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A Systematic Literature Review of Multimedia Technology-Based Interventions for Self-Management in T1D Children: Classification, Trends,Challenges, and Future Directions

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ABSTRACT

Diabetes self-management (DSM) is crucial for children with diabetes, especially those aged 3–7 years. With the increasing number of children with diabetes and the trend toward younger children, there is growing interest in multimedia technology-based interventions (MTBIs) to help them achieve DSM. However, T1D children face unique challenges in DSM due to their need to complete seven target behaviors: learning diabetes basics, monitoring blood glucose levels, adhering to insulin therapy, problem-solving, dietary modifications, physical activity, and psychological aspects. Over the past 20 years, MTBIs have become powerful tools to support DSM, using interactive content, digital platforms, mobile apps, and virtual coaching. This systematic literature review aims to analyze the classification and trends in MTBIs' use in self-management for T1D children, explore key challenges, and suggest future directions for advancing these technologies. This study provides a comprehensive investigation of the application of multimedia technologies for interventions in self-management for T1D children and offers research foundation and practical guidance for the later application of multimedia technologies in this area.

KEYWORDS

Children With Type 1 Diabetes, Diabetes Self-Management, Multimedia Technology-Based Interventions, Classification, Trends, Challenges and Future Directions

1. INTRODUCTION

Recently, diabetes incidence has increased internationally due to socio-economic advancements and improved living standards (Lin et al., 2020). The World Health Organization reports 800 million diabetics globally, up from 200 million 20 years ago (World Health Organization, 2023). Furthermore,

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increasing numbers of children aged 3–7 have the condition. For instance, Li et al.'s (2022) research in China found that the prevalence of diabetes among children aged 3–7 is 1.93 per 100,000 people. Without intervention, one diabetic dies every 10 seconds worldwide (Zimmet et al., 2014). Diabetes will reach 828 million by 2025, according to Bener & Al-Hamaq (2016). Since 2000, the number of children with type 1 diabetes has tripled. The average yearly rise in the incidence rate of children under 7 is 5–34%, indicating a tendency toward diabetes at a younger age (Patterson et al., 2014).

Type 1 diabetes (T1D) is a chronic condition requiring lifetime management, often beginning in childhood (Simmons, 2015). Children with Type 1 Diabetes (T1D) encounter a persistent challenge in diabetes self-management, which encompasses understanding the disease fundamentals, meticulously monitoring blood glucose levels, complying with insulin therapy, engaging in problem-solving and decision-making, modifying dietary habits, participating in physical activity, and fostering mental resilience (Xie et al., 2020). The Chinese diabetic Association delineates these seven goal behaviors as the 7 aspects of diabetic self-management (CDA7) (Xie et al., 2020). The intricacy of these responsibilities may be daunting for children with Type 1 Diabetes, particularly when confronted with the additional responsibility of sustaining healthcare throughout time (Streisand & Monaghan, 2014). Children who have difficulty comprehending their medical state or adhering to their treatment regimen may find it even more challenging (Rankin et al., 2018).

Limited diabetes education, cultural misconceptions, and insufficient family support hinder T1D self-management in children (Lindsay et al., 2011; Ahola & Groop, 2013). Systemic issues, including underfunded healthcare programs, specialist shortages, and restricted access to affordable insulin and devices like CGMs, exacerbate the problem (Lucas, 2015; Kehlenbrink et al., 2023). Cultural stigmas, dietary conflicts, and inadequate national awareness further complicate management efforts (Hewa, 2019; Ergun-Longmire et al., 2021). Technological underuse, data integration challenges, and insufficient professional training highlight gaps in care, while low investment in affordable diabetes research limits solutions (Al-Worafi, 2024). Addressing these barriers requires improving education, fostering cultural sensitivity, enhancing systemic healthcare support, and developing accessible therapies to empower T1D children and their families.

Improving T1D self-management in children requires addressing these complex concerns at these levels. Thus, T1D children require ways to receive diabetic self-management information and control their diabetes via interventions.

Recent technological advances have fueled the development of multimedia technology-based interventions (MTBIs), which use a combination of educational tools, digital platforms, and interactive content to support diabetes self-management (DSM) (Alaslawi et al., 2022). The goal of MTBIs is to engage children in DSM through digital platforms such as mobile apps, online educational videos, interactive games, virtual coaches, and telemedicine. These tools not only improve diabetes knowledge but also promote treatment adherence, develop self-efficacy, and reduce diabetes healthcare-related distress. The study found that there is a lack of articles that categorize and summarize trends in the use of multimedia technology for implementing interventions in the self-management of T1D children. There is also a lack of articles that look at the problems and difficulties of using or implementing interventions with current technologies in the self-management of T1D children, as well as the future trends.

Therefore, this research investigates a systematic literature review to analyze the application of MTBI interventions in the self-management of children with T1D. It focuses on their categorization, research trends, challenges faced in the application or implementation of MTBI, and future directions for research and development.

2. RESEARCH QUESTIONS

The study concentrates on the application of multimedia technology in self-management for T1D children. Therefore, the study formulated and framed the following research questions (Table 1) to facilitate a detailed review of the topic.

Table 1. The problem statement and objective

Number	Problem Statement	Objective
RQ 1	What are the classifications of multimedia technology-based interventions for self-management in T1D children?	The goal is to comprehend the types of multimedia technologies that children with T1D have utilized for self-management over the past two decades, with the aim of pinpointing the areas where technology application is most prevalent.
RQ 2	What are the current trends in the use of multimedia technology-based interventions for the self-management of T1D children?	By analyzing application trends, it is possible to gauge the direction of future research and the challenges it faces.

3. RESEARCH METHODOLOGY

This study's dataset was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009; Moher et al., 2010). This study adhered to established procedures in research synthesis by concentrating on articles published in leading peer-reviewed journals, which are regarded as the principal avenue for disseminating high-quality research (Piran & Tran, 2024).

(1) Literature Sources

The "source title" method was used to find research papers in the chosen journal database about using multimedia technology for self-management interventions in children with T1D. The journal databases were Science Direct, Scopus, Wiley, Springer Link, Google Scholar, and AMC Digital Library. The study also searched the China Biomedical Literature Database, the China Journal Full Text Database, and the Wanfang Database, which ensured the breadth and relevance of the literature sources.

