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Review

Therapeutic Education in Children and Adolescents with Type 1 Diabetes Mellitus: A Systematic Review

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Abstract

Background/Objectives: Therapeutic education for children and adolescents with Type 1 Diabetes Mellitus (T1DM) is a continuous and essential process in the effective management of the disease. These programs consider the unique characteristics and developmental needs of each child or adolescent, aiming to empower them to take responsibility for their disease self-management, improve quality of life, and prevent complications. The purpose of this systematic review was to evaluate the impact of therapeutic education in children and adolescents with T1DM on self-management of their disease. **Methods**: International bibliography was reviewed using electronic databases such as PubMed, Cochrane Library, and Scopus. Key words such as "Therapeutic Education", "Type 1 diabetes", "children", "self-management", "glycemic control", and "educational programs" in combination with Boolean operators (AND, OR) were used in English language to search for studies conducted during 2014–2024. **Results**: A total of 23 studies met the inclusion criteria. Most reported improvements in glycemic control, though not all showed statistically significant reductions in glycated hemoglobin (HbA1c). Enhanced treatment adherence and increased diabetes-related knowledge were common outcomes. Combined educational approaches incorporating psychoeducational interventions demonstrated greater effectiveness in promoting self-management. Digital tools, such as Continuous Glucose Monitoring (CGM), further supported adherence. Quality-of-life improvements were noted but were not always sustained long-term. Parental involvement appeared to improve children's confidence in disease management. The critical role of interdisciplinary diabetes care teams, particularly nurses' role, was also highlighted. **Conclusions**: Therapeutic education appears to support self-management among children and adolescents with T1DM, particularly when programs are individualized, family-centered, multidisciplinary, and supported by psychosocial or technological components. However, effects on glycemic control were not consistent across studies, and further research is needed to confirm long-term outcomes.

Keywords: therapeutic education; Type 1 Diabetes Mellitus; children; adolescents; self-management; glycemic control; educational programs

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1. Introduction

Type 1 Diabetes Mellitus is a chronic autoimmune disease characterized by the destruction of pancreatic β-cells and absolute insulin deficiency. It typically presents during

childhood or adolescence and requires lifelong insulin therapy and self-management to prevent both acute and chronic complications, such as diabetic ketoacidosis, nephropathy, retinopathy, and cardiovascular disease [1–3]. The global incidence of T1DM is increasing annually, placing a significant emotional and clinical burden on pediatric populations and their families [4].

Effective management of T1DM extends beyond insulin administration and relies on a comprehensive, multidisciplinary approach. This includes regular glucose monitoring, nutritional planning, physical activity, psychological support, and, critically, therapeutic education [5]. Adequate education is essential to help young patients maintain glycemic control and avoid complications. Without the necessary skills and knowledge, children and adolescents may struggle with daily management tasks, leading to suboptimal outcomes [6].

Therapeutic education is defined as a continuous, structured process that enables individuals with diabetes to acquire and maintain the skills needed for optimal self-care [7]. For younger patients, these educational interventions must be tailored to their developmental stage, cognitive abilities, and emotional needs. The ultimate goal is to promote autonomy and empower youth to take active responsibility for their health [8]. In this context, family involvement and a supportive care environment are key facilitators of success [9].

A growing body of research highlights the benefits of structured educational programs on treatment adherence, diabetes-related knowledge, and psychosocial outcomes [10,11]. These programs often integrate psychoeducational strategies, such as Coping Skills Training (CST), motivational interviewing, or family-based behavioral interventions. Additionally, the use of digital tools, such as CGM, mobile health apps, and online platforms, has expanded the potential reach and personalization of diabetes education [12,13]. However, despite these promising findings, the current literature reveals variability in outcomes. While some studies report statistically significant reductions in HbA1c, others show only modest or short-term improvements [14]. Differences in program design, duration, intensity, and population characteristics may contribute to these inconsistent findings. Moreover, long-term sustainability of behavioral and metabolic benefits remains a major concern in pediatric populations. These divergent results emphasize the need for a more in-depth understanding of which components make educational programs most effective for youth with T1DM. Specialized diabetes nurses, as core members of the interdisciplinary team, play a vital role in delivering therapeutic education. Their continuous involvement in supporting patients and families is often cited as a determinant of program success [15].

This systematic review aims to evaluate the impact of therapeutic education on self-management in children and adolescents with T1DM. The review synthesizes findings from the last decade and identifies the key components of successful interventions, contributing to future program development and evidence-based pediatric diabetes care.

