Original Article

Open Access

Experiences of Continuous Glucose Monitoring Systems in Patients of Type1 Diabetes Mellitus; Intermittently Scanned vs Real Time Device

Alia Zubair[a], Wajiha Mah Jabeen[*a], Shahida Mushtaq[a], Sana Ajmal[b]
[a]*Department of Pathology Hitec-IMS Taxila,Pakistan*
[b]*Executive Director Meethi Zindagi, Rawalpindi Pakistan*
*Correspondence:** doctor_wajeeha@yahoo.com

How to site this **Alia Zubair[a], Wajiha Mah Jabeen[a], Shahida Mushtaq[a], Sana Ajmal[b] Experiences of Continuous Glucose Monitoring Systems in Patients of Type 1 Diabetes Mellitus; Intermittently Scanned vs Real-Time Device Study PAMS 2025; 1(1): 25-34**

Abstract

Objective: The present study was designed to get evidence-based data for assessing the effectiveness of real-time (rt) or intermittently scanned (is) CGM sensors and comparing their burdens and benefits among patients of type 1 diabetes mellitus (T1DM) in our setup.

Method: A cross-sectional study with nonprobability convenience sampling was performed from July 2023-December 2023 on all the patients and parents of patients with TIDM, on insulin therapy enrolled with Meethi Zindagi. With ethical consent, a validated questionnaire was filled out by participants. Burdens and benefits of technology were assessed in isCGM and rtCGM users.

Results: Of the 53 participants, 34 were male and 19 female. A total of 41 were isCGM users, whereas 12 were using rtCGM. Levels of HbA1c were significantly lower in the rtCGM group (*p* value=0.015). As compared to the isCGM group, the percentage of rtCGM users having <7% HbA1c was more (84%) with a significant *p-value* of 0.005. Comparing CGM benefits in terms of item agreement, 100% of all rtCGM users agreed to easy "diabetes care" and "management of hypoglycemia". Regarding "less fingerpicks" and "feeling of security" majority (91.7%, 75%) of rtCGM users were in favor. The majority of the participants of both groups found CGM devices expensive; 28 out of 41 in the case of rtCGM and 8 out of 12 of isCGM users.

Conclusion: This analysis highlights the encouraging benefits of rtCGM for better glycemic outcomes in the population with T1DM. The data supports the significance of real-time sensors for easy care of diabetes and management of hypoglycemia, providing guidance to clinicians while discussing one-to-one care preferences with their patients. Support for making it more cost-effective, as well as working out to address specific hurdles are needed to grow technology.

Keywords: Continuous glucose monitoring, intermittently scanned CGM, real-time CGM, and type 1 diabetes mellitus.

Introduction

Prevalence of diabetes is continuously increasing globally; it is anticipated that by 2040 more than 700 million people will be suffering from this disorder.[1] by 2040, the number of prevalent cases is projected to rise to between 13.5 and 17.4 million, representing a 60% to 107% increase compared to 2021. The most significant relative growth is expected in low-income and lower-middle-income countries.[2] Recent data collected in Pakistan reported the incidence of T1DM 1.02 per 100,000 per year.[3]

The continuous glucose monitoring (CGM) system has taken an important place in the management of T1DM. This system is capable of replacing the disadvantages or problems faced by routinely used portable glucose meters along with test strips and lancets at home.[4] CGM technology is nearly replacing self-management of blood glucose (SMBG) in patients with diabetes taking insulin therapy. [5]

Abundant obtainable data is establishing the advantages of CGM in patients with diabetes, in terms of HbA1c reduction, less hypoglycemic events and diabetes-related stress with an overall improvement in life quality.[6] CGM systems come in the form of either real-time (rt) or intermittently scanned (is) CGM, both types are shown to have benefits.[6]

Around 1.5 million people are using isCGM worldwide[7], which transfers the data on a reader or smartphone by scanning the sensor manually. With this device, the user has to put extra effort into scanning the sensor by hand. More recent research highlights the positive effects of isCGM use in diabetes management by reducing hypoglycemia and improving long-term glucose control.[8]

