



EFFECTIVENESS OF DIGITAL HEALTH INTERVENTIONS IN OPTIMIZING PARENTAL SUPPORT FOR ADOLESCENT TYPE 1 DIABETES MELLITUS MANAGEMENT: A SYSTEMATIC REVIEW

Elvi Kurnia Damayanti¹, Andri Setiya Wahyudi², Praba Diyan Rachmawati³

¹Master Study Program of Nursing, Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia

^{2,3}Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia

elvikurniaaaa@gmail.com

Abstract

Adolescents with Type 1 Diabetes Mellitus (T1DM) require consistent self-management support, where parental involvement is crucial. However, the complexity of diabetes care often places a significant burden on families. Digital health interventions (DHIs) offer innovative ways to strengthen parental support but require further evaluation. This systematic review aims to examine the effectiveness of DHIs in optimizing parental support for adolescents managing T1DM. A systematic search was conducted across Scopus, PubMed, Web of Science, and ProQuest for studies published from 2015 to 2025. Following PRISMA guidelines, randomized controlled trials involving DHIs for parents of adolescents with T1DM were included. Quality was appraised using the Joanna Briggs Institute (JBI) checklist. Eleven studies were included, featuring DHIs such as mobile apps, web-based education, telehealth, and remote monitoring. These interventions improved parental outcomes, including increased knowledge, reduced stress, better monitoring, and greater self-efficacy. Adolescents also showed improved glycemic control, adherence, and emotional well-being. DHIs are effective in strengthening parental support and engagement in adolescent diabetes care. Integrating DHIs into family-centered nursing practice may enhance chronic illness management. Future studies should address cultural adaptations and long-term impacts.

Keywords: *Adolescents, Digital Health Intervention, Family-Centered Care, Mhealth, Parental Support, Type 1 Diabetes Mellitus.*

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* Corresponding author :

Address : Universitas Airlangga

Email : elvikurniaaaa@gmail.com

Phone : 085781483048

INTRODUCTION

Type 1 diabetes mellitus (T1DM) requires rigorous daily management by adolescents, a process where parents play a critical role in monitoring, decision-making, and emotional support (Mukamana S, 2024). Adolescents in particular, face challenges in adhering to these routines due to developmental and psychosocial factors (Azar et al., 2024; Bombaci et al., 2024). Parents face multifaceted challenges, including navigating their child's developmental transitions, psychosocial stressors, and the pervasive familial burden of diabetes care. The DHIs included mobile apps, web-based parenting modules, telehealth consultations, and remote glucose monitoring which offer promising tools to strengthen parents' ability to support diabetes management (Sinisterra et al., 2020; Wyatt et al., 2021). Despite this potential, no systematic review has comprehensively evaluated the effectiveness of DHIs specifically tailored for parents, highlighting a significant gap this study aims to address.

Type 1 diabetes (T1DM) is the most common form of diabetes in children and adolescents, making up 80–90% of cases in young people globally (Kharroubi, 2015). As of 2017, about nine million people worldwide lived with T1DM, mostly in high-income countries (Faizi et al., 2025). However, in low- and middle-income countries like Indonesia preventable deaths from T1DM remain high leading to underreported cases (Faizi et al., 2025). In Indonesia, T1DM cases rose seven-fold between 2000 and 2010, from 3.88 to 28.19 per 100 million people and continue to grow (Pulungan et al., 2021). The actual number is likely higher due to underdiagnosis, misdiagnosis, and poor management (Pulungan et al., 2021). Based on *International Diabetes Federation* (IDF), globally 415 million people had diabetes in 2015 a number expected to reach 642 million by 2040, with T1DM accounting for 5–10% of cases (Ogurtsova et al., 2017). In Indonesia, 1,220 children were reported with T1DM in 2018, and 71% of new cases in 2017 were diagnosed with diabetic ketoacidosis (DKA) (Fauziani et al., 2024). Challenges such as low public awareness, limited access to trained specialists, and inadequate support systems make managing T1DM harder (Fauziani et al., 2024). These issues increase the financial, social, and emotional burdens on families of children and adolescents with T1DM in Indonesia. This highlights the need for innovative solutions like DHIs to support parents in resource constrained settings.

