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Review

Challenges and Barriers of Physical Activity Among Pediatric Patients with Type 1 Diabetes Mellitus and Their Parents: A Systematic Review

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ABSTRACT

Introduction: Pediatric patients with type 1 diabetes mellitus (T1DM) and their parents seems unsure about participating in physical exercise. We explored the challenges and barriers experienced by pediatric patients with T1DM and their parents in implementing physical activity.

Methods: This study used a systematic review design with a literature search in CINAHL, PubMed and Scopus, from May to July 2022. The inclusion criteria used a primary study with the outcomes of research studies explaining the status and barriers to implementing physical activity, and restricted the publication year from the year of 2017-2022. The PRISMA guideline anchored in the organization of this systematic review study.

Results: Seven study articles, four qualitative and three quantitative studies, were included in the final synthesis. The challenges consist of the motivation and high level of self-efficacy had been well demonstrated as significant factors in the internal group. While barriers of implementing adequate physical activity are the parent's fearness about hypoglycemia risk while being physically active, parental fears and pressures in preparing a healthful diet to keep their children active and safe, stigma, demand of supportive ambiance from the family members, school, and peers, the sufficient level of knowledge, and the limited number of technology tools provided to assist physical exercise practice were recognized as the barriers burdened the T1DM management in the external factor group.

Conclusion: The most prominent challenge perceived was the fear of hypoglycemia due to the inappropriate level of physical activity.

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1. INTRODUCTION

Type 1 Diabetes Mellitus (T1DM) is a chronic condition that usually appears in children or adolescents. DMT1 occurs due to the autoimmune disease that induces little or no insulin production due to beta cell malfunction (absolute insulin deficiency) and eventually generates a hyperglycemic state. The number of children with T1DM is increasing significantly worldwide, evenly high in industrialized and developing countries (Pasi & Ravi, 2022).

T1DM contributes to 5-10% of all causes of diabetes. According to United States population data, 283,000 children and adolescents under the age of 20 had been diagnosed with diabetes in 2019, and 244,000 of them were living with T1DM (Centers for Disease Control and Prevention, 2021). The Indonesian Pediatric Society (IPS) discovered 1,249 cases of T1DM among children and adolescent in Indonesia from the year of 2017 to 2019. It is estimated to be lower than the true prevalence of T1DM survivors in Indonesia, which may be concealed due to the underdiagnosed or misdiagnosed cases (Pulungan et al., 2021). T1DM could appear at any age. However, the peak occurs in children between five to seven years old or around adolescence, thereby familiarizing its occurrence in childhood (Centers for Disease Control and Prevention, 2021). In line with this statement, Passanisi et al. (2022) stated that the highest prevalence of T1DM was found at the age of 5 to 9 years and 10 to 14 years. Although its prevalence is relatively lower among younger children, the incidence tends to increase progressively in this age group.

IPS published a guideline for T1DM management that suggested several components of guidance for the family in caring for a T1DM patient, including a daily recommendation of physical exercise among children and adolescents with T1DM. An adequate physical activity level among T1DM patients bestows proper glycemic control, insulin sensitivity enhancement and insulin need reduction, heart disease prevention, body composition improvement, higher quality of life, and lifetime fitness (Pulungan et al., 2021; Quirk et al., 2018). All children need to do physical exercise, T1DM pediatric patients are no different. They are advised to do at least 60 minutes of physical activity in a day that may establish as a combination of aerobic, muscle-strengthening, and bone-building exercises. Health professionals should ensure the acceptable physical activity level among T1DM patients, particularly because of their tendency to be less active than their non-diabetic peers. A study demonstrated that T1DM adolescents with a sufficient level of physical activity (60 minutes/day, at least five days per week) reported a higher level of quality of life compared to those with less physical activity (Pulungan et al., 2021).