In the case of rtCGM, data is automatically transmitted to a smartphone.[9] rt-CGM device supports patients and clinicians in identifying blood glucose trends, making it easier to modify diets, manage insulin doses, and drive the individual for physical activity.[10] Better control of glucose levels with rt CGM is seen as compared to isCGM.[9] Recent evidence proves the greater effectiveness of rtCGM compared to isCGM in reducing the time of hypoglycemia and increasing the time in range with improved HbA1c levels in patients with T1DM.[11] It helps in the easy management of T1DM with an increased sense of safety, however, operating the device has been found challenging.[6]

We have already determined the significant effect of the overall CGM devices on glycemic control in T1DM patients12. Thus there is a need to explore the experiences of different types of CGM technology among patients of T1DM for better diabetes care in our set-up. It will also help healthcare professionals (HCPs) to choose which type of CGM device can benefit their patients in diabetes management. For this purpose, the present study was designed to get evidence-based data through a validated questionnaire for assessing the effectiveness of isCGM and rtCGM and comparing their burdens and benefits.

Methodology

This research work was ratified by the Ethical Committee of the HITEC-Institute of Medical Sciences, Taxila. It was a cross-sectional study with nonprobability convenience sampling. All patients of T1DM of all age groups, enrolled with Meethi Zindagi (MZ), on insulin therapy, and using isCGM (Free Style Libre 1) or rtCGM devices were included in the study. HbA1c data was collected from patients using a Google Form. Individuals with any other type of diabetes were excluded. The total number of enrolled patients who met the inclusion criteria during the study period was 53. The usefulness and weaknesses of the CGM systems were evaluated using a validated questionnaire 13 via the MZ platform. The questionnaire depicts 8 items for benefits and burdens each. To rate each item, 1 describes strongly disagree, 2 disagree, 3 neutral, 4 agree and 5 strongly agree. A higher mean score shows the participant's agreement with the item. Parents were asked to fill out the questionnaire in case of patients less than 12 years of age. Data was collected in six months, from July - December 2023. The participants were divided into two groups; isCGM and rtCGM users.

Statistical analysis was done with SPSS software (version 25.0.0.2, 2018). For quantitative variables, mean and standard deviation (SD) and for categorical data, numbers and percentages were calculated. The chi-square and independent sample t-test were used for the comparison of variables in both groups. The association of variables was determined by the Spearmen correlation. P value ≤0.05 was considered statistically significant.

Results

Of the 53 participants, 34 were male and 19 were female. A total of 41 were isCGM users, whereas 12 were using rtCGM. Levels of HbA1c were significantly lower in the rtCGM group (p value=0.015), a significantly higher proportion of rtCGM users achieved HbA1c <7% (84%) compared to isCGM users (p = 0.005). Characteristics of participants including gender, age, duration of diabetes and physical activity between both group's isCGM and rtCGM were statistically the same. (Table 1).

Almost all participants agree with the benefits of CGM use. (Table 2A).

Comparing CGM benefits in terms of item agreement, 100% of rtCGM users agreed to easy "diabetes care" and "management of hypoglycemia" in contrast to the isCGM group where few were neutral. Regarding "fewer fingerpricks" and "feeling of security" in contrast to the isCGM group, majority (91.7%, 75%) of rtCGM users were in favor. (Table 2B).

When looking at the average scores for how participants perceived the burden of using CGM, most either agreed or disagreed with the statements. However, when it came to the cost of the device, most participants were either neutral or agreed. The average score was 3.68 ± 1.46 for isCGM users and 3.83 ± 1.47 for rtCGM users, with no significant difference between them (p = 0.75). Sensor technology was found equally burdensome due to both types' high cost. There was no statistically significant difference was noted between the two groups except item "painful to wear" showing 2.12 ±1.005 with isCGM while 1.42 ±0.90 with rtCGM (p = 0.03). Here difference was only evident between disagreed and strongly disagreed. (Table 3A).

When comparing burdens in terms of item agreement, majority of the participants of both groups found CGM device expensive; 28 out of 41 in case of rtCGM and 8 out of 12 of isCGM users. While analyzing the statement, "readings not trusted", majority of the isCGM users did not agree while few were neutral or agreed. In contrast, in rtCGM group equal number of participants were neutral or showed disagreement. Main stream of the participants of both groups opposed the statement that sensor was not helpful. (Table 3B).

