www.idosr.org Odile
©IDOSR PUBLICATIONS
ISSN: 2550-794X

International Digital Organization for Scientific Research IDOSRJSR10.1.17210
IDOSR JOURNAL OF SCIENTIFIC RESEARCH 10(1):17-21, 2025.
https://doi.org/10.59298/IDOSRJSR/2024/10.1.17.210

Impact of Continuous Glucose Monitoring (CGM) vs Self-Monitoring of Blood Glucose (SMBG) on Glycemic Control in Adolescents with Type 1 Diabetes

Odile Patrick Thalia

Faculty of Biological Sciences Kampala International University Uganda

ABSTRACT

This review article explored the comparative effectiveness of Continuous Glucose Monitoring (CGM) versus Self-Monitoring of Blood Glucose (SMBG) in improving glycemic control among adolescents with Type 1 Diabetes Mellitus (T1DM). Adolescents with T1DM face significant challenges in managing their condition, with fluctuating blood glucose levels, the demands of insulin therapy, and adherence to self-monitoring practices. SMBG, the traditional method for glucose monitoring, provides intermittent snapshots of glucose levels, which may not be sufficient for optimal glycemic control. In contrast, CGM offers continuous, real-time tracking of glucose levels, enabling a more comprehensive understanding of glucose trends and variability. This review synthesized evidence regarding the impact of CGM on HbA1c levels, time-in-range (TIR), hypoglycemia prevention, and quality of life in comparison to SMBG. Methodologically, the review examined a combination of randomized controlled trials, observational studies, and meta-analyses to evaluate both the clinical benefits and challenges associated with CGM use. The findings suggest that CGM significantly improves glycemic control, reduces hypoglycemic episodes, and enhances the overall quality of life in adolescents with T1DM. However, challenges such as cost, sensor accuracy, and technical expertise still hinder widespread adoption. The review concluded with a discussion on the potential role of CGM in adolescent diabetes management and future directions for research and clinical practice.

Keywords: Continuous Glucose Monitoring (CGM), Self-Monitoring of Blood Glucose (SMBG), Type 1 Diabetes Mellitus (T1DM), Glycemic Control, Adolescents.

INTRODUCTION

Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune condition characterized by the destruction of insulin-producing beta cells in the pancreas, necessitating lifelong insulin therapy [1, 2]. Adolescents with T1DM face unique challenges in managing their condition, including physiological changes associated with puberty, psychological stressors, and the need for increasing independence in diabetes self-management. Glycemic control, as measured by HbA1c levels and time-in-range (TIR), is critical in preventing acute and long-term complications, such as diabetic ketoacidosis, retinopathy, nephropathy, and cardiovascular disease [3]. However, achieving optimal glycemic control in adolescents remains a significant challenge due to the complexity of insulin dosing, frequent blood glucose fluctuations, and inconsistent adherence to self-monitoring practices. Self-Monitoring of Blood Glucose (SMBG) has long been the standard of care for individuals with T1DM, requiring frequent fingerstick measurements to guide insulin dosing and lifestyle decisions [4, 5]. While effective, SMBG provides only intermittent snapshots of glucose levels, leaving gaps in understanding glucose trends and variability. Continuous Glucose Monitoring (CGM), a relatively recent technological advancement, offers real-time, continuous tracking of glucose levels, providing a more comprehensive picture of glycemic patterns [6]. CGM systems use subcutaneous sensors to measure interstitial glucose levels, transmitting data to a receiver or smartphone app, and often include alerts for hypo- and hyperglycemia. This review examines the impact of CGM compared to SMBG on glycemic control in adolescents with T1DM, focusing on HbA1c levels, TIR, hypoglycemia prevention, and quality of life. By synthesizing the latest evidence, this review aims to provide insights into the efficacy, benefits, and challenges of CGM in this population, offering valuable guidance for clinicians, researchers, and policymakers.