However, the majority of children with T1DM have not performed the recommended daily exercise sufficiently. Miscellaneous issues propose considerable obstacles to the physical exercise practice as challenges and barriers among the patients: exercise-induced hypoglycemia incidence, parental fear of hypoglycemia, mixed blood glucose responses to physical exercise, and the need for nutrition and insulin administration and management (Chetty et al., 2019; Czenczek-Lewandowska et al., 2019). On the other hand, physical activity is established as an unseparated element of diabetes management, posing a vital role in supporting positive responses to T1DM therapies. This essential role of physical activity indicated the need for an in-depth study to dissect the challenges and barriers encountered in establishing sufficient physical exercise practice among T1DM patients. Therefore, this study aimed to explored the challenges and barriers experienced by pediatric patients with T1DM and their parents in implementing physical activity.

2. METHOD

2.1 Design

The recent study enrolled a systematic review approach according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist. We conducted the literature search process from May to July 2022 in three health databases: CINAHL, PubMed, and Scopus. Studies were limited to several criteria according to the PICOT framework. Table 1 presents the

PICOT framework in this study.

Table 1. Inclusion and xclusion Criteria

PICO S/ T Framework	Inclusion Criteria
Population	T1DM pediatric patients and their parents or guardians
Intervention	Studies reported physical activities among T1DM pediatric patients
Comparator	No limitation set according to study design
Outcome	Status and barriers in physical activity practices
Study type	Primary study with quantitative and qualitative design
Time	The publication year was limited from the year of 2017 to 2022

Articles were collected using the combination of Medical Subject Headings (MeSH) to generate the best keywords. Operator Boolean is used to expand or narrow our search parameters in order to surface articles that are most relevant to the study's inclusion criteria and objectives. Several keywords applied were “exercise” OR “physical activity” OR “fitness” AND “diabetes type 1” AND “children” OR “adolescents” OR “youth” OR “child” OR “teenager” AND “challenges” OR “barriers” OR “difficulties” OR “issues” OR “problems “OR “limitations” OR “obstacles” NOT “diabetes type 2” NOT “adult”. Studies were excluded if the articles did not meet the inclusion criteria set in this study.

We gathered 399 articles from three journal databases: CINAHL, PubMed, and Scopus. These articles were subsequently analyzed for their eligibility in the screening process before being synthesized and analyzed. Seven study articles were included in the final analysis eventually. The study selection process is visualized in Figure 1.

