Internet of Medical Things (IoMT)-Enabled Glucometer-Based Digital Health Framework for Enhancing Self-Monitoring Practices Among Elderly Diabetic Patients in Chennai

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Abstract

Introduction: IoMT enables real-time monitoring of patients using devices such as wearable sensors, smart glucometers, heart rate monitors, and automated insulin pumps. Recent advancements in healthcare technology have enabled the development of smarter and more efficient diabetes management systems. This study explores the IoMT-based framework that supports digital integration of self-monitoring blood glucose (SMBG) for effective diabetes care among elderly patients. **Methods:** A multi-stage stratified cluster sampling technique was employed. Selected hospitals were chosen through random sampling, and eligible elderly diabetic patients were subsequently recruited from these facilities using simple random sampling through inclusion and exclusion criteria. A total of 117 participants were selected. Interview schedule covered Socio-demographic factors, clinical factors, and knowledge and practice of smart glucometer. Data was entered using SPSS version 27.0. **Results:** Concerning the impact of SMBG on quality of life, the vast majority of participants (95.73%) stated that SMBG had improved their quality of life and notably, none of the participants reported that SMBG had reduced their quality of life. **Conclusion:** Regular monitoring of blood glucose, medication adherence, diet, and physical activity contributes to better glycemic control. Enhancing diabetes education, family support, and access to affordable monitoring tools can significantly improve self-care outcomes and quality of life.
Keywords: IoMT, Glucometer, self-monitoring, Diabetic patient, SDG-3, SDG-5.

Introduction

The Internet of Medical Things (IoMT) is a network of connected medical devices and healthcare applications that collect, transmit, and analyze patient health data through the internet. IoMT enables real-time monitoring of patients using devices such as wearable sensors, smart glucometers, heart rate monitors, and automated insulin pumps (1). Healthcare providers can remotely access patient data, allowing faster diagnosis, timely interventions, and improved management of chronic diseases (2). By automating data collection and communication, IoMT reduces manual errors, enhances patient safety, and supports personalized treatment plans. IoMT improves the overall quality of healthcare by increasing accessibility, reducing hospital visits, and enabling continuous monitoring of patients both at home and in clinical settings.

Diabetes mellitus is one of the most prevalent chronic diseases worldwide, requiring continuous monitoring and effective management of blood glucose levels to prevent complications. Traditional diabetes care often relies on manual blood glucose measurements and insulin administration, which can be time-consuming and prone to human error (3). Recent advancements in healthcare technology have enabled the development of smarter and more efficient diabetes management systems (4). IoMT has emerged as a transformative technology that connects medical devices, sensors, and healthcare platforms through the internet, facilitating real-time data collection, analysis, and communication. An IoMT-based framework for glucometer-assisted self-monitoring offers significant benefits for elderly diabetic patients. The framework continuously tracks blood glucose levels, transmits data to healthcare providers, and supports intelligent insulin administration, thereby reducing the burden of manual intervention (5). By enhancing accuracy, improving patient compliance, and enabling real-time decision-making, IoMT-driven diabetes management systems have the potential to improve clinical outcomes and quality of life for elderly diabetic patients (6). This study explores the IoMT-based framework that supports digital integration of self-monitoring for effective diabetes care among elderly patients.

Related studies

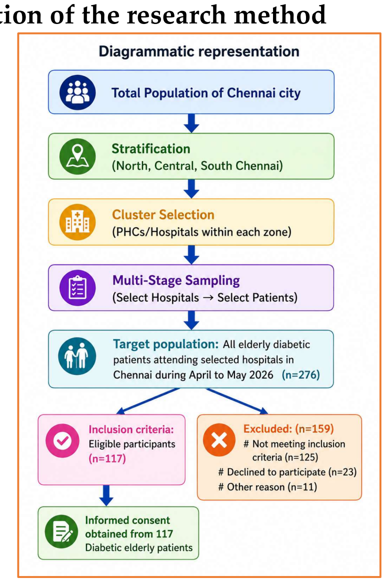
Makroum et al. (2022) conducted a systematic review of machine learning and smart devices for diabetes management. The authors found that artificial intelligence, wearable sensors, and connected medical devices enable predictive analytics and real-time monitoring, contributing to improved diabetes self-management and patient safety (7). Zafra-Tanaka et al. (2022) evaluated various technologies for diabetes self-monitoring and reported that continuous glucose monitoring systems provide accurate and continuous health data. The study emphasized the need for affordable and accessible monitoring solutions, especially in resource-constrained settings. The study concluded that glucose monitoring technologies represents a significant advancement toward data-driven and patient-centered diabetes care (8). Another study also highlights the comorbidity of diabetes such as osteoarthritis among elderly patients (9). Kesavadev et al. (2022) investigated a digitally supported self-monitoring of blood glucose (SMBG) program involving smartphone-connected glucometers and real-time counseling in a large cohort of patients with Type 2 diabetes in India (10). The study found significant reductions in fasting, pre-prandial, and post-prandial blood glucose levels following the intervention.