Adolescence is a critical period for diabetes management, marked by rapid physical growth, hormonal changes, and evolving psychosocial dynamics [7]. These factors contribute to increased insulin resistance, greater glycemic variability, and heightened risk of both hyperglycemia and hypoglycemia [8]. Adolescents with T1DM often struggle with adherence to diabetes management regimens, including frequent blood glucose monitoring, insulin administration, and dietary adjustments. Poor glycemic control during adolescence is associated with an increased risk of acute complications, such as diabetic ketoacidosis, and long-term complications, including microvascular and macrovascular diseases. SMBG has been the cornerstone of diabetes self-management for decades, enabling individuals to monitor their blood glucose levels and make informed decisions about insulin dosing, food intake, and physical activity. However, SMBG has limitations, including the inconvenience of frequent fingerstick, the discomfort associated with blood sampling, and the inability to capture glucose trends between measurements. These limitations are particularly pronounced in adolescents, who may find SMBG burdensome and disruptive to their daily lives. CGM technology addresses many of these limitations by providing continuous, real-time glucose data without the need for frequent fingerstick [6, 9]. CGM systems offer several advantages, including the ability to track glucose trends, detect asymptomatic hypoglycemia, and provide alerts for impending hypo- or hyperglycemia. These features make CGM particularly well-suited for adolescents, who may benefit from the additional support and feedback provided by continuous monitoring. However, the adoption of CGM in this population is not without challenges, including cost, sensor accuracy, and user adherence.

Efficacy in Improving Glycemic Control

Glycemic control is a key determinant of diabetes management success, with HbA1c levels and TIR serving as primary metrics [10]. CGM has been shown to significantly improve glycemic control in adolescents with T1DM compared to SMBG. Studies have demonstrated that CGM use is associated with reductions in HbA1c levels, particularly in individuals with suboptimal baseline control. For example, a 6-month randomized controlled trial found that adolescents using CGM experienced an average reduction in HbA1c of 0.5% compared to those using SMBG. This improvement is attributed to the continuous feedback provided by CGM, which enables more precise insulin dosing and timely interventions to prevent hyperglycemia.

TIR, defined as the percentage of time spent within the target glucose range (typically 70-180 mg/dL), is another important measure of glycemic control [11]. CGM has been shown to increase TIR by an average of 10-15% in adolescents with T1DM. This improvement is particularly significant given the association between increased TIR and reduced risk of diabetes-related complications. CGM's ability to provide real-time glucose data and trendy arrows allows adolescents and their caregivers to make more informed decisions about insulin administration, food intake, and physical activity, leading to more stable glucose levels.

Hypoglycemia Prevention

Hypoglycemia is a common and potentially dangerous complication of T1DM, particularly in adolescents who may have irregular eating patterns and varying levels of physical activity [12]. Severe hypoglycemia can lead to seizures, loss of consciousness, and even death, making its prevention a critical aspect of diabetes management. CGM has been shown to significantly reduce the frequency and severity of hypoglycemic episodes in adolescents with T1DM. By providing real-time alerts for low glucose levels, CGM enables timely interventions, such as carbohydrate consumption or insulin adjustment, to prevent hypoglycemia. CGM systems also offer predictive alerts, which notify users of impending hypoglycemia based on glucose trends. This feature is particularly beneficial for adolescents, who may not always recognize the early symptoms of hypoglycemia. Studies have demonstrated that CGM use is associated with a 30-50% reduction in the incidence of severe hypoglycemia in adolescents with T1DM [13]. This reduction in hypoglycemia risk is a significant advantage of CGM over SMBG, which provides only intermittent glucose measurements and cannot predict hypoglycemia.

Quality of Life and Psychological Benefits

The psychological and emotional impact of T1DM on adolescents cannot be overstated. Managing a chronic condition during a period of significant physical, emotional, and social development can lead to stress, anxiety, and burnout [14]. CGM has been shown to improve quality of life and reduce diabetes-related distress in adolescents with T1DM. By providing continuous glucose data and reducing the need for frequent finger sticks, CGM alleviates some of the burdens associated with diabetes management. CGM also empowers adolescents by giving them greater control over their condition. The ability to track glucose trends, set personalized alerts, and receive real-time feedback fosters a sense of autonomy and self-efficacy, which are critical for long-term diabetes management [15]. Additionally, CGM can improve family dynamics by reducing the stress and conflict associated with frequent blood glucose monitoring. Parents and caregivers often report feeling more confident and less anxious when their child uses CGM, as they have access to real-time glucose data and can provide support when needed.

