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THE ROLE OF INNOVATIVE TELEMEDICINE TECHNOLOGIES IN DIABETES CARE: A NARRATIVE REVIEW OF METABOLIC, BEHAVIORAL, AND SOCIAL OUTCOMES

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ABSTRACT

Introduction: Diabetes mellitus remains a major public health challenge worldwide, requiring continuous monitoring, long-term treatment, and active patient participation. Recent advances in telemedicine, continuous glucose monitoring systems, mobile health applications, and artificial intelligence have created new opportunities for remote and personalized diabetes management.
Aim: This narrative review evaluated the impact of telemedicine and digital health technologies on metabolic control, treatment adherence, self-management behaviors, and psychosocial outcomes among adults with type 1 and type 2 diabetes mellitus.
Materials and Methods: A narrative review of the literature was conducted using keywords in the PubMed database. Recent studies involving adult patients with type 1 and type 2 diabetes were analyzed. Attention was paid to outcomes related to glycated hemoglobin (HbA1c), continuous glucose monitoring metrics, treatment adherence, patient engagement, self-management, and quality-of-life indicators.
Results: Most reviewed studies demonstrated that telemedicine interventions significantly improved glycemic control, particularly by reducing HbA1c levels. Digital care models incorporating continuous glucose monitoring increased Time in Range and reduced hyperglycemic exposure. Telemedicine was also associated with improved adherence to treatment recommendations, greater patient engagement, enhanced self-management competencies, and positive psychosocial outcomes, including improved quality of life and reduced diabetes-related distress. The greatest benefits were observed in patients with poor baseline metabolic control and in programs integrating remote monitoring with structured educational support.
Conclusions: Telemedicine represents an effective and innovative complement to conventional diabetes care. Digital health technologies facilitate personalized disease management, improve patient participation in therapeutic processes, and may contribute to more accessible and sustainable healthcare delivery.

KEYWORDS

Diabetes Mellitus, Telemedicine, Telemonitoring, Digital Health, Continuous Glucose Monitoring, Innovative Healthcare Technologies

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1. Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia and progressive microvascular and macrovascular complications (**Table 1).** The increasing prevalence of both type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM) represents a major challenge for healthcare systems worldwide, generating significant clinical, economic, and social burdens (Bhattacharya et al., 2026; Cogiel et al., 2025; Montero et al., 2021). Effective disease management requires continuous monitoring, individualized treatment, lifestyle modification, and active patient involvement.

Table 1. Common Comorbidities Associated with Diabetes Mellitus

Macrovascular comorbidities	**Microvascular comorbidities**	**Metabolic and systemic comorbidities**	**Psychological comorbidities**
Hypertension	Diabetic nephropathy	Obesity	Depression
Coronary artery disease	Diabetic retinopathy	Dyslipidemia	Anxiety
Heart failure	Diabetic neuropathy	NAFLD	
Peripheral arterial disease		Obstructive sleep apnea	
		Osteoporosis	

Overview of diabetes-related comorbidities grouped into macrovascular, microvascular, metabolic, systemic, and psychological categories; NAFLD – nonalcoholic fatty liver disease.

Conventional diabetes management relies on periodic clinical consultations and intermittent monitoring. However, this model often fails to provide timely therapeutic adjustments and continuous support, contributing to suboptimal glycemic control in many patients (Cogiel et al., 2025; Montero et al., 2021). The rapid digital transformation of healthcare, accelerated by the COVID-19 pandemic, has facilitated the widespread implementation of telemedicine and virtual care models (Bokolo Anthony Jnr., 2020).

Telemedicine encompasses a broad spectrum of technologies, including remote patient monitoring, continuous glucose monitoring (CGM), mobile health applications, cloud-based data-sharing platforms, and algorithm-supported decision systems (Bhattacharya et al., 2026; Cogiel et al., 2025). These technologies enable continuous disease monitoring, improve communication between patients and healthcare professionals, and support personalized diabetes management strategies (Bhattacharya et al., 2026; Mubeen et al., 2023).

Beyond clinical monitoring, digital health technologies may influence patient behavior, treatment adherence, self-management capacity, and healthcare accessibility. Consequently, telemedicine should be considered both a clinical intervention and a socio-technological innovation within contemporary healthcare systems (Bhattacharya et al., 2026; Cogiel et al., 2025).