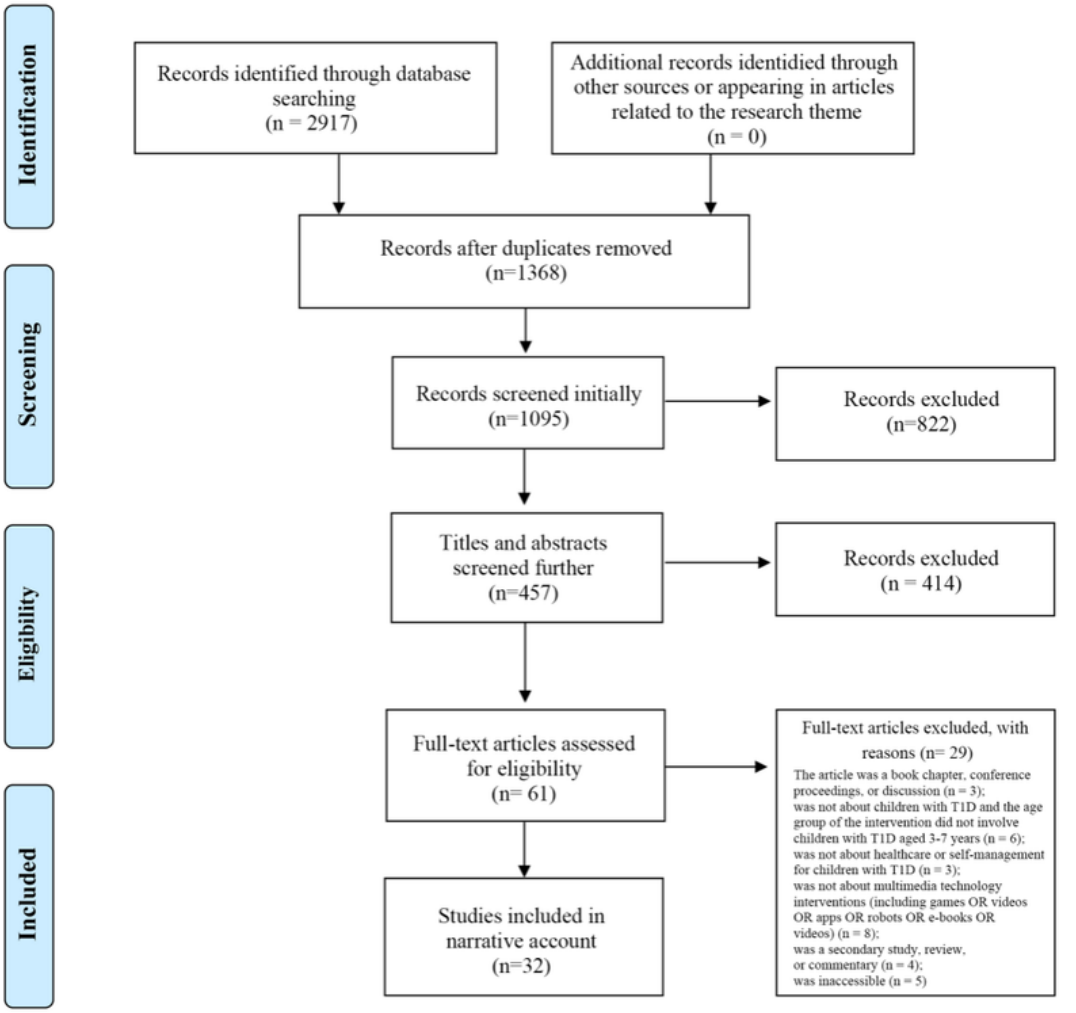
(2) Search Keywords

Search terms included "multimedia technology OR games OR video OR apps OR robots OR e-books" AND "children OR kid" AND "Type 1 Diabetes (mellitus) OR T1D" AND "self-management OR healthcare." The year of publication was not subject to any restrictions.

(3) Search Procedures

With the search queries that were built based on the search keywords discussed in the previous section, the general literature searching procedure was executed, which followed four main steps: the identification stage, screening stage, eligibility stage, and inclusion stage. All retrieved articles were screened using inclusion and exclusion criteria. A total of 32 journal articles were identified for coding and analysis. Thus, the PRISMA flowchart in Figure 1 (Moher et al., 2010) shows how the relevant and high-quality research articles are chosen for the systematic literature review.

Figure 1. PRISMA flow diagram



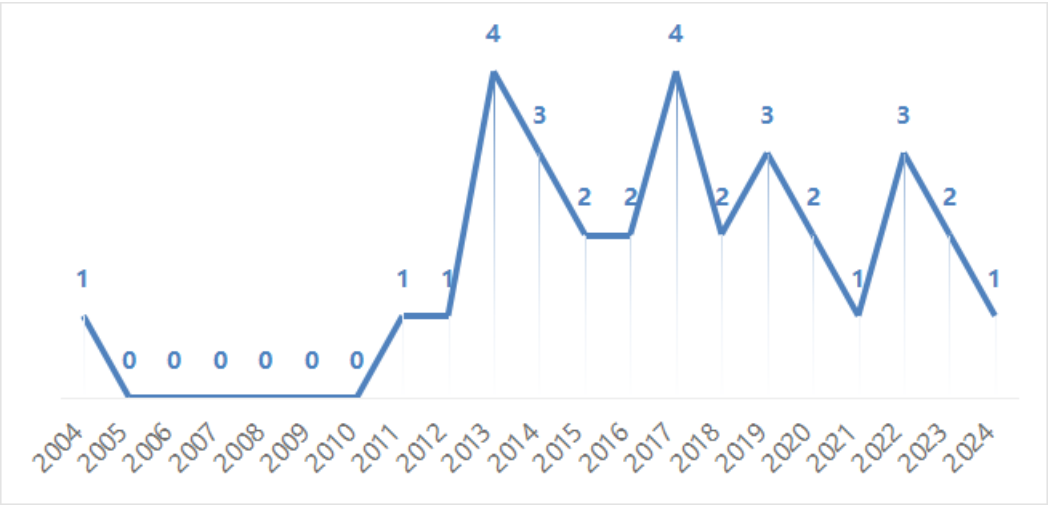
(4) Literature Selection

A preliminary review was conducted on 2,917 relevant articles, comprising 2,909 articles in English and 8 articles in Chinese. The literature selection process comprised four distinct stages. The initial stage involved the elimination of duplicate entries from a corpus of 1,368 literature pieces, resulting in a total of 1,095 distinct items. The second stage consisted of screening the 457 articles pertinent to the study, utilizing title and abstract as criteria. For the last 61 articles, the third stage involved a full review of the text-related literature. The fourth stage was a final evaluation based on the five criteria and reasons that were already given. The article constituted a book chapter, conference proceedings, or discussion (n = 3); it did not focus on children with T1D, nor did the intervention age group include children with T1D aged 3-7 years (n = 6); it was unrelated to healthcare or self-management for children with T1D (n = 3); it did not address multimedia technology interventions (including games, videos, apps, robots, or e-books) (n = 8); it was categorized as a secondary study, review, or commentary (n = 4); and it was inaccessible (n = 5). Following four stages of screening, a total of 32 papers were ultimately included, comprising experimental, survey, quantitative, or qualitative data, all published in English language journals.

(5) Search Results

The final dataset comprises 32 articles published from January 2004 to December 2024. This information adds to what is already known about how games, videos, e-books, robots, and apps can help children with Type 1 Diabetes (T1D) take care of themselves. It also shows what researchers are interested in. Figure 2 shows that there have been more papers in general talking about how multimedia technology can help kids with Type 1 Diabetes (T1D) take care of themselves. However, there is a notable gap in the research over the past 20 years, particularly between 2005 and 2010, suggesting a relative neglect of this demographic in existing studies. Due to the absence of a publication year limitation, it indicates that research on multimedia technology interventions for self-management in children with Type 1 Diabetes has been published in selected journals since 2004. This also highlights the necessity for greater focus on multimedia technology interventions in the self-management of children with T1D.

Figure 2. Line graph representing the number of papers in the dataset over the years



The analysis of 32 articles yielded the relevant content analysis table, Table 2, which provides a more intuitive view of the information in the articles.