Digital health interventions deliver tools via mobile devices such as smartphones and tablets, offering innovative solutions for managing chronic conditions like type 1 diabetes (T1D) (Lin et al., 2022). For parents of adolescents with T1DM, these technologies include remote glucose

monitoring systems, insulin tracking apps, and virtual consultation platforms (Forlenza & Lal, 2022). The benefits of digital health interventions for parents include real-time oversight of their child's glycemic trends, enhanced communication with healthcare teams, access to tailored educational resources, and data driven decision support (Doupis et al., 2020; Eberle et al., 2021). By providing tools for self-monitoring, data analysis, and decision support, DHIs empower parents to actively engage in their care, promoting better glycemic control, improved self-management behaviors, and enhanced quality of life adolescents with diabetes (Geoffrey, 2024; Holtz et al., 2021). DHIs can bridge critical gaps in traditional diabetes care and alleviate familial strain by reducing parental anxiety, improving care coordination, and fostering informed caregiving.

Poor glycemic control in adolescents elevates risks of complications such as retinopathy and cardiovascular disease (Chiesa & Marcovecchio, 2021; Msanga et al., 2020). Nurses and healthcare providers can leverage DHIs to equip parents with culturally sensitive education, remote monitoring capabilities, and psychosocial support (Sherazi et al., 2024). For example, culturally adapted eHealth interventions have improved outcomes in marginalized groups, such as Black adolescents with comorbid depression (D. Ellis et al., 2024). This systematic review evaluates the effectiveness of DHIs in optimizing parental support for T1DM management in adolescents, synthesizing evidence to guide clinical practice and policy.

METHOD

A systematic review was conducted to comprehensively synthesize existing research on the effectiveness of digital health intervention in managing type 1 diabetes mellitus (T1DM) among adolescents. The methodological quality of included studies was assessed using guidelines from the Joanna Briggs Institute. The systematic review process adhered to the PRISMA checklist to ensure rigorous reporting, analysis, and transparency of findings.

Search Strategy

Electronic databases including Scopus, PubMed, Web of Science, and ProQuest were systematically searched to identify studies evaluating the effectiveness of DHIs in optimizing parental support for T1DM management in adolescents. The search was conducted from March to April 2025. The research question was structured using the PICOS framework: P (Population): Parents or caregivers of adolescents (aged 10–19 years) with T1DM; I (Intervention): Digital health interventions; C (Comparator): Standard care or non-digital interventions; O (Outcome): Parent-focused metrics (e.g., stress,

self-efficacy, caregiving burden) and adolescent health outcomes (e.g., HbA1c, adherence, quality of life, or user satisfaction); S (Study type): Randomized controlled trials (RCTs), quasi-experimental, cross-sectional. Inclusion criteria required studies to evaluate DHIs for parents of T1DM adolescents, report measurable parents centric outcomes and be peer-reviewed and published in English between 2015–2025 to capture advancements in digital health technologies. Studies on type 2 diabetes, adult populations, or non-digital interventions were excluded.

The search strategy keywords based on Medical Subjects Heading (MeSH) and combined using Boolean operators: ("digital health" OR "e-health" OR "telehealth" OR "health technology") AND ("intervention" OR "program" OR "strategy" OR "approach") AND ("parental support" OR "caregiver" OR "family support" OR "guardian") AND ("diabetes" OR "diabetes management" OR "glucose control" OR "insulin therapy") AND ("adolescents" OR "teenagers" OR "youth" OR "young adults"). Filters were applied to include RCTs, quasi-experimental, cross-sectional designs, while excluding non-peer-reviewed articles.

Study Selection

Based on the results of the literature search in four databases using keywords that have been adjusted to MeSH, the researchers identified the articles obtained. Two reviewers (AHZ and EKD) independently screened the articles by applying the inclusion criteria, resulting in a total of 835 articles, including from Scopus (n = 120), PubMed (n = 26), ProQuest (n = 621), and Sciencedirect (n = 68). Next, the four databases were searched to find duplicate articles (n = 243). Further filtering was carried out by excluding titles and abstracts that did not match the study participant criteria (n = 385).

