

## LITERATURE REVIEW

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# Family-Supported Telemedicine for Blood Glucose Monitoring in Patients with Type 2 Diabetes Mellitus: A Systematic Literature Review

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## ABSTRACT

**Background:** Type 2 diabetes mellitus (T2DM) is a chronic condition requiring continuous self-management and regular blood glucose monitoring. Family support and telemedicine may help overcome barriers to healthcare access and strengthen patients' ability to manage their condition.

**Methods:** A systematic literature review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. Literature was searched in Scopus, ScienceDirect, SINTA, and Google Scholar using combinations of keywords related to telemedicine, type 2 diabetes mellitus, family support, caregivers, telehealth, and digital health between 2021 and 2026.

**Results:** The search identified 21,450 records, and 15 studies met the eligibility criteria. Telemedicine interventions consistently improved self-management, treatment adherence, and remote glucose monitoring. Improvements in HbA1c and fasting blood glucose were reported in several studies, whereas others found no significant differences, indicating variable glycemic outcomes. Family involvement contributed to better treatment adherence, technology utilization, patient engagement, and sustained diabetes self-management, while digital literacy, technology access, intervention duration, and professional support also influenced intervention effectiveness.

**Conclusion:** Family-supported telemedicine has substantial potential to strengthen T2DM self-management and continuous glucose monitoring. Its clinical effectiveness is likely to be enhanced when digital interventions are integrated with family involvement, patient education, and professional healthcare support.

## 1 | Introduction

Type 2 diabetes mellitus (T2DM) is a major global public health problem that contributes substantially to morbidity, mortality, and healthcare expenditure. Diabetes-related complications, including cardiovascular disease, nephropathy, and neuropathy, can substantially reduce quality of life and increase the burden on individuals, families, and healthcare systems. Accordingly, optimal diabetes management, particularly through regular blood glucose monitoring, is essential

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for preventing complications and improving patient outcomes. [1] Although glycemic control is central to T2DM management, its achievement depends considerably on patients' ability to perform self-care. Self-care includes dietary management, physical activity, medication adherence, and regular blood glucose monitoring. However, successful self-care is influenced not only by individual factors but also by support from the immediate social environment, particularly the family. Family support has been associated with improved self-care activity and diabetes management among patients with T2DM. [2] Routine self-monitoring of blood glucose may nevertheless be constrained by limited access to healthcare services, reduced mobility, inconsistent monitoring practices, and comorbidities. These barriers can be particularly relevant among older adults and patients living in settings where healthcare access is limited. Restricted access to continuous care is an important challenge in achieving adequate glycemic control. [3]

Telemedicine has emerged as an increasingly relevant strategy for chronic disease management. Its use expanded substantially during the COVID-19 pandemic, when remote health monitoring became essential. In diabetes care, remote glucose monitoring and continuous glucose monitoring may improve glycemic management and patient satisfaction [4]. Evidence from systematic reviews and meta-analyses has also reported improvements in HbA1c, postprandial glucose, blood pressure, and diabetes self-management following telemedicine interventions. [5, 6] However, the effectiveness of telemedicine is not uniform. Some studies report meaningful clinical benefits, whereas others demonstrate stronger effects on behavioral outcomes than on short-term biochemical indicators. Digital literacy, access to devices, intervention duration, patient characteristics, and the availability of ongoing education and professional support may influence outcomes. Family involvement may therefore represent an important psychosocial component that can help patients use telemedicine consistently and translate digital monitoring into sustainable self-care behavior.

Therefore, this systematic literature review aimed to synthesize evidence regarding the role of telemedicine and family-supported digital health interventions in blood glucose monitoring and the management of patients with T2DM. The review specifically examined the effects of telemedicine on self-management, treatment adherence, remote monitoring, and glycemic outcomes, as well as factors influencing its effectiveness.

## **2 | Methods**

This review was conducted as a systematic literature review and was structured according to the main stages of evidence identification, screening, eligibility assessment, and inclusion. The reporting structure was aligned with the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to provide a transparent account of the literature selection process.