Table 2. Analysis of the literature obtained through the search

Reference	Multimedia form	Display device/ technology	Study population (Nationality)	Targeted behavior (CDA7)							Evaluation methodologies
				1	2	3	4	5	6	7	
1 (Kyfonidis & Lennon, 2016)	Game + Products (Matched)	MP +Combination toys	T1D patients aged 3-8		√	√		√	√	√	Usability and Psychological
2 (Bitar et al., 2022)	App	MP	T1D patients aged 6-13		√	√	√	√	√		Usability and Psychological
3 (Khan et al., 2023)	APP + Product (Matched)	MP+Toy Bear BGM Products	T1D patients aged 7-23		√	√		√			Usability and Psychological

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Table 2. Continued

Reference	Multimedia form	Display device/ technology	Study population (Nationality)	Targeted behavior (CDA7)							Evaluation methodologies
				1	2	3	4	5	6	7	
4 (Tsvyatkova & Storni, 2014)	eBook	PC	T1D patients aged 8-12		√	√		√			Usability and Psychological
5 (Andersen et al., 2020)	APP	MP	T1D patients aged 3-18	√			√	√			Usability
6 (Alsalman et al., 2021)	Game	MP	T1D patients aged 7-12		√	√		√	√	√	Usability and Psychological
7 (Klangpremjit, 2019)	Game	MP	T1D patients aged 5–6	√	√	√		√	√		Usability
8 (Hagert, 2022)	APP	MP	T1D patients aged 9-12	√				√			Usability and Psychological
9 (Cañamero & Lewis, 2016)	Human-robot interaction	AI	T1D patients aged 7–12		√	√				√	Usability and Psychological
10 (Nørlev et al., 2022)	Game	MP	T1D patients aged 8-14				√	√	√		Usability, Clinical and Psychological
11 (Coninx et al., 2015)	Human-robot interaction	AI	T1D children	√			√	√		√	Usability and Psychological
12 (Klingensmith et al., 2013)	Game + Product (Matched)	MP+ A glucose meter	T1D patients aged 5-24		√	√		√			Usability Clinical and Psychological
13 (Al-Mansoori et al., 2011)	Game	PC	T1D patients aged 3-8	√				√	√		Usability
14 (Blanson Henkemans et al., 2013)	Human-Robot interaction	AI	T1D patients aged 8–12	√	√	√			√	√	Usability, Clinical and Psychological
15 (Brattland, 2023)	Game	MP	T1D patients aged 8–12	√	√			√			Usability and Psychological
16 (Berndt et al., 2014)	APP	MP	T1D patients aged 8–18		√					√	Usability, Clinical and Psychological
17 (Gu et al., 2017)	App + Product (Matched)	MP+A CGM device	T1D children		√						Usability and clinical
18 (Stone, 2013)	Game + Product (Matched)	MP+ A glucose meter	T1D patients aged 12-16	√	√	√					Usability and Psychological
19 (Bomark et al., 2012)	Game	MP	T1D children		√	√		√	√		NM
20 (Henkemans et al., 2017)	Human-robot interaction	AI	T1D patients aged 7-12	√	√					√	Usability and Psychological
21 (Calle-Bustos et al., 2017)	Game	Augmented Reality	T1D patients aged 5-14					√			Usability and Psychological
22 (Alexandra Makhlysheva, 2013)	Game	MP	T1D patients aged 12-16	√	√	√		√	√		Usability and Psychological

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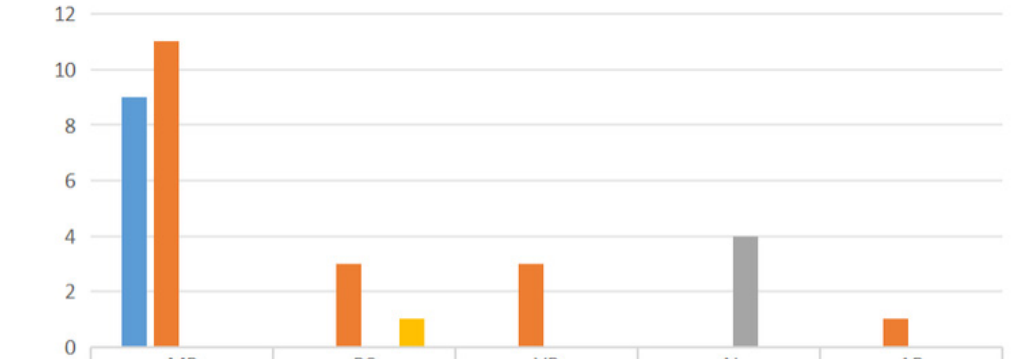
Table 2. Continued

Reference	Multimedia form	Display device/ technology	Study population (Nationality)	Targeted behavior (CDA7)							Evaluation methodologies
				1	2	3	4	5	6	7	
23 (Klee et al., 2018)	APP	MP	T1D patients aged 10-18		√						Usability, Clinical and Psychological
24 (Otis et al., 2020)	Game	MP	T1D patients aged 5-14	√	√	√					Usability, Clinical and Psychological
25 (Ebrahimpour et al., 2014)	Game	PC	T1D patients aged 3-12			√					Usability and Psychological
26 (Zholdas et al., 2022)	App + Product (Matched)	MP+A IoT sensors	T1D patients aged 7-15		√						Usability and Clinical
27 (Cai, 2019)	App	MP	T1D patients aged 7-12	√	√						Usability and psychological
28 (Aoki et al., 2004)	Game	PC	T1D children		√	√		√	√		Usability and Clinical
29 (Chomutare et al., 2018)	Game	MP	T1D children	√			√			√	NM
30 (Alsharbi & Richards, 2017)	Game	Virtual Reality	T1D patients aged 11-15	√	√	√	√			√	Usability and psychological
31 (Burkholz & Von Mammen, 2019)	Game	Virtual Reality	T1D children	√	√	√		√			NM
32 (Pesare et al., 2015)	Game	Virtual Reality	T1D children			√	√	√			Usability
			Total	15	23	18	7	19	10	9	

CDA7:1. Learning the Basics of Diabetes (understanding the types, causes, symptoms, complications, and other related basics of diabetes); 2. Blood Glucose Monitoring (self-monitoring their blood glucose levels daily to assess how food, physical activity, and medications are affecting their blood glucose levels); 3. Insulin Therapy (learning information about each medication and how it affects them); 4. Problem Solving and Decision Making (being able to use their problem-solving skills to make quick, informed decisions about food, activity, and medications); 5. Dietary Modification (making informed and appropriate healthy food choices, eating times, and weight management to achieve optimal blood glucose levels); 6. Physical Exercise (engaging in appropriate levels of exercise and physical activity); 7. Mental Construction (helping individuals with motivation to change their behaviors, setting goals, and guiding them to overcome multiple barriers).

MP=Mobile Phone, PC=Personal Computer, APP=Application, NM=Not Mention

Figure 3. Statistics from the last 20 years of research related to the use of multimedia technology-based interventions in the self-management of T1D children



	MP	PC	VR	AI	AR
APP	9				
Game	11	3	3		1
Robot				4	
eBook		1			

4. RESULTS AND FINDINGS

This study examines multimedia technology interventions for self-management in children with Type 1 Diabetes from 2004 to 2024. The research questions guide the data summarization. For the purpose of the analysis presented below, Table 2 enumerates the 32 articles as 1-32.

4.1 RQ1 What are the Classifications of Multimedia Technology-Based Interventions for Self-Management in T1D Children?

The analysis of multimedia forms and display devices or technologies across the 32 articles in Table 2 indicates that applications, games, robots, and e-books are the primary types of MTBIs utilized to assist children with T1D in self-management. The content and presentation formats of multimedia technologies consist of a combination of multimedia forms, display devices (such as MP and PC), and technologies including AI, AR, and VR. The data presented in Figure 3 indicates that games represent the most significant multimedia form, with a total of 18 studies[1,6,7,10,12,13,15,18,19,21,22,24,25,28-32]. Various display terminals and technologies are utilized across the studies, with 11 studies employing MP[1,6,7,10,12,15,18,19,22,24,29], 3 studies utilizing PC display platforms[13,25,28], 3 studies using VR technologies[30-32], and 1 study incorporating AR technologies[21]. The research identified nine studies on technological interventions for MP applications[2,3,5,8,16,17,23,26,27]and four studies related to AI robots[9,11,14,20]. The research identified three studies that integrated game interventions with corresponding actual products[1,12,18]. Furthermore, three studies were identified that integrated real products into the MP apps[3,17,26].