2. Materials and Methods

2.1. Study Design and Protocol

This systematic review followed the PRISMA 2020 guidelines and was designed to evaluate the effectiveness of therapeutic education in children and adolescents with T1DM. The review protocol was defined before study selection and data extraction; however, it was not prospectively registered in PROSPERO or another international registry. The research question was structured according to the PICO framework:

- P (Population): Children (ages 1–12) and adolescents (ages 13–19) diagnosed with T1DM.
- I (Intervention): Therapeutic education programs (individual, group-based, digital, psychoeducational).
- C (Comparison): Children and adolescents with T1DM who did not receive therapeutic education.

- Outcome (O): Impact of therapeutic education on self-management of T1DM (glycemic control, treatment adherence, diabetes knowledge, and quality of life).

2.2. Search Strategy

An extensive literature search was performed in PubMed, Scopus, and the Cochrane Library to identify relevant studies published between January 2014 and April 2024. The search strategy combined Medical Subject Headings (MeSH), where applicable, and free-text terms related to type 1 diabetes, children and adolescents, therapeutic education, diabetes self-management education, glycemic control, treatment adherence, diabetes-related knowledge, quality of life, psychosocial outcomes, and family involvement. Boolean operators (AND/OR), truncation, and database-specific syntax were applied according to the requirements of each database. The complete search strings for each database, including applied filters, date limits, date of search, and number of records retrieved, are presented in Supplementary Table S2. In addition, the reference lists of included articles were manually screened to identify further eligible studies.

2.3. Inclusion and Exclusion Criteria

Including the PICO framework, as previously described, the criteria for study selection were defined as follows: studies were required to be published in the English language and within the time frame of 2014 to 2024. Eligible studies included primary research designs such as Randomized Controlled Trials (RCTs), non-randomized interventional studies, cohort studies (both prospective and retrospective), cross-sectional studies, as well as qualitative and mixed-methods research.

The exclusion criteria were defined as follows: studies not directly related to the research question and studies published prior to 2014 were excluded. Additionally, studies involving adult populations with T1DM or those including children and adolescents with T2DM were not considered eligible. Studies for which the full text was not available or that did not report final outcomes were also excluded. Furthermore, conference abstracts and proceedings limited to summary data were omitted, as were case reports, editorials and letters to the editor. Finally, studies based on experimental animal models were excluded from the analysis.

2.4. Study Screening and Selection Process

The study selection was conducted by two independent reviewers in two phases: initial screening of titles and abstracts, followed by full-text evaluation for eligibility. Any disagreements were resolved through discussion or consultation with a third reviewer. The selection process is illustrated in the PRISMA flow diagram.

2.5. Data Extraction

The data from studies that met the inclusion criteria were extracted using a standardized table. The extracted information included: authors and year of publication, country and duration of the study, study objectives, total sample size, methodology, and key outcomes. These data are summarized in Supplementary Table S1, presented in chronological order.

2.6. Quality Assessment and Risk of Bias

To enhance the methodological rigor and transparency of this systematic review, two independent reviewers performed a critical appraisal of all included studies using validated quality assessment tools, tailored to the study design. The PRISMA 2020 checklist was used as a reporting guideline for the appraisal of reporting quality and transparency of included meta-analyses [16]. The detailed results of this assessment are presented in

Supplementary Table S2. RCTs were evaluated based on the CONSORT 2010 checklist, which comprises 25 criteria assessing methodological completeness and quality [17]. The results are presented in Supplementary Table S3. Non-randomized and observational studies, including cohort, case–control, and quasi-experimental pre-post designs, were assessed using the Newcastle-Ottawa Scale, focusing on selection, comparability, and outcome [18]. The detailed results of this assessment are presented in Supplementary Table S4. Qualitative studies were appraised using the Critical Appraisal Skills Programme (CASP) checklist, which includes 10 items related to methodological rigor and the trustworthiness of data analysis [19]. The results of the quality assessment are presented in Supplementary Table S5.

2.7. Data Synthesis

Due to significant heterogeneity in study design, interventions, comparator groups, follow-up duration, and outcome measures, a meta-analysis was not feasible. Although HbA1c was frequently reported, formal subgroup analysis was not feasible because studies differed substantially in baseline HbA1c, intervention duration, comparator group, follow-up timing, age range, and reporting of effect estimates. A narrative synthesis was therefore performed. Findings were organized into thematic categories: glycemic control (HbA1c), treatment adherence, diabetes-related knowledge, quality of life and psychosocial outcomes, family involvement, and the role of healthcare professionals in delivering education. Where possible, findings were interpreted according to study design. Randomized controlled trials and controlled interventional studies were considered more informative for evaluating intervention effectiveness, whereas qualitative and mixed-methods studies were used primarily to contextualize psychosocial, behavioral, and family-related findings.

