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PHYSICAL THERAPY MANAGEMENT FOR DIABETES MELLITUS IN PEDIATRIC

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ABSTRACT

Back ground*: Diabetes Mellitus in pediatric population presents unique challenges in managing glycemic control and preventing long term complications.*

Aim*: This systematic review aims to explore the role of physical therapy in managing pediatric Diabetes Mellitus (DM), focusing on glycemic control, cardiovascular health, and psychological well-being.*

Methods*: A narrative systematic review was conducted, analyzing data from studies involving structured physical activity interventions, such as aerobic and resistance training, in children with Type 1 DM .*

Results*: Regular exercise was found to have significant benefits on blood glucose regulation, insulin sensitivity, cardiovascular health, and psychological well-being. Despite these advantages, barriers such as fear of hypoglycemia and lack of provider awareness hinder optimal implementation.*

Conclusion*: Physical therapy plays a pivotal role in managing pediatric DM, and individualized exercise programs, continuous glucose monitoring, and greater education for healthcare providers and families are essential. Physiotherapists can design targeted interventions to improve functional abilities, prevent complications, and foster healthy development, ultimately empowering young patients to manage their condition effectively and live healthier lives.*

KEY WORDS: *Pediatric Diabetes, Physical Therapy, Glycemic Control, Exercise , Childhood Diabetes Management, Aerobic Exercise , Strength Training.*

INTRODUCTION

Diabetes Mellitus is a chronic and debilitating disease affecting millions worldwide, with a prevalence of approximately 8% globally[1]. It is characterized by high blood glucose levels, leading to serious complications if left untreated or poorly managed[1]. Type 1 diabetes requires prompt medical attention and ongoing management. A comprehensive approach to diabetes management, incorporating medical treatment, physical therapy, and exercise, is crucial for improving health outcomes[3].

Pediatric physical therapy focuses on treating movement difficulty in infants and young children, including those with diabetes[2]. By incorporating physical exercise and therapy, individuals with diabetes can better manage their condition and reduce complication risks[2]. However, the incidence of diabetes is increasing, with poor health outcomes in pediatric diabetes worsening over time[4]. Minority racial/ethnic groups are disproportionately affected, with suboptimal glucose control and higher complication risks[4]. Socioeconomic inequalities affect access to type 2 diabetes services[10] .Studies have demonstrated the benefits of exercise on glycemic control in children with type 1 diabetes, highlighting the importance of regular exercise as adjunct therapy[12],[13]. Diabetes is a syndrome characterized by disturbed carbohydrate, protein, and fat metabolism due to insulin deficiency or resistances[14].

Gestational Diabetes Mellitus (GDM) is a condition characterized by high blood sugar levels that develop during pregnancy, typically in the second or third trimester[17]. GDM increases the mother's risk of developing Type 2 Diabetes Mellitus later in life and affects 1-30% of pregnancies globally, with the highest prevalence in Middle Eastern, South-East Asian, and Pacific regions[17].

For pediatric diabetes care, emphasizing regular screening for complications, blood pressure monitoring, and lipid profile monitoring[15]. The medical management of pediatric type 1 diabetes involves a comprehensive approach, with insulin therapy as the cornerstone of treatment[16]. The goal is to achieve near-normal blood glucose levels using a basal-bolus insulin regimen, adjusting insulin doses based on carbohydrate counting, pre-meal blood glucose levels, and physical activity[16].

The primary objective of this study is to identify the present scope of physical therapy intervention and the awareness of the same among parents and healthcare professionals. In addition to the primary objective this study focused on the potential benefits of

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physiotherapeutic exercises and fitness strategies that can be prevent pediatric population from becoming diabetic at their young age. This involves educating children and their family members about physical activity and exercise, creating personalized plans, promoting regular exercise, monitoring and managing complications, and fostering a supportive environment. By collaborating with healthcare teams and staying updated on research, this study continues to educate kids to take charge of their condition, build confidence, and develop the skills needed to optimize their quality of life.

