Original Article

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Use of Continuous Glucose Monitoring Sensors for Type 1 Diabetes Management and its Effect on Glycemic Control

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ABSTRACT

Objectives: To determine the frequency of use of Continuous glucose monitoring (CGM) sensors in individuals with type 1 diabetes mellitus (T1DM). To compare the levels of glycosylated haemoglobin (HbA1c) between CGM users and non-users along with its association with demographics and other variables.

Methodology: In this cross-sectional study, data was collected through non-probability convenience sampling, from all patients with TIDM (from June 2023 to November 2023) enrolled with Meethi Zindagi. After ethical permission, self-structured proforma was filled by patients and parents of patients <12 years having T1DM, under insulin therapy. Participants were divided into Group 1 (CGM Users) and Group II (CGM non-users).

Results: Out of the total 84 participants, 63% were CGM users. Among CGM users, 60% were male and 59% were children up to 12 years of age. The levels of HbA1C in CGM users were significantly lower compared to non-users. HbA1C levels have a strong negative correlation with the duration of using CGM and the frequency of scanning.

Conclusion: Our data offers initial proof that CGM could serve as an effective instrument across patients of T1DM, to give better glycemic control. The more frequently the CGM sensor is scanned by the user better be glycemic outcomes. The promising role of CGM use for a longer duration helps in effective diabetes management.

Keywords: Blood glucose, continuous glucose monitoring, glycated haemoglobin, self-monitoring of blood glucose, type 1 diabetes mellitus.

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Introduction

Diabetes mellitus (DM) is a physiological and metabolic disorder affecting millions of individuals worldwide, contributing significantly to global mortality and imposing a substantial financial burden. The incidence of DM is increasing alarmingly, and regular glucose monitoring is critical to manage this disease.[1,2] Having high blood glucose (BG) levels in DM can lead to serious illnesses like heart problems, retinopathy, and kidney failure, which can eventually be fatal.[3] Long-term problems of DM can be avoided by regular checking of BG levels. Better control of BG levels could lead to better health outcomes and prevent disease complications. [4,5]

Currently, Self-monitoring of blood glucose (SMBG) is done by an invasive method using glucometers.[6] An alternative method for diabetes management is the emerging Continuous glucose monitoring (CGM) system.[7] CGMs have overcome the limitations of SMBG and revolutionized diabetes management, especially for people with type 1 diabetes mellitus (T1DM).[8] Recent studies show that there is a significant reduction in glycated haemoglobin levels with regular use of CGM.[9] This newer technology gives us a better understanding of real-time changes in BG levels. [10] CGM data can be more helpful than SMBG because it shows patterns and changes in glucose levels. [1] Low blood glucose levels without symptoms might go undetected by SMBG. In contrast, CGM provides continuous blood glucose data for 24 hours, enabling the monitoring of low glucose levels during the night and early morning.[11]

Researchers have also studied how CGM can impact patients of different age groups, exploring both the advantages and disadvantages.[9] K. Rubelj et al. in 2021 established that CGM is effective in attaining better control of diabetes by improving HbA1C levels in a population of children, teenagers and young adults living with T1DM. [12]

Our local population has a big gap between the use and awareness of these technologies. A study at Agha Khan University in Karachi, Pakistan, described the difficulties in using technology to manage DM in both young people and adults;[13] the research was done with a small group of people who used CGM sensors. They found that many diabetic patients were unaware of wearable diabetes technology. There is limited information on how adults, children, and caregivers in Pakistan use sensor-based technology to manage T1DM. Detailed insights into their experiences with this technology are lacking.

To improve DM management, new non-invasive blood sugar monitoring technologies should be developed. Therefore, it necessitates awareness of continuous glucose monitoring (CGM) and examining its impact on local glycemic control in our population.

This study was planned to determine the frequency of CGM use in the Pakistani population with T1DM. Levels of HbA1c were also compared between CGM users and non-users and the association of HbA1c levels was assessed with variables including duration of using CGM and frequency of scanning in CGM users.