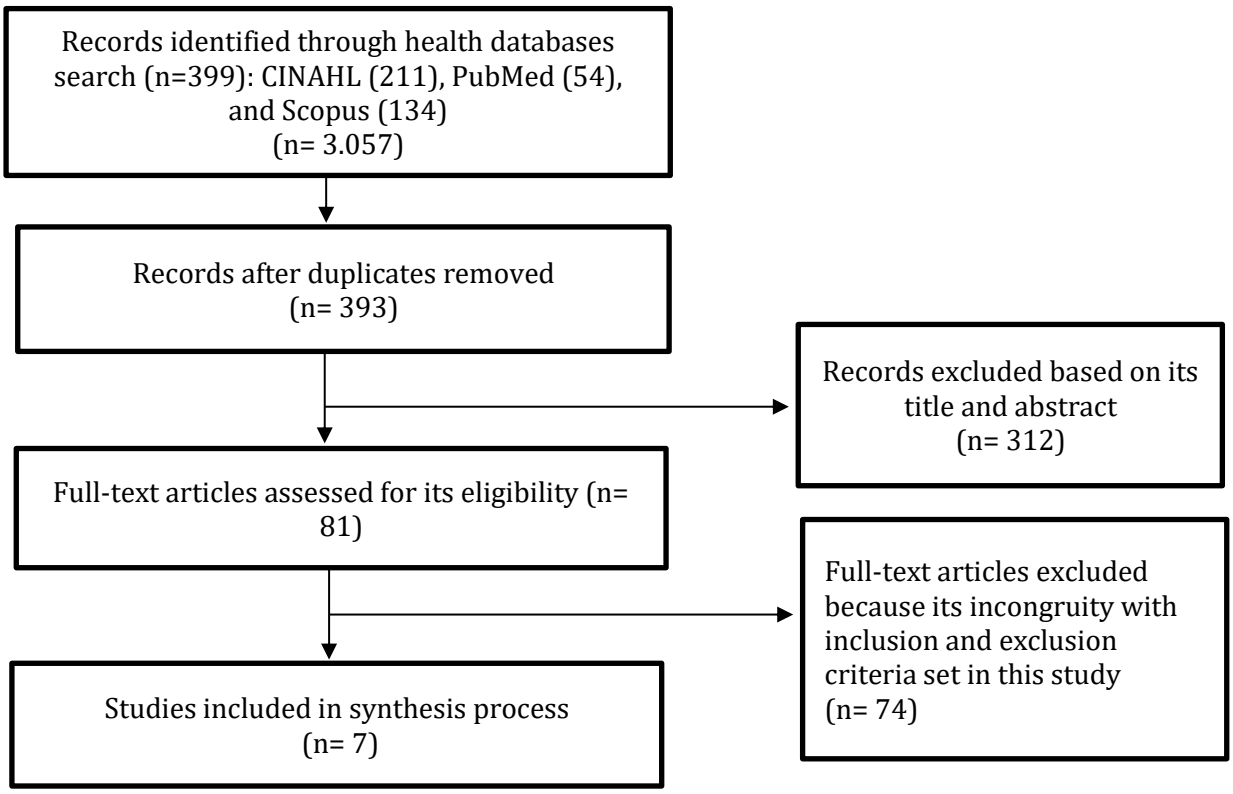

Figure 1. PRISMA Flowchart

2.2 Data Extraction

The Joanna Briggs Institute (JBI) Critical Appraisal Checklist was applied to assess the article's quality. The JBI provides several responses: 'yes', 'no', 'unclear', or 'not applicable with a score of 1 for the answer of 'yes' and 0 for other answers. We used the cut-off point value from the total score to classify the judgement of the study quality into two categories: adequate and poor. The minimal total score of 50% indicated an eligible article quality according to the critical appraisal criteria. Articles with poor quality would be excluded from the recent study to prevent bias on the validity of the study findings.

Study articles were filtered using the inclusion criteria, then carefully extracted into a table. Articles then dissected precisely according to the authors, year of publication, study design, instruments, statistical analysis, and study results. A review process on the abstract and full-text articles was thoroughly conducted in each journal to spot their likeness and distinctive characteristics. The final conclusion was drawn in the final analysis. The result of the systematic review was presented in a table to offer more systematic findings, enhance comprehension, and provide better interpretation.

3. RESULT

3.1 Study Selection

We initially identified 399 full-text articles from three health databases: CINAHL, PubMed, and Scopus. Six duplicates were then removed. Thereby, 393 articles were included in the screening process for their eligibility. According to this screening process, we excluded 312 articles due to the inconsistencies between the title, problem formulation, abstract, and the article's general content. Hence, 81 articles were processed into the second step of eligibility screening that fully relied on the study inclusion and exclusion criteria in the PICOT framework. Seventy-four articles were finally excluded due to the unclear result and discussion section that seemed straying away from the topic of physical activity among children and adolescents with T1DM, the presence of vague physical exercise-based-intervention or medication, the enrollment of adult diabetes mellitus patients, and major discussion about physical exercise among non-T1DM patients. Thus, seven eligible articles were eventually included in the final analysis and synthesis process.

3.2 Study Design and Participant's Characteristics

Four qualitative studies with an average number of 7, 14, and 116 T1DM participants and their parents were employed in this study (Alburno et al., 2022) (Collard et al., 2020; Fried et al., 2021; Morrow et al., 2022). We also enrolled three quantitative studies that involved 96 to 1,129 T1DM patients and their parents (Livny et al., 2020; Michaud et al., 2017; Roberts et al., 2021).

The majority of the study enrolled T1DM patients aged from six to eighteen years. One study did not mention the age of the participants. However, they stated that the average age of the participants was 13.7 (Livny et al., 2020). A study mentioned that their participants were aged between 17 to 18, however, did not state the age of the parents or patient's guardians (Alburno et al., 2022). However, six studies had mentioned the age of the patients and their parents, with the age range of the patient from 9 to 18 years (Collard et al., 2020; Fried et al., 2021; Livny et al., 2020; Michaud et al., 2017; Morrow et al., 2022; Roberts et al., 2021).