Table 1—Baseline characteristics of participants

Variables	isCGM (n=41)	rtCGM (n=12)	P-value
Male; n (%)	29(71)	5(42)	0.09
Female; n (%)	12(29)	7(58)	
Age, years; median (IQR)	10(6.0 – 19.5)	13(9 – 34)	0.28
Duration of diabetes, years ; median (IQR)	4 (2-7)	4 (2 -17.75)	0.39
Physical activity; n (%)			
Mild	14(34)	4(33)	0.98
Moderate	21(51)	6(50)	
Strenuous	6(15)	2(17)	
HbA1c levels			
Mean±SD	7.28±0.80	6.63±0.73	0.015
HbA1c; n (%)			
<7%	13(32)	10(84)	0.005
7-8%	23(56)	01(8)	
>8%	05(12)	01(8)	

Table 2A—Benefits of CGM use: Mean Scores.

CGM Type	Diabetes care easier	*P*-value	Alarms are helpful	*P*-value	Less Finger-sticks	*P*-value	Helps with low blood sugar	*P*-value	Feel more secure	*P*-value	Family wants	*P*-value	Diabetes care better	*P*-value	Helps during exercise	*P*-value
isCGM (n=41)	4.34 ±0.62	0.97	3.39 ±1.05	0.59	4.05 ±0.97	0.50	4.24 ±0.58	0.974	4.02 ±.91	0.63	3.98 ±0.79	0.38	4.10 ±0.89	0.62	3.29 ±1.01	0.89
rtCGM (n=12)	4.33 ±0.49		3.58 ±1.17		4.25 ±0.62		4.25 ±0.45		4.17 ±.84		3.75 ±0.75		4.25 ±1.06		3.25 ±0.87	

Table 2B—Benefits of CGM Use: Item Agreement.

CGM Type	Frequency (%)	Diabetes care easier	Alarms are helpful	Less fingersticks	Helps with low blood sugar	Feel more secure	Family wants	Diabetes care better	Helps during exercise
isCGM (n=41)	Strongly agree	17(41.5)	9(22)	17(41.5)	13(31.7)	14(34.1)	12(29.3)	15(36.6)	7(17.1)
	Agree	21(51.2)	6(14.6)	12(29.3)	25(61.0)	17(41.5)	16(39)	18(43.9)	7(17.1)
	Neutral	3(7.3)	18(43.9)	9(22)	3(7.3)	7(17.1)	13(31.7)	5(12.2)	18(43.9)
	Disagree	0	8(19.5)	3(7.3)	0	3(7.3)	0	3(7.3)	9(22.0)
	Strongly disagree	0	0	0	0	0	0	0	0
rtCGM (n=12)	Strongly agree	4(33.3)	4(33.3)	4(33.3)	3(25)	5(41.7)	2(16.7)	7(58.3)	2(16.7)
	Agree	8(66.7)	1(8.3)	7(58.4)	9(75)	4(33.3)	5(41.7)	2(16.7)	0
	Neutral	0	5(41.7)	1(8.3)	0	3(25)	5(41.7)	2(16.7)	9(75)
	Disagree	0	2(16.7)	0	0	0	0	1(8.3)	1(8.3)
	Strongly disagree	0	0	0	0	0	0	0	0

Table 3A—Burdens of CGM Use: Mean Scores.

CGM Type	**Too costly**	*P*- value	**Painful to wear**	*P*- value	**Readings not trusted**	*P*- value	**Too much time to use**	*P*- value	**Not helpful**	*P*- value	**Cause worry**	*P*- value	**Embarrassed wearing**	*P*- value	**Hard to under-stand**	*P*- value
isCGM (n=41)	3.68 ±1.457	0.75	2.12 ±1.005	0.03	2.10 ±0.86	0.59	1.90 ±0.80	0.96	1.59 ±0.74	0.16	2.12 ±0.98	0.08	1.90 ±0.80	0.13	1.90 ±0.80	0.24
rtCGM (n=12)	3.83 ±1.47		1.42 ±0.90		2.25 ±0.87		1.92 ±1.08		1.25 ±0.62		1.58 ±0.67		1.50 ±0.79		1.58 ±0.90	