2.8. Ethical Considerations

This review was based exclusively on previously published studies. It did not involve human participants or the collection of personal data. Therefore, no ethical approval was required.

3. Results

3.1. Study Selection

The systematic database search identified 138 records. After removing 7 duplicates, 131 records were screened based on titles and abstracts. Of these, 95 records were excluded for not meeting the inclusion criteria. The full texts of 36 records were sought for retrieval; however, 2 full texts could not be accessed. Therefore, 34 full-text articles were assessed for eligibility. Twelve articles were excluded after full-text assessment, leaving 22 studies from the database search. An additional 10 records were identified through manual searching of reference lists. Among these, 5 reports were not retrieved, 4 studies were excluded after eligibility assessment, and 1 study fulfilled the inclusion criteria. Ultimately, 23 studies were included in the final synthesis. The study selection process is presented in the PRISMA 2020 flow diagram (Figure 1).

3.2. Study Characteristics

The 23 included studies were published between 2014 and 2024 and were conducted in various countries including the United States, United Kingdom, Canada, Australia, and several European nations. The studies varied in design, comprising RCTs, non-randomized interventional studies, cohort studies, qualitative research, and mixed methods approach. Sample sizes ranged from 15 to 1126 participants. Most studies targeted children and adolescents with T1DM aged 6–18 years, while some included family members (parents or caregivers) as part of the intervention group. The duration of interventions

ranged from a few weeks to 24 months. Educational interventions varied across studies, including structured programs delivered in-person, web-based modules, school-based interventions, and mobile health applications. These characteristics are presented in Supplementary Table S1, which summarizes the key features of the included studies.

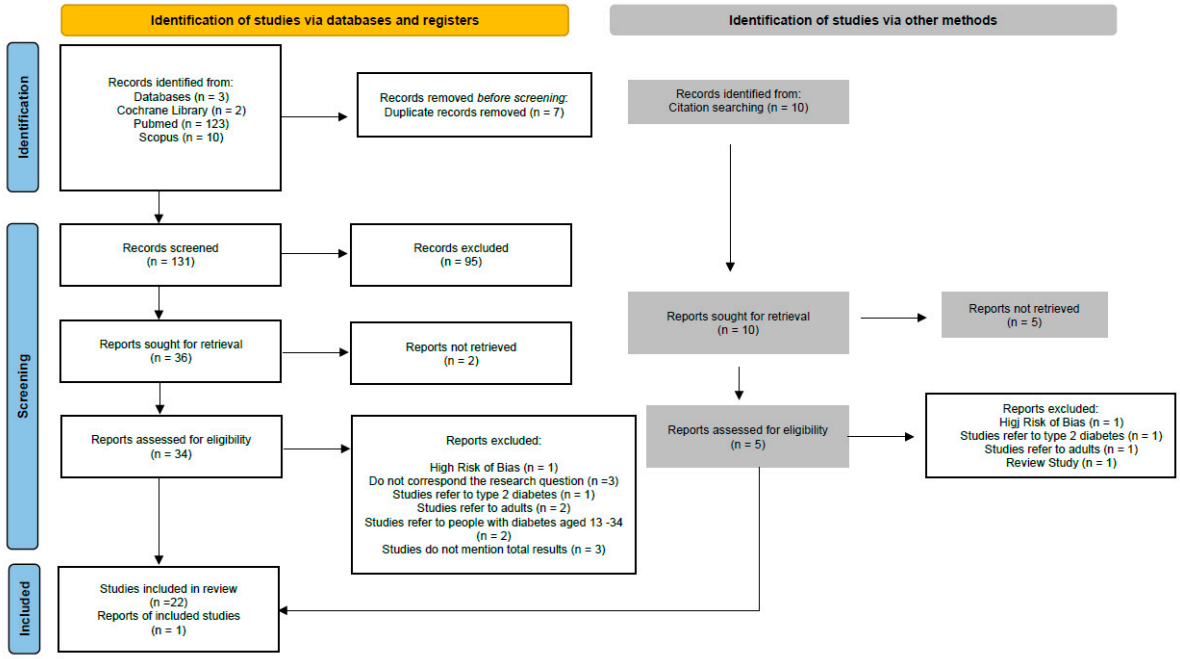

Figure 1. PRISMA 2020 flow diagram illustrating the study selection process.