3.3 Summary of Literature Study

Table 2. presents the summary of the articles on challenges and barriers to physical activities among pediatric patients with T1DM and their parents. Findings suggested numerous challenges and barriers encountered by pediatric patients and their parents or patient guardians in executing sufficient physical activity level according to the patients' condition. An article mentioned the significant influence of motivation, intention, and high self-efficacy as internal factors on the T1DM management (Alburno et al., 2022). Further, five articles discovered the fear of hypoglycemia while being physically active as the leading factor that commonly impeded the physical activity intensity and frequency among pediatric and adolescents with T1DM (Collard et al., 2020; Fried et al., 2021; Livny et al., 2020; Michaud et al., 2017; Roberts et al., 2021). Findings

also highlighted the lack of parental confidence in encouraging their children to be physically active due to the potency of unstable blood glucose level, parental responsibility in preparing adequate diet for their children with T1DM (Fried et al., 2021), the need of physical activity variation to stimulate physical exercise practice for children and adolescents with T1DM (Michaud et al., 2017), the presence of stigma from the surrounding about the physical capability of T1DM patients (Fried et al., 2021), adequate support from the family, school, and peer to adjust with the pace of type and intensity of the physical activity (Alburno et al., 2022; Livny et al., 2020), adequate level of knowledge about the physical activity recommendation and blood glucose level management control (Collard et al., 2020; Fried et al., 2021; Livny et al., 2020), and the unavailability of technology or tools to ensure an adequate level of physical activity practice and safety while being physically active as the perceived challenges and barriers in caring for patients with T1DM (Morrow et al., 2022).

Table 2. Systematic Literature Review of Challenges and barriers to Physical Activity among the Pediatric Patients with T1DM and Their Parents

No.	Author and Year of Publication	Study Design	Instrument and Analysis	Finding(s)
Qualitative Study				
1.	Fried et al. (2021)	Interpretivism paradigm with constructivist epidemiology.	A semi-structured interview and NVivo software (QSR International) were applied to perform the statistical analysis.	Results signified that adolescent with T1DM perceived glucose control management while being physically active as a major challenge in their life. Four themes emerged in this study were: 1. Challenges of unpredictability. The blood glucose level prediction before and after the physical activity was influenced by various factors, which affected the subject's mental status in performing any physical activities. The diverse range of physical activity would produce different blood glucose level responses. Thereby, presenting challenges for their parent in providing the "right" diet to maintain an adequate blood glucose level while being physically active. 2. Trust. Autonomy and trust given to the subjects were necessary to healthily perceive their capability to be safe while being physically active regarding the fluctuation of the blood glucose level. 3. Stigma. Participants perceived difficulties confronting others' responses toward their situation and wished to be equally treated while being physically active. 4. Knowledge. The need for the proper level of personal knowledge was identified as a challenge and key to be physically active. A poor level of knowledge among the teachers, peers, and the general population has been contributing to the wrong perception and manner in responding to the subject's situation.
As 2.	Alburno et al.	Qualitative	A semi-structured	Facilitators of adherence were recognized as