2. Methodology

A narrative literature review was conducted using the PubMed database to identify studies evaluating telemedicine and digital health interventions in diabetes management. The search was performed in March 2026 and included articles published between January 2007 and February 2026. The initial search identified 229 records. After title and abstract screening, potentially relevant articles underwent full-text review. Ultimately, 34 studies met the eligibility criteria and were included in the narrative synthesis.

The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to diabetes and digital health technologies. Search terms included “diabetes mellitus”, “telemedicine”, “telemonitoring”, “continuous glucose monitoring”, “CGM”, “flash glucose monitoring”, “remote patient monitoring”, and *“Libre*”. Keywords were combined using Boolean operators (AND, OR) where appropriate.

Study selection was performed in two stages. First, titles and abstracts were screened to identify potentially relevant articles. Subsequently, full-text articles were assessed for eligibility according to predefined inclusion and exclusion criteria. Due to the substantial heterogeneity of intervention types, study designs, outcome measures, and patient populations, a narrative review methodology was considered more appropriate than a quantitative meta-analysis.

Studies were eligible for inclusion if they met the following criteria:

(1) Original research articles evaluating the use of telemedicine, telemonitoring, remote patient monitoring, virtual diabetes clinics, mobile health applications, or other digital health interventions in diabetes care;

(2) Studies involving adult patients with T1DM and/or T2DM;

(3) Randomized controlled trials (RCTs), prospective interventional studies, non-randomized interventional studies, or observational studies;

(4) Studies reporting clinical, metabolic, behavioral, patient-reported, or healthcare-related outcomes associated with telemedicine-based diabetes management;

(5) Full-text articles published in peer-reviewed journals;

(6) Publication available in English.

Studies were excluded from the primary results synthesis if they were review articles, systematic reviews, meta-analyses, case reports, editorials, commentaries, letters, conference abstracts, study protocols without reported clinical outcomes, economic evaluations, survey-based studies, or studies that did not report clinical outcomes in patients with diabetes, studies focusing on diseases other than diabetes mellitus, and non-English publications.

The following outcomes were extracted from the included studies:

- Glycemic control, including glycated hemoglobin (HbA1c);
- Continuous glucose monitoring metrics, including Time in Range (TIR), Time Above Range (TAR), Time Below Range (TBR);
- Cardiometabolic parameters, including body weight, body mass index (BMI), blood pressure, and lipid profile;
- Measures of treatment adherence and diabetes self-management;
- Patient-reported outcomes (PROs), including quality of life (QoL) and psychosocial outcomes.

Only studies indexed in PubMed and published in English were included. Consequently, relevant studies indexed in other databases or published in other languages may not have been identified.

Economic evaluations, surveys, and implementation studies were excluded from the primary results synthesis but were considered in the discussion where relevant to contextualize telemedicine implementation.

3. Results

A total of 34 studies evaluating telemedicine interventions in adults with type 1 and type 2 diabetes mellitus were included in this narrative review. The interventions varied in terms of technological components, including continuous glucose monitoring systems, remote patient monitoring platforms, mobile health applications, virtual diabetes clinics, and teleconsultation-based care models. The principal characteristics of the reviewed studies and their main outcomes are summarized in **Table 2**.

Table 2. Summary of selected studies evaluating telemedicine interventions in adults with type 1 and type 2 diabetes mellitus.

Study	Population	Telemedicine intervention	Follow-up	Main metabolic outcomes	Behavioral/ Psychosocial outcomes
Gaudillère et al. (2021) (5)	T1DM, poorly controlled (mean HbA1c = 8.69 +- 0.13%)	CGM-based telemonitoring with remote follow-up	6 months	HbA1c ↓ 0.5%; TIR ↑ from 43.0% to 48.0%; GMI improved	Enhanced remote disease monitoring
González-Molero et al. (2012) (6)	T1DM on an insulin pump and rtCGM	Monthly remote transmission of glucose and pump data with e-mail feedback	6 months	HbA1c ↓ from 7.50% to 6.97%	Improved treatment satisfaction and quality of life
Rigla et al. (2008) (8)	T1DM on insulin pump therapy	RtCGM combined with telemedical assistance	3 months	HbA1c ↓ from 8.1% to 7.3%; improved glucose stability	Improved treatment engagement
Rodríguez de Vera-Gómez et al. (2022) (9)	T1DM	CGM with telemedicine and education	9 months	HbA1c ↓ 0.45% overall; ↓ 1.08% in HbA1c ≥8% subgroup	Reduced fear of hypoglycemia; improved quality of life
Notemi et al. (2022) (10)	T1DM	Sensor-augmented pump therapy with telemedicine support	3 years	Sustained HbA1c improvement over long-term follow-up	Improved long-term diabetes management