Then, the availability of full-text articles was explored, and full-text articles whose participants did not focus on acupuncture interventions to reduce pain in coronary angiography patients were excluded (n = 7). The final result of this process resulted in 7 articles that were considered eligible for systematic review and in accordance with the inclusion and exclusion criteria of the article (Figure 1). If there are differences or disagreements between reviewers during the screening process, these will be discussed until consensus is reached.

Table 1. Database Search Strategies

Database	Search Strategy	Result
Scopus	((("digital health" OR "e-health" OR "telehealth" OR "health technology") AND ("intervention" OR "program" OR "strategy" OR "approach") AND ("diabetes" OR "diabetes management" OR "glucose control" OR "insulin therapy") AND ("adolescents" OR "teenagers" OR "youth" OR "young adults") AND ("parent" OR "guardian" OR "caregiver" OR "family"))	55
PubMed	("digital health" OR "e-health" OR "telehealth" OR "health technology") AND ("intervention" OR "program" OR "strategy" OR "approach") AND ("parents" OR "caregivers" OR "guardians" OR "families") AND ("adolescents" OR "teenagers" OR "youth" OR "young adults") AND ("diabetes" OR "diabetes mellitus" OR "blood sugar" OR "glucose management")	26
Web of Science	("digital health" OR "e-health" OR "telehealth" OR "health technology") AND ("intervention" OR "program" OR "strategy" OR "approach") AND ("parents" OR "caregivers" OR "guardians" OR "families") AND ("adolescents" OR "teenagers" OR "youth" OR "young adults") AND ("diabetes" OR "diabetes mellitus" OR "blood sugar" OR "glucose control")	44
Proquest	("digital health" OR "e-health" OR "telehealth" OR "health technology") AND ("intervention" OR "program" OR "strategy" OR "approach") AND ("parents" OR "caregivers" OR "guardians" OR "families") AND ("adolescents" OR "teenagers" OR "youth" OR "young adults") AND ("diabetes" OR "diabetes mellitus" OR "blood sugar" OR "glucose management") AND ("modernized" OR "controlled" OR "trial" OR "RCT")	1298

Study Selection

Article selection was conducted using the following criteria: publication within the last 10 years, English language, relevance of keywords, abstract, full text, study type, and elimination of duplicates. Initially, 1423 studies were identified through database searches. After removing duplicates, the titles and abstracts of the remaining articles were screened for relevance. Articles were included for review if they fulfilled the predefined criteria. Following this process, the number of studies was narrowed down to 11 empirical publications. A final screening of titles and abstracts was performed to ensure alignment between the article content and the research topic.

One thousand four hundred twenty three publications were found from the database searches (Figure 1), publications duplicated (n = 46) were removed from the results. The duplicates were then removes and the title and abstract of the articles were screened. We found eleven full-text articles were eligible to conduct systematic review. During the literature screening process, researchers defined common reasons for exclusion criteria, including irrelevant study type, no complete explanation of digital health intervention and grey literature.

Assessment of study quality and risk of bias

The methodological quality of included studies (RCT, cross-sectional, quasi-experimental designs) was evaluated using the Joanna Briggs Institute (JBI) critical appraisal tools specific to each study type. Each study (n = 11) was assessed against criteria such as randomization processes, blinding, and sampling methods. For studies (RCTs, cross-sectional, quasi-experimental), criteria were scored as ‘yes,’ ‘no,’ ‘unclear,’ or ‘not applicable,’ with one point awarded for each ‘yes.’ A predetermined cutoff of ≥75% (agreed upon by researchers) was applied to ensure high-quality inclusion; studies scoring below this threshold were excluded to safeguard the review’s validity (Munn et al., 2021). In the last screening, eleven studies reached a score higher that 75% and were ready to do data synthesis.

Table 2. Criteria for Assessment of Research Results.