Challenges and Limitations

Despite its many benefits, CGM is not without challenges. One significant barrier is cost, as CGM systems can be expensive and may not be covered by all insurance plans [16-18]. This financial burden can limit access to CGM, particularly for families with limited resources. Additionally, CGM requires a certain level of technical proficiency, which may be a barrier for some adolescents and their caregivers. Proper use of CGM involves regular sensor changes, calibration (for some systems), and troubleshooting, which can be daunting for users who are not technologically savvy [19-20].

Sensor accuracy is another concern, particularly during periods of rapid glucose changes or when the sensor is not properly calibrated. Inaccurate glucose readings can lead to inappropriate insulin dosing decisions, potentially resulting in hypo- or hyperglycemia. Furthermore, some adolescents may experience skin irritation or discomfort from wearing a sensor, which can affect adherence [21-23]. Finally, while CGM provides continuous glucose data, it does not eliminate the need for occasional fingerstick measurements, particularly during periods of sensor inaccuracy or when making critical treatment decisions [24-25].

Future Directions

The field of diabetes technology is rapidly evolving, with ongoing advancements in CGM systems aimed at improving accuracy, usability, and accessibility. Future developments may include non-invasive CGM systems, which eliminate the need for subcutaneous sensors, and integration with insulin pumps to create fully automated closed-loop systems [17]. These advancements have the potential to further enhance glycemic control and reduce the burden of diabetes management for adolescents with T1DM. Research is also needed to explore the long-term impact of CGM on diabetes-related complications, quality of life, and healthcare costs. Longitudinal studies following adolescents with T1DM over several years can provide valuable insights into the sustained benefits of CGM and its impact on long-term health outcomes. Additionally, efforts to address barriers to CGM adoption, such as cost and technical complexity, will be critical in ensuring equitable access to this technology.

CONCLUSION

CGM represents a significant advancement in diabetes management for adolescents with T1DM, offering continuous, real-time glucose data that can improve glycemic control, reduce hypoglycemia risk, and enhance quality of life. Compared to SMBG, CGM provides a more comprehensive picture of glucose trends, enabling more precise insulin dosing and timely interventions to prevent hypo- and hyperglycemia. While challenges such as cost, sensor accuracy, and user adherence remain, the potential benefits of CGM make it a valuable tool in the management of T1DM in adolescents. Healthcare providers should consider CGM as a first-line option for adolescents with T1DM, particularly those with suboptimal glycemic control or a history of hypoglycemia. Public health initiatives should focus on promoting CGM adoption and addressing barriers to access, ensuring that all adolescents with T1DM can benefit from this transformative technology. As the field of diabetes technology continues to evolve, CGM is likely to play an increasingly important role in improving outcomes for adolescents with T1DM, offering hope for a healthier and more manageable future.

REFERENCES

1. Alum, E.U., Ugwu, O.P.C., Obeagu, E.I.: Beyond Pregnancy: Understanding the Long-Term Implications of Gestational Diabetes Mellitus. INOSR Scientific Research. 11, 63–71 (2024). https://doi.org/10.59298/INOSRSR/2024/1.1.16371
2. Egwu, C.O., Offor, C. E., Alum, E.U..: Anti-Diabetic Effects of Buchholzia Coriacea Ethanol Seed Extract and Vildagliptin On Alloxan-Induced Diabetic Albino Rats. Int J Biol Pharm Allied Sci. (2017)
3. Bellido, V., Pinés-Corrales, P.J., Villar-Taibo, R., Ampudia-Blasco, F.J.: Time-in-range for monitoring glucose control: Is it time for a change? Diabetes Res Clin Pract. 177, 108917 (2021). https://doi.org/10.1016/J.DIABRES.2021.108917
4. Babaya, N., Noso, S., Hiromine, Y., Taketomo, Y., Niwano, F., Yoshida, S., Yasutake, S., Kawabata, Y., Ikegami, H.: Flash glucose monitoring in type 1 diabetes: A comparison with self-monitoring blood glucose. J Diabetes Investig. 11, 1222–1229 (2020). https://doi.org/10.1111/JDI.13229
5. Moström, P., Ahlén, E., Imberg, H., Hansson, P.O., Lind, M.: Adherence of self-monitoring of blood glucose in persons with type 1 diabetes in Sweden. BMJ Open Diabetes Res Care. 5, 342 (2017). https://doi.org/10.1136/BMJDRC-2016-000342