Study	Population	Telemedicine intervention	Follow-up	Main metabolic outcomes	Behavioral/ Psychosocial outcomes
Saetang et al. (2024) (15)	Insulin-treated T2DM	Insulin adjustment through a cloud-based telemonitoring platform	6 months	HbA1c ↓ 0.65% compared with usual care	Improved treatment adherence
Wang et al. (2017) (16)	T2DM	Internet-based integrated diabetes management system through a medical service platform	6 months	Greater HbA1c reduction than the control group	Better adherence and patient-provider communication
Cuan et al. (2025) (17)	T2DM, poorly controlled (HbA1c >8,5%) in under-resourced setting	Remote patient monitoring with CGM	6 months	HbA1c ↓ 3.0%; higher proportion reaching HbA1c targets	Increased engagement in self-management
Majithia et al. (2020) (18)	T2DM, poorly controlled (HbA1c 12-8%)	CGM-driven Virtual Diabetes Clinic combined of a mobile app, remote personalized lifestyle coaching, connected devices, and live video consultation with endocrinologists and rt-CGM	4 months	HbA1c ↓ up to 2.4%; TIR ↑ 10.2%; improved weight, BP and lipids	Enhanced patient engagement
Lau et al. (2024) (19)	Non-insulin-treated T2DM (HbA1C > 7.0%)	CGM with telemonitoring and virtual educator visits	12 weeks	HbA1c reduction greater than usual care; significant weight loss	Improved treatment satisfaction
Dixon et al. (2020) (20)	T2DM	Virtual diabetes clinic with CGM and endocrinology visits	4 months	HbA1c ↓ 0.2–2.3% depending on baseline control	Improved continuity of care
Zakaria et al. (2024) (22)	T2DM	Hybrid diabetes care with mobile application and weight monitoring	3 months	HbA1c ↓ 2.19%; improved BMI and lipid profile	Higher engagement associated with better outcomes
Jeong et al. (2018) (23)	T2DM	Smart care based on telemonitoring (1 group) and telemedicine (2 group)	6 months	Improved metabolic control – HbA1c reductions similar in all groups; FGC lower in telemonitoring and telemedicine group; lower rates of hypoglycemia in telemedicine group	Higher educational level associated with better adherence
Dicembrini et al. (2026) (25)	Elderly T2DM nursing-home residents	Telemedicine-assisted insulin titration based on CGM	6 months	Significant reduction in HbA1c and increase in TIR; TBR reduction in the intervention group; lower insulin requirements	Improved monitoring efficiency
Turnin et al. (2021) (26)	T2DM	Remote monitoring and lifestyle education software	12 months	No significant between-group HbA1c difference; significant weight loss, but only in women	Improved lifestyle support

Study	Population	Telemedicine intervention	Follow-up	Main metabolic outcomes	Behavioral/ Psychosocial outcomes
Weinstock et al. (2024) (27)	Insulin-treated T1DM and T2DM	Virtual CGM support and education	6 months	Significant HbA1c reductions and TIR improvements across all age groups	Improved technology utilization
Davidson et al. (2019) (28)	Insulin-treated T1DM and T2DM (HbA1c > 8%)	Remote glucose monitoring with an insulin dose adjustment algorithm	6 months	HbA1c ↓ from 10.0% to 7.6%	Improved treatment optimization
Salzsieder et al. (2007) (29)	Insulin-treated T1DM and T2DM	KADIS® decision-support system with CGM and telemedicine	3 months	HbA1c ↓ 0.62%; greater reductions in poorly controlled patients	Improved clinical decision support
Hood et al. (2024) (36)	T1DM and T2DM CGM users	Virtual diabetes care model	12 months	Stable glycemic improvement	Reduced diabetes distress; improved sleep quality and quality of life
Pyatak et al. (2025) (37)	Young adults with T1DM (HbA1c >= 7.5%)	Telehealth occupational therapy intervention	12 months	No significant glycemic improvement	Improved psychosocial well-being; reduced diabetes distress

Most interventions that combined remote monitoring technologies with structured feedback, education, or continuous glucose monitoring systems resulted in improvements in glycemic control, patient engagement, and psychosocial outcomes. T1DM - diabetes mellitus type 1; T2DM - diabetes mellitus type 2; HbA1C - glycated hemoglobin; TIR - time in range; TBR – time below range; GMI - glycemic management indicator; FGC - fasting glucose concentration; BP - blood pressure; CGM - continuous glucose monitoring; rtCGM - real-time continuous glucose monitoring.