In summary, T1D children frequently use MP apps and games for self-management. However, many of these apps in these studies are also linked to games such as Cai (2019), Kyösti Hagert (2022), and Khan et al. (2023), which are based on either game or gamification design concepts. These approaches align with children's thinking, promoting long-term training and positive behavior development (Johnson et al., 2022). Despite the use of various technologies and display terminals in games, the delivery of DSM content through games has demonstrated significant real-life benefits, enhancing self-management among T1D children. Thus, game-based multimedia forms dominate self-management interventions for T1D children.

The MP+ games multimedia model is most used in T1D self-management interventions for three reasons: i) Children's curiosity and love for animation make gaming experiences engaging, boosting satisfaction and confidence. ii) Storylines, animation, and characters enhance appeal. iii) Mobile phones serve as key platforms for gaming access and emotional support. Whether mobile games truly dominate interventions is explored in 4.2 RQ2.

Furthermore, Hari Narayanan & Hegarty's (2002) distinguished static multimedia (text, graphics, images) from dynamic multimedia (sound, animation, video, interactive apps). Dynamic multimedia is more effective for T1D children's self-management interventions (Tsvyatkova et al., 2016), as children's visual triggers often dominate sensory inputs (Smith, 2013). For example, while static multimedia like ebooks (Tsvyatkova & Storni, 2014) relied on text and images, dynamic VR games (Burkholz & Von Mammen, 2019) offered multisensory interactions, enabling effective skills training in blood glucose monitoring, medication adherence, and dietary management. These target behaviors will be further analyzed in section 3.

Table 3. Depth analysis based on classification of multimedia technology interventions

Classification	Study type	Duration of study	National	Average age (sample size)	Measured outcomes			Research Limitation
					Cognition	Biological	Psychological	
MP/PC Game								
6 (Alsalman et al., 2021)	Mixed	30 minutes	Saudi Arabian	7 (N = 65)	Knowledge about diabetes		Cognition and executive function	Lack of time span
7 (Klangpremjit, 2019)	Qualitative	A month	Thai	5.5 (N = 5)			Satisfaction; Cognition and executive function	Single measurement results; Lack of longitudinal data studies
10 (Nørlev et al., 2022)	Qualitative	60-90 minutes	Danish	11 (N=4)	Knowledge about diabetes	HbA1c	Satisfaction	Lack of longitudinal data studies
13 (Al-Mansoori et al., 2011)	Qualitative	7 days	Emirates	3 (N=9)	Knowledge about diabetes			Single measurement results; Lack of longitudinal data studies
15 (Brattland, 2023)	Qualitative	30 minutes	Norwegian	9 (N= 3)			Enjoyment; Satisfaction	Single measurement results; Lack of longitudinal data studies
19 (Bomark et al., 2012)	**NM**							
22 (Alexandra Makhlysheva, 2013)	Qualitative	30 minutes	Norwegian	10 (N=18)	Knowledge about diabetes		Satisfaction	Lack of longitudinal data studies
24 (Otis et al., 2020)	Mixed	30 minutes	American	9.5 (N=20)	Knowledge about diabetes	HbA1c	Satisfaction Motivation	Insufficient sample size; Lack of time span
25 (Ebrahimpour et al., 2014)	Qualitative	6 months	Iranian	7.5 (N=8)			Enjoyment Diabetes-related distress	Single measurement results; Lack of longitudinal data studies
28 (Aoki et al., 2004)	Quantitative	90 minutes	American	8 (N=58)		Blood glucose level	Satisfaction Enjoyment	Lack of time span

continued on following page

Table 3. Continued

Classification	Study type	Duration of study	National	Average age (sample size)	Measured outcomes			Research Limitation
					Cognition	Biological	Psychological	
29 (Chomutare et al., 2018)	**NM**							
MP/PC Game+Product(Matched)								
1 (Kyfonidis & Lennon, 2016)	Qualitative	60-90 minutes	English	6.5 (N=10)			Satisfaction; Cognition and executive function	Single measurement results; Lack of longitudinal data studies
12 (Klingensmith et al., 2013)	Quantitative	3-5 days	American	14 (N=58)		HbA1c	Motivation; Satisfaction	Lack of time span
18 (Stone, 2013)	Qualitative	90 minutes	American	14 (N= 8)			Diabetes-related distress	Single measurement results; Lack of longitudinal data studies
AR Game								
21 (Calle-Bustos et al., 2017)	Quantitative	90 minutes	Spaniard	9.5 (N=70)	Knowledge about diabetes		Satisfaction	Single Self-management target behaviors setting
VR Game								
30 (Alsharbi & Richards, 2017)	Qualitative	90 minutes	Australian	13 (N=11)			Self-efficacy Diabetes-related distress	Single measurement results; Lack of longitudinal data studies
31 (Burkholz & Von Mammen, 2019)	**NM**							
32 (Pesare et al., 2015)	Quantitative	Two hours	Italian	10 (N=20)	Knowledge about diabetes			Insufficient sample size; Lack of time span
AI Robot								
9 (Cañamero & Lewis, 2016)	Mixed	Half an hour	Italian	9.5 (N=17)	Knowledge about diabetes		Motivation; Self-efficacy	Insufficient sample size; Lack of time span
11 (Coninx et al., 2015)	Mixed	2 months	Italian	11 (N=3)	Knowledge about diabetes		Motivation; Cognition and executive function	Insufficient sample size
14 (Blanson Henkemans et al., 2013)	Quantitative	90 minutes	Dutch	10.2 (N=12)	Knowledge about diabetes	HbA1c	Enjoyment; Satisfaction	Insufficient sample size; Lack of time span
20 (Henkemans et al., 2017)	Mixed	30 minutes	Dutch	10.6 (N=27)	Knowledge about diabetes		Enjoyment; Motivation	Insufficient sample size; Lack of time span
MP APP								

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Table 3. Continued

Classification	Study type	Duration of study	National	Average age (sample size)	Measured outcomes			Research Limitation
					Cognition	Biological	Psychological	
2 (Bitar et al., 2022)	Qualitative	90 minutes	Saudi Arabian	8.5 (N=9)			Satisfaction; Social well-being; Cognition and executive function	Single measurement results; Lack of longitudinal data studies
5 (Andersen et al., 2020)	Qualitative	2 hours	English	11 (N=8)	Knowledge about diabetes		Cognition and executive function	Lack of longitudinal data studies
8 (Hagert, 2022)*	Qualitative	90minutes	Swede	8 (N = 2)			Motivation; Satisfaction; Self-esteem;	Single measurement results; Lack of longitudinal data studies
16 (Berndt et al., 2014)	Quantitative	4 weeks	German	15 (N= 68)		HbA1c; Weight; BMI	Quality of life; Self-Efficacy	Under-sampling of T1D children aged 3-7 years
23 (Klee et al., 2018)	Quantitative	3 months	Swiss	14 (N=33)		HbA1c; Hypoglycemia	Quality of life	Under-sampling of T1D children aged 3-7 years; Single Self-management target behaviors setting
27 (Cai, 2019)*	Quantitative	2.5 hours	Swede	8 (N=2)			Enjoyment Motivation Diabetes-related distress	Single measurement results; Lack of longitudinal data studies
MP APP + Product(Matched)								
3 (Khan et al., 2023)*	Mixed	A week	Pakistani	15 (N=9)	Knowledge about diabetes		Stress relief; Enjoyment; Self sufficiency; Empowerment	Insufficient sample size; Lack of time span
17 (Gu et al., 2017)	Quantitative	6 days	Chinese	16 (N= 68)		HbA1c; BMI		Under-sampling of T1D children aged 3-7 years
26 (Zholdas et al., 2022)	Quantitative	5-6days	Kazakhstani	11 (N=26)		Blood glucose level; Hypoglycemia		Insufficient sample size; Lack of time span; Single Self-management target behaviors setting

Note: MP= Mobile Phone, PC=Personal Computer, AR=Augmented Reality, VR=Virtual Reality, NM=Not Mention
BMI, body mass index; HbA1c, hemoglobin A1c; * = Gamification App

4.2 In-Depth Analyses Based on the Classification of Multimedia Technology Interventions

(1) Target Behaviors

The key findings of the studies are summarized in the Target Behaviors section of Table 2. In order to standardize the behavioral findings, the shortlisted studies were analyzed in comparison to the behavioral findings set through the CDA7. The findings and methods used by the original authors in their respective studies are also summarized in conjunction with Table 3.