No.	Author, Years	Study Design	JBI (%)
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1.	(Whittemore et al., 2020)	RCT	11/13 = 85%
2.	(Klee et al., 2018)	RCT	10/13 = 77%
3.	(Patton et al., 2021)	RCT	11/13 = 85%
4.	(D. A. Ellis et al., 2017)	RCT	10/13 = 77%
5.	(D. Ellis et al., 2024)	RCT	11/13 = 85%
6.	(Zarifsaniey et al., 2022)	RCT	10/13 = 77%
7.	(Harris et al., 2015)	RCT	10/13 = 77%
8.	(Huang et al., 2022)	RCT	10/13 = 77%
9.	(Knauf et al., 2024)	RCT	10/13 = 77%
10.	(Burckhardt et al., 2018)	RCT	11/13 = 85%
11.	(Duke et al., 2016)	RCT	11/13 = 85%

Data extraction and analysis

Data relevant to the review question were extracted, including: author, country, year, setting, research aim, DHIs type, study design, sample size, sampling method, participant demographics (e.g., age, diabetes duration), reliability and validity of tools, measurement instruments (e.g., HbA1c levels, user satisfaction surveys), analytical and statistical techniques, clinical outcomes (e.g., glycemic control, adherence), and results. A narrative synthesis approach was employed to aggregate evidence on the effectiveness of DHIs interventions, identify patterns in study outcomes, and construct a coherent analysis of similarities and variations across studies, such as differences in digital health, intervention duration, and impact on diabetes management

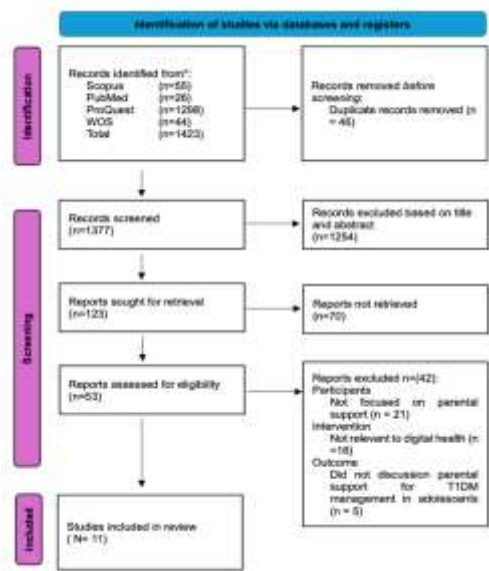


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses search article according to the criteria.

RESULT AND DISCUSSION

Result

Characteristics of selected studied

A total of eleven studies that met the inclusion criteria were synthesised in this review. Conducted between 2015 and 2025, all of the studies were randomised controlled trials (RCTs). The research was carried out in various countries, including the United States, Switzerland, China, Iran and Australia. It involved adolescent patients with type 1 diabetes mellitus (T1DM), aged 10–19 years, and their parents or caregivers. Across all studies, digital health interventions (DHIs) were specifically designed or adapted to strengthen parental involvement in diabetes management.

Types of Digital Health Interventions (DHIs)

The DHIs examined included mobile apps, web-based parenting modules, telehealth consultations, remote glucose monitoring, and culturally sensitive platforms such as WeChat. These interventions were tailored to promote parental engagement through various strategies: real-time monitoring of adolescent glucose levels, guided behavior therapy sessions, structured education on diabetes care, and communication tools for family-centered goal setting. The delivery ranged from brief interventions (three sessions) to intensive 12-week programs. Although intervention frequency varied, most studies emphasized the active participation of parents in using the technology alongside their children.

Effectiveness of DHIs on Aspects of Parental Support

Findings consistently demonstrated the effectiveness of DHIs in enhancing key dimensions of parental support. Multiple studies reported significant reductions in parenting stress and anxiety levels following digital interventions (Huang et al., 2022; Whittemore et al., 2020). Other studies found improvements in parental knowledge, confidence, and monitoring behavior (D. A. Ellis et al., 2017; Patton et al., 2021), facilitated by tools such as the Perceived Stress Scale (PSS), Pediatric Inventory for Parents (PIP), and the Parental Monitoring of Diabetes Care Scale (PMDC-R). For example, CGM devices with remote access allowed parents to intervene more effectively in glycemic control without increasing family conflict or burden (Burckhardt et al., 2018).

Indirect Effects on Adolescents, Linked to Improved Quality of Parental Support

Moreover, while adolescent outcomes such as HbA1c levels and treatment adherence were not the primary focus, several studies indicated that improved parental engagement mediated better health outcomes in adolescents. Ellis et al., (2024)

and Knauff et al., (2024) found that family-based eHealth interventions were especially effective among adolescents experiencing high levels of emotional distress or depression, suggesting that strengthened parental support may buffer psychological risk factors in this population.