Table 3B—Burdens of CGM Use: Item Agreement

	Frequency (%)CGM	Too costly	Painful to wear	Readings not trusted	Too much time to use	Not helpful	Cause worry	Embarrassed wearing	Hard to understand
isCGM (n=41)	Strongly agree	16(39)	0	0	0	0Type	0	0	0
	Agree	12(29.3)	3(7.3)	3(7.3)	2(4.9)	0	4(9.8)	1(2.4)	1(2.5)
	Neutral	3(7.3)	14(34.1)	8(19.5)	5(12.2)	6(14.6	10(24.4)	8(19.5)	8(19.5)
	Disagree	4(9.8)	9(22)	20(48.8)	21(51.2)	12(29.3)	14(34.1)	18(43.9)	18(44)
	Strongly disagree	6(14.6)	15(36.6)	10(24.4)	13(31.7)	23(56.1)	13(31.7)	14(34.1)	14(34.1)
rtCGM (n=12)	Strongly agree	6(50)	0	0	0	0	0	0	0
	Agree	2(16.7)	1(8.3)	0	1(8.3)	0	0	0	1(8.4)
	Neutral	1(8.3)	0	6(50)	3(25.0)	1(8.3)	1(8.3)	2(16.6)	0
	Disagree	2(16.7)	2(16.7)	3(25)	2(16.7)	1(8.3)	5(41.7)	2(16.7)	4(33.3)
	Strongly disagree	1(8.3)	9(75)	3(25)	6(50.0)	10(83.3)	6(50)	8(66.7)	7(58.3)

Discussion

CGM technology has professed barriers or benefits conferring to the experiences of individuals with T1DM.[14] Choice of the CGM, recommended by The National Institute for Health and Care Excellence (NICE), is according to the individual's requirements and preferences, and the availability of the devices.[15] For that purpose, the present study explored the perceptions of CGM technology in T1DM patients of all age groups.

Demographically the larger study population was <13 years of age, had a higher female %age, better HbA1c, and longer duration of diabetes in individuals who were rtCGM users as compared to isCGM. Similar results were reported by Brown RE et.al.[16] Among isCGM users of our study, the majority were young adults parallel to findings of previous data; where 88% of the study population was younger individuals using isCGM sensors.[17]

Our major concern was comparing the impact of both devices on glycemic control. There was a noticeable difference in HbA1c levels in both the groups; <7% of HbA1c level was found in the majority of rtCGM users as compared to those wearing intermittently scanned sensors in parallel to a recent analysis that demonstrated the role of different types of devices in improving HbA1c and advocated the superiority of real-time sensors over isCGM.[9] Study states that the presence of an alert system and real-time readings of blood glucose levels are the reasons for better glycemic control with rtCGM[9] Another study on isCGM users showed that patients transitioned to rtCGM for better diabetes management and achieved improved outcomes with fewer low blood sugar episodes and more stable glucose levels.[11]

Our data validates the better life quality with the use of either technology, including all age groups. A survey, regardless of any specific age supports that sensor technology may improve quality of life, increase feelings of safety, and self-reliance in diabetes management and, stress-free everyday life.[18] A Dutch analysis of adults with T1DM using rtCGM highlights less anxiety with better physical and emotional health in these individuals.10 Youngsters describe easy insulin dose and diet management, upkeeping sports activities and diabetes care in school and outside, with the use of rtCGM.[19]

Increased risk of hypoglycemia especially at night is a common problem in the pediatric age group of T1DM patients.[11] Our users' satisfaction was almost equal with both devices; nearly all the participants agreed that CGM helps with low blood sugar. Conversely, Zhou Y et al illustrate more satisfaction with rtCGM and found it a safer choice for individuals facing nocturnal hypoglycemia.[20] Similarly another study shares the comparison of sensors in children and establishes a remarkable reduction of hypoglycemia in rtCGM users.[21] Although both systems are clinically acceptable, the real-time device is more promising than isCGM, however, the aptness of the systems depends on individuals' requirements and choices.[22]

The presence of alerts and continuous blood glucose data in rtCGM enables patients to timely address the low or high blood sugar, especially after meals and exercise, observing good glycemic control.[23] Moreover, keeping the blood sugar most of the time within range is also possible with this alarm system.[24] Real-time CGM was found superior over the first generation isCGM that lacks an alert system.[11] Contrariwise, sensor alarms may be bothersome for some individuals as experienced in our study. Likewise, previous data emphasizes alarm fatigue and distress in children and their families using CGM technology.[18] Alarm exhaustion with rtCGM needs to be addressed distinctly. The alarm feature is missing in isCGM (Free Style Libre 1) used in this study. The new FreeStyle Libre 2 system is more accurate and efficient with an alert system for better glycemic control.[25] We were not able to figure out the number of patients using either version of isCGMs. This may be the reason for neutral results with the statement, "alarms are helpful".