In Table 2, the longitudinal analysis of the CDA7 behavioral objectives shows that "basic knowledge of diabetes" was the focus of 15 studies[5,7,8,11,13-15,18,20,22,24,27,29-31], "blood glucose monitoring" was the focus of 23 studies[1-4,6,7,9,12,14-20,22-24,26-28,30,31], and "insulin therapy" was the focus of 18 studies [1-4,6,7,9,12,14,18,19,22,24,25,28,30-32]. Seven studies sought to improve participants' "decision-making and problem-solving" skills[2,5,10,11,29,30,32]. Nineteen studies focused on improving healthy eating[1-8,10-12,13,15,19,21,22,28,31,32]. The impact of "physical exercise" was emphasized and directly encouraged in 10 studies[1,2,6,7,10,13,14,19,22,28]. Finally, nine studies were concerned with the "mental construction" of the participants[1,6,9,11,14,16,20,29,30]. All of the interventions investigated in this study addressed behaviors related to diabetes self-management.

In addition, through a cross-sectional analysis of the CDA7 behavioral objectives in Table 2, it is revealed that the targeted behaviors in the relevant studies align with the seven elements of self-management ability, although not all studies begin with these aspects. For instance, Gu et al. (2017), Klee et al. (2018), and Zholdas et al. (2022) only look at the behavior of monitoring blood glucose; Ebrahimpour et al. (2014) look at medication adherence; and Calle-Bustos et al. (2017) look at making dietary changes for health. Seven studies have identified five or more target behaviors1,2,6,7,14,22,30. Other studies set 2–4 target behaviors.

Unfortunately, no studies have included all seven target behaviors. Research should not fragment the seven target behaviors for diabetes self-management, as they represent an integrated process. Teaching these behavioral goals from an early age, similar to a learning process, is crucial for laying a solid foundation for positive future lifestyle and medical habits, especially for young T1D children (Sundberg et al., 2017). Therefore, the development of multimedia technology in the later stages should consider the comprehensive goal behaviors set for T1D children.

(2) Evaluation Methods in Research

Table 2 shows that there are three main types of methods used to evaluate MTBIs for self-management in children with T1D. These are usability, psychological, and clinical approaches.

i) Usability Evaluation

Usability is the primary assessment approach for the use of multimedia technology in self-management for children with Type 1 Diabetes. It is important to judge the usefulness, satisfaction, or effectiveness of multimedia technology because it supports and ensures wide distribution in later stages (Olsen et al., 2011). Of the 32 research studies, usability evaluations were conducted in 29, while three studies did not specify their assessment methodologies.

The designs in the studies were evaluated based on the usability or user interface of the multimedia technology, although there was very limited analysis of how the children actually applied it (multimedia technology strategies and experiences). Some articles, on the other hand, used self-report questionnaires to look at multimedia technologies. These asked about things like how easy they were to use, how complicated the interface was, how reliable it was, and how accessible it was (Alsalman et al., 2021; Klangpremjit, 2019; Hagert, 2022; Al-Mansoori et al., 2011; Otis et al., 2020).

Table 3 also revealed the frequent use of psychological indicators in evaluating the usability of multimedia technologies. For instance, the measurements identified satisfaction with multimedia technologies (12 studies[1,2,7,8,10,12,14,15,21,22,24,28]) and enjoyment (7 studies[3,14,15,20,25,27,28]) as psychological indicators.

ii) Psychological Evaluation

Psychological evaluation may indicate the psychological impact of multimedia technology on participants, and Tables 2 and 3 reveal 22 studies that used psychometrics as a study conclusion. Seven studies in this area support getting children with Type 1 Diabetes involved in multimedia technology by motivating them to do so[8,9,11,12,20,24,27]. This can lead to interventions that help children with diabetes manage their own behaviors related to the disease.

Hagert (2022) and Cai (2019) demonstrated that offering video game points as incentives during blood glucose tests effectively encouraged monitoring, gaining support from participants and healthcare professionals. Studies by Cañamero & Lewis (2016), Coninx et al. (2015), and Henkemans et al. (2017) used robots to observe T1D children's monitoring behaviors, finding that the novelty of incentive systems effectively motivated self-management practices.

Klingensmith et al. (2013) and Otis et al. (2020) used game-based external rewards to encourage T1D children's adherence. The key challenge is integrating these behaviors into intrinsic motivation. Internalization improves medication adherence, glycemic control, and diabetes management by fostering empowerment and supportive caregiver relationships. Others psychological assessment indicators will be detailed in (3) measured outcomes.

iii) Clinical Evaluation

Finally, clinical evaluation is vital for implementing multimedia technology in T1D self-management interventions, ensuring effectiveness, safety, and optimization (Ghodousi Moghadam et al., 2024). Scientific clinical evaluation demonstrates that such technology improves health management and quality of life for T1D children. Nine studies[10,12,14,16,17,23,24,26,28] used clinical data (e.g., blood glucose, HbA1c, weight, BMI) as indicators, overseen by professionals, to assess these interventions. For detailed clinical assessments, see (3) Measured outcomes.

However, there are numerous studies that have implemented all three evaluation methods, including Blanson Henkemans et al. (2013), Berndt et al. (2014), and Henkemans et al. (2017). The three studies, starting with usability, conducted effectiveness checks on relevant multimedia technologies. They also analyzed the psychological definition of target behaviors in children with T1D through research on self-efficacy and well-being. Finally, they assessed the self-management outcomes of children with T1D through clinical trials, such as clinical measurements of HbA1c levels. Therefore, through the combination of these three evaluation methods, the results of the experiment are more convincing.

(3) Measured Outcomes

Due to the heterogeneity of these studies, the present study extracted findings and measured them against the four dimensions of self-management CDA7 outcomes in Table 2: (a) behavioral, (b) knowledge, (c) biological, and (d) psychological. Table 3 describes the data reported by the authors, which were examined in this study through literature analysis in the four dimensions and the key outcomes.

All of the studies measured some form of behavioral outcome. Participants' knowledge of diabetes was a key focus and outcome measure in 13 studies. As for the results of psychometric tests, six studies looked at cognition and executive function[1,2,5-7,11]. Researchers found effectiveness when the multimedia technology intervention was sufficient to alter the target behavior's cognition and executive functioning. For instance, Kyfonidis and Lennon's (2016) study found that a mobile game technology intervention helped children with T1D understand blood glucose testing and insulin therapy better, and they were able to use what they learned in real life after the intervention. Further, five studies analyzed stress and distress during diabetes self-management as interventions[3,18,25,27,30], three studies used self-efficacy as a measure[9,16,30], and two studies included quality of life in their evaluations[16,23]. Finally, there are some miscellaneous findings, including social well-being[2], self-esteem[8], self-sufficiency and empowerment[3].