LITERATURE REVIEW

Title	Author and Year	Major Finding	Contribution/Significance of the study
Perspectives on the role of exercise in the treatment of pediatric type 1 diabetes"	Jeniece R. Ilkowitz, Fen Wu, Yu Chen, and Mary P. Gallagher May 2020	A significant majority (85.5%) of the 84 respondents considered counseling on exercise recommendations a priority. However , 87.8% of providers could not correctly identify the ODPHP guidelines, and 79.3% were unfamiliar with the ADA guidelines. Provider who regularly engaged in exercise themselves were more likely to correctly identify ADA guidelines (P = .009). Those who accurately identified ODPHP guidelines were also more likely to know the ADA guidelines (P = .004). Providers familiar with ADA guidelines were 4.21 times more likely to make appropriate exercise recommendations (OR 4.21; 95% CI 1.30-13.7). Discussing exercise recommendations at the time of diabetes diagnosis increased the likelihood of making appropriate recommendations by 6.10 times (OR 6.10; 95% CI 1.76-21.2).	This study is the first to investigate healthcare providers' perspectives on exercise promotion in children with type 1 diabetes. It reveals a disconnect between the perceived importance of exercise counseling and providers' familiarity with official exercise guidelines. The findings suggest a need for enhanced provider education on exercise recommendations and the development of tools to support effective exercise promotion in this patient population.
Strength training is more effective than aerobic exercise for improving glycaemic control and body composition in people with normal-weight type 2 diabetes: a randomised controlled trial,"	Yukari Kobayashi, Jin Long, Shozen Dan, Neil M. Johannsen, Ruth Talamoa, Sonia Raghuram, Sukyung Chung, Kyla Kent, Marina Basina, Cynthia Lamendola, Francois Haddad, and Mary B. Leon Guerrero. October 2023	The study found that strength training led to significant improvements in glycaemic control and favorable changes in body composition compared to aerobic exercise. Participants in the strength training group exhibited better regulation of blood glucose levels and increased muscle mass.	This research provides evidence that strength training may be more beneficial than aerobic exercise for glycaemic control and body composition in normal-weight individuals with type 2 diabetes. It suggests that exercise recommendations for this population should include strength training to achieve optimal health outcomes.
Glucose management for exercise using continuous glucose monitoring (CGM) and intermittently	Othmar Moser, Michael C. Riddell, Max L. Eckstein, Peter Adolfsson, Rémi Rabasa-Lhoret, Louisa van den Boom, Pieter Gillard, Kirsten Nørgaard, Nick S.	The position statement highlights that exercise can lead to both hypoglycaemia and hyperglycaemia in individuals with type 1 diabetes, depending on factors such as exercise type, intensity, and	This position statement serves as a valuable resource for healthcare professionals and individuals with type 1 diabetes by offering clear, evidence-based guidelines on

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scanned CGM (isCGM) systems in type 1 diabetes" is a position statement jointly issued by the European Association for the Study of Diabetes (EASD) and the International Society for Pediatric and Adolescent Diabetes (ISPAD), endorsed by JDRF and supported by the American Diabetes Association (ADA)	Oliver, Dessi P. Zaharieva, and others October 2020	duration. It emphasizes the benefits of using CGM and isCGM systems to monitor real-time glucose levels, which can help in making informed decisions about carbohydrate intake and insulin adjustments before, during, and after exercise. The statement also provides specific strategies to reduce the risk of exercise-induced hypoglycaemia and hyperglycaemia.	managing glucose levels during exercise using CGM and isCGM technologies. By addressing the complexities of exercise-induced glycaemic variability, it contributes to safer and more effective diabetes management strategies, encouraging individuals with type 1 diabetes to engage in regular physical activity with greater confidence.
Experimental study on physical exercise in diabetes: pathophysiology and therapeutic effects"	Giuseppe Messina, Anna Alioto, Maria Chiara Parisi, Omar Mingrino, Donatella Di Corrado, Caterina Crescimanno, Szymon Kuliś, Fatma Nese Sahin, Elvira Padua, Alberto Canzone, and Vincenzo C. Francavilla. October 2023	Blood Glucose Levels: In Group A (sedentary), blood glucose values decreased from 160/150 mg/dl to 130 mg/dl. In Group B (active), levels decreased from 140 mg/dl to 120/110 mg/dl. BMI: Both groups experienced a 60% reduction in BMI, with greater significance observed in Group B, where 60% of participants were obese. Cholesterol and HbA1c: Both parameters decreased in both groups, though the reductions were more gradual compared to blood glucose and BMI improvements. These findings suggest that physical activity, when combined with insulin therapy, effectively regulates blood glucose levels and improves other metabolic parameters in individuals with type II diabetes.	The study underscores the therapeutic and preventive benefits of physical exercise in managing type II diabetes. It highlights the importance of interdisciplinary collaboration among diabetologists, sports medicine doctors, and kinesiologists or personal trainers to develop tailored exercise programs that complement medical treatments. The research supports the integration of structured physical activity as a fundamental component of diabetes management strategies.
Physical therapy approaches for children with diabetes	Egypt J Appl Sci	Exercises like running, swimming, and cycling help children with Type 1 Diabetes control their blood sugar. Strength training also improves their health by lowering bad cholesterol and keeping a healthy weight. These activities reduce the risk of heart problems and make diabetes easier to manage.	Shows that exercise is an important part of diabetes care for kids. Helps doctors and parents choose the best exercises for managing diabetes in children.
A Review of the Effect of		Exercise helps reduce pain and improves leg strength and balance.	The study shows that exercise can be a natural way to