### **2.1 | Search Strategy and Information Sources**

Literature was searched in SINTA, Scopus, ScienceDirect, and Google Scholar. The search was initiated on 15 March 2026 using combinations of the following terms: “telemedicine” AND “type 2 diabetes mellitus” AND “healthcare” OR “telehealth in diabetes care” OR “digital health diabetes management”. The search focused on literature concerning the use of telemedicine and digital health in the management and monitoring of patients with T2DM.

### **2.2 | Eligibility Criteria**

Studies published between 2021 and 2026 in Indonesian or English were considered. Eligible publications addressed telemedicine, digital health, remote monitoring, self-management, treatment adherence, or glycemic control in patients with diabetes, particularly T2DM. The source review also considered research articles with accessible full-text information and relevance to the review topic. Articles that were not research articles, were unrelated to the topic, were available only as abstracts, or could not be accessed in full were excluded.

### **2.3 | Study Selection and Data Extraction**

The initial search yielded 21,450 records: 120 from SINTA, 2,430 from Scopus, 3,200 from ScienceDirect, and 15,700 from Google Scholar. After initial filtering based on publication period, full-text availability, open access, and open archive status, 6,610 records remained for further screening. Additional screening excluded records that were not research articles, were not relevant to the topic, lacked full-paper availability, were available only as abstracts, or were not

retrievable. Forty-five articles were assessed for eligibility, and 30 were excluded during the final evaluation, resulting in 15 studies included in the synthesis.

## 2.4 | Data Synthesis

Data were synthesized narratively. Extracted information included study title, author and year, objective, design, population or sample, principal findings, and factors influencing intervention effectiveness. Because the included studies varied in design, intervention characteristics, populations, and outcomes, a narrative synthesis was considered appropriate.

## 3 | Results

### 3.1 | Study Selection

The literature search identified 21,450 records. Following filtering and screening, 6,610 records remained for further review. Subsequent assessment of study type, relevance, full-text availability, and retrievability resulted in 45 articles assessed for eligibility. Thirty articles were excluded during the final assessment, and 15 studies were included in the final synthesis.