Concerned families and parents of T1DM children when involved in diabetes care may find it a hefty burden. Our participants who wore a device when "family wants" supported to reduce caregivers' burnout. Families recount the benefits of CGM for easy diabetes management, reduced worries about hypoglycemia and generalized emotional well-being in individuals with T1DM.[26]

Regarding exercise management with CGM, users of both devices yielded similar answers; the majority were neutral. However, 22% of isCGM users did not agree with the statement. Contrasting experiences of rtCGM users were described, finding the device helpful in correcting upcoming hypoglycemia during exercise,[23] recommending rtCGM use in young patients involved in regular workouts. A lack of awareness about the device may be the reason for our neutral results.

Data exploring the adoption of digital health technology (DHT) including CGM among diabetic patients in Pakistan showed that gender differences, varied education and income levels highlight how socioeconomic factors affect its implementation. Sixty percent cited cost as the primary issue. However, 97% expressed willingness to adopt DHT, indicating strong growth potential if affordability

was addressed. Cultural resistance was low, but lack of government support remained a significant challenge for widespread adoption.[27]

A small percentage of our study participants showed some other undesirable effects of both devices including wear-related concerns, life incursions, mistrust of readings, and idealistic anticipations. Such types of problems described as psychosocial impediments associated with diabetes technology were also seen in the adult population of diabetes.18 CGM is certainly the impending technology in management of T1DM. It is approaching to have enhanced glucose control and reduced burden of care in these patients,[23] making a U-turn in diabetes care with a healthier quality of life.[13] Increased facilitation to make the best use of different kinds of CGM sensors and to curtail their related problems is also needed. Trained clinicians can make appropriate patient selections based on individual needs and preferences to achieve maximum benefit from this technology.[23]

Real time CGM is found superior to isCGM mainly because it provides continuous real-time glucose data with alerts for high or low levels, allowing users to take immediate action and maintain better glycemic control. Users who actively respond to these alerts tend to achieve improved outcomes. However, in low-resource settings, the high cost, limited availability, lack of trained healthcare support, and socioeconomic factors pose significant barriers to rtCGM adoption. Overcoming these challenges through subsidies, education, and improved healthcare infrastructure is essential to make this technology accessible and effective for all patients.

Limitations: The major limitation was the small sample size which may be insufficient to draw inferences for some quantitative assessments.

Conclusion

This analysis highlights the encouraging benefits of rtCGM for better glycemic outcomes in the population with T1DM. The data supports the significance of real-time sensors for easy care of diabetes and the management of hypoglycemia. These findings provide substantial guidance to clinicians while discussing one-to-one care preferences with their patients. Support for making it more cost-effective and insurance coverage, as well as working out to address specific hurdles are needed to grow CGM technology.

Recommendations:

- A multicenter large-scale study should be conducted
- Regional education and support in multiple languages/formats should be offered to understand the CGM use.
- Training programs should be conducted to improve digital skills and guide CGM usage.
- User-friendly tools should be developed to ease CGM usage.
- Feedback mechanisms should be set up (surveys, focus groups, user reviews) for ongoing input.

CONFLICT Of INTEREST: None.

GRANT SUPPORT AND FINANCIAL DISCLOSURE: None.

References:

1. IDF Diabetes Atlas, 10th ed. Brussels: International Diabetes Federation; 2021. ISBN-13: 978-2-930229-98-0 NCBI
2. Gregory GA, Robinson TIG, Linklater SE, Wang F, Colagiuri S, de Beaufort C, Donaghue KC; International Diabetes Federation Diabetes Atlas Type l Diabetes in Adults Special Interest Group; Magliano DJ, Maniam J, Orchard TJ, Rai P, Ogle GD. Global incidence, prevalence, and mortality of type 1 diabetes in 2021 with projection to 2040: a modelling study. Lancet Diabetes Endocrinol.2022;10(10):741–760. doi: 10.1016/S2213-8587(22)00218-2. PubMedespeyearbook.org
3. Ahmedani MY, Fawwad A, Shaheen F, Tahir B, Waris N, Basit A. Optimized health care for subjects with type 1 diabetes in a resource-constrained society: a three-year follow-up study from Pakistan. World JDiabetes.2019; 10(3):224–233. doi:10.4239/wjd.v10.i3.224.
4. Tauschmann M, Forlenza G, Hood K, Cardona-Hernandez R, Giani E, Hendrieckx C, et al. ISPAD Clinical Practice Consensus