6. Obeagu, E.I., Okechukwu, U., Alum, E.U.: Poor Glycaemic Control among Diabetic Patients: A Review on Associated Factors. (2023)
7. de Wit, M., Gajewska, K.A., Goethals, E.R., McDarby, V., Zhao, X., Hapunda, G., Delamater, A.M., DiMeglio, L.A.: ISPAD Clinical Practice Consensus Guidelines 2022: Psychological care of children, adolescents and young adults with diabetes. Pediatr Diabetes. 23, 1373 (2022). https://doi.org/10.1111/PEDI.13428
8. Okechukwu, U.P., Ugo Alum, E., Okon, M., Maduabuchi Aja, P.: Ethanol root extract and fractions of *Sphenocentrum jollyanum* abrogate hyperglycemia and low body weight in Streptozotocin-induced diabetic Wistar albino Rats. (2023). https://doi.org/10.1093/rpsppr/rqad010/7099615
9. Adie, A.E.: Comparing the Effectiveness of Continuous Glucose Monitoring Versus Traditional Blood Glucose Monitoring in Reducing HbA1c Levels among Adults with Type 2 Diabetes Over Six Months. International Digital Organization for Scientific Research IDOSRJAS101580000 IDOSR Journal of Applied Sciences. 10, 5–8 (2025). https://doi.org/10.59298/IDOSRJAS/2025/101.58000
10. Landstra, C.P., Ruissen, M.M., Regeer, H., Nijhoff, M.F., Ballieux, B.E.P.B., van der Boog, P.J.M., de Vries, A.P.J., Huisman, S.D., de Koning, E.J.P.: Impact of a Public Health Emergency on Behavior, Stress, Anxiety and Glycemic Control in Patients with Pancreas or Islet Transplantation for Type 1 Diabetes. Transplant International. 37, 12278 (2024). https://doi.org/10.3389/TI.2024.12278/BIBTEX
11. Kalra, S., Shaikh, S., Priya, G., Baruah, M.P., Verma, A., Das, A.K., Shah, M., Das, S., Khandelwal, D., Sanyal, D., Ghosh, S., Saboo, B., Bantwal, G., Ayyagari, U., Gardner, D., Jimeno, C., Barbary, N.E., Hafidh, K.A., Bhattarai, J., Minulj, T.T., Zufry, H., Bulugahapitiya, U., Murad, M., Tan, A., Shahjada, S., Bello, M.B., Katulanda, P., Podgorski, G., AbuHelaiqa, W.I., Tan, R., Latheef, A., Govender, S., Assaad-Khalil, S.H., Kootin-Sanwu, C., Joshi, A., Pathan, F., Nkansah, D.A.: Individualizing Time-in-Range Goals in Management of Diabetes Mellitus and Role of Insulin: Clinical Insights From a Multinational Panel. Diabetes Therapy. 12, 465–485 (2021). https://doi.org/10.1007/S13300-020-00973-0/FIGURES/4
12. Zucchini, S., Tumini, S., Scaramuzza, A.E., Bonfanti, R., Delvecchio, M., Franceschi, R., Iafusco, D., Lenzi, L., Mozzillo, E., Passanisi, S., Piona, C., Rabbone, I., Rapini, N., Rigamonti, A., Ripoli, C., Salzano, G., Savastio, S., Schiaffini, R., Zanfardino, A., Cherubini, V.: Recommendations for recognizing, risk stratifying, treating, and managing children and adolescents with hypoglycemia. Front Endocrinol (Lausanne). 15, 1387537 (2024). https://doi.org/10.3389/FENDO.2024.1387537/PDF
13. Rodbard, D.: Continuous glucose monitoring: A review of recent studies demonstrating improved glycemic outcomes. Diabetes Technol Ther. 19, S25–S37 (2017). https://doi.org/10.1089/DIA.2017.0035/ASSET/IMAGES/LARGE/FIGURE1.JPEG
14. Anclair, M., Lappalainen, R., Muotka, J., Hiltunen, A.J.: Cognitive behavioural therapy and mindfulness for stress and burnout: a waiting list-controlled pilot study comparing treatments for parents of children with chronic conditions. Scand J Caring Sci. 32, 389–396 (2018). https://doi.org/10.1111/SCS.12473
15. Coman, L.I., Ianculescu, M., Paraschiv, E.A., Alexandru, A., Bădărău, I.A.: Smart Solutions for Diet-Related Disease Management: Connected Care, Remote Health Monitoring Systems, and Integrated Insights for Advanced Evaluation. Applied Sciences 2024, Vol. 14, Page 2351. 14, 2351 (2024). https://doi.org/10.3390/APP14062351
16. García-Lorenzo, B., Rivero-Santana, A., Vallejo-Torres, L., Castilla-Rodríguez, I., García-Pérez, S., García-Pérez, L., Perestelo-Pérez, L.: Cost-effectiveness analysis of real-time continuous monitoring glucose compared to self-monitoring of blood glucose for diabetes mellitus in Spain. J Eval Clin Pract. 24, 772–781 (2018). https://doi.org/10.1111/JEP.12987
17. Ma, R., Shao, R., An, X., Zhang, Q., Sun, S.: Recent advancements in noninvasive glucose monitoring and closed-loop management systems for diabetes. J Mater Chem B. 10, 5537–5555(2022). https://doi.org/10.1039/D2TB00749E
18. Alum EU, Ugwu OPC, Obeagu EI, Aja PM, Ugwu CN, Okon MB. Nutritional care in diabetes mellitus: a comprehensive guide. Int J Innov Appl Res. 2023;11(12):16-25.
19. Alum EU, Okwaja PR, Obeagu EI, Obeagu GU, Odo EO, Igwe MC, Ugwu OPC. Nutritional

