1c level among T1DM patients during the COVID-19 pandemic was 10.06% (high-risk) [10]. HbA1c is a marker reflecting average glucose concentrations over the past 8-12 weeks due to the average erythrocyte lifespan of approximately 120 days. Approximately 50% of the HbA1c value represents glucose exposure from the previous 30 days, 40% from 31-90 days, and 10% from 91-120 days [12].

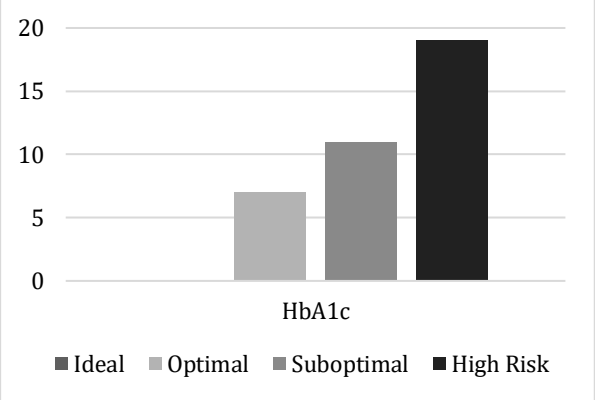

FIGURE 1: HbA1c Levels in Children with T1DM.

Figure 2 illustrates the physical activity levels in children with T1DM where the x-axis represents the physical activity scores from 1 to 5 obtained from the questionnaire, and the y-axis indicates the number of children. 56.75% of the 37 samples showed physical activity level 2, followed by level 3 (27.03%), level 4 (10.81%), and levels 1 and 5 (2.70% each). Mutlu (2015) found no significant difference in physical activity levels between children with T1DM and healthy children, with both groups generally displaying low physical activity levels [5]. Physical activity for T1DM patients requires careful adjustment of insulin doses before exercise, typically in consultation with a physician. Insulin pumps should be removed, or basal insulin should be administered at least 90 minutes before exercise. The risk of hypoglycemia increases with longer exercise durations. Conversely, acute hyperglycemia may occur during high-intensity exercise, especially in a fast state. To prevent post-exercise hypoglycemia, high-carbohydrate foods should be consumed immediately after exercise [13]. Patients with proliferative retinopathy or nephropathy should avoid anaerobic exercise due to the risk of high blood pressure [9].

Physical activity benefits for children with T1DM include lowering HbA1c by approximately 0.3%–0.5% depending on initial HbA1c levels and physical activity amount, reducing cardiovascular morbidity and mortality risk, enhancing cardiovascular and cardiorespiratory fitness, increasing muscle mass and strength, reducing adiposity, improving bone mineral density, enhancing overall well-being, and potentially prolonging remission in children with newly onset diabetes [1].

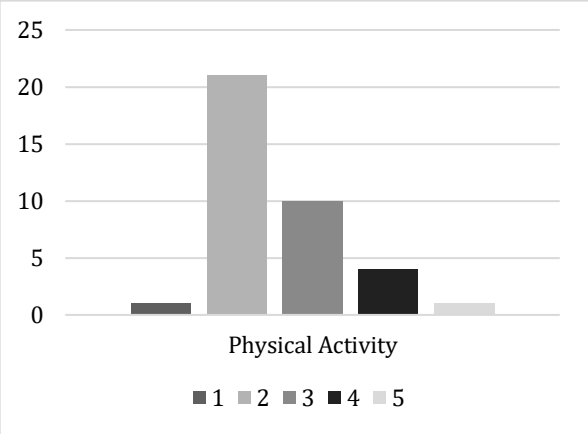

FIGURE 2: Physical Activity in Children with T1DM.

Figure 3 presents the BMI classification of children with T1DM, where the x-axis represents the BMI categories and the y-axis indicates the number of children. Most children fall within the underweight BMI category, followed by normal BMI, at-risk, and obesity categories. The average BMI of T1DM patients at Dr. Soetomo General Academic Hospital was 16.7 (underweight) [10]. Similarly, Wicaksono (2021) reported an average BMI of 17.27 (underweight) among T1DM patients in his study [2]. Mutlu (2015) also found that the average BMI for children with T1DM was 17.83 (underweight) [5]. BMI serves as a screening tool to identify potential weight-related issues in children and adolescents but should not be used as a diagnostic criterion.