Because the HbA1c level is the most clinically evaluated sign of the efficacy of self-management in diabetes, seven of the nine studies that examined clinical outcomes utilized it as their major biological indicator[10,12,14,16,17,23,24]. Other diabetic outcome markers, including blood glucose levels[26,28], weight[16], BMI[16,17], and hypoglycemia[23,26], were also employed in the remaining investigations.

Except for three studies that did not specify the evaluation methodology[19,29,31], all others demonstrated the feasibility and potential of interventions utilizing the multimedia techniques

discussed in the studies to enhance self-management in children with T1D. A total of 15 studies utilized games as multimedia technology interventions. These games can be categorized into MP/PC games[1,6,7,10,12,13,15,18,19,22,24,25,28,29], AR game[21], and VR games[30-32].

i) MP/PC Game

The MP/PC game study found that (1) the game-based intervention improved the mental health of children with T1D and their ability to carry out self-management-related behaviors. It also improved the cognitive level of people with diabetes[1,6,30]; (2) participants learned more about their diets while playing an MP/PC game[1,6,7,10,12,13,15,21,22,28,32]; (3) players recorded greater enjoyment when a game protagonist shared their condition[7,13,15,18,22,24,30]; and (4) those who participated saw improvements in their HbA1c levels, fasting glucose, mental health, well-being, and quality of life[10,12,24,28]. In three studies[1,12,18], interventions were combined with real products in the MP/PC game intervention. This is a creative way to turn props in a virtual gaming platform into real-life products that can be touched. This type of virtual and real synchronized intervention helps children with T1D better manage their condition, which is a new trend that should be thought about.

ii) AR Game

Another study confirmed that AR game was a good way to help children with T1D eat better by looking at their knowledge and how happy they were with the technology (Calle-Bustos et al., 2017).

iii) VR Game

Three studies have used VR game interventions. Alsharbi & Richards, (2017) observed significant improvements in self-efficacy and diabetes-related distress following their intervention with VR games. Pesare et al. (2015) measured the effectiveness of VR games before and after interventions in blood glucose testing, insulin medication, and decision-making and problem-solving target behaviors through diabetes knowledge. Although one of them did not have an evaluation methodology (Burkholz & Von Mammen, 2019), its analysis in identifying VR games as an intervention as well as the final game design were analyzed in detail from the subject of the T1D child user. Burkholz & Von Mammen, (2019) indicated that VR games have been shown in several studies, such as Theng et al. (2015) and Van den Berg et al. (2012), to significantly lower HbA1c levels, make depressive symptoms more likely, and improve the effectiveness of diabetes self-management. However, the intervention was not aimed at children with T1D. Therefore, VR gaming is a technological intervention with great potential for utilization.

The ultimate goal of VR and AR gaming in self-management for children with T1D is to combine immersive gaming experiences with learning practical health management skills to help children simulate and cope with diabetes-related challenges in a virtual environment.

iv) AI Robot

Four studies have used AI robots as interventions[9,11,14,20], enriching the use of multimedia technology interventions for children with T1D. Furthermore, it was found that the AI robot used in all four studies was the standard commercial Nao robot "Robin" developed by Aldebaran, a subsidiary of United Robotics Group (Germany). However, the target behaviors and measurements they tested differed, with Henkemans et al. (2017) identifying basic knowledge of diabetes, blood glucose testing, and psychological building as target behaviors.In contrast, Blanson Henkemans et al., (2013) integrated insulin therapy and physical activity according to the behavioral goals established by Henkemans et al. (2017). Cañamero & Lewis, (2016) included blood glucose testing, insulin therapy, and mental construction as target behaviors. Coninx et al., (2015), on the other hand, included diabetes basics, decision-making and problem-solving, diet improvement, and psychological building as target behaviors. In all four studies, the outcome was based on both knowledge about diabetes and psychometrics. However, only Blanson Henkemans et al., (2013) used both clinical indicators (HbA1c).

v) MP APP

Nine studies examined interventions utilizing the MP APP[2,3,5,8,16,17,23,26,27], with three integrating realistic medical product design[3,17,26]. When combined, children's health literacy and clinical data, including HbA1c, BMI, blood glucose levels, and hypoglycemia, showed significant improvement. This approach represents an integrative innovation, similar to the use of games with products. Although the six MP APP intervention studies have demonstrated significant effects on self-management in children with T1D, there remains a gap in MP APP research when compared to the dynamic multimedia offered by VR and AR games. For instance, the research conducted by Andersen et al. (2020) incorporated static multimedia elements, including text and images, in diabetes education, while VR games have the capacity to create situational narratives (Alsharbi & Richards, 2017)to facilitate knowledge transfer in contextual teaching.

(4) Limitations of These Studies

An analysis of the 32 articles reveals that most studies focused on subjects from developed countries like Denmark, Sweden, the UK, the US, and Australia, accounting for 23 studies (see Table 4 for details). Although there are studies from developing countries such as Thailand (Klangpremjit, 2019), UAE (Al-Mansoori et al., 2011), Iran (Ebrahimpour et al., 2014), Pakistan (Khan et al., 2023), Kazakhstan (Zholdas et al., 2022), Saudi Arabia (Alsalman et al., 2021; Bitar et al., 2022), and China (Gu et al., 2017), the lack of global representation and cultural diversity limits the variability of multimedia technology interventions for children with T1D across different backgrounds.

Furthermore, many studies lacked longitudinal data to track trends and changes over time in the effects of technology interventions on T1D self-management[1,2,5,7,8,10,13,15,18,22,25,27,30]. Additionally, small sample sizes and short time frames in these studies limit their ability to assess the long-term effectiveness of interventions, as self-management is a prolonged process. Statistical analyses, such as Sharma et al.'s (2020), suggest that a sample size of at least 80 respondents is necessary for reliable results.

Finally, it is important to note that many of the studies didn't look at enough self-management behaviors or how complex and multifaceted self-management really is. Additionally, the studies' evaluation systems lacked coherence, with only five articles incorporating cognitive, biological, and psychological tests[10,12,14,16,23]. It is recommended that children with T1D be given a more complete and integrated evaluation system for multimedia interventions that should be tested to see how well they work.

4.3 RQ 2 What are the Current Trends in the use of Multimedia Technology-Based Interventions for the Self-Management of T1D Children?

According to (3) measured outcomes, MP/PC games, AR/VR game(Immersive gaming experience), AI robots, and multimedia product design integration are key intervention trends for T1D self-management.

In the above analysis, RQ1 found that MP/PC games are multimedia technology-based interventions for the self-management of children with T1D. Most studies have also revealed the benefits and advantages of MP/PC games. While mobile and computer games may improve treatment, challenges include decreased game attraction, low long-term adherence (Fleming et al., 2016), and the risk of prioritizing rewards over health (King et al., 2013). Excessive screen time can harm vision, promote sedentary behavior, and reduce social interactions (Brantly, 2023). Privacy and data security are also concerns (Al-Rayes et al., 2022). Future interventions should balance education, entertainment, social support, and data security, with a focus on AR/VR gaming, AI robots, and multimedia integration for optimal outcomes.

(1) Immersive Gaming Experience in Diabetes Self-Management Intervention

Virtual Reality (VR) and Augmented Reality (AR) are computer technologies that create three-dimensional environments for users to interact with. AR overlays virtual information onto the real world using transparent or semi-transparent displays (see figure 4), while VR generates entirely virtual environments using headset devices (see figure 5). Both technologies enable user engagement with virtual environments through gestures, voice, or line of sight. They are widely used across various disciplines, such as gaming, training, and medical simulation, while AR is used in navigation, education, and marketing to augment real-world experiences.