Park and Park (2024) conducted a randomized controlled trial among older adults with Type 2 diabetes to evaluate the effectiveness of a digital self-care intervention. The 12-week program incorporated mobile health technologies, self-monitoring tools, and health education modules. Results indicated improvements in self-management behaviors, medication adherence, and diabetes-related health outcomes. The study highlighted the potential of digital health frameworks in promoting independent disease management among elderly diabetic patients (11). Overweight and obesity have a significant impact on overall health-related quality of life, self-esteem, physical well-being, and emotional well-being of adolescents in particular (12). Kim et al. (2025) examined the impact of digital care coordination and remote monitoring systems that integrated connected glucometers, wearable devices, and health coaching. The study reported substantial improvements in diabetes outcomes and demonstrated that remote monitoring platforms can effectively support chronic disease management in community settings (13). The authors emphasized that

IoMT-based digital health ecosystems enable continuous patient monitoring, early detection of abnormalities, and personalized healthcare delivery.
Although substantial evidence exists regarding connected diabetes technologies, there is limited research evaluating fully integrated IoMT frameworks of glucometer-assisted self-monitoring, cloud-based data storage, and real-time clinical feedback systems, particularly in low- and middle-income countries such as India. This gap justifies the need for the proposed study.

Methods and materials

Technique: A multi-stage stratified cluster sampling technique was employed. Chennai city was stratified into North, Central, and South zones. Within each zone, healthcare facilities serving elderly diabetic patients were considered clusters. Selected hospitals were chosen through random sampling, and eligible elderly diabetic patients were subsequently recruited from these facilities using simple random sampling. Simple random sampling can be conducted after applying the inclusion and exclusion criteria.
Inclusion criteria of patients: above 60 years, diagnosed with Type 1 or Type 2 Diabetes Mellitus, able to use a glucometer, and willing to provide informed consent.
Exclusion criteria of patients: severe cognitive impairment, critically ill patients, and patients with severe visual or hearing disabilities preventing participation. Eligible elderly diabetic patients were identified according to the inclusion and exclusion criteria.
Sample size: A sampling frame comprising all eligible participants was prepared, and simple random sampling was used to recruit the required sample size, ensuring equal selection probability for all participants. A total of 117 participants met the inclusion criteria and were recruited for the study. Since the number of eligible participants was equal to the required sample size, all eligible participants were included using total enumeration, is a best method rather than random sampling. This avoids losing valuable data and increases the study's statistical power.
Figure 1. Diagrammatic representation of the research method



Note: Diagram compiled by author using AI tool.
Interview schedule: A cross-sectional study was conducted from April to May 2026. All eligible patients were interviewed face-to-face using interview schedule. It included (1) Socio-demographic factors: the patient's basic information, such as age, gender, marital status, education, employment status, family size and household income; (2) Clinical factors: self-reported health, body mass index (BMI), duration of

diagnosis, types of diabetes, comorbidities and usage of insulin injection; (3) Practice of SMBG level through smart glucometer and its outcome.

Dependent and independent variable: The dependent variable was the frequency of blood glucose monitoring of patients, and independent variables included socio-demographic characteristics, such as gender, age, marital status etc. Also included as independent variables were self-reported health (good, normal, poor), physical examination etc.

Statistical analysis: Data was entered into a computer using the Statistical Package for Social Sciences (SPSS) software version 27.0 (IBM) Data was described using frequencies and proportions wherever appropriate. A P value of 0.05 was considered to be statistically significant.

Ethical committee: The study protocol for this study involving human participants was approved by the Ethical Committee of Saveetha University, Chennai. The research was conducted after the informed consent of all participants was obtained.