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Therapeutic Exercise on Polyneuropathy in Patients with Diabetes"		Aerobic exercises (like walking and cycling) seem to be the most effective. Exercise may also slow down or prevent neuropathy from getting worse. More research is needed to confirm these benefits.	manage nerve pain in diabetes. This can help doctors and physiotherapists create better exercise programs for diabetic patients.
Management of Diabetes Mellitus in Children and Adolescents: Engaging in Physical Activity"	Transl Pediatr. 2017	Aerobic exercises (running, swimming) and strength training improve blood sugar control. Many children lack exercise due to fear and insufficient guidance.	The study stresses the need for safe and structured exercise programs for diabetic children
Physiotherapy and rehabilitation in the management of diabetes mellitus: a review	Kaur, J., Singh, S. K., & Vij, J. S. (2015). Indian Journal of Scientific Research, 6(2), 171-181.	Regular exercise, stretching, and strength training can help people with diabetes stay mobile and reduce pain. Activities like walking, cycling, and swimming improve blood circulation and prevent complications. Therapies like electrical stimulation and ultrasound can help with nerve-related issues.	study highlights the importance of physiotherapy as part of diabetes care, showing that it can be an effective way to manage symptoms without relying only on medication.
Effect of exercise training on cardiac autonomic function in type 2 diabetes mellitus: a systematic review and meta-analysis"	Sohini Raje, G. Arun Maiya, Padmakumar R, Mukund A. Prabhu, Krishnananda Nayak, Shivashankara KN, B. A. Shastry, and Megha Nataraj. February 2025	Three studies met the inclusion criteria, with two included in the meta-analysis focusing on outcomes such as the E:I ratio, 30:15 ratio, and Valsalva ratio. The pooled analysis revealed: No significant effect of exercise training on the E:I and 30:15 ratios. A significant improvement in the Valsalva ratio following exercise interventions. The studies utilized diverse exercise interventions, and the certainty of evidence ranged from low to moderate.	This study contributes to the understanding of exercise's role in managing CAN among T2DM patients by highlighting that while certain aspects of cardiac autonomic function may not be significantly influenced by exercise, others, like the Valsalva ratio, show improvement. These findings underscore the potential of tailored exercise programs in mitigating specific components of autonomic dysfunction in T2DM.
Diabetes mellitus in childhood and adolescence (Update 2023)	2023	T1D is the most common form of diabetes in children and adolescents, necessitating specialized management. Lifelong insulin therapy is essential, with treatment plans individualized based on age and family routines. The use of diabetes technologies, including glucose sensors and	This update provides healthcare professionals with current, evidence-based recommendations tailored to the unique needs of children and adolescents with diabetes, promoting individualized care and the integration of advanced