Figure 4. VR-immersive virtual experience (Alsharbi & Richards, 2017)



Figure 5. AR-adding a virtual experience to reality (Calle-Bustos, 2017)



Children with type 1 diabetes (T1D) are increasingly integrating virtual reality (VR) and augmented reality (AR) technologies into their self-management programs. VR can simulate hypoglycemic emergency situations, helping children acquire coping skills and decision-making abilities (Alsharbi & Richards, 2017). AR integrates knowledge into daily life, assisting in dietary management and insulin dose adjustment (Calle-Bustos, 2017).

VR and AR technologies are increasingly integrated into diabetes self-management programs for children, simulating hypoglycemic emergencies and assisting with dietary management and insulin adjustments. These technologies enhance motivation, responsibility, and social support through gamified tasks, virtual classrooms, and collaborative apps. Real-time data feedback reinforces healthy habits, while VR/AR combined with wearable devices personalizes the experience. Anurogo et al. (2023) also say that cross-cultural adaptation, psychological support, and AI integration can help

people improve their self-management skills even more by giving them personalized interventions and smart virtual tutors.

(2) Robot-Human Interaction (AI Technologies)

In terms of application trends, robot-human interaction and artificial intelligence technology also play an important role in the treatment of diabetes in children (Cañamero & Lewis, 2016; Coninx et al., 2015**;** Blanson Henkemans et al., 2013; Henkemans et al., 2017). Claudia Sinoo (2018) conducted a comparative study as shown in Figure 6. The study compared the use of AI robots and virtual characters in children with diabetes. It found that children formed stronger friendships with physical robots than with virtual characters. The more children believed the robot and its avatar were the same, the stronger their friendship with the virtual image became, motivating them to play the game app and improving its usability score. This study confirms the positive intervention effects of robots in the self-management of T1D children.

Figure 6. Robin-an AI robots help children improve their mental health and manage themselves (Cañamero & Lewis, 2016)



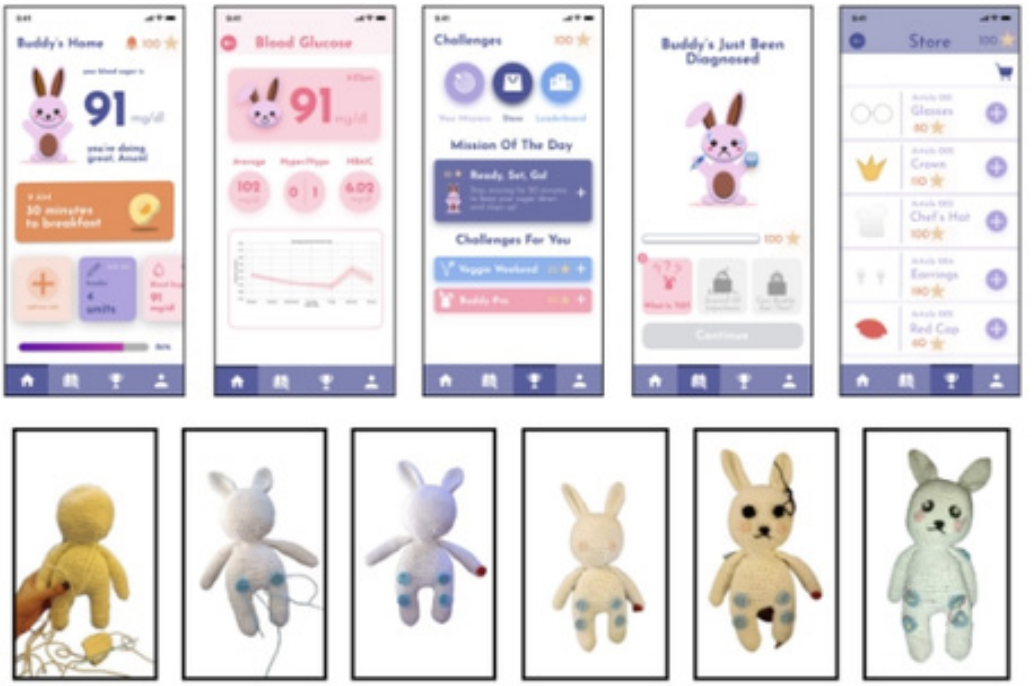
AI and robotics are enhancing self-management in children with T1D by analyzing glucose trends, adjusting insulin, and providing personalized reports. AI chatbots offer management advice and psychological support, while wearable devices predict risks like hypoglycemia and provide reminders (A. Sharma et al., 2024). Social robots offer emotional support, and AI monitors health data in real-time for remote guidance (Cantone et al., 2023). Emerging technologies like deep learning and robot-assisted surgery improve treatment options. Future trends include advanced closed-loop systems, emotionally intelligent tools, and AI-based healthcare solutions, improving self-management and reducing burdens on families and healthcare systems.

(3) Integrated use of Multimedia Technology Matching Product Design

The intervention model combining multimedia technology with supportive products offers numerous benefits, including a non-invasive approach that helps children achieve behavioral goals and self-management without harm (Kyfonidis & Lennon, 2016; Khan et al., 2023;

Klingensmith et al., 2013; Gu et al., 2017; Stone, 2013; Zholdas et al., 2022). Khan et al. (2023) designed the blood glucose monitor as a small rabbit doll, drawing inspiration from children's thinking patterns. The MP application also incorporates these same elements, as illustrated in Figure 7. This design offers emotional value and a sense of care for T1D children's blood glucose management, which sets it apart from the coldness of existing blood glucose medical products on the market and makes it more suitable for children. This design provides emotional value and a sense of care for T1D children's blood glucose management, unlike existing medical products on the market.

Figure 7. Simultaneous design of APP and product integration (Khan, 2023)



Multimedia technology and affective medical product design are used together to help children with Type 1 Diabetes (T1D) better manage their condition. The goal is to get them more involved by giving them personalized, emotionally supportive tools. These interventions integrate functionality (e.g., glucose monitoring) with emotional needs by using gamification, virtual characters, and rewards to motivate participation and long-term adherence. Furthermore, AI-driven personalized recommendations improve self-monitoring and decision-making, while social support via platforms and virtual interactions reduces isolation (Liang et al., 2024).

5. CHALLENGES

The use of multimedia technology in supporting self-management for children with Type 1 Diabetes (T1D) faces several challenges despite its potential benefits. As T1D diagnoses increase among younger demographics, the need to establish a strong foundation for long-term self-management becomes critical (Gao et al., 2021).

Firstly, one challenge lies in the design and development of multimedia tools that effectively address the unique needs of children with T1D. Achieving multimedia diversification—integrating robotics with gaming, combining applications with medical products, or merging virtual and real-world elements—requires innovative approaches to ensure these tools enhance self-management skills.

Another challenge is systematization, which involves defining self-management target behaviors across seven aspects while accounting for the psychological needs of T1D children. This systematic approach is crucial to creating interventions that are not only effective but also sustainable in fostering lifelong self-management habits.