	(2022)	approach.	interview according to the integrative health behavior change model. An inductive and deductive study approach was applied in this study.	being convinced of the advantages of healthful eating (HE) and physical activity, having support and high self-efficacy, a high level of intention, and a good health care system.
3.	Morrow et al. (2022)	An exploratory qualitative study of lived.	A photovoice was used to explore the experiences of technology and physical exercise while living with T1DM. Six phases of reflexive thematic analysis were enrolled in this study.	The current technology did not address the complex needs of adolescents with T1DM to support their active participation in physical exercise without risking their life and health safety.
4.	Collard et al. (2020)	Qualitative study.	A semi-structured interview and a thematic analysis.	Three themes related to the benefits of the insulin delivery system were commonly discussed in this study: (a) more freedom and spontaneity in an individual's ability to exercise, (b) removing worries and fear of hypoglycemia as the result of physical exercise, and (c) eliminating the tendency of 'guesswork' to adjust the insulin dosage for the physical exercises. Further, two themes also appeared in the interview sessions. The majority of subjects mentioned the potential concerns related to a safe physical exercise while using an automated insulin delivery system.
Quantitative Study				
5.	Michaud et al. (2017)	No specific design clearly mentioned in the study.	The barriers to physical activity in the T1DM score (BAPAD1) Questionnaire and parental physical activity profile questionnaire. Several statistical analyses were applied: Pearson's chi-square, non-parametric Mann–Whitney-Wilcoxon test, multiple linear regression, and logistic.	Fear of hypoglycemia was identified as the main barrier to physical exercise practices in both intervention groups. A more diverse parental physical activity profile was associated with a moderate level of physical activity and a lower intensity of screen time among the subjects (adolescents). They concluded that a more diverse parental activity profile is a major factor for healthier habit practices among adolescents with T1DM.
6.	Roberts et al. (2021)	Cross-sectional study	Fear of Hypoglycemia (FOH) Questionnaire and Physical Activity	The FOH score (behavior subscale) among adolescents was higher and associated with the enhancement of high-intensity physical exercise. No significant association between parental FOH and adolescents' physical activity

			Questionnaire. Statistical analysis with t-test or Kruskal-Walls test and linear regression.	was identified in this study.
7.	Livny et al. (2020)	Cross-sectional study	A questionnaire on barriers to physical activity in T1DM score (BAPAD1) (to evaluate the level of knowledge of physical exercise among T1DM survivors) and a Questionnaire assessing the exercise-directed education provided in the clinic were employed in this study. Statistical analysis was conducted using Pearson and Spearman tests.	Findings reported two common barriers to physical activity: (1) fear of hypoglycemia and (2) low fitness. Family and social support were found to be correlated with the level of physical activity. Further, this study highlighted the need of overcoming the fears of hypoglycemia to enhance the level of physical activity among children with T1DM effectively. Active participation from their family and social environment is demanded to increase the amount of safe exercise in pediatric patients with T1DM. Additionally, further efforts should be put into the standardization of education.

4. DISCUSSION

Findings highlighted the fear of hypoglycemia as a major challenge and barrier to physical activity among children and adolescents with T1DM. The difference between this challenge and barrier context is challenge means there are things related inaccurate understanding while barrier means something that hinders the act of physical acitivity from pediatricts with T1DM and their parents.

Hypoglycemia is an acute complication that commonly occurs during diabetes treatment. The state of hypoglycemia has been presenting life-threatening barrier in achieving optimal blood glucose control and frequently deteriorating the quality of life among the survivors. Serious cognitive dysfunction, such as seizure or loss of consciousness, marks a state of severe hypoglycemia. This situation would need external assistance from another person to administer oral or parenteral blood glucose resources and glucagon or other blood glucose correction interventions (Verbeeten et al., 2021). Fear of severe hypoglycemia is frequently causing an anxious feeling. In the most cases, a high anxiety level is associated with confusion and insufficient diabetes management (Urakami, 2020). Parental fear of hypoglycemia is also found as a barrier that prevents their children from engaging in a sufficient level of physical activity. Studies also explained difficulties encountered by the T1DM pediatric patients and their parents in predicting a safe blood glucose level after engaging in a certain level of physical exercise may be rooted in the presence of miscellaneous factors, such as exercise type and duration, exercise intensity, mood, the growth acceleration, climate situation, exercise timing, and previous physical activities (Fried et al., 2021; Michaud et al., 2017). The uncertain level of blood glucose while being physically active induced various emotional responses, such as frustration, fear, anxiety, and stress. This desperation response finally posed a challenge for the parents in providing sufficient support for their children to maintain a physically active routine in a safe range of blood glucose levels and provide an adequate diet (Fried et al., 2021).