Overall, these findings highlight that DHIs serve not only as clinical tools but also as behavioral and emotional supports for parents, empowering them to play a more active, informed, and confident role in their child's diabetes care. No adverse events or negative psychosocial effects were reported across the studies, indicating high acceptability and feasibility of DHIs in family-centered diabetes management.

Discussion

Type 1 Diabetes Mellitus (T1DM) is a chronic autoimmune condition that demands strict daily management, particularly challenging during adolescence due to developmental transitions. Parents play a vital role in ensuring effective glycemic control through supervision, decision-making, and emotional support. Globally, T1DM accounts for 80–90% of diabetes cases in children and adolescents (Kharroubi, 2015). High-income countries such as the United States and Australia report the highest prevalence, likely due to better diagnostic capacity. In contrast, low- and middle-income countries (LMICs) like Indonesia face rising incidence rates, yet underdiagnosis and mismanagement are common. Pulungan et al. (2021) and Fauziani et al. (2024) highlight a dramatic increase in T1DM among Indonesian children, often presenting with diabetic ketoacidosis due to delayed recognition and limited access to pediatric diabetes care. These challenges contribute to emotional, financial, and informational strain on families. Therefore, scalable, accessible tools such as Digital Health Interventions (DHIs) are urgently needed to support parents, especially in resource-limited contexts.

DHIs deliver support through mobile devices, web-based platforms, telehealth, and remote glucose monitoring technologies. In this systematic review, eleven studies implemented diverse DHI formats: eHealth parenting modules (Whittemore et al., 2020), patient-designed mobile apps like Webdia (Klee et al., 2018), culturally contextualized platforms such as WeChat (Huang et al., 2022), and video-based therapy sessions. The intervention durations varied from three sessions to 12-week programs, with frequencies tailored to study goals. DHIs consistently demonstrated multiple benefits for parents, including increased knowledge, improved self-efficacy, stress reduction, and enhanced involvement in diabetes management. These outcomes were validated through standardized tools such as the Pediatric Inventory for Parents

(PIP) and Parental Monitoring of Diabetes Care Scale (PMDC-R). The flexibility and personalization of DHIs made them well-suited for engaging families in daily care, ultimately leading to improved adolescent outcomes.

Parental involvement is a critical determinant of treatment adherence and glycemic control in adolescents with T1DM. Studies by D. A. Ellis et al. (2017) and D. Ellis et al. (2024) show that digital interventions aimed at increasing family communication and parental monitoring significantly improve adolescent HbA1c levels and emotional well-being. These findings align with the principles of Family-Centered Care, which emphasize the importance of equipping parents with the tools, knowledge, and emotional readiness to manage chronic illness collaboratively. Measurement instruments such as the Perceived Stress Scale (PSS) and Hypoglycemia Fear Survey confirmed improvements in parental outcomes across multiple studies. DHIs do more than deliver clinical data, they foster empowered, confident caregivers who actively contribute to their child's diabetes care with reduced anxiety and greater consistency.

This systematic review supports the use of DHIs as effective tools to enhance parental support in adolescent T1DM management. DHIs provide accessible, evidence-based platforms that improve communication, reduce caregiving stress, and facilitate better glycemic monitoring. For healthcare providers, especially nurses, DHIs represent practical tools to promote digital health literacy and implement family-centered care approaches. In LMICs like Indonesia, culturally adapted and scalable digital tools can bridge gaps in education and access, alleviating family burden. The authors recommend future research to focus on longitudinal outcomes, adaptation across diverse populations, and participatory co-design methods. Ultimately, the integration of DHIs into standard care pathways has the potential to redefine chronic disease management by positioning families as empowered partners in care.

From a nursing perspective, these findings reinforce the critical role of nurses in promoting family-centered diabetes care through digital innovation. Nurses are uniquely positioned to educate parents, facilitate the integration of DHIs into care plans, and monitor family responses to digital tools. In resource-limited settings, including Indonesia, the adoption of DHIs could serve as an accessible and cost-effective solution to support families struggling with chronic disease management. Future nursing research should prioritize the development of culturally sensitive, long-term digital interventions and advocate for the inclusion of DHI training in nursing curricula.