Methodology

It was a cross-sectional study. After ethical permission data was collected through non-probability convenience sampling from all patients with TIDM enrolled with Meethi Zindagi (MZ); a people-centric organization that recognizes people with diabetes throughout Pakistan. After taking the written informed consent, self-structured proforma was filled by patients and parents of patients <12 years having T1DM, under insulin therapy from all over Pakistan. Individuals with type II diabetes and other types of diabetes were excluded from this study. The study was conducted for six months (From June 2023 to November 2023). After data collection, participants were divided into 2 groups; Group 1 (CGM Users) and Group II (CGM non-users) to calculate the frequency of CGM use.

Statistical analysis was performed using SPSS software (version 25.0.0.2, 2018). Mean, and standard deviation (SD) were calculated for quantitative variables and numbers and percentages for categorical data. The chi-square and independent sample t-test were used to compare the variables in case and control groups. Spearmen correlation was applied to determine the association of variables.

Results

Out of the total 84 participants, 60% were male. Table I shows the baseline demographic and clinical information of participants. There was no statistically significant difference regarding gender, age, marital status, duration of diabetes, impact of physical activity and duration of last HbA1C test for CGM users and non-users.

Most responders (63%) were CGM users. Among CGM users, the majority (60%) of respondents were male (60%) and were children up to 12 years of age (59%).

Most of the CGM users (57%) had been diagnosed with diabetes for more than three years and the majority of them were engaged in mild and moderate physical activity (79%).

Most CGM users (58%), check their HbA1C levels more than 3 months before. The levels of HbA1C in CGM users were significantly lower compared to non-users. Maximum CGM users (89%) have an HbA1C of not more than 8%.

In CGM users, the duration of CGM use and frequency of scanning was 24 (12-36) months and 18 (15-40) times per day respectively. There was no significant association of HbA1C levels found with age and duration of diabetes. HbA1C levels have a strong negative correlation with the duration of using CGM and the frequency of scanning (Table II)

Table I: Demographic and Clinical Characteristics of Participants.

Variables	Total n*=84	CGM users n=53	CGM non-users n=31	p-value
Gender; n (%)				
Male	50(60)	34(64)	16(52)	0.357
Female	34(40)	19(36)	15(48)	
Age (years); median (IQR)**	12(8.25-25.75)	11(7.5-25)	16(9-26)	0.265
Age (years); n (%)				
1-12	45(54)	31(59)	14(45)	0.123
13-18	11(13)	07(13)	04(13)	
>18	28(33)	15(28)	13(42)	
Marital status; n (%)				
Married	14(17)	8(15)	6(20)	0.763
Unmarried	70(83)	45(85)	25(81)	
Duration of diabetes (years); median (IQR)	4(2-7)	4(2-7)	4(2-7)	0.938
Duration of diabetes (years); n (%)				
<1	07(8)	05(9)	02(6)	0.755
>1-3	27(32)	18(34)	09(29)	
>3	50(60)	30(57)	20(65)	
Physical activity; n (%)				
Not-done	05(06)	03(06)	02(06)	0.678
Mild	26(31)	18(34)	08(26)	
Moderate	42(50)	24(45)	18(58)	
Strenuous	11(13)	08(15)	03(10)	
Duration of Last HbA1C tested; n (%)				
<3 months	35(42)	22(41)	13(42)	0.219
>3 months	20(24)	16(30)	04(13)	
>6 months	24(29)	13(24)	11(35)	
>1 year	05(06)	2(04)	03(10)	
Last HbA1C levels (%); mean±SD	7.39±1.22	7.13±0.82	7.85±1.61	0.008
Group of last HbA1C levels (%); n (%)				
≤7%	31(37)	25(47)	08(26)	0.034
7-8%	37(44)	22(42)	13(42)	
>8%	16(19)	06(11)	10(32)	

Discussion

Diabetes requires 24/7 management, which mainly consists of diet, physical exercise and drug/insulin therapy.[14] Almost all these activities, especially the dosing of insulin, rely on the capability of correctly measuring the blood glucose levels by using suitable technology. In 2020, the Standards of Care: American Diabetes Association (ADA) stated that CGM is the preferred method for glucose monitoring.[15] The benefits of using CGM are observed with consistent adherence and ongoing use among youth with insulin-dependent T1DM.[16]

Table II: Association of HbA1C levels with demographic & other variables in CGM users.