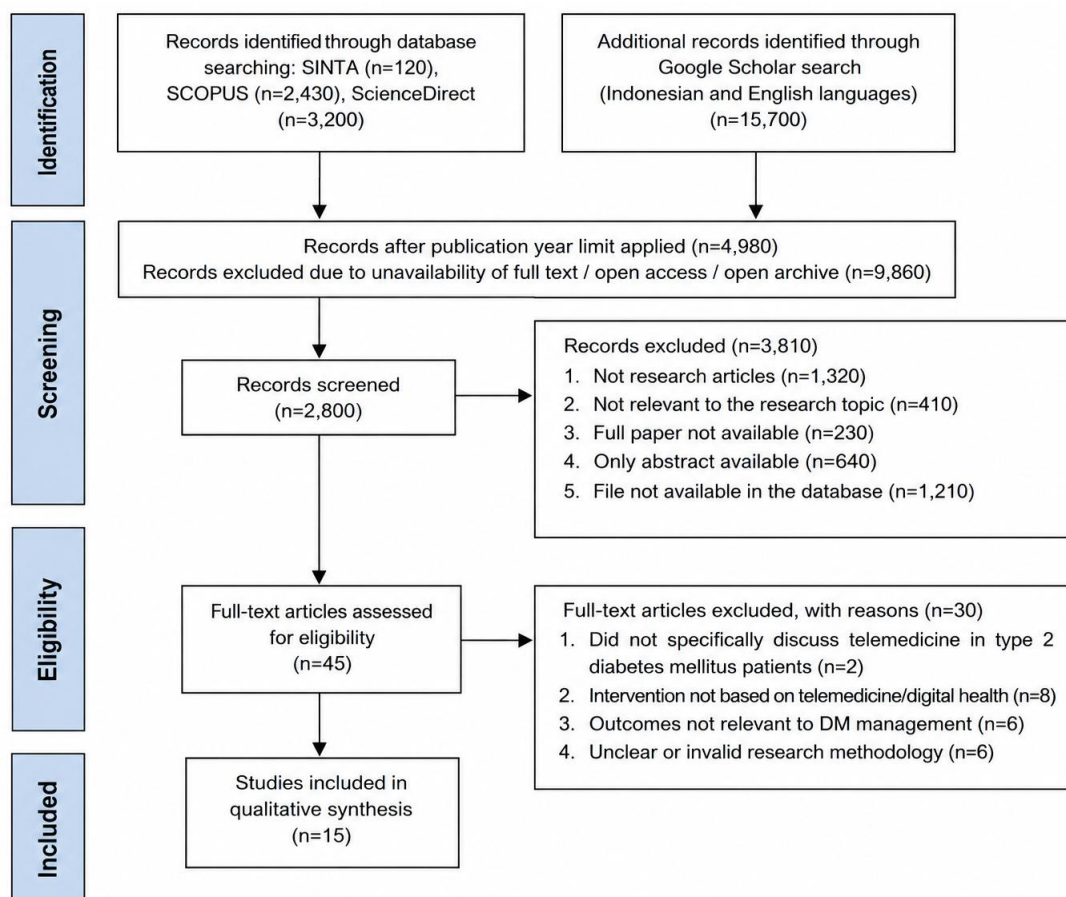


**FIGURE 1** | PRISMA-style study selection flow based on the reported search and screening process.

### 3.2 | Characteristics of Included Studies

The 15 included studies represented a range of designs, including randomized controlled trials, quasi-experimental studies, cross-sectional studies, retrospective cohorts, observational studies, research and development studies, and an evidence-based case report present on Figure 1. The interventions included continuous glucose monitoring, mobile health applications, Android-based self-care platforms, telemedicine-assisted self-monitoring of blood glucose, hybrid care, and

remote monitoring. The studies generally examined behavioral outcomes, including self-management and adherence, as well as clinical outcomes such as HbA1c, fasting blood glucose, time in range, and hypoglycemia risk.

### **3.3 | Characteristics of Included Studies**

Three major patterns emerged from the synthesis. First, telemedicine and digital health interventions consistently supported behavioral aspects of diabetes management. Several studies reported improvements in self-management, treatment adherence, self-efficacy, diet, physical activity, foot care, and independent glucose monitoring. [1, 7, 8, 9]

Second, clinical effects were positive in several studies but were not entirely consistent. Continuous glucose monitoring and telemedicine-assisted structured self-monitoring were associated with improved HbA1c and time in range in selected populations. [10, 11] Other interventions maintained stable glycemic control or demonstrated no significant short-term improvement in HbA1c or fasting blood glucose. [7, 12, 13, 14]

Third, intervention effectiveness was strongly influenced by contextual and psychosocial factors. Digital literacy, access to devices and internet connectivity, patient adherence, age, family support, professional education, intervention duration, and the usability of digital platforms shaped the benefits of telemedicine. These findings indicate that technology alone may be insufficient without supportive social and healthcare systems.

Family support emerged as a key psychosocial factor influencing the effectiveness of telemedicine interventions across the included studies. Family involvement contributed to improved treatment adherence, facilitated the use of digital technologies, encouraged regular blood glucose monitoring, supported lifestyle modification, and promoted sustained patient engagement in self-management. Studies by [8] and [15] identified family support as an important determinant of technology acceptance and continued telemedicine utilization. These findings suggest that integrating family participation into telemedicine programs may enhance both behavioral outcomes and long-term diabetes self-management.

## **4 | Results**

This review indicates that telemedicine is a promising approach for supporting the long-term management of T2DM, particularly in relation to self-management, treatment adherence, and remote glucose monitoring. Across the included studies, the most consistent benefits were observed in behavioral outcomes. Digital interventions provided reminders, education, monitoring tools, and opportunities for continued contact with healthcare providers, thereby supporting patients in performing daily self-care activities.

The findings also demonstrate that improvements in behavioral outcomes do not always translate immediately into significant biochemical improvements. Some studies showed improved self-management without significant changes in fasting glucose or HbA1c. [1, 7, 8] This may reflect the multifactorial nature of glycemic control, which is influenced by disease duration, medication use, comorbidities, diet, physical activity, adherence, and intervention duration. Therefore, telemedicine should not be viewed as a stand-alone replacement for comprehensive diabetes care.

Unlike several previous systematic reviews that primarily focused on technological effectiveness, this review highlights that family involvement acts as an enabling factor that bridges digital interventions with daily diabetes self-management. Family members contribute not only emotional encouragement but also practical assistance in monitoring blood glucose, reinforcing medication adherence, and facilitating technology use among older adults and individuals with limited digital literacy.