Guidelines 2022: Diabetes technologies: Glucose monitoring. Pediatr Diabetes. 2022 ;23(8):1390–1405. doi: 10.1111/pedi.13451. ncbi.nlm.nih.govscholarworks.indianapolis. iu.edu

5. Garg SK. Past, present, and future of continuous glucose monitors. Diabetes Technol Ther. 2023;25(S3):S-1–S-4. doi:10.1089/dia.2023.0041. Europe PMCLiebert Publishing
6. Messer LH, Cook PF, Lowe NK, Hood KK, Driscoll KA, Hernandez TL. Predicting optimal use of continuous glucose monitors in adolescents with type 1 diabetes: It's about benefit and burden. J Pediatr Nurs. 2022;62:23–29. doi: 10.1016/j.pedn.2021.12.005. PubMed
7. Winterdijk P, Aanstoot HJ, Nefs G. The impact of real-time sensor technology on quality of life for adults with type 1 diabetes: A Dutch national survey. Diabetes Res Clin Pract. 2023;203:110886. doi:10.1016/j.diabres.2023.110886. Available from: https://pubmed.ncbi.nlm.nih.gov/37604282/
8. Steenhuysen J. Abbott to hike production of lower-cost glucose monitors as diabetes soars. Reuters. 2019 Jul 16. Available from: https://www.reuters.com/article/us-abbott-diabetes/abbott-to-hike-production-of-lower-cost-glucose-monitors-as-diabetes-soars-idUSKCN1UB0Z3. Accessed: Sep 11, 2019.
9. Lu J, Ying Z, Wang P, Fu M, Han C, Zhang M. Effects of continuous glucose monitoring on glycaemic control in type 2 diabetes: A systematic review and network meta-analysis of randomized controlled trials. Diabetes Obes Metab. 2024;26(1):362–372. doi:10.1111/dom.15328.
10. Overend L, Simpson E, Grimwood T. Qualitative analysis of patient responses to the ABCD FreeStyle Libre audit questionnaire. Practical Diabetes. 2019; 36(2):45–50. doi:10.1002/pdi.2213. Available from: https://insight.cumbria.ac.uk/id/eprint/4663/
11. Visser MM, Charleer S, Fieuws S, De Block C, Hilbrands R, Van Huffel L, Maes T, Vanhaverbeke G, Dirinck E, Myngheer N, Vercammen C, Nobels F, Keymeulen B, Mathieu C, Gillard P. Effect of switching from intermittently scanned to real-time continuous glucose monitoring in adults with type 1 diabetes: 24-month results from the randomised ALERTT1 trial. Lancet Diabetes Endocrinol. 2023; 11(2):96–108. doi:10.1016/S2213-8587(22)00352-7.
12. Zubair A, Israr S, Ali Z, et al. Use of continuous glucose monitoring sensors for type 1 diabetes management and its effect on glycemic control. Annals of PIMS - Shaheed Zulfiqar Ali Bhutto Medical University. 2024; 20(1):620-624
13. Messer LH, Cook PF, Tanenbaum ML, Hanes S, Driscoll KA, Hood KK. CGM benefits and burdens: two brief measures of continuous glucose monitoring. J Diabetes Sci Technol. 2019; 13(6):1135–1141. doi:10.1177/1932296819862898.
14. Divan V, Greenfield M, Morley CP, Weinstock RS. Perceived burdens and benefits associated with continuous glucose monitor use in type 1 diabetes across the lifespan. J Diabetes Sci Technol. 2022; 16(1):88–96. doi:10.1177/19322968211061376.
15. National Institute for Health and Care Excellence (NICE). Type 1 diabetes in adults: diagnosis and management. NICE guideline [NG17]. 2015 [updated 2022 Aug]. Available from: https://www.nice.org.uk/guidance/ng17. Accessed September 6, 2023.
16. Brown RE, Chu L, Norman GJ, Abitbol A. Real-world glycaemic outcomes in adult persons with type 1 diabetes using a real-time continuous glucose monitor compared to an intermittently scanned glucose monitor: a retrospective observational study from the Canadian LMC diabetes registry (REAL-CGM-T1D). Diabet Med. 2022; 39(11):e14937. doi:10.1111/dme.14937.
17. Rubelj K, Stipančić G, La Grasta Sabolić L, Požgaj Šepec M. Continuous glucose monitoring and type 1 diabetes mellitus control in child, adolescent and young adult population – arguments for its use and