Results

Table 1:Socio-demographic factors and Clinical factors of elderly diabetic patients (n=117)

Socio-demographic factors	n	%	Clinical factors	n	%
Age (Years)			**Self-reported health**		
61 to 70	35	29.91	Good	23	19.66
71 to 80	57	48.72	Normal	73	62.39
81 to 90	23	19.66	Poor	21	17.95
> 90	2	1.71	**Body Mass Index (BMI)**		
Gender			<18.5	0	0.00
Male	43	36.75	18.5 to 24.99	14	11.97
Female	74	63.25	25 to 28	93	79.49
Marital status			> 28	10	8.55
Single	7	5.98	**Duration of Diagnosis (Year)**		
Married	62	52.99	< 5	0	0.00
Widowed	48	41.03	5 to 10	11	9.40
Education			11 to 15	41	35.04
Illiterate	0	0.00	>15	65	55.56
Primary school	0	0.00	**Type of Diabetes**		
High school	52	44.44	Type I	33	28.21
Higher secondary	41	35.04	Type II	84	71.79
Degree & above	24	20.51	**Comorbidities**		
Employment			Yes	76	64.96
Unemployed	56	47.86	No	41	35.04
Employed	61	52.14	**Usage of Insulin Injection**		
Family size			Yes	37	31.62
< 3	2	1.71	No	80	68.38
3 to 5	108	92.31	**Frequency of SMBG level**		

Socio-demographic factors	n	%	Clinical factors	n	%
6 to 8	7	5.98	Every day	2	1.71
> 8	0	0.00	Weekly	27	23.08
Household income (per month- in Rs)			Monthly	50	42.73
< 50,000	3	2.56	Six months	20	17.09
50,000 to 1,00,000	98	83.76	Rarely	18	15.38
>1,00,000	16	13.67	Never	0	0.00

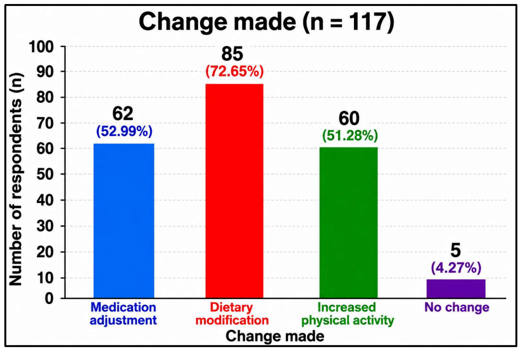
Table 1 stated that among the 117 elderly participants, nearly half (48.72%) were aged 71–80 years, females constituted the majority of the study population (63.25%), more than half of the participants were married (52.99%), most had completed high school (44.44%), 52.14% of the participants were employed, majority of participants (92.31%) belonged to families consisting of 3–5 members and 83.7% of participants had the household income between 50,000 to 1,00,000. Regarding the frequency of SMBG, the majority of participants (59.83%) reported monitoring their blood glucose levels monthly and none of the participants reported never performing SMBG. These findings indicate a population with chronic diabetes and a considerable burden of associated health conditions.

Table 2: Detail related self-monitoring blood glucose (SMBG) among elderly diabetic patients

Questions	n	%
To what extent do you feel capable of performing SMBG?		
Definitely capable	40	34.19
Rather capable	36	30.77
Difficult to assess	41	35.04
Rather incapable	0	0.00
Who recommended you to use a smart glucometer?		
Healthcare professional	61	52.14
Family members	19	16.24
Friends	14	11.97
No one (self-initiated)	23	19.66
What impact has SMBG had on your quality of life?		
Improved my quality of life	112	95.73
No change in my quality of life	2	1.71
Causes me some worry about my blood glucose readings	3	2.56
Reduced my quality of life	0	0.00

The table 2 presents information regarding the participants' perceived capability to perform SMBG, sources of recommendation for smart glucometer use, and the perceived impact of SMBG on quality of life. Concerning the impact of SMBG on quality of life, the vast majority of participants (95.73%) stated that SMBG had improved their quality of life and notably, none of the participants reported that SMBG had reduced their quality of life. Furthermore, highlighting its positive role in diabetes self-management among older adults.

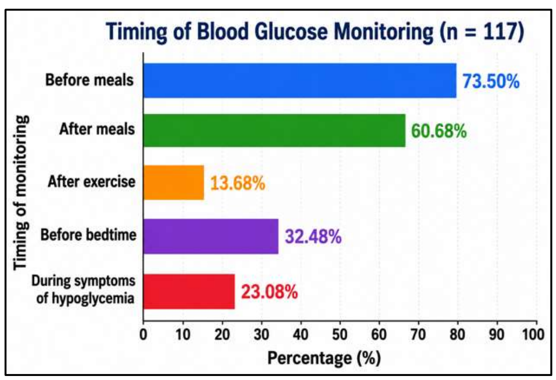
Figure 2. Changes made to reduce blood glucose levels based on glucometer readings



Note : *Multiple responses were allowed; therefore, percentages may exceed 100%.*

The findings of figure 2 indicate that the majority of participants used glucometer readings to make lifestyle and treatment-related modifications. Dietary modification was the most common change reported by participants (72.65%), suggesting that blood glucose monitoring encouraged individuals to pay greater attention to their food choices and dietary habits. These findings suggest that SMBG plays an important role in promoting self-management behaviors among individuals with diabetes.