Limitation

Nevertheless, this review also identified several limitations in the current body of evidence. Most studies were conducted in high-income countries with limited representation of underserved or diverse populations. The short duration of many interventions and lack of long-term follow-up restrict conclusions about sustained effectiveness. Furthermore, some studies did not clearly report the theoretical basis or validation of measurement instruments. These limitations underline the need for further research involving diverse populations, longer intervention periods, and theory-driven designs that incorporate robust evaluation tools.

Implication for Clinical Practice

From a nursing perspective, these findings reinforce the critical role of nurses in promoting family-centered diabetes care through digital innovation. Nurses are uniquely positioned to educate parents, facilitate the integration of DHIs into care plans, and monitor family responses to digital tools.

This systematic review underscores the effectiveness of Digital Health Interventions (DHIs) in enhancing parental support for adolescents with Type 1 Diabetes Mellitus (T1DM). DHIs improve parental knowledge, reduce caregiving stress, and strengthen monitoring behaviors, leading to better diabetes management in adolescents. Integrating DHIs into family-centered care empowers parents and supports glycemic control, adherence, and emotional well-being in youth. For nurses and healthcare professionals, DHIs offer practical tools for education and digital literacy. In countries like Indonesia, culturally adapted and scalable DHIs can bridge educational gaps and ease caregiving burdens. Future research should focus on long-term outcomes, diverse populations, and theory-based interventions. Co-designing DHIs with families and providers is essential for usability and relevance. Overall, DHIs show strong potential in transforming chronic care through active family involvement.

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Table 3. Characteristics of included studies

Title, Author(s), Year	Country	Design	Population & Sample Size	Study Objective	Type of Digital Health Intervention (DHI)	Duration & Frequency of Intervention	Parental Outcomes	Adolescent Outcomes	Measurement Tools	Key Findings	Clinical Implications
An eHealth Program for Parents of Adolescents With T1DM Improves Parenting Stress: A Randomized Control Trial (Whittemore et al., 2020)	United States	RC T	Parents of adolescents with T1DM (n=162)	To evaluate the short-term effects of the Type 1 Teamwork program on psychosocial stress in parents	eHealth program (Type 1 Teamwork)	Not specified	Reduction in parenting stress	Not directly measured	Pediatric Inventory for Parents (PIP), Perceived Stress Scale (PSS), State-Trait Anxiety Inventory, Center for Epidemiologic Studies Depression Scale, Diabetes-Specific Parental Support for Autonomy Scale, Diabetes Family Conflict Scale	Parents in the Type 1 Teamwork group demonstrated less parenting stress compared with the control group	An eHealth program tailored to the needs of parents of adolescents with T1DM can improve parenting stress
An Intervention by a Patient-Designed Do-It-Yourself Mobile Device App Reduces HbA1c in Children and Adolescents with Type 1 Diabetes (Klee et al., 2018)	Switzerland	RC T	Children and adolescents with T1DM, aged 10-18 years (n=55)	To evaluate the impact of using Webdia, a patient-designed app for smartphones, on metabolic control of T1DM in children	Mobile application (Webdia)	3 months with monthly feedback and treatment adaptation	Reduction in HbA1c, no increase in hypoglycemia prevalence, no change in QoL scores	Significant decrease in HbA1c	HbA1c measurement, Hypoglycemia events reporting, Quality of Life (QoL) scores	The intervention led to a significant reduction in HbA1c by 0.33% compared to the control group. No increase in hypoglycemia	The use of Webdia app in combination with a multidisciplinary intervention can significantly reduce HbA1c levels in patients with initial HbA1c values >8.0% without increasing the risk of hypoglycemia