3.1 Glycemic Control

Improvement in glycemic control was the most consistently reported benefit of telemedicine-based diabetes interventions across the included studies. Multiple RCTs, prospective studies, and real-world investigations demonstrated significant reductions in HbA1c among T1DM and T2DM populations following implementation of remote monitoring and virtual care models. Generally telemedicine interventions were associated with improved glycemic outcomes, particularly among patients with elevated baseline HbA1c levels (Cuan et al., 2025; Davidson & Davidson, 2019; Dicembrini et al., 2026; Dixon et al., 2020; Gaudillère et al., 2021; González-Molero et al., 2012; Majithia et al., 2020; Mubeen et al., 2023; Notemi et al., 2022; Ólafsdóttir et al., 2025; Rigla et al., 2008; Rodríguez De Vera-Gómez et al., 2022; Saetang et al., 2024; Salzsieder et al., 2007; Vitale et al., 2016; Zakaria et al., 2024).

Among patients with T1DM, telemonitoring combined with CGM and structured feedback resulted in clinically meaningful reductions in HbA1c (Gaudillère et al., 2021; González-Molero et al., 2012; Notemi et al., 2022; Ólafsdóttir et al., 2025; Rigla et al., 2008; Rodríguez De Vera-Gómez et al., 2022). Greater benefits were consistently observed in individuals with poor baseline metabolic control (Gaudillère et al., 2021; Notemi et al., 2022; Rodríguez De Vera-Gómez et al., 2022). Rigla et al. (2008) demonstrated that combining real-time CGM with telemedical assistance improved glucose stability and reduced glycemic variability in pump-treated patients (Rigla et al., 2008). Likewise, González-Molero et al. (2012) reported improved glycemic outcomes among insulin pump users receiving telemedicine support (González-Molero et al., 2012), while Notemi et al. (2022) confirmed the long-term effectiveness of sensor-augmented pump therapy combined with remote follow-up (Notemi et al., 2022). Gaudillère et al. (2021) observed significant HbA1c reductions in individuals with poorly controlled T1DM enrolled in an intensive telemonitoring program (Gaudillère et al., 2021). Similarly, educational telemedicine interventions accompanying the implementation of flash glucose monitoring improved metabolic control and patient satisfaction (Rodríguez De Vera-Gómez et al., 2022; Nieto De La Marca et al., 2023).

Similar findings were reported in T2DM populations, where personalized telemonitoring programs, remote patient monitoring, and virtual diabetes clinics produced significant reductions in HbA1c and improved achievement of therapeutic targets (Cuan et al., 2025; Dixon et al., 2020; Majithia et al., 2020; Mubeen et al., 2023; Saetang et al., 2024; Salzsieder et al., 2007; Vitale et al., 2016; Zakaria et al., 2024). In particular, CGM-supported virtual diabetes clinics produced meaningful improvements in glycemic outcomes (Majithia et al., 2020). Comparable reductions in HbA1c were observed in studies combining remote patient monitoring with endocrinologist consultations (Dixon et al., 2020), telemonitoring-enabled virtual educator visits (Lau et al., 2024), and integrated personalized diabetes management systems (Saetang et al., 2024). More recently, Cuan et al. (2025) demonstrated improved glycemic outcomes in patients treated within a safety-net hospital setting using CGM-supported remote monitoring (Cuan et al., 2025).

Collectively, the available evidence suggests that telemedicine interventions are most effective when combined with continuous glucose data, structured clinical feedback, and individualized treatment adjustments, resulting in improved glycemic control across a diverse diabetes population.

3.2 Continuous Glucose Monitoring Outcomes

Beyond HbA1c reduction, contemporary diabetes management increasingly emphasizes CGM-derived metrics such as TIR, TAR, and glycemic variability. These indicators provide a more detailed representation of daily glucose control and have become important therapeutic targets.