3.3. Thematic Synthesis of Findings

3.3.1. Glycemic Control—HbA1c

The impact of therapeutic education on glycemic control, particularly as measured by HbA1c, varied across the included studies. Several studies did not report a statistically significant reduction in HbA1c in intervention groups compared to controls, indicating limited direct effect of educational programs on glycemic regulation in certain populations [20–28]. For example, Christie et al. observed stable HbA1c levels over a 24-month period, suggesting the absence of sustained benefit from the intervention [20]. Similarly, Basarir et al. [21] found no significant difference in mean HbA1c between intervention and control groups. However, in the subgroup with baseline HbA1c > 9.5%, a significant reduction in severe hypoglycemia and ketoacidosis was recorded, contributing to long-term cost reduction. Conversely, other studies reported statistically significant HbA1c improvements following structured educational interventions. Obarcanin et al. [29] showed significant reductions as early as three months ($p = 0.000022$), which were sustained at six months ($p = 0.0075$). Brorsson et al. [30] noted more pronounced effects in boys, while Hasan et al. [31] linked participation in diabetes camps with clinical benefits. Additionally, Mohammed et al. [32] highlighted that combining education with lifestyle modification was more effective than education alone. Although some studies, such as Donzeau et al. [25] and Ait-Taleb Lahsen et al. [33], reported non-significant trends in HbA1c improvement, they still observed favorable shifts in pre- and postprandial glycemia. In summary, therapeutic education may support glycemic control in some settings, particularly when integrated with individualized or multidisciplinary approaches. However, the inconsistent statistical significance across studies indicates that effects on HbA1c should be interpreted cautiously.

3.3.2. Treatment Adherence

Adherence to therapeutic recommendations in children and adolescents with T1DM is a critical determinant of successful diabetes management and long-term health outcomes. Several studies highlighted the positive effect of structured educational interventions on improving adherence behaviors [24,25,27,34–36]. In the study by Holmes et al. [34] participation in an educational program led to improved adherence and gradual enhancement in diabetes self-care behaviors. Maranda et al. [35] reported a significantly greater adherence response among younger adolescents (10–13 years) compared to older adolescents (14–17 years), with statistically significant differences ($p = 0.04$). However, challenges in maintaining adherence, especially during adolescence, were also reported. Fonte et al. [36] emphasized that adolescents often experience emotional strain and strive for independence, which may lead to treatment fatigue and occasional non-adherence. This underscores the importance of psychosocial support within educational interventions. Parental involvement appears to play a beneficial role. In the study by Walker et al. [25] both children and their caregivers reported high levels of satisfaction and commitment to the program, suggesting a potential positive influence on adherence and family engagement. Moreover, the integration of technological tools was shown to facilitate adherence. DiMeglio et al. [27] found that groups using CGM devices performed fewer fingerstick Blood Glucose (BG) measurements, indicating a potential shift toward more sustainable adherence practices. Collectively, the findings suggest that therapeutic education, particularly when tailored to age-specific needs and supported by caregivers and technology, can substantially enhance adherence to T1DM management.

3.3.3. Parental Involvement and Psychosocial Functioning

Therapeutic education appeared to positively influence psychosocial well-being of children and adolescents with T1DM and parental involvement in several included studies. Studies by Christie et al. [20] and Fonte et al. [36] indicated that educational interventions enhanced emotional support and collaboration between parents and children, promoting self-efficacy in disease management. Interventions such as CST improved coping abilities, autonomy, and perceived quality of life, while fostering confidence in diabetes self-management [26,37]. Culturally adapted programs further contributed to increased trust and improved lifestyle behaviors among adolescents and their caregivers [37]. The use of digital tools like CGM+ Family Behavioral Intervention (FBI) not only reduced parental stress related to hypoglycemia but also enhanced satisfaction with diabetes care [27]. Significant psychosocial, emotional, and academic benefits were reported across several studies, as demonstrated in the findings of Ben Abdesselam et al. [38]. However, some studies [22,31,35] reported limited effects on psychosocial outcomes, particularly in cases of persistent anxiety or where strong initial family conflicts existed. These findings highlight the importance of tailoring educational interventions to individual family dynamics. Moreover, Brorsson et al. [30] underlined that active parental participation and ongoing psychological support are essential components in promoting adaptive functioning. Overall, structured educational interventions contributed to improved psychosocial outcomes and strengthened the overall support system for youth with T1DM.

3.3.4. Satisfaction and Body Image

The reviewed studies examined participants' satisfaction and body image in relation to T1DM management, highlighting both challenges and positive outcomes. Christie et al. [20] reported reduced body satisfaction, likely linked to psychosocial stressors associated with the chronic nature of the disease. However, interventions integrating dietary education, such as those described by Mohammed et al. [32] and Ben Abdesselam et al. [22], were as-

sociated with positive changes in health indicators, including BMI reduction and increased physical activity. A notable intervention was the "Football with Diet Group" (FDG), where participants demonstrated significant physical improvement, reinforcing the holistic benefit of educational programs [33]. Moreover, the study by Brosrson et al. [30] and Pabedinskas et al. [39] underscored the psychosocial benefits of such programs, reporting enhanced self-confidence and readiness to change disease management behaviors. Specifically, in the intervention by Ben Abdesselam et al. [38], significant physical health progress was documented, indicating the role of structured education in overall well-being.