Furthermore, balancing technological innovation with accessibility, personalization, and the psychological well-being of young users remains a significant hurdle in advancing multimedia interventions for T1D self-management. Multimedia technology-based interventions (MTBI) have potential for self-management in children with type 1 diabetes (T1D) but face challenges such as technology accessibility, financial cost, complexity of personalization needs, user engagement, data security, privacy, and clinical validation (L. Johnson & Teitelman, 2018). Accessibility and financial costs are significant barriers, as families struggle to afford hardware devices and high-quality multimedia apps (Huang, 2020). Personalization needs also vary among children, making it difficult to adapt existing content and understand complex interfaces. User engagement and adherence are also challenges, with potential loss of interest in long-term use and difficulty for parents to support children's use due to time or technical comprehension constraints (Hagström et al., 2022). Data security and privacy are also key issues, with multimedia tools potentially exposed to leakage and legal compliance barriers when used across borders (Brooks, 2011).

In addition, lack of extensive, long-term validation studies and challenges in quantifying their effectiveness limit the efficacy of MTBI products. Rapid changes in technology can make old products useless, and different standards for device platforms make it challenging to add new features and share data (Brantly, 2023). Psychological and socio-cultural barriers, including limited acceptance of technological interventions, should be taken into account.

6. FUTURE DIRECTIONS

This study outlines the future direction of multimedia technology interventions for self-management in children with Type 1 Diabetes (T1D). The content analysis of the previous two questions suggests potential future directions for the design of multimedia technology, interventions, and the viewpoints of pertinent policymakers and healthcare professionals.

6.1 From a Multimedia Technology Design Perspective

(1) Application of Immersive gaming experience multimedia technology in the further direction in younger T1D children

Immersive gaming technologies, like Virtual Reality (VR) and Augmented Reality (AR), offer a promising approach for enhancing self-management in younger children with Type 1 Diabetes (T1D). These technologies create engaging, interactive environments where children can safely practice essential tasks such as blood glucose monitoring and insulin injections. Future advancements will focus on using AI for real-time health monitoring and personalized feedback while fostering emotional connections and social support through multiplayer interactions (A. Sharma et al., 2024; Cantone et al., 2023). Gamification elements and cross-platform integration with devices like continuous glucose monitors (CGMs) will encourage long-term adherence and healthier behaviors. As these technologies evolve, they will provide a more effective, enjoyable way for children to manage their diabetes, improving both health outcomes and quality of life.

6.2 Multi-Perspective Consideration can Help T1D Children Lead Better Lives

(1) Child-friendly diabetes medical product design

Advancements in medical products for Type 1 Diabetes (T1D) management, such as blood glucose meters and insulin syringes, have focused on non-invasive designs that reduce resistance and align with children's preferences. By rethinking the appearance, materials, and colors of these products, designers ensure a pain-free and fun experience while also considering children's physiological and psychological needs (Chhiba, 2019). When combined with multimedia technology, these products create a unified and engaging design that enhances self-management for children with T1D (Khan, 2023).

(2) Persuasion and companionship by personalized AI robots for T1D children

Multiple studies have explored the benefits of personalized robots in educating children with T1D toward self-management (Blanson Henkemans, 2013; Cañamero & Lewis, 2016; Henkemans, 2017; and Claudia Sinoo, 2018). Claudia Sinoo's (2018) research suggests that personalization has additional benefits for child-robot interaction (CRI), including engagement, well-being, meeting social needs, and motivation. Furthermore, studies have demonstrated that personalization amplifies the influence of CRI on the development of academic skills and the elevation of health awareness. These studies also point to the need for further research into the benefits of personalized robots in helping children with T1D to achieve self-management.

(3) Integrated application of multimedia technology in the further direction in younger T1D children

Medical products incorporating multimedia technology are revolutionizing the management of Type 1 Diabetes (T1D) in children. These products offer personalized support through interactive learning, behavioral guidance, and data management features like animation, VR, and AR to simulate real-world scenarios. They provide intelligent reminders, healthy behavior prompts, and reward systems, along with dynamic data visualization for collaborative feedback. Emotional support is delivered via virtual companions and relaxation tools. Additionally, multimedia technology fosters collaboration with peers, parents, and teachers through online platforms. Future products will leverage AI, VR, and big data to further enhance personalized self-management and improve the quality of life for children with T1D.

6.3 From the Perspective of Multimedia Technology Interventions

Multimedia technology-based interventions (MTBIs) have enormous potential to improve self-management in children with Type 1 Diabetes (T1D). Future development will focus on personalized, AI-driven interventions, using machine learning, voice, and emotion recognition to tailor support based on the child's age, background, and health. A comprehensive ecosystem will integrate platforms, smart devices, wearables, and AR/VR for immersive learning. Blockchain will enhance data security, while gamified tools and behavioral interventions improve engagement (Lopez-Barreiro et al., 2023). Clinical research, industry standards, and integration with healthcare systems will advance, alongside cultural and psychological support for diverse backgrounds. Emerging technologies like wearables, 5G, and IoT will optimize real-time health monitoring and intervention strategies (A. Sharma, Singh, et al., 2024).

6.4 From the Perspective of Policy Development and Healthcare Workers

Future development of multimedia technology-based interventions (MTBI) for Type 1 Diabetes (T1D) self-management will require key actions. Policymakers should offer financial support for

low-income families, ensure data privacy protection, and establish clinical accreditation. Healthcare workers need training in relevant technologies and interprofessional collaboration. Data-driven interventions and remote monitoring will allow better health tracking. Cross-sector collaboration is essential to integrate MTBI into public health, education, and technology (Pham, 2019). Mental health support, emotional counseling, and family involvement are crucial for stress relief. Clinical research and evaluations will enhance long-term effectiveness while considering cultural and regional needs in global development.

7. CONCLUSION

This study investigates the application of multimedia technology in self-management interventions for children with Type 1 diabetes (T1D) over the past two decades. It highlights the diverse ways multimedia applications and games have been used to enhance self-management skills, focusing on their ability to promote medical autonomy and improve outcomes. The research underscores the promising potential of integrating multimedia tools with product design to achieve better results in self-management practices.

The study also identifies future trends that prioritize the integration of immersive gaming experiences (such as virtual reality (VR) and augmented reality (AR)) with innovative medical products. Additionally, it emphasizes the critical role of AI-powered robots in providing supervision, emotional accompaniment, and persuasive interventions. This combination not only reduces resistance to medical treatments but also fosters self-efficacy, encourages better self-management practices, and lays a foundation for T1D children to achieve independent medical care and lifelong self-management.

To maximize the benefits of multimedia technology in self-management for children with Type 1 Diabetes (T1D), future research should focus on the systematic and diverse integration of these tools. Personalization and accessibility are key, with adaptive tools designed to meet the unique needs of T1D children while addressing barriers like cost and device availability. Immersive experiences such as VR and AR gaming should be combined with medical and educational interventions to create engaging simulations for skill training. AI and robotics can enhance outcomes by providing real-time supervision, personalized feedback, and emotional support. Longitudinal studies are needed to evaluate the long-term effectiveness of these interventions, helping children transition to independent self-management. Collaboration among healthcare professionals, educators, and technologists is essential to develop evidence-based, clinically effective interventions with standardized evaluation frameworks across medical, psychological, and behavioral domains. Ethical considerations, including robust data protection and cultural adaptability, should guide the development and deployment of these technologies. By addressing these priorities, multimedia technology can improve T1D children's self-management, enhance their autonomy, and lay a foundation for lifelong health and independence.

CONFLICT OF INTEREST

The authors state that the study was done without any commercial or financial links that may be seen as a possible conflict of interest.

AUTHOR CONTRIBUTIONS

HF contributed to the current study's statistical analysis as well as data storage for future usage. Nadia reviewed and modified the initial draft of the article. Nassiriah helped design the section on data processing using statistical approaches. All of the writers listed above have agreed to the appropriate duties of the article content.

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DATA AVAILABILITY STATEMENT

The author confirms that the data supporting the results of this study can be found in the article.

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