CGM-integrated telemedicine programs were frequently associated with improvements in TIR and reductions in hyperglycemic exposure (Dicembrini et al., 2026; Gaudillère et al., 2021; Gómez Medina et al., 2025; Guzman et al., 2023; Majithia et al., 2020; Salzsieder et al., 2007; Weinstock et al., 2024; Williamson et al., 2024). Improvements in TIR were particularly evident in patients with higher baseline dysglycemia and in programs involving regular remote consultations and individualized therapeutic adjustments (Gaudillère et al., 2021; Majithia et al., 2020; Weinstock et al., 2024).

Advanced virtual clinic models integrating CGM data, remote specialist supervision, and automated feedback demonstrated sustained improvements in glucose control by significantly increasing TIR without increasing hypoglycemia risk, regardless of prior therapy (Gómez Medina et al., 2025). Similar benefits have been observed among insulin-treated patients with T2DM and older adults participating in remote monitoring programs (Dicembrini et al., 2026). In the educational program integrating continuous glucose monitoring with remote consultations by Majithia et al., TIR increased by 10.2%, which corresponded to an additional 2.4 hours per day spent within the target glucose range (Majithia et al., 2020).

3.3 Cardiometabolic Parameters

Although glycemic control remains the primary outcome in most studies, several of them have reported favorable effects on broader cardiometabolic risk factors.

Digital lifestyle interventions integrated with telemonitoring systems have been associated with weight reduction, improved blood pressure control, and enhanced lipid profiles (Lau et al., 2024; Majithia et al., 2020; Michaud et al., 2020; Williamson et al., 2024; Zakaria et al., 2024). Furthermore, in a study by Turnin et al., significant weight loss was observed exclusively among women (Turnin et al., 2021). A post-hoc analysis of a remote monitoring program demonstrated a significant association between weight loss and improvements in glycemic outcomes, suggesting that behavioral changes facilitated through digital platforms may contribute substantially to metabolic benefits (Michaud et al., 2020).

4. Behavioral and Social Outcomes

Telemedicine exerts its effects through behavioral mechanisms in addition to direct clinical interventions. Increased monitoring frequency, immediate access to health data, and continuous communication with healthcare professionals encourage active participation in disease management and foster self-regulatory behaviors.

Studies consistently report improvements in treatment adherence, glucose monitoring frequency, and self-management competencies among participants using digital diabetes platforms (Chen et al., 2013; Jeong et al., 2018). Higher engagement with telemedicine technologies has been associated with improved glycemic outcomes, whereas lower engagement has been associated with poorer metabolic control (Su et al., 2019; Zakaria et al., 2024). Educational attainment and digital literacy appear to be important determinants of successful technology adoption. Patients with higher educational levels generally demonstrate greater adherence to monitoring protocols and more effective utilization of digital tools (Jeong et al., 2018). Mobile applications, such as mySugr®, are characterized by high adherence to and satisfaction with the app (Cuixart et al., 2025).

5. Psychosocial Outcomes

The psychosocial impact of diabetes extends beyond metabolic parameters and substantially influences long-term treatment success. Consequently, PROs have become increasingly important endpoints in digital health research.

Several studies have demonstrated that telemedicine-based diabetes care may improve psychological well-being and patient-reported outcomes (Hood et al., 2024; Pyatak et al., 2025; Rodríguez De Vera-Gómez et al., 2022).

Participation in virtual diabetes care has been associated with reduced diabetes-related distress, lower levels of depressive symptoms, improved sleep quality, and greater treatment satisfaction (Hood et al., 2024; Nieto De La Marca et al., 2023). Educational interventions delivered through telemedicine have also improved QoL and reduced fear of hypoglycemia among individuals with T1DM (González-Molero et al., 2012; Rodríguez De Vera-Gómez et al., 2022). Furthermore, randomized trials evaluating telehealth-based psychosocial interventions reported improvements in emotional well-being and self-efficacy, even when changes in glycemic outcomes were limited (Pyatak et al., 2025).