Conversely, several studies demonstrated clinically meaningful improvements. The Melpredia intervention significantly reduced HbA1c and improved self-management, while Android-based self-care management and telemedicine-assisted structured self-monitoring improved glycemic outcomes. [11, 31, 32] Continuous glucose monitoring also improved time in range and HbA1c in older adults treated with basal insulin. [10] These findings suggest that interventions combining monitoring, education, feedback, and structured follow-up may be more effective than technology-based monitoring alone.

**TABLE 1** | Summary of the 15 included studies and their principal findings.

| No | Title                                                                                                                                        | Author                | Year | Objective                                                                                                                    | Design                                                      | Subject                                                                                                     | Result                                                                                                                                                                                                         | Factor                                                                                                 |
|----|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
| 1. | Continuous Glucose Monitoring Use in Rural Area: An Evidence-Based Case Report                                                               | Pramudito et al. [16] | 2025 | To determine the effectiveness of CGM in monitoring blood glucose levels in patients with diabetes mellitus in remote areas. | Evidence-based case report                                  | One 24-year-old female patient with type 2 diabetes mellitus in rural Papua with limited healthcare access. | Telemedicine-based CGM enabled real-time monitoring and comprehensive assessment of glycemic variability, supported remote monitoring and treatment adjustment, but did not always significantly reduce HbA1c. | Therapy adherence, technology access, high CGM costs, and limited healthcare facilities.               |
| 2. | The Effect of mHealth Program on Behavior Modification and Health Outcomes among Patients with Diabetes: A Randomized Controlled Trial Study | Firdaus et al. [17]   | 2023 | To determine the effect of an mHealth program on behavior modification and health outcomes among patients with diabetes.     | Randomized controlled trial                                 | 58 patients with uncontrolled type 2 diabetes mellitus.                                                     | Improved self-management behaviors, including foot care and diet, but no significant reduction in fasting blood glucose.                                                                                       | Short intervention duration, comorbidities, medication use, and physiological complexity.              |
| 3  | Design and Development of the Diabestfriend Android Application for Type 2 Diabetes Self-Care Management                                     | Alkharis et al. [18]  | 2025 | To develop and evaluate the usability of the Diabesfriend Android application for type 2 diabetes self-care management.      | Research and development study                              | 22 patients for feature testing and 10 for user-experience evaluation.                                      | Supported real-time monitoring, engagement, and self-care adherence, but no significant HbA1c reduction was demonstrated.                                                                                      | Usability, feature completeness, digital literacy, technology access, and professional support.        |
| 4. | Penggunaan Aplikasi Le-Diabet dalam Pengelolaan Diabetes Melitus: Studi Kesiapan dengan Technology Acceptance Model                          | Erlina et al. [19]    | 2025 | To assess readiness and acceptance of the Le-Diabet application for diabetes management.                                     | Descriptive study using TAM                                 | 82 patients with diabetes mellitus.                                                                         | Potential to support self-management, treatment adherence, and independent glucose monitoring; direct clinical impact was not evaluated.                                                                       | Perceived usefulness and ease of use, technology attitudes, family support, digital literacy, and age. |
| 5. | The Effectiveness of Melpredia Prediabetes Self Management Education Based on Android Applications on HbA1c                                  | Hakim et al. [20]     | 2022 | To determine the effectiveness of the Melpredia Android application in improving self-                                       | R&D with quasi-experimental pretest-posttest control design | 30 participants with prediabetes.                                                                           | Significantly reduced HbA1c in the intervention group ( $p=0.001$ ) and improved self-management.                                                                                                              | Application features, adherence, digital literacy, professional support, and self-management.          |