Variables	HbA1C ≤7% n=25 n (%)	HbA1C 7-8%% n=22 n (%)	HbA1C >8% n=06 n (%)	p-value
Gender				
Male	17(68)	12(55)	05(83)	0.367
Female	08(32)	10(45)	01(17)	
Age				
1-12	12(48)	13(59)	6(100)	0.192
13-18	05(20)	02(09)	0(0)	
>18	08(32)	07(32)	0(0)	
Marital status				
Married	05(20)	03(14)	0(0)	0.456
Unmarried	20(80)	19(86)	06(100)	
Duration of diabetes (years)				
I	01(04)	01(4.5)	02(33.3)	0.082
>1-3	07(28)	10(45.5)	02(33.3)	
>3	17(68)	11(50)	02(33.3)	
Status of Physical Activity				
Not-done	02(08)	01(4.5)	0(0)	0.073
Mild	06(24)	11(50)	01(17)	
oderate	15(60)	07(32)	02(33)	
Strenuous	02(08)	03(14)	03(50)	
Duration of using CGM (years)				
0-1	06(24)	10(45.5)	06(100)	0.007
1-3	11(44)	10(45.5)	0(0)	
>3	08(32)	02(09)	0(0)	
Frequency of scanning/day;n(%)				
≤12	0(0)	07(32)	05(83)	0.001
>12	25(100)	15(68)	01(17)	

The primary focus of this study was to determine how often CGMs are used. In our study, 63% of participants reported using sensor-based CGM data. Male respondents made up the majority of CGM users (64%). These results are in parallel with Cho et al. who stated that the majority of CGM users were male. [17]

Table III: Correlation of HbA1C levels in CGM users. (n=53)

Variables	r-value	p-value
Duration of using CGM (years)	-0.557	0.001
Frequency of Scanning	-0.734	0.001

Children till age 12 made up the largest percentage (59%) of CGM users. These results supported that CGM may address unique challenges of T1DM in children and increase parental comfort with diabetes management, yet there are multiple hurdles in initiating or maintaining CGM use as described in recent studies[17, 18.] According to recent research in China, CGM was found useful in children (1-4 years of age) with T1DM and was recommended for good glycemic control. [19]. This is supported by the fact that parents and caregivers are more

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concerned about their children's health and are ready to adopt new diabetes care systems.

Most of the CGM users (57%) had been diagnosed with diabetes for more than three years and the majority of them were involved in mild and moderate physical activity (79%). The use of CGM might support the pattern to maintain blood glucose levels during exercise and they could continue moderate physical activity over the years. Similar results are described by a study on cyclists that concludes the effective role of CGM for riders to get real-time data used for blood glucose adjustments .[20]

CGM users had significantly better levels of HbA1C compared to non-users. The benefit was shown across all age groups with low HbA1C in CGM users as compared to non-users. These results are similar to those presented in previous research. [21]

Another significant finding of current data was a negative correlation of HbA1C levels with increased frequency of sensor scanning per day. We found that >12 times of scanning per day was associated with better glycemic control. The same is reported in recent studies that put forward that better HbA1C can be accomplished by regular scanning of CGM. [1, 11] With frequent scanning, a real-time picture of blood sugar levels can be achieved. [22] The trend arrows analysis can predict upcoming hypo or hyperglycemic events to be addressed timely. [23]

HbA1C levels have also a strong negative correlation with the extent of using CGM; the longer the patients used the device, the lower was their HbA1C. Encouraging effects of long-term use of CGM are supported by Lind M et al. in terms of general well-being, treatment gratification, and persistent lowering of HbA1C.[24] They explored an independent beneficial outcome of CGM on glycemic control in individuals with T1D and explained the various reasons. Real-time guidance regarding current glucose levels, helping in dosing insulin, glucose level reactions to various food items, and CGM alarm systems are a few of them. [24]

Conclusion

Our data offers initial proof that CGM could serve as an effective instrument for patients with type 1 diabetes, possessing the potential to give better glycemic control. The more frequently the CGM sensor is scanned by the user, the better glycemic outcomes. The promising role of CGM use for a longer duration helps in effective diabetes management.

Recommendations: Extended exploration of patients 'experiences with the use of Continuous Glucose Monitoring (CGM)' are necessary. It may help to spread awareness and more the uptake of CGM devices in clinical practice.

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