Title, Author(s), Year	Count ry	Des ign	Popul ation & Sampl e Size	Study Objective	Type of Digital Health Interventi on (DHI)	Durati on & Freque ncy of Interv ention	Parenta l Outco mes	Adoles cent Outco mes	Measur ement Tools	Key Finding s	Clinical Implications
An Intervention to Reduce Hypoglycemia Fear in Parents of Young Kids using Video-Based Telehealth (REDCHiP) (Patton et al., 2021)	United States	RC T	Parents of young children with T1D, aged 1-6 years (n=42)	To evaluate the efficacy of a video-based telehealth intervention to reduce hypoglycemia fear in parents	Video-based telehealth intervention (REDCHiP)	10 sessions delivered over 14 weeks	Reduction in hypoglycemia fear and parenting stress	Not directly measured	Hypoglycemia Fear Survey for Parents of Young Children (HFS-PYC), Pediatric Inventory for Parents (PIP), Problem Areas in Diabetes (PAID-PR), HbA1c levels	prevalence and no modification in QoL scores The intervention resulted in significant reductions in parental hypoglycemia fear and parenting stress, and a trend towards improvement in glycem ic outcomes for children above target at baseline	The REDCHiP intervention shows initial efficacy in reducing hypoglycemia fear and parenting stress in parents of very young children with T1D
Brief Computer-Delivered Intervention to Increase Parental Monitoring in Families of African American Adolescents with Type 1 Diabetes: A Randomized Controlled Trial (D. A.	United States	RC T	African American adolescents with T1D, aged 11-14 years, and their primary caregivers (n=67)	To test the feasibility and efficacy of a computer-delivered motivational intervention (The 3Ms) to promote increased parental monitoring	Computer-delivered motivational intervention (The 3Ms)	Three sessions delivered over a 6-month period	Increase in parental monitoring	Improvement in glycem ic control	Parental Monitoring of Diabetes Care Scale-Revised (PMDC-R), HbA1c levels	Parents in the intervention groups showed significant increases in knowledge of the need to monitor adolescent diabetes management. Adolescents in	A brief, computer-delivered parenting intervention can improve health outcomes among African American adolescents with T1D

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Ellis et al., 2017)										the group where parents received the motivational intervention and adolescents received the control intervention showed significant improvements in HbA1c levels	
Moderating Effect of Depression on Glycemic Control in an eHealth Intervention Among Black Youth With Type 1 Diabetes (D. Ellis et al., 2024)	United States	RC T	Black adolescents with T1D, aged 10-14 years, and their primary caregivers (n=149)	To test whether baseline levels of depression moderate the effects of a brief eHealth parenting intervention on youths' glycemic control	eHealth parenting intervention (The 3Ms)	Up to 3 sessions delivered over a 12-month period	Not directly measured	Adolescents with higher baseline levels of depressive symptoms who received the intervention had significantly greater improvements in HbA1c levels	Hemoglobin A1c (HbA1c) levels, Depressive symptoms	Adolescents with higher baseline levels of depression who received the intervention showed significant improvements in HbA1c levels	A brief, culturally tailored eHealth parenting intervention can improve health outcomes among Black adolescents with T1D and depressive symptoms
Promoting self-management behaviors in	Iran	RC T	Adolescents with type 1 diabetes	To assess the effects of digital storytelling on the self-	Digital storytelling	3 months	Not directly measured	Improved self-management behaviors	Self-Management of Type 1 Diabetes	Significant improvement in self-management	Digital storytelling is a potentially beneficial training modality for

Title, Author(s), Year	Count ry	Des ign	Popul ation & Sampl e Size	Study Objective	Type of Digital Health Interventi on (DHI)	Durati on & Freque ncy of Interv ention	Parenta l Outco mes	Adoles cent Outco mes	Measur ement Tools	Key Finding s	Clinical Implications
adolescent s with type 1 diabetes, using digital storytelling (Zarifsanie y et al., 2022)			(N=66)	managem ent behavior of adolescent s with type 1 diabetes					amongst Adolesce nce (SMOD -A) question naire, HbA1c	ment behavio rs; no signific ant change in HbA1c levels	adolescents with type 1 diabetes
Seeing Is Believing: Using Skype to Improve Diabetes Outcomes in Youth (Harris et al., 2015)	USA	RC T	Adoles cents aged 12-18 years with type 1 diabet es and their caregi vers (N=90)	To compare the effectiveness of delivering Behavioral Family Therapy for Diabetes (BFST-D) via face-to-face clinic visits and Internet videoconf erencing (Skype)	Internet videoconf erencing (Skype)	Up to 10 therapy session s within a 12-week period	Improve d family function ing, adheren ce, and glycemi c control	Improv ed adheren ce and glycemi c control	Diabete s Self- Manage ment Profile (DSMP) , HbA1c assay	No signific ant -group differen ces; signific ant improve ments in adheren ce and glycemi c control from baseline to post-interven tion and follow-up	Delivery of BFST-D via Internet-based videoconferenci ng is viable for addressing nonadherence and suboptimal glycemic control in adolescents with type 1 diabetes
Telehealth Education via WeChat Improves the Quality of Life of Parents of Children with Type-1 Diabetes Mellitus (Huang et al., 2022)	China	RC T	Parent s of childre n with type-1 diabet es mellitu s (N=92)	To explore the effect of telehealth education and care guidance via WeChat on improving the quality of life of parents	WeChat-based telehealth education	6 months	Reduce d anxiety and depressi on, improve d quality of life	Not directly measur ed	Self-Rating Anxiety Scale (SAS), Self-Rating Depress ion Scale (SDS), World Health Organiz ation Quality of Life Brief Scale (WHO	Signific ant reductio n in SAS and SDS scores, improve ment in quality of life measure s	Telehealth education via WeChat can effectively relieve anxiety and depression in parents and improve their quality of life