| No  | Title                                                                                                                                                                                                      | Author                   | Year | Objective                                                                                                          | Design                                         | Subject                                                    | Result                                                                                                                              | Factor                                                                                                     |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------|--------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
|     | Levels in People with Prediabetes                                                                                                                                                                          |                          |      | management and HbA1c levels.                                                                                       |                                                |                                                            |                                                                                                                                     |                                                                                                            |
| 6.  | The Effect of Android-Based Self Care Management on Self Efficacy and Control of Fasting Blood Sugar Levels of People with Type 2 Diabetes Mellitus in the Working Area of the Tempel Sleman Health Center | Hapsari et al. [21]      | 2025 | To determine the effect of Android-based self-care management on self-efficacy and fasting blood glucose.          | Quasi-experimental randomized controlled trial | Patients with type 2 diabetes mellitus.                    | Improved self-efficacy and reduced fasting blood glucose compared with conventional methods.                                        | Patient adherence, technology access, education, physical activity, and digital self-management.           |
| 7.  | Telemedicine and Preventive Behaviors in Type 2 Diabetes: A Prolanis Study in Semarang, Indonesia                                                                                                          | Wulan et al. [22]        | 2026 | To examine the relationship between telemedicine use and preventive behaviors, including blood glucose monitoring. | Cross-sectional study                          | 157 Prolanis participants, including 100 older adults.     | No significant association between telemedicine use and preventive behavior or blood glucose monitoring ( $p>0.05$ ).               | Limited telemedicine knowledge, low digital literacy among older adults, and suboptimal technology use.    |
| 8.  | Diabetes Mellitus Patient Care: An Android-Based Application Development Model for "Telogorejo Diabetes Self Management Education"                                                                         | Tanujiarso & Kusuma [23] | 2025 | To develop an Android-based application for diabetes self-management education.                                    | R&D using the ADDIE model                      | 20 patients with type 2 diabetes mellitus.                 | High usability and efficiency; potential to improve self-efficacy and self-management through education, monitoring, and reminders. | Knowledge, medication adherence, self-management ability, technology use, and application-based education. |
| 9.  | Effectiveness of Continuous Glucose Monitoring in Older Adults with Type 2 Diabetes Treated with Basal Insulin                                                                                             | Bao et al. [24]          | 2022 | To evaluate the effectiveness of CGM in older adults with type 2 diabetes treated with basal insulin.              | Randomized controlled trial                    | 175 patients with type 2 diabetes, including older adults. | Improved HbA1c and time in range compared with conventional monitoring, with low hypoglycemia risk.                                 | Real-time glucose data and early detection of glucose changes.                                             |
| 10. | The Influence of Telemedicine on Diabetes Mellitus Control and Treatment Adherence in Riyadh Region                                                                                                        | Almalki et al. [25]      | 2023 | To examine the influence of telemedicine on diabetes control and treatment adherence.                              | Cross-sectional study                          | 583 patients with type 2 diabetes mellitus.                | Improved glycemic control, HbA1c target achievement, treatment adherence, and reduced complication risk.                            | Telemedicine utilization and treatment adherence.                                                          |

| No  | Title                                                                                                                           | Author                 | Year | Objective                                                                                                          | Design                                 | Subject                                               | Result                                                                                                           | Factor                                                                                             |
|-----|---------------------------------------------------------------------------------------------------------------------------------|------------------------|------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| 11. | Telemedicine-assisted Structured Self-Monitoring of Blood Glucose in Management of T2DM: Results of a Randomized Clinical Trial | Han et al. [26]        | 2023 | To evaluate the effectiveness of telemedicine-assisted structured SMBG in type 2 diabetes management.              | Open-label randomized clinical trial   | 418 patients with type 2 diabetes mellitus.           | Greater HbA1c reduction and lower hypoglycemia risk than conventional monitoring.                                | Improved self-management, continuous education, and real-time professional monitoring.             |
| 12. | Role of Telemedicine During COVID-19 Pandemic in Type 2 Diabetes Outpatients                                                    | Russo et al. [27]      | 2022 | To evaluate the role of telemedicine in maintaining diabetes care during the COVID-19 pandemic.                    | Observational cohort study             | 364,898 face-to-face and 46,424 telemedicine visits.  | Supported stable glycemic control despite reduced face-to-face visits.                                           | Monitoring frequency, healthcare quality, adherence, and diabetes management.                      |
| 13. | Hybrid vs In-person Diabetes Care: Outcomes and Barriers to Telemedicine Utilization                                            | Kongmalai et al. [28]  | 2026 | To compare glycemic outcomes between hybrid and in-person diabetes care and identify barriers to telemedicine use. | Cross-sectional and longitudinal study | 464 patients with diabetes mellitus.                  | Hybrid care maintained glycemic control comparable with face-to-face care without significant HbA1c differences. | Age, family support, insulin use, digital literacy, and technology access.                         |
| 14. | Impact of Telemedicine on Glycemic Control in Type 2 Diabetes Mellitus During COVID-19 Lockdown                                 | Al-Mutairi et al. [29] | 2023 | To assess the impact of telemedicine on glycemic control during the COVID-19 lockdown.                             | Retrospective cohort study             | 4,266 patients with type 2 diabetes mellitus.         | Most patients maintained or improved HbA1c, although the mean change was not statistically significant.          | Age, sex, hypertension history, treatment type, and lockdown conditions.                           |
| 15. | Telemedicine for the Management of Diabetic Patients in a High-Complexity Latin American Hospital                               | Casas et al. [30]      | 2023 | To describe telemedicine use and changes in HbA1c among patients with diabetes mellitus.                           | Retrospective cohort study             | 663 patients with type 1 or type 2 diabetes mellitus. | HbA1c remained stable between baseline and follow-up among patients receiving telemedicine follow-up.            | Follow-up duration, diabetes type, treatment adherence, self-monitoring, and lifestyle management. |