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		insulin pumps, is recommended to improve management outcomes. Goals of therapy include normal physical, cognitive, and psychosocial development, prevention of acute complications (e.g., severe hypoglycemia, diabetic ketoacidosis), screening for associated conditions, and prevention of long-term complications to maintain a high quality of life.	technologies to enhance patient outcomes
Progressive resistance exercise improves glycaemic control in people with type 2 diabetes mellitus: a systematic review	2009 Author(s): Casey Irvine and Nicholas F. Taylo	PRE led to a statistically significant absolute reduction in HbA1c levels by 0.3%, indicating improved glycemic control. Participants experienced substantial increases in muscle strength compared to those who did not exercise or engaged in aerobic exercise.	This research highlights PRE as a viable and effective strategy for improving glycemic control and enhancing muscle strength in individuals with type 2 diabetes. The findings support incorporating PRE into diabetes management plans to achieve better health outcomes.
Effects of exercise training on glycaemic control in youths with type 1 diabetes: A systematic review and meta-analysis of randomised controlled trials	2022 Author(s): Antonio García-Hermoso, Yasmin Ezzatvar, Nidia Huerta-Uribe, Alicia M. Alonso-Martínez, Maria J. Chueca-Guindulain, Sara Berrade-Zubiri, Mikel Izquierdo, and Robinson Ramírez-Vélez	The meta-analysis included 14 studies with a total of 509 participants. Overall, exercise interventions were associated with a reduction in HbA1c levels, indicating improved glycaemic control. The effectiveness of the interventions varied based on factors such as exercise type, intensity, duration, and frequency. Longer intervention durations (e.g., programs lasting several months) and higher session frequencies were linked to more significant improvements in HbA1c levels.	This study contributes to the understanding of exercise's role in managing CAN among T2DM patients by highlighting that while certain aspects of cardiac autonomic function may not be significantly influenced by exercise, others, like the Valsalva ratio, show improvement. These findings underscore the potential of tailored exercise programs in mitigating specific components of autonomic dysfunction in T2DM.
Outcome measures for physical activity interventions in children with Type 1 Diabetes: A Systematic Literature Review	Emer, Evindar 2023-10-09	The review found that physical activity interventions lasting more than 12 weeks were more effective in improving glycemic control, but the psychosocial outcomes were not generalizable due to limited sample sizes.	The study's findings Inform clinical practice and identify research gaps, highlighting the importance of physical activity for children with T1D and the need for further research.
Physical activity and cardiometabolic health in adolescents with type 2 diabetes: a	Jana L Slaght,Brandy Alexandra,Allison B Dart 14 May 2021	The study found that youth who participated in regular vigorous-intensity PA had lower HbA1c, diastolic blood pressure, and mean arterial pressure, as well as lower odds of albuminuria	The study highlights the importance of regular physical activity in managing type 2 diabetes and reducing CVD risk factors in youth.

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cross-sectional study			
Benefits of physical activity in children and adolescents with type 1 diabetes: A systematic review	Hélène Absil a 1, Lia Baudet a 1, Annie Robert b, Philippe A. Lysy - October 2019,	Physical activity had positive effects on: 1. Blood lipid profiles 2. Physical fitness 3. Quality of life 4. Body composition However, only one study showed improved glycemic control.	The review highlights the benefits of physical activity for children with type 1 diabetes and emphasizes the need for standardized study protocols and larger sample sizes.
Effect of Physical Activity/Exercise on Cardiorespiratory Fitness in Children and Adolescents with Type 1 Diabetes	Xinyi Chang ORCID, Ziheng Wang , Hongzhi Guo RCID,Yinghan Xu ORCID andAtsushi Ogihara Year- 12 January 2023	The effects of exercise on CRF in youth with T1DM varied depending on the type, frequency, and intensity of the exercise. However, the durtion of exercise in the included studies did not meet recommended guidelines.	The review highlights the need for more research to develop specific exercise modes that can improve CRF and overall health outcomes in youth with T1DM.