Nevertheless, psychological barriers remained. Lahsen et al. [40] highlighted that participants experienced anxiety and emotional challenges, emphasizing the need for psychological support during and after interventions. Although initial willingness to change was evident in some groups [30], sustained improvement required continuous engagement and emotional reinforcement. In conclusion, therapeutic education can improve both physical and psychological well-being in children and adolescents with T1DM. However, issues related to body image, emotional distress, and self-esteem call for integrated programs combining behavioral, nutritional, and psychological components to optimize health outcomes and quality of life.

3.3.5. Cost of Care

Studies assessing the cost of care highlighted the relationship between economic efficiency and the effectiveness of various educational programs. In the study by Christie et al. [20] standard care appeared to be more cost-effective, yielding similar outcomes to structured psychoeducational programs but at a lower financial burden. In contrast, another study found that the "Kids in Control OF Food" (KICk-OFF) intervention, although associated with higher initial costs, offered greater long-term benefits [21]. Specifically, the program was more cost-effective for individuals with elevated HbA1c levels, suggesting its value for patients requiring more intensive glycemic management. Overall, while conventional care may be more economical in the short term, structured interventions such as KICk-OFF may prove more beneficial in the long run, particularly for those facing challenges in glycemic control [21].

3.3.6. Quality of Life

Therapeutic education appears to impact various aspects of quality of life (QoL) among children and adolescents with T1DM, though results were heterogeneous. Several studies reported significant improvements in QoL following structured interventions. For instance, Ben Abdesselam et al. [38] demonstrated that participants in a therapeutic education program showed substantial enhancement in QoL scores ($p < 0.001$), indicating improved subjective well-being compared to the control group. Similarly, Ait-Taleb Lahsen et al. [33] found significant gains in health-related quality of life (HRQoL) within the intervention group, while the control group experienced a decline, particularly in domains related to diabetes, therapy-related concerns, and communication. In contrast, some studies showed no statistically significant change in QoL. For example, Mauri et al. [41] reported that while the Patient Education and Empowerment Program (PED program) increased illness acceptance, it did not directly influence perceived QoL. Maranda et al. [35] also observed no significant difference in QoL between the intervention and control groups ($p = 0.09$), despite improvements in HbA1c. Similarly, Hasan et al. [31] found enhanced glycemic knowledge and control, but not QoL. Other findings suggest selective improvements in specific QoL domains. Donzeau et al. [25] reported that the "Advanced Carbohydrate Counting" (ACC) group achieved better psychological and physical health ratings, despite no overall QoL improvement. Likewise, Hood et al. [23] observed reduced emotional

distress across all participants, though this did not translate to improved depression or resilience scores. In some cases, improved glycemic outcomes were not mirrored by QoL gains. For example, Obarcanin et al. [29] noted significant HbA1c improvement without corresponding QoL changes. Conversely, Brorsson et al. [30] reported lower QoL ratings in the intervention group, potentially due to increased diabetes-related awareness or perceived burden. Overall, therapeutic education shows potential to improve various facets of QoL in youth with T1DM. However, mixed outcomes highlight the need for interventions tailored to the developmental stage, individual needs, and psychosocial context of participants. Further research is essential to identify which program components most effectively enhance QoL and to understand how QoL interacts with clinical outcomes.

3.3.7. Tailored Educational Approaches and Monitoring

Evidence suggests that personalized and intensive therapeutic education enhances self-management in children and adolescents with T1DM. In the study by Obarcanin et al. [29], participants who received frequent follow-up (more than six monthly visits and 5–6 daily BG measurements) achieved better glycemic outcomes compared to the control group with fewer visits. Similarly, Tandon et al. [28] found that individualized carbohydrate counting education improved participants' adherence and acceptance of dietary strategies, underscoring the value of tailored interventions. However, studies by Charalampopoulos et al. [22] and Dubovi et al. [42] indicated that general psychoeducational methods were not always sufficient. Charalampopoulos et al. [22] reported no statistically significant improvement in diabetes-related knowledge post-intervention, while Dubovi et al. [42] noted limited understanding of diabetes self-management routines, suggesting that more focused approaches are needed. In contrast, Mauri et al. [41] and Hasan et al. [31] demonstrated significant gains in participants' knowledge regarding diabetes monitoring and nutrition. Notably, Mauri et al. [41] observed that structured educational activities during diabetes camps significantly improved disease-related knowledge, highlighting the benefits of experiential learning. Lahsen et al. [40] emphasized the importance of culturally adapted programs, identifying the need for specialized content for Moroccan children and adolescents with T1DM. Furthermore, Pabedinskas et al. [39] found that the use of visual and role-based pedagogical tools enhanced engagement and improved acceptance of diabetes-related responsibilities among participants. In summary, tailored and intensive educational approaches, incorporating frequent follow-up, culturally relevant content, and interactive learning tools, appear more effective in improving knowledge, self-efficacy, and diabetes management skills. Nevertheless, the need for more targeted and customized strategies remains critical, especially in settings where standard psychoeducational interventions prove insufficient.