Family support is particularly relevant to psychosocial and family nursing practice. Family members may facilitate technology use, encourage adherence, provide emotional and instrumental support, and help patients maintain lifestyle changes. The role of the family may be especially important among older adults and patients with limited digital literacy. However, the included evidence also indicates that family support should be integrated with professional education and accessible technology rather than assumed to compensate for structural barriers.

Hybrid models may offer a practical balance between digital and face-to-face care. Evidence from hybrid care suggests that combining telemedicine with in-person services can maintain glycemic outcomes comparable to conventional care while potentially reducing the burden of frequent clinic visits. [15] This model may be particularly useful where digital access is available but patients still require periodic physical assessment and individualized clinical care.

For nursing practice, the findings support the development of family-centered telemedicine interventions. Nurses can assess digital literacy, educate patients and families about glucose monitoring, provide structured feedback, identify barriers to adherence, and coordinate with other healthcare professionals. In rural or underserved settings, telemedicine may be particularly valuable when combined with community-based support and family empowerment.

#### **4.1 | Limitations**

This review has several limitations. No formal quality assessment or risk-of-bias appraisal was performed. Future systematic reviews should incorporate standardized appraisal tools, such as the JBI Critical Appraisal Checklist or Cochrane Risk of Bias tool, to strengthen the quality of evidence. The included studies were heterogeneous in design, population, intervention type, and outcome measures, limiting direct comparison. The source review also reported difficulties accessing some articles because of paywalls and limited evidence specifically examining the integration of family support with telemedicine. In addition, the review relied on the information available in the source literature and did not conduct a quantitative meta-analysis. These limitations should be considered when interpreting the overall consistency of the evidence.

#### **5 | Conclusion**

Family-supported telemedicine has considerable potential to improve the management of patients with T2DM. Across the reviewed evidence, telemedicine and digital health interventions most consistently improved self-management, treatment adherence, and remote glucose monitoring, while effects on HbA1c and fasting blood glucose were variable. Clinical benefits appeared more likely when interventions incorporated structured education, continuous monitoring, feedback, and professional support.

Family involvement is an important psychosocial component that may strengthen adherence, facilitate technology use, and support sustainable lifestyle changes. Future research should examine family-centered telemedicine models using longer follow-up periods, standardized clinical outcomes, and explicit measures of family support, digital literacy, and patient engagement. In nursing practice, telemedicine should be integrated with family empowerment and professional care to maximize its contribution to glycemic control and quality of life.

#### ***CRedit Authorship Contribution Statement***

A.P.: Conceptualization, methodology, formal analysis, writing original draft, and writing review and editing. S.D., R.R.P.A., A.D.S., N.A.R.: literature searching, data extraction, analysis, manuscript review, and editing. D.R.H: formal analysis, writing review, editing. All authors approved the final manuscript.

#### ***Instruction for AI Assistance Declaration***

Generative AI tools were used solely for language enhancement, grammatical correction, academic English editing, and manuscript formatting. The authors remain fully responsible for the accuracy, interpretation, completeness, and scientific integrity of the manuscript.

### **Declaration of Interest**

The authors declare that there are no conflicts of interest.

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None

### **Data Availability**

None

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