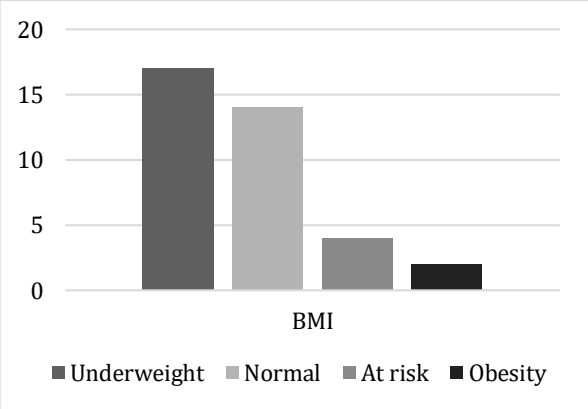

FIGURE 3: BMI Classification in Children with T1DM.

The normality test results using the Kolmogorov-Smirnov test showed a value of 0.079 for HbA1c, 0.001 for physical activity and 0.200 for BMI. Since the physical activity data yielded a result <0.05, indicating a non-normal distribution, the Spearman coefficient correlation was applied. Meanwhile, HbA1c and BMI showed values >0.05, indicating a normal distribution, so these data were processed using Pearson correlation.

The Spearman correlation test between HbA1c and physical activity produced a significance value (Sig.) of 0.373, which is >0.05, indicating a non-significant correlation between HbA1c and physical activity. Similarly, the Pearson correlation test yielded a Sig. Value of 0.230, which is also >0.05, reflecting a non-significant correlation between HbA1c and BMI.

Figure 4 illustrates the relationship between physical activity levels and HbA1c levels in children with T1DM, where the x-axis represents physical activity scores ranging from 1 to 5 with HbA1c levels of the children. The highest result indicated that 27.03% of respondents had high-risk HbA1c levels with physical activity level 2, while the lowest result (2.70%) was observed in three respondents who had optimal HbA1c levels with physical activity levels 1 and 4 and high-risk HbA1c with physical activity level 5. These findings are consistent with Putri et al., who found no significant association between physical activity and poor glycemic control (p = 0.437) [8].

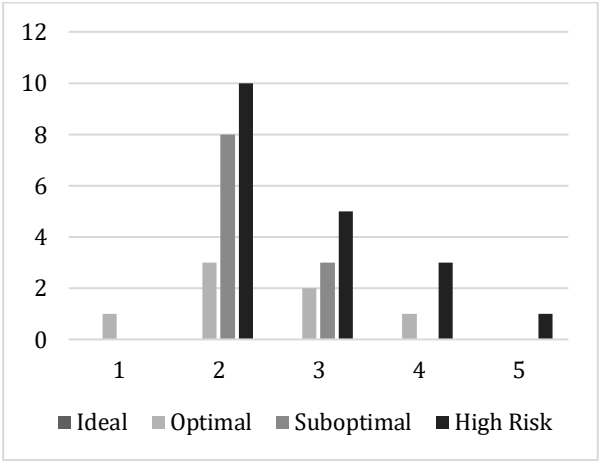

FIGURE 4: Relationship Between Physical Activity and HbA1c.

Figure 5 illustrates the relationship between BMI classification and HbA1c levels in children with T1DM. The x-axis represents BMI classifications alongside the corresponding HbA1c levels, while the y-axis indicates the number of children. The study results indicate that 24.32% of respondents have high-risk HbA1c levels with a normal BMI. Komariah (2020) also found no significant relationship between fasting blood glucose (FBG) and BMI (p = 0.502) [4]. This finding is consistent with Suryanti et al., who reported no association between BMI and FBG in diabetes mellitus patients [11].

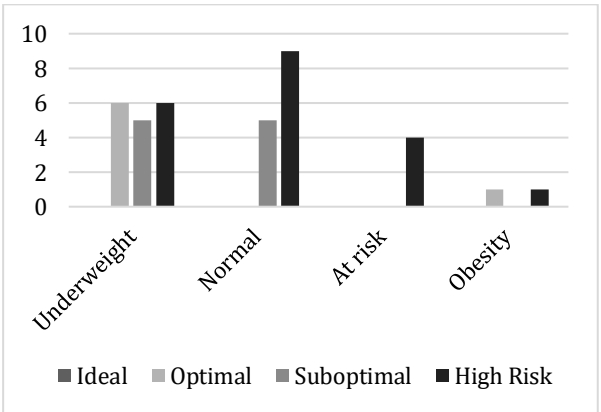

FIGURE 4: Relationship Between BMI and HbA1c.