Figure 3. Timing of blood glucose monitoring among participants (n = 117)



Note : *Multiple responses were allowed; therefore, percentages may exceed 100%.*

The figure 3 shows that participants monitored their blood glucose levels at various times throughout the day. The most commonly reported time for blood glucose testing was before meals (73.50%), followed by after meals (60.68%), reflecting participants' interest in assessing the impact of food intake on glycemic control. Overall, the findings indicate that participants predominantly used SMBG around meal times, which is consistent with recommended diabetes self-management practices and may help guide dietary and treatment decisions.

Table 3: Association Between Frequency of Self-Monitoring of Blood Glucose (SMBG) and Its Impact on Quality of Life (n = 117)

Frequency of SMBG	Improved QoL	No Change in QoL	Worried by Reading	Reduced QoL	p-value
Every day	2 (1.71)	0 (0.00)	0 (0.00)	0 (0.00)	<0.001
Weekly	26 (22.22)	1 (0.85)	0 (0.00)	0 (0.00)	
Monthly	61 (52.14)	8 (6.84)	1 (0.85)	0 (0.00)	
Rarely	7 (5.98)	10 (8.55)	1 (0.85)	0 (0.00)	
Never	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
Total	96 (82.05)	19 (16.24)	2 (1.71)	0 (0.00)	
Note: Table indicate n=117 (%)					

Chi-square test: $\chi^2 = 28.21$, df = 6, $p < 0.001$

Table 3 indicates the percentages were calculated using the total sample size (n = 117). Due to small cell frequencies and zero counts in some categories, the Chi-square test results should be interpreted with caution. A statistically significant association was observed between the frequency of SMBG and its perceived impact on quality of life ($p < 0.001$). Most participants reported that SMBG improved their quality of life (82.05%), particularly among those monitoring blood glucose weekly or monthly. These findings suggest that regular SMBG is positively associated with perceived improvements in quality of life among individuals with diabetes.

Discussion

A considerable proportion of elderly patients demonstrated inconsistent monitoring practices, which may negatively affect glycemic control and increase the risk of diabetes-related complications (14). These findings are consistent with previous research indicating that self-monitoring is a crucial component of diabetes management among older adults. A study by Shrivastava et al. (2013) emphasized that effective self-monitoring enhances patients' awareness of disease status and promotes timely behavioral modifications (15). Similarly, research by American Diabetes Association (2024) highlighted that regular self-monitoring of blood glucose improves treatment adherence and facilitates better glycemic outcomes, particularly among patients receiving insulin therapy (16).

The study also observed that educational status and family support positively influenced self-monitoring practices. Elderly individuals with higher health literacy were more likely to monitor their blood glucose regularly and follow recommended lifestyle modifications. This finding aligns with the work of Powers et al. (2020), who reported that diabetes self-management education significantly improves self-care behaviors and clinical outcomes (17). Furthermore, family involvement has been identified as an important determinant of successful diabetes management among older adults, especially in developing countries where family members often assist with medication administration and healthcare decision-making (18). Despite the recognized benefits of self-monitoring, barriers such as poor vision, reduced manual dexterity, financial constraints, forgetfulness, and limited access to monitoring devices were reported by some participants. Similar challenges have been documented by Sinclair et al. (2020), who noted that age-related physical and cognitive limitations can hinder effective self-management among elderly diabetic patients (19).

Conclusion

Overall, the findings underscore the need for targeted diabetes education programs, affordable monitoring technologies, and family-centered interventions to enhance self-monitoring practices among elderly diabetic patients. Strengthening these measures can contribute to improved glycemic control, reduced complications, and a better quality of life in the aging diabetic population (20). The study concludes that self-monitoring practices play a vital role in effective diabetes management among elderly patients. Regular monitoring of blood glucose, medication adherence, diet, and physical activity contributes to better glycemic control. Enhancing diabetes education, family support, and access to affordable monitoring tools can significantly improve self-care outcomes and quality of life.

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