4. Discussion

This systematic review highlights the impact of therapeutic education programs on various clinical, psychosocial, and behavioral outcomes in children and adolescents with T1DM. Overall, the findings demonstrate that structured educational interventions can contribute positively to glycemic control, treatment adherence, knowledge acquisition, and quality of life, although outcomes vary depending on intervention type, delivery method, and participant characteristics. The findings are consistent with contemporary literature, which conceptualizes therapeutic education as a core component of Diabetes Self-Management Education and Support (DSMES), operating across clinical, behavioral, and psychosocial domains [43,44].

The findings of the present review are consistent with previous systematic reviews and meta-analyses examining educational, psychoeducational, and diabetes self-management

education interventions in pediatric T1DM. Charalampopoulos et al. reported that psychoeducational interventions in children and young people with T1DM showed no significant pooled improvement in HbA1c, although interventions targeting self-efficacy demonstrated a moderate beneficial effect [22]. Similarly, Rohilla et al., in an umbrella review of systematic reviews, highlighted substantial heterogeneity in DSMES-related interventions and concluded that evidence across clinical, behavioral, and psychosocial outcomes remains variable, with important gaps regarding long-term sustainability [45]. Reviews focusing on quality of life have also emphasized that DSMES may influence psychosocial and patient-reported outcomes, but effects are not uniform across studies and depend on intervention content, outcome measurement, and follow-up duration [46,47]. More recently, Cockcroft et al. reported small short-term improvements in HbA1c and quality of life following educational and psychoeducational self-management interventions but concluded that the available evidence remains insufficient to confirm clinically meaningful and sustained benefits [48]. Therefore, the present review should be interpreted as an updated multidimensional synthesis of recent therapeutic education programs rather than as a fundamentally novel conceptual contribution.

Improvements in glycemic control were reported in several studies, especially when education was integrated into multidisciplinary or personalized approaches [22,25,29,31,32,34,35]. Programs combining structured education with psychological support or technological tools, such as CGM, appeared to show more favorable HbA1c outcomes in some studies. However, not all studies reported statistically significant improvements, indicating that educational interventions alone may not always suffice to achieve optimal metabolic control. These inconsistencies may be attributed to variability in baseline HbA1c levels, intervention duration, intensity, and family involvement. This variability observed in glycemic control outcomes across studies aligns with evidence from other systematic reviews and meta-analyses. This heterogeneity is well-documented in the literature, suggesting that educational interventions tend to exert stronger effects on behavioral and psychosocial outcomes than on metabolic indices [49]. Glycemic control is influenced by a complex interaction of factors, including adherence, psychological state, and family environment, indicating that education alone may be insufficient to achieve sustained metabolic improvements without integration into broader, multicomponent care models.

The heterogeneity observed across studies likely reflects differences in intervention intensity, duration, cultural adaptation, family involvement, baseline glycemic control, and integration of psychosocial support. Interventions combining behavioral, technological, and family-centered components generally demonstrated more consistent benefits than education-only approaches. Variability in outcome assessment tools and follow-up duration further complicated direct comparison between studies.

The inclusion of diverse study designs allowed a broad understanding of therapeutic education in pediatric T1DM but limited direct comparability across studies. Therefore, conclusions regarding intervention effectiveness were based primarily on randomized controlled trials and controlled interventional studies, while qualitative and mixed-methods evidence was used to explain contextual factors, family dynamics, psychosocial experiences, and barriers to self-management.

Treatment adherence was another key outcome influenced by therapeutic education. Interventions incorporating behavioral and technological components, such as CGM or family-based strategies, promoted better adherence to treatment regimens [25,27,34–37]. Younger participants often responded more positively to interventions, underscoring the importance of age-specific strategies. Nevertheless, psychological barriers such as emotional distress, burnout, and the desire for autonomy among adolescents were found to challenge sustained adherence, especially during transitional phases of development [36].

Adolescents frequently report tension between the demands of disease management and their developmental need for autonomy, identity formation, and social integration [50]. These psychosocial dynamics contribute to treatment fatigue and variability in adherence, particularly during transitional developmental stages.