However, psychosocial outcomes remain heterogeneous across studies. While many interventions improve satisfaction and perceived empowerment, technology alone may not adequately address emotional burdens associated with diabetes. Psychological benefits are not universally observed, indicating that technological solutions alone may be insufficient without integrated educational and behavioral support components (Cuixart et al., 2025; Dario et al., 2017).These findings suggest that digital solutions should be integrated with psychological support and patient-centered educational approaches to maximize their effectiveness.

6. Discussion

The findings of this review suggest that telemedicine represents an effective and increasingly important component of diabetes management. The consistent improvements in glycemic outcomes observed across the included studies are in line with previous evidence demonstrating the effectiveness of telemedicine in diabetes management (Faruque et al., 2017; Hangaard et al., 2023; Lee et al., 2018; Tchero et al., 2019). Meta-analytic evidence of 43 RCTs further supports the effectiveness of telemedicine in improving glycemic outcomes in T2DM, confirming that digital interventions can contribute to clinically relevant HbA1c reductions and improvement in several cardiometabolic outcomes, including fasting glucose plasma, post-prandial glucose, body weight, BMI, blood pressure, and quality of life (De Groot et al., 2021).

The observed improvements in HbA1c may be explained by more frequent patient-provider interactions, real-time access to glucose data, enhanced self-monitoring, and the possibility of timely treatment adjustments. Telemedicine facilitates a shift from episodic consultations to continuous disease management, enabling healthcare professionals to identify emerging glycemic trends and intervene before deterioration.

Importantly, the benefits of telemedicine appeared more consistent among patients with T2DM than among those with T1DM. This difference may reflect the greater influence of lifestyle modification, medication adherence, and behavioral interventions on glycemic outcomes in T2DM. In contrast, glycemic control in T1DM is influenced by multiple factors, including insulin dosing complexity, carbohydrate counting, and day-to-day glycemic variability, which may partially explain the more heterogeneous findings observed across T1DM studies. Nevertheless, studies integrating telemedicine with CGM systems, insulin pumps, and structured educational support demonstrated meaningful improvements in both populations.

Table 3 summarizes the principal benefits and challenges associated with telemedicine and digital health interventions in diabetes care. While improvements in HbA1c, TIR, glucose stability, patient engagement, and healthcare accessibility were frequently reported, the evidence also highlights important implementation barriers that may influence real-world effectiveness.

Table 3. Benefits and Challenges of Telemedicine in Diabetes Care

Domain	Benefits	Challenges
Clinical outcomes	Improved glycemic control (HbA1c reduction), increased TIR, improved glucose stability, better monitoring of treatment effectiveness (Cuan et al., 2025; Davidson & Davidson, 2019; Dixon et al., 2020; Fritzen et al., 2019; Gaudillère et al., 2021; Gómez Medina et al., 2025; González-Molero et al., 2012; Guzman et al., 2023; Jeong et al., 2018; Lau et al., 2024; Majithia et al., 2020; Notemi et al., 2022; Ólafsdóttir et al., 2025; Rigla et al., 2008; Rodríguez De Vera-Gómez et al., 2022; Saetang et al., 2024; Salzsieder et al., 2007; Vitale et al., 2016; Wang et al., 2017; Weinstock et al., 2024; Williamson et al., 2024; Zakaria et al., 2024)	Variable effectiveness among well-controlled patients; limited evidence regarding long-term sustainability of outcomes and no significant improvements (Chen et al., 2013; Cuixart et al., 2025; Dario et al., 2017; Nieto De La Marca et al., 2023; Schultz et al., 2026; Toschi et al., 2024; Turnin et al., 2021)
Patient engagement and self-management	Enhanced adherence to treatment, more frequent glucose monitoring, improved self-management skills, increased patient empowerment (Wang et al., 2017; Williamson et al., 2024)	Reduced engagement among some patient groups, particularly individuals with lower digital literacy, lower educational attainment, and poor baseline adherence (Jeong et al., 2018; Su et al., 2019)
Psychological well-being	Reduced diabetes-related distress, lower fear of hypoglycemia, increased treatment satisfaction, improved quality of life (González-Molero et al., 2012; Hood et al., 2024; Lau et al., 2024; Pyatak et al., 2025; Rodríguez De Vera-Gómez et al., 2022)	Not all interventions demonstrate significant psychosocial benefits; some studies report no differences compared with standard care (Cuixart et al., 2025; Dario et al., 2017)
Healthcare accessibility	Improved access to specialist services, reduced travel burden, enhanced care continuity for rural and underserved populations (Bokolo Anthony Jnr., 2020; Cogiel et al., 2025; Dario et al., 2017)	Digital exclusion and technological barriers (Bhattacharya et al., 2026; Cogiel et al., 2025)
Healthcare system efficiency	Reduced need for face-to-face visits, improved monitoring efficiency, potential reduction in hospitalizations and healthcare utilization (Bokolo Anthony Jnr., 2020; Cuan et al., 2025; Fritzen et al., 2019)	Additional workload related to data review, staff training requirements, and integration with existing clinical workflows (Bhattacharya et al., 2026; Mubeen et al., 2023)
Digital technologies and innovation	Integration of CGM, mobile applications, cloud platforms, remote monitoring systems, and decision-support algorithms enables personalized care (Bhattacharya et al., 2026; Gómez Medina et al., 2025; Majithia et al., 2020; Salzsieder et al., 2007)	Interoperability limitations between platforms and lack of standardization across digital health solutions (Bhattacharya et al., 2026); technical issue linked to internet access (Bokolo Anthony Jnr., 2020)
Economic impact	Potential cost savings through improved metabolic control, reduced complications, and more efficient resource allocation (Fritzen et al., 2019)	Initial investment costs, reimbursement uncertainties, and insufficient cost-effectiveness evidence in some healthcare settings (Mubeen et al., 2023)