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The moderating role of diabetes distress on the effect of a randomized eHealth intervention on glycemic control in Black adolescents with type 1 diabetes (Knauft et al., 2024)	USA	RCT	Black adolescents with type 1 diabetes and their caregivers (N=149)	To examine the moderating effect of diabetes distress on the efficacy of a family-based eHealth intervention	eHealth parenting intervention (The 3Ms)	Up to three sessions within a 12-month intervention window	Not directly measured	Improved glycemic control in adolescents with high diabetes distress	Problem Areas In Diabetes (PAID) scale, HbA1c	Adolescents with high diabetes distress showed significant decreases in HbA1c following the intervention	Family-based eHealth interventions may be particularly effective for adolescents with high diabetes distress
The Use of Continuous Glucose Monitoring With Remote Monitoring Improves Psychosocial Measures in Parents of Children With Type 1 Diabetes: A Randomized Crossover Trial (Burckhardt et al., 2018)	Australia	RCT	Children with type 1 diabetes aged 2-12 years and their parents (N=49)	To explore the effect of continuous glucose monitors with remote monitoring on psychosocial outcomes in parents	Continuous glucose monitoring (CGM) with remote monitoring	Two 3-month periods	Reduced fear of hypoglycemia, improved quality of life, reduced stress and anxiety, improved sleep	Not directly measured	Hypoglycemia Fear Survey, Pediatric Quality of Life Inventory (PedsQL), Depression Anxiety Stress Scale (DASS), State and Trait Anxiety Inventory (STAI), Pittsburgh Sleep Quality Index (PSQI)	Significant improvements in parental fear of hypoglycemia, quality of life, stress, and sleep	CGM with remote monitoring can reduce the disease burden for families of children with type 1 diabetes
Videoconferencing	USA	RCT	Adolescents	To	Behavioral	Up to	Improve	Improve	Helping	BFST-	Telehealth

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erencing for Teens With Diabetes: Family Matters (Duke et al., 2016)		T	cents with type 1 diabet es and their parent s (N=90)	evaluate the effectiveness of Behaviora l Family Systems Therapy for Diabetes (BFST-D) delivered via telehealth compared to clinic-based treatment	l Family Systems Therapy for Diabetes (BFST-D) via telehealth	10 session s of 1 to 1.5 hours each, comple ted within a 12-week period	d miscarri ed helping, reduced family conflict, improve d accepta nce of illness	ed miscarri ed helping, reduced family conflict, improv ed accepta nce of illness	for Health Inventor y (HHI), Conflict Behavior r Questio nnaire (CBQ), Accepta nce of Illness Scale (AIS), Diabete s Self- Manage ment Profile (DSMP) , HbA1c assay	D deliver ed via telehealt h was as effectiv e as clinic-based treatme nt in improvi ng family function ing and health outcom es. Reducti ons in family conflict mediate d the relation ship between miscarri ed helping and accepta nce of illness.	delivery of BFST-D can be an effective alternative to traditional clinic-based treatment, particularly for families with barriers to accessing clinic-based care.