CONCLUSIONS

Based on the conducted study, the following conclusions can be drawn: The range of HbA1c among respondents was 6.8% –13.6%, with an average

HbA1c of 9.44% (high risk). The range of physical activity levels, as measured by the PAQ-C and PAQ-A, was between 1 and 5, with an average activity level of 2. The respondents' BMI ranged from 8.44 to 26.02, with an average BMI of 18.81 (underweight). No significant association was found between physical activity and BMI with HbA1c levels in children with T1DM.

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REFERENCES

[1] Adolfsson, P. et al. (2022) 'ISPAD Clinical Practice Consensus Guidelines 2022: Exercise in children and adolescents with diabetes', Pediatric Diabetes, 23(8), pp. 1341–1372. doi: 10.1111/pedi.13452.

[2] Garindra Wicaksono *et al.* (2021) 'The correlation between duration of illness and hemoglobin A1C levels with quality of life in children with type 1 diabetes mellitus', *International Journal of Frontiers in Medicine and Surgery Research*, 1(1), pp. 019–024. doi:10.53294/ijfmsr.2021.1.1.0062.

[3] IDF (2022) 'Idf Atlas Reports'.

[4] Komariah and Rahayu, S. (2020) 'Dengan Kadar Gula Darah Puasa Pada Pasien Diabetes Melitus Tipe 2 Di Klinik Pratama Rawat Jalan', *Jurnal Kesehatan Kusuma Husada*, 11(1), pp. 41–50. Available at: http://jurnal.ukh.ac.id/index.php/JK/article/view/412/320

[5] Mutlu, E. K. et al. (2015) 'Association of physical activity level with depression, anxiety, and quality of life in children with type 1 diabetes mellitus', Journal of Pediatric Endocrinology and Metabolism, 28(11–12), pp. 1273–1278. doi: 10.1515/jpem-2015-0082.

[6] Pulungan, A. B., Annisa, D. and Imada, S. (2019) 'Diabetes Melitus Tipe-1 pada Anak: Situasi di Indonesia dan Tata Laksana', Sari Pediatri, 20(6), p. 392. doi: 10.14238/sp20.6.2019.392-400.

[7] Pulungan, A. B., Fadiana, G. and Annisa, D. (2021) 'Type 1 diabetes mellitus in children: Experience in Indonesia', *Clinical Pediatric Endocrinology*, 30(1), pp. 11–18. doi: 10.1297/cpe.30.11.

[8] Putri, M. G., Nugroho, H. and Adi, M. S. (2022) 'Hubungan Indeks Massa Tubuh dan Tingkat Aktivitas Fisik dengan Kontrol Glikemik Diabetes Melitus Tipe 2', Jurnal Epidemiologi Kesehatan Komunitas, 7(1), pp. 341–350. doi: 10.14710/jekk.v7i1.6791.

[9] Riddell, M. C., Wolfsdorf, J. I. and Hoppin, A. G. (2017) 'Management of exercise for children and adolescents with type 1 diabetes mellitus', UpToDate, pp. 1 26.

[10] Rochmah, N. et al. (2021) 'Quality of life differences in pre- and post-educational treatment in type 1 diabetes mellitus during COVID-19', Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, Volume 14, pp. 2905–2911. doi:10.2147/dmso.s313575.

[11] Suryanti, S. D. *et al.* (2019) 'Hubungan Indeks Masa Tubuh Dengan Kadar Gula Darah Puasa Pada Pasien Diabetes Melitus Tipe 2', *Poltekita: Jurnal Ilmu Kesehatan*, 13(2), pp. 86–90

[12] Wang, M. and Hng, T. (1989) 'Standards of medical care for patients with diabetes mellitus.', Diabetes care, 12(5), pp. 365–368. doi: 10.2337/diacare.12.5.365.

[13] Yati, N. P. and Trijaja, B. (2017) 'Diagnosis dan Tata Laksana Diabetes Melitus Tipe-1 pada Anak dan Remaja', Ikatan Dokter Anak Indonesia, pp. 1–15.