Domain	Benefits	Challenges
Data security and ethics	Secure data sharing may improve care coordination and continuity (Majithia et al., 2020; Toschi et al., 2024)	Concerns regarding privacy protection, cybersecurity risks, informed consent, and ethical use of health data (Bhattacharya et al., 2026; Bokolo Anthony Jnr., 2020; Cogiel et al., 2025; Mubeen et al., 2023)
Artificial intelligence and decision support	Potential for predictive analytics, automated insulin titration, and personalized recommendations based on real-time data (Bhattacharya et al., 2026; Cogiel et al., 2025; Davidson & Davidson, 2019; Salzsieder et al., 2007)	Regulatory uncertainty, algorithm transparency, risk of bias, and need for clinical validation before widespread implementation (Bhattacharya et al., 2026; Cogiel et al., 2025)

The principal advantages and challenges associated with telemedicine implementation; HbA1C – glycated haemoglobin; TIR – time in range; CGM – continuous glucose monitoring.

The variability of outcomes observed across studies deserves particular attention. Not all interventions produced significant clinical benefits, and several studies reported outcomes comparable to standard care. This heterogeneity may be explained by differences in baseline HbA1c levels, patient characteristics, intervention intensity, duration of follow-up, healthcare system organization, and the degree of integration between telemedicine platforms and routine clinical care. Consistent with previous literature, patients with poorer baseline glycemic control generally achieved the greatest improvements, whereas benefits were often less pronounced among those with well-controlled glycemia.

Beyond glycemic outcomes, telemedicine appears to positively influence patient engagement and self-management. Mobile health applications, remote monitoring systems, and digital therapeutics facilitate continuous communication between patients and healthcare providers, fostering greater accountability and adherence to treatment recommendations (Bhattacharya et al., 2026; Cogiel et al., 2025; Wang et al., 2017). These technologies support behavioral change through educational content, medication reminders, self-monitoring tools, and personalized feedback mechanisms. Such benefits are particularly relevant in chronic diseases such as diabetes, where long-term adherence to treatment plays a crucial role in determining outcomes.

The findings also suggest that telemedicine may improve psychological well-being. The psychosocial benefits observed in several studies may be related to increased patient confidence, enhanced understanding of the disease, and reduced uncertainty resulting from continuous access to medical support and real-time feedback. However, psychosocial outcomes remain less consistent than glycemic outcomes, indicating the need for further investigation into the mechanisms underlying these effects.

From a healthcare system perspective, telemedicine may improve access to specialist services, reduce travel burden, and enhance continuity of care, particularly for individuals living in rural or underserved regions (Cogiel et al., 2025). The ability to remotely monitor patients may also improve healthcare efficiency by reducing unnecessary clinic visits and facilitating earlier intervention when glycemic deterioration is detected. Economic evaluations further suggest that telemedical approaches may reduce healthcare expenditures by improving metabolic control, preventing diabetes-related complications, and reducing acute care utilization. A pan-European economic analysis estimated substantial cost savings associated with integrating glucose-monitoring-based telemedical approaches into diabetes care pathways (Fritzen et al., 2019). Nevertheless, robust evidence regarding long-term cost-effectiveness remains limited and requires further investigation.