The role of family and psychosocial functioning emerged as a central theme. Educational interventions that actively engaged parents and addressed psychosocial dynamics improved emotional coping, communication, and perceived quality of life [20,24–27,36–39]. Family-based and culturally tailored programs enhanced trust and health behaviors, while also reducing emotional distress and diabetes-related anxiety. However, some studies showed limited or non-significant effects, suggesting the need for continuous support and individualized follow-up [22,31,35]. These findings are in accordance with a recent systematic review focusing on caregiver-targeted educational interventions demonstrated that improving parental knowledge and self-efficacy significantly enhances children's adherence and overall diabetes management outcomes [51]. These findings support a shift toward a family-centered model of care, in which caregivers act as key mediators of self-management behaviors. The present review aligns with this perspective, emphasizing that parental involvement is integral to both clinical and psychosocial outcomes in pediatric T1DM.

Regarding body image and satisfaction, mixed results were observed. While some participants reported increased self-esteem and improved physical activity habits after engaging in educational programs involving nutrition and exercise [30–32,38], others continued to struggle with psychosocial stressors related to chronic illness management [39,40]. These findings underline the need for comprehensive interventions that address both emotional and physical aspects of care.

Quality of life outcomes were among the most frequently assessed. Many studies demonstrated significant improvements in QoL indicators, particularly those using validated tools such as HRQoL questionnaires [23,25,27,29,31,32,35,38,41]. However, not all participants experienced improvements across all domains, and some studies reported no changes or even decreased scores in specific QoL subscales. This variation may reflect the multidimensional nature of QoL and the diverse needs of children and adolescents with T1DM, depending on age, family context, and disease burden. Evidence from a systematic review indicates that DSMES interventions tend to improve specific psychosocial domains, such as emotional distress, treatment satisfaction, and coping, without consistently improving overall QoL scores [46]. This suggests that QoL should be conceptualized as a dynamic and domain-specific construct, influenced by individual, social, and disease-related factors rather than a singular global outcome.

The cost-effectiveness of educational interventions was also considered. Traditional care was generally more economical in the short term but provided fewer long-term benefits compared to structured education programs [20,21]. Interventions such as the "KICk-OFF" program showed higher initial costs but resulted in improved outcomes for participants with poorly controlled diabetes, indicating that upfront investments in education may lead to better long-term health and economic outcomes. The cost-effectiveness of therapeutic education is also supported by existing evidence. Although structured educational programs may involve higher initial costs, they are associated with long-term economic benefits through improved disease management and reduced complications, particularly among individuals with suboptimal glycemic control [21]. This supports the integration of structured education into routine care as a sustainable healthcare strategy.

A significant component highlighted in the literature is the need for personalized education and intensive monitoring [22,28,29,31,39–42]. Tailored interventions that included multiple visits, interactive tools, and culturally adapted materials were more successful in

enhancing knowledge, self-efficacy, and disease management skills. Educational strategies combining didactic elements with experiential learning (e.g., camps or interactive activities) showed promising results, especially among younger participants. Recent evidence suggests that tailored educational approaches, considering developmental stage, cultural context, and individual needs, are more effective in improving engagement and health outcomes [44,49]. Furthermore, current clinical guidelines emphasize the integration of digital technologies, such as continuous glucose monitoring and digital health tools, as essential components of modern therapeutic education frameworks [43].

The findings should be interpreted in light of the methodological quality of the included studies. Evidence from randomized controlled trials and controlled interventional studies was considered more robust, whereas findings from small, uncontrolled, qualitative, or self-reported studies were interpreted more cautiously. Variability in methodological quality may partly explain the inconsistent effects observed across outcomes, particularly for HbA1c, treatment adherence, psychosocial functioning, and quality of life. Therefore, conclusions regarding intervention effectiveness were drawn with caution and considered in relation to study design, sample size, follow-up duration, and outcome measurement.

Despite the encouraging findings, several limitations must be acknowledged. The heterogeneity in study designs, populations, and outcome measures limits the comparability of results. The inclusion of heterogeneous study designs also limited the possibility of formal stratified analysis and required cautious interpretation of the findings. Many studies lacked long-term follow-up, making it difficult to assess the sustainability of observed benefits. Additionally, some interventions were evaluated using self-reported measures, which are subject to bias. Moreover, the methodological quality of the studies included varied, which limits the strength of the conclusions that can be drawn across outcomes. The exclusion of conference abstracts, unpublished studies, and grey literature may have introduced publication bias, as studies with statistically significant or favorable findings are more likely to be published in peer-reviewed journals. In addition, restricting the search to English-language studies may have introduced selection bias. Formal assessment of publication bias, such as funnel plot analysis, was not feasible because a meta-analysis was not performed due to substantial heterogeneity in study designs, interventions, and outcome reporting. Furthermore, Cohen's kappa statistics were not calculated during the screening process. Moreover, cultural, socioeconomic, and health system differences may influence intervention effectiveness, necessitating adaptation and contextualization of programs. The review protocol was not prospectively registered in PROSPERO or another international database. Although the methodology was predefined before study selection and data extraction, the absence of protocol registration may reduce methodological transparency and increase the potential risk of selective reporting. Formal grading of evidence certainty using GRADE was not performed. Therefore, the certainty of evidence for each outcome could not be formally classified, and the strength of conclusions should be interpreted with caution.