effects. Acta Clin Croat. 2021; 60(4):609–615. doi:10.20471/acc.2021.60.04.14.
18. Polonsky WH. Psychosocial aspects of diabetes technology: adult perspective. Endocrinol Metab Clin North Am. 2020; 49(1):143–155. doi:10.1016/j.ecl.2019.10.006.
19. Sinisterra M, Hamburger S, Tully C, Hamburger E, Jaser S, Streisand R. Young children with type 1 diabetes: sleep, health-related quality of life, and continuous glucose monitor use. Diabetes Technol Ther. 2020 Aug 1; 22(8):639–642. doi:10.1089/dia.2019.0416.
20. Zhou Y, Sardana D, Kuroko S, Haszard JJ, de Block MI, Weng J, et al. Comparing the glycaemic outcomes between real-time continuous glucose monitoring (rt-CGM) and intermittently scanned continuous glucose monitoring (isCGM) among adults and children with type 1 diabetes: A systematic review and meta-analysis of randomized controlled trials. Diabet Med. 2024; 41(3):e15280. doi:10.1111/dme.15280.
21. Urakami T, Terada H, Yoshida K, Kuwabara R, Mine Y, Aoki M, et al. Comparison of the clinical effects of intermittently scanned and real-time continuous glucose monitoring in children and adolescents with type 1 diabetes: A retrospective cohort study. J Diabetes Investig. 2022; 13(10):1745–1752. doi:10.1111/jdi.13837.
22. Yeoh E, Png D, Khoo J, Chee YJ, Sharda P, Low S, et al. A head-to-head comparison between Guardian Connect and FreeStyle Libre systems and an evaluation of user acceptability of sensors in patients with type 1 diabetes. Diabetes Metab Res Rev. 2022; 38(7):e3560. doi:10.1002/dmrr.3560.
23. Soni A, Wright N, Agwu JC, Timmis A, Drew J, Kershaw M, et al. A practical approach to continuous glucose monitoring (rtCGM) and FreeStyle Libre systems (isCGM) in children and young people with Type 1 diabetes. Diabetes Res Clin Pract. 2022; 184:109196. doi:10.1016/j.diabres.2022.109196.
24. Hásková A, Radovnická L, Petruželková L, Parkin CG, Grunberger G, Horová E, et al. Real-time CGM is superior to flash glucose monitoring for glucose control in type 1 diabetes: the CORRIDA randomized controlled trial. Diabetes Care. 2020; 43(11):2744–2750. doi:10.2337/dc20-0831.
25. Al Hayek AA, Robert AA, Al Dawish MA. Effectiveness of the Freestyle Libre 2 flash glucose monitoring system on diabetes self-management practices and glycemic parameters among patients with type 1 diabetes using insulin pump. Diabetes Metab Syndr. 2021; 15(5):102265. doi:10.1016/j.dsx.2021.102265.
26. Polonsky WH, Fortmann AL. Impact of real-time CGM data sharing on quality of life in the caregivers of adults and children with type 1 diabetes. J Diabetes Sci Technol. 2020. doi:10.1177/1932296820978423.
27. Fayez M, Begum R, Khan L, Ahmad M, Ahmed W, Sana F. Bridging the digital divide: affordability and adoptability of health tech in Pakistan's evolving healthcare landscape. 2024. Available from: https://doi.org/10.21203/rs.3.rs-5138453/v1. [Preprint].

Authors Contribution:

Ali Zubair: Conceptualized the study, collected data, analyzed it, written the manuscript and proof read it, agree to be held accountable for all aspects of study.

Wajeeha Mah Jabeen: Conceptualized the study, analyzed the data, written the manuscript and proof read it, ; agree to be held accountable for all aspects of study.

Shahida Mushtaq: Conceptualized the study, collected data, analyzed it, written the manuscript and proof read it, ; agree to be held accountable for all aspects of study.

Sana Ajmal: Conceptualized the study, collected data, analyzed it, written the manuscript and proof read it, ; agree to be held accountable for all aspects of studying

Received for Publication: August 07, 2025
Accepted for Publication: September 12, 2025
IRB approval # HITEC-IRB-38-2023