Telemedicine should also be viewed within the broader context of digital health transformation. Contemporary diabetes management increasingly relies on interconnected digital ecosystems incorporating CGM devices, mobile health applications, cloud-based data repositories, electronic health records, teleconsultation platforms, and decision-support systems. Such integration enables personalized, data-driven care and supports the transition toward proactive disease management. However, successful implementation depends on interoperability between technologies, which remains a major challenge across many healthcare systems.

The growing availability of real-time patient-generated health data has stimulated increasing interest in artificial intelligence and clinical decision-support systems. Emerging technologies may facilitate predictive analytics, automated insulin titration, and individualized treatment recommendations. However, despite their considerable potential, these systems require rigorous clinical validation before widespread implementation.

Concerns regarding algorithm transparency, explainability, reproducibility, and potential bias remain important considerations for clinicians, healthcare organizations, and policymakers.

Several barriers continue to limit the large-scale adoption of telemedicine. Limited digital literacy, unequal access to technology, inadequate digital infrastructure, concerns regarding cybersecurity and data privacy, reimbursement uncertainties, and increased provider workload may all hinder implementation (Bhattacharya et al., 2026; Bokolo Anthony Jnr., 2020). Furthermore, telemedicine cannot fully replace physical examinations, complication screening, or emergency diabetes care. Consequently, telemedicine should be regarded as a complementary component of diabetes management rather than a complete substitute for traditional healthcare delivery.

The findings of this review support the growing recognition of hybrid care models as a potentially optimal approach to future diabetes management (Schultz et al., 2026; Toschi et al., 2024; Zakaria et al., 2024). Combining telemedicine with periodic face-to-face consultations may provide an effective balance between the efficiency of remote monitoring and the clinical value of direct patient-provider interaction. Hybrid models preserve opportunities for physical examination and complication assessment while maintaining the benefits of continuous monitoring and timely intervention.

The COVID-19 pandemic catalyzed the rapid adoption of telemedicine in diabetes care. Several healthcare systems implemented remote monitoring and virtual consultations out of necessity, generating real-world evidence that demonstrated the feasibility and effectiveness of telemedicine-based diabetes management. Many of these innovations have been retained beyond the pandemic, supporting the long-term integration of digital health technologies into routine care.

Future research should focus on evaluating the long-term sustainability of telemedicine interventions, particularly regarding glycemic control, patient adherence, and healthcare utilization. Additional studies are needed to establish cost-effectiveness across different healthcare systems and patient populations. Furthermore, future investigations should explore integrating artificial intelligence, predictive analytics, and automated decision-support systems into diabetes care pathways. The development of standardized interoperability frameworks and evidence-based regulatory guidelines will also be essential to support safe and effective implementation of digital health technologies.

Several limitations should be considered when interpreting the findings of this review. First, the narrative design does not follow a formal systematic review methodology and may therefore be subject to selection bias. Second, substantial heterogeneity in intervention characteristics, study populations, outcome measures, and follow-up duration limited direct comparisons across studies. Third, publication bias cannot be ruled out, as studies reporting positive outcomes may be more likely to be published than studies demonstrating neutral or negative findings. In addition, the review relied exclusively on the PubMed database, potentially omitting relevant studies indexed in Scopus, Web of Science, Embase, or Cochrane Library. Finally, although comprehensive search strategies were employed, the rapidly evolving nature of telemedicine research means that some relevant studies may not have been identified, and the selected search terms may not have captured all available evidence related to digital diabetes care.

7. Conclusions

Telemedicine and digital health technologies represent a significant innovation in diabetes care. This review indicates that remote monitoring systems, teleconsultations, CGM technologies, and mobile health applications can improve glycemic control, strengthen treatment adherence, and enhance patient engagement in self-management. In addition to clinical benefits, telemedicine may improve access to healthcare and support more patient-centered models of chronic disease management. However, the magnitude of benefit varies across patient populations and intervention types, highlighting the need for individualized implementation strategies. Future research should focus on long-term effectiveness, cost-effectiveness, digital equity, and the integration of artificial intelligence into diabetes care pathways.

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