Physical activity has demonstrated its

effect in delaying cardiovascular incidences among T1DM pediatric patients. A better understanding of the T1DM subject's lifestyle and related factors would provide a strong basis of knowledge to develop promising strategies for physical activity improvement among this vulnerable group. The specific component of physical activity (intensity, duration, frequency, and variation) is declared as the major key to organizing an active healthy lifestyle (Michaud et al., 2017). Technology is a vital means to bring substantial improvement in the level and type of physical exercise among T1DM pediatric patients. The increasing number of technologies adopted to identify the physical activity level was signaling constructive changes in physical activity practice in diabetes mellitus patients. However, further studies are required to be directed in recognizing its weakness and threats. Several studies pointed out the flaws of technology application in diabetic self-management according to the parent's testimonies: signal loss, data loss, and insufficiency of connected devices. These flaws were perceived as a frightening experience by the parents and a worrying situation by the adolescents. Thereby, several recommendations for technology-based tools for physical activity among T1DM patients were mainly concentrated on its integration with the accelerometry and glucose variability tools. The presence of resources that facilitate and promote sufficient health education and information for peers and educational institutions was also recognized in several studies. These resources contributed to stimulating peers supports and delivering psycho-education to navigate the independence of the T1DM children and adolescents, particularly during the transition period. The content of digital education, such as pump use or CGM, should be relevant to the technology tools applied. This situation may lead to variation in technology development in T1DM management (Morrow et al., 2022).

Another study stated that teachers in educational institutions had reported multiple shortcomings in various areas to support adequate diabetes management. It comprised the lack of substantial knowledge of diabetes, institutional support, and communication with the parents and health professionals. A method suggested to the teachers to assist T1DM children in school was to provide them with written instruction on how to manage the hypoglycemic state and help integrate T1DM children into educational settings (Gutzweiler et al., 2020). The educational institutions should have sufficiently responded by issuing appropriate policies to support hypoglycemia and hyperglycemia management during school hours, providing reassuring diabetes management at school and a chance for the T1DM children to engage in daily physical activity with their peers (Neu et al., 2019).

Orienting physical activity as an integral part of diabetic management among children and adolescents in the T1DM population have been adding more challenge. A comprehensive level of understanding of the energy expenditure and thorough insulin adjustment or titration requires continuing and appropriate education coupled with well-directed behavioral changes. This type of information is prone to fallacy due to its complicated and intensive attributes (Codella et al., 2017). Parallel with this situation, our recent findings indicated that motivation and high self-efficacy among the T1DM pediatric patients mediated their ability to adjust to physical activity practices. We also discovered that a higher parental physical activity profile was associated with a higher level of physical activity among T1DM pediatric patients (Alburno et al., 2022; Michaud et al., 2017). Further, self-efficacy and participation from the patient's family members or peers were also identified as factors that drove the patient's motivation to actively engage in physical exercise practices (Wilkie et al., 2017).

The limitation of this systematic review study is the high heterogeneity in all studies included. Both the quantitative and qualitative design studies revealed a high degree of variation, which was not suitable to perform a meta-analysis. In addition, we acknowledged our limitation in assessing comprehensive and specific challenges and barriers to physical activity practices among T1DM patients and parents due to difficulties in identifying and acquiring several studies that were issued in another form of publication, such as a report paper.

5. CONCLUSION

The recommendation of daily physical activities among children and adolescents with T1DM remains a formidable challenge. This issue was not only distresses the T1DM survivors, but also considerably affected the parents. The most prominent challenge perceived was the fear of hypoglycemia due to the inappropriate level of physical activity. This fear often induces anxiety and mental health issues among the patients and their parents. Health education and training sessions for the community members such as children and adolescents with T1DM, parents, peers, schools, and educational institutions have been widely demonstrated as compelling means to manage this situation. Thoughtful policies in the school and community are also crucial to enhance the integration between physical exercise practices and the patient's daily activities. Further, the assistance from proper technology tools would provide more convenience for the patients and their parents in managing and monitoring their blood glucose levels..

6. CONFLICT OF INTEREST

There are no conflicts of interest.

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