These limitations underscore the importance of developing evidence-based, adaptable educational frameworks that address the evolving needs of children and adolescents with T1DM. Future research should prioritize high-quality randomized controlled trials with standardized outcome measures and longer follow-up periods. Future studies should also systematically examine potential moderators of educational effectiveness, including socioeconomic status, cultural context, baseline HbA1c, diabetes duration, insulin delivery method, digital literacy, family structure, and parental education level. These factors may influence engagement with therapeutic education and may partly explain heterogeneity across studies. Special attention should also be given to vulnerable populations and to the integration of technology and family-centered approaches in therapeutic education.

5. Conclusions

Therapeutic education appears to be an important component of pediatric T1DM management and may support self-management among children and adolescents. The present review indicates that therapeutic education may contribute to improvements across several domains, including glycemic control, treatment adherence, diabetes-related knowledge, psychosocial functioning, family involvement, quality of life, and cost-effectiveness. However, the findings across studies were not uniformly consistent. Variability in intervention types, follow-up duration, cultural adaptations, and assessment tools may account for the heterogeneity in outcomes.

Despite these limitations, the findings suggest that structured educational programs may be beneficial in pediatric diabetes care, particularly when they are tailored to individual, developmental, cultural, and family-related needs. Such programs may support self-management skills, psychosocial adaptation, and selected clinical outcomes. Multidisciplinary, intensive, interactive, and technology-supported approaches appear promising, although their effectiveness varies across studies and outcomes.

Future research should focus on the long-term sustainability of these benefits, the identification of optimal delivery models, and the development of standardized assessment metrics. Expanding access to culturally sensitive and individualized therapeutic education could substantially improve the overall experience and outcomes of young individuals living with T1D.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/diabetology7070132/s1, Figure S1 PRISMA 2020 Checklist: Completed PRISMA checklist for reporting systematic reviews, Table S1: Summary of the included studies, Table S2. Quality assessment of systematic reviews and meta-analyses based on PRISMA guidelines. Summary Table, Table S3. Quality Assessment of Randomized Controlled Trials Using the CONSORT 2010 Checklist. Summary Table, Table S4. Quality assessment of non-randomized and observational studies using the Newcastle–Ottawa Scale (NOS). Summary Table, Table S5. Quality Assessment of Qualitative Studies Using the CASP Checklist. Summary Table.

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Abbreviations

The following abbreviations are used in this manuscript:

ACC	Advanced Carbohydrate Counting
BCC	Behavior Change Communication
BG	Blood Glucose
BGM	Blood Glucose Monitoring
CASP	Critical Appraisal Skills Programme

CC	Carbohydrate Counting
CG	Control Group
CGM	Continuous Glucose Monitoring
CSII	Continuous Subcutaneous Insulin Infusion
CST	Coping Skills Training
DFIS	Diabetes Family Impact Scale
DG	Diet Group
DLC	Diabetes Learning Center
DSME	Diabetes Self-Management Education
FBI	Family Behavioral Intervention
FDG	Football with Diet Group
FG	Football Group
GSD-Y	Guided Self-Determination-Young
HbA1c	Glycated Hemoglobin A1c
HFS-PYC	Hypoglycemia Fear Survey—Parent Version for Young Children
HRQoL	Health-Related Quality of Life
KICk-OFF	Kids in Control OF Food
MeSH	Medical Subject Headings
NHS	National Health Service
PAID-PR	Problem Areas in Diabetes—Parent Revised
PED	Patient Education and Empowerment Program
PedsQL 3.0	Pediatric Quality of Life Inventory Version 3.0 Diabetes Module
PhC	Pharmacist-led Care
PICO	Population, Intervention, Comparison, Outcome
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRP	Pennsylvania Resilience Program
QALYs	Quality-Adjusted Life Years
QoL	Quality of Life
RCTs	Randomized Controlled Trials
RNE	Routine Nutrition Education
SEP	Structured Education Program
SimDCell	Simulated Diabetes Education Cell
STePS	Supporting Teens Problem Solving
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus

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