METHODOLOGY

This research was conducted as a narrative systematic review to explore the role of physical therapy interventions in managing Diabetes Mellitus (DM) among the pediatric population. A total of 20 studies were analyzed, each investigating the effects of structured physical activity—such as aerobic exercises, resistance training, or combined programs—on children diagnosed with Type 1 DM. The primary objective was to assess how these interventions influence glycemic control, physical function, psychological well-being, and overall quality of life in pediatric patients. A thorough literature search was conducted using electronic databases including PubMed, Google Scholar. Studies were included if they were published in English, involved pediatric DM patients, and implemented structured physical therapy or exercise-based interventions. Studies focusing on adult populations or non-exercise approaches were excluded. Each study was reviewed for relevance, methodological features, and reported outcomes. Key data extracted included study design, sample size, type and duration of the intervention, and outcomes related to glycemic markers, physical activity levels, and psychosocial health. The findings were synthesized qualitatively to highlight consistent patterns and the overall impact of physical therapy interventions on the pediatric diabetic population.

RESULTS

Regular exercise is a crucial component of diabetes management, offering numerous benefits that extend beyond physical health to mental and emotional well-being. By incorporating physical activity into their daily routine, pediatric with diabetes can experience significant improvements in blood sugar control, insulin sensitivity, and overall quality of life. Exercise reduces the risk of complications associated with diabetes, such as neuropathy, retinopathy, and cardiovascular disease, while also improving psychological well-being and reducing stress and anxiety.

Despite the benefits, pediatric with diabetes may face challenges like fear of hypoglycemia and inadequate monitoring. However, individualized exercise plans and continuous glucose monitoring systems can help overcome these barriers. A recent study found that self-directed exercise may be more effective in improving glycemic control in children with type 1 diabetes mellitus. By prioritizing physical activity and education, individuals with diabetes can take control of their health and improve their overall quality of life. Regular exercise, combined with proper management and education, can help individuals with diabetes manage their condition effectively and reduce the risk of complications.

DISCUSSION

This study highlights the critical role of exercise in managing diabetes, emphasizing its benefits on glycemic control, functional abilities, and overall quality of life. A significant knowledge gap exists among healthcare providers in promoting exercise among children with type 1 diabetes. Physiotherapy including fitness training plays a vital role in managing diabetes by improving glycemic control, enhancing functional abilities, and preventing complications. Exercise has far-reaching benefits, including improved insulin sensitivity, strengthened muscles, and improved postural stability. However, challenges such as fear of hypoglycemia and inadequate monitoring can limit participation. To address these barriers, individualized exercise plans and continuous glucose monitoring systems can help mitigate risks.

The American Diabetes Association recommends at least sixty minutes of moderate-to-vigorous physical activity per day for children and adolescents with diabetes, and interventions lasting twelve weeks or more are more effective in improving health outcomes. Healthcare providers should prioritize education and guidance on exercise and physical activity to improve patient outcomes and support functional independence, reducing complications and improving overall quality of life. By

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promoting regular exercise as a key component of diabetes care, healthcare providers can help individuals with diabetes manage their condition effectively and improve their overall well-being. The article has been drafted following the TAILMRDCR model proposed by Kumar[21]. The findings are useful for the practitioners and medical tourism scope[22,23].

CONCLUSION

The physical management of diabetes in pediatric populations requires a holistic and proactive approach that integrates education, individualized care, and active lifestyle support. Physiotherapists play a vital role in promoting healthy development, preventing complications, and improving insulin sensitivity through tailored exercise programs, postural training, and cardiovascular conditioning. The primary objectives are to provide comprehensive care and support, educate children and families about physical activity, and encourage regular participation in exercise. Collaboration with multidisciplinary teams and staying updated with emerging research ensure effective care.

Lifestyle physiotherapeutic fitness strategies, such as structured daily routines, balanced nutrition, stress management techniques, and active family involvement, empower young patients to take ownership of their condition. These measures improve metabolic control, build the foundation for long-term health and independence, and enhance overall well-being. Early intervention, personalized physiotherapy strategies, and continuous support equip children with the tools, knowledge, and confidence to thrive. With coordinated care and active engagement of the mentioned concepts, children with diabetes can transform their living to an improved quality of life.

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