approaches for enhancing immune competence in HIV-positive individuals: a comprehensive review. IDOSR J Appl Sci. 2024;9(1):40-50.

20. Afiukwa CA, Ogah O, Ugwu OPC, Oguguo JO, Ali FU, Ossai EC. Nutritional and antinutritional characterization of two wild yam species from Abakaliki, southeast Nigeria. 2013;4(2):840-8.
21. Afiukwa CA, Oko AO, Afiukwa JN, Ugwu OPC, Ali FU, Ossai EC. Proximate and mineral element compositions of five edible wild-grown mushroom species in Abakaliki, southeast Nigeria. Res J Pharm Biol Chem Sci. 2013;4:1056-64.
22. Nwali BU, Egesimba GI, Ugwu PCO, Ogbanshi ME. Assessment of the nutritional value of wild and farmed Clarias gariepinus. Int J Curr Microbiol Appl Sci. 2015;4(1):179-82.
23. Ugwu OPC, Alum EU, Obeagu EI, Okon MB, Aja PM, Samson AO, Amusa MO, Adepoju AO. Effect of ethanol leaf extract of *Chromolaena odorata* on lipid profile of streptozotocin-induced diabetic Wistar albino rats. 2023;10(1):109-17.
24. Obeagu EI, Ugwu OPC, Alum EU. Poor glycaemic control among diabetic patients: a review on associated factors. Newport Int J Res Med Sci. 2023;3(1):30-33.
25. Ugwu OPC, Alum EU, Uhama KC. Dual burden of diabetes mellitus and malaria: exploring the role of phytochemicals and vitamins in disease management. Res Invention J Res Med Sci. 2024;3(2):38-49.

CITE AS: Odile Patrick Thalia (2025). Impact of Continuous Glucose Monitoring (CGM) vs Self-Monitoring of Blood Glucose (SMBG) on Glycemic Control in Adolescents with Type 1 Diabetes. IDOSR JOURNAL OF SCIENTIFIC RESEARCH 10(1):17-21. https://doi.org/10.59298/IDOSRJSR/2024/10.1.17.210