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REVIEW ARTICLE

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Psychoeducational interventions to improve adolescents' medical management of diabetes: A comprehensive review

Implementation of psychoeducational interventions for adolescents with diabetes is a critical component of medical management and overall well-being. There have been significant advances and innovations since the last major comprehensive review of the literature in 2006 (Murphy, Rayman, & Skinner, 2006). The increase in technologically assisted psychoeducational interventions using text, apps, and interactive Internet-based programming results in a qualitative update of psychoeducational interventions and program evaluations. Also noted is an increase in the number of family-focused interventions that have been evaluated and published. The results of the current comprehensive literature review yield 42 evaluative studies of psychoeducational interventions for adolescents with type 1 diabetes with mixed outcomes. Despite the variety of interventions and research designs, only two of the 42 studies reported moderate effect sizes. All the others indicated no effects or small effects. Although not conclusive, the most promising approaches involve the use of motivational interviewing involving individual, family, and technological support. The ramifications for future research, potential value of psychoeducational interventions for adolescents, and implementation of technology for delivering psychoeducational interventions for adolescents with diabetes are described.

KEY WORDS
diabetes; adolescents; psychoeducational interventions; literature review; pediatric psychology

ORGANIZATION – McGill University, Montreal, QC, Canada

AUTHORS' CONTRIBUTIONS – A: Study design · B: Data collection · C: Statistical analysis · D: Data interpretation · E: Manuscript preparation · F: Literature search · G: Funds collection

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BACKGROUND

Type 1 diabetes is one of the most common chronic illnesses affecting young people in North America (Babler & Strickland, 2015). The incidence of diabetes is growing in the general population, but this growth is especially apparent in low socioeconomic status and ethnic minority groups (Kassai et al., 2015). Being diagnosed with diabetes has a negative influence on academic, social, medical, and overall well-being. However, these negative outcomes are mitigated by effective medical and psychoeducational management (Murphy, Wadham, Hassler-Hurst, Rayman, & Skinner, 2012). Medical management of diabetes requires a multidisciplinary approach that includes medical treatment and adherence to supportive lifestyle management (Sajatovic et al., 2011; Shalev, & Geffken, 2015). Changing behaviour involves psychoeducational interventions that are implemented by physicians, nurses, educators, and parents for the benefit of adolescents. However, the effectiveness of these interventions for changing long-term behaviours is not clear.

Adolescents with diabetes present a specific set of developmental challenges in care and management. There is an increased desire for independence, yet the daily living skills required for independence are developing (Markowitz, Garvey, & Laffel, 2015). For all adolescents, this is a challenging developmental period. Many experience a wide range of adjustment and mental health problems (Chilton & Pires-Yfantouda, 2015). Behavior patterns established during this process, including those related to the management of chronic medical issues such as diabetes, can have long-lasting positive or negative effects on future health and well-being. As a result, professionals have unique opportunities to influence adolescents. Parents, members of the community, medical professionals, and educators have the responsibility to promote adolescent development and adjustment as well as to intervene effectively when problems arise. For adolescents with diabetes, the requirement that medical regimens be adhered to with fidelity may clash with common adolescent rebellion in the development of self-directed identity (Hanna & Guthrie, 2003). This can have dangerous consequences for adolescents' health. Failure to effectively monitor blood glucose levels, insulin delivery, diet, or physical activity can result in negative medical outcomes ranging from long-term effects such as vascular damage to acute issues such as diabetic ketoacidosis and hypoglycemia (Weissberg-Benchelle et al., 1995). Adolescence is also a challenging period for persons with diabetes because responsibilities for management shift from parent-directed to self-managed care (Cheraghi, Shamsaei, Mortazavi, & Moghimbeigi, 2015). Often the ability to self-manage is not mastered during this transition, placing adolescents at risk for medical complications and lower quality of life as they develop into adulthood (Anderson, Brackett, Ho, & Laffel, 1999; Corathers et al., 2015). Sustainable self-management requires the development of a sophisticated skill set, which includes self-monitoring, self-injection, adhering to a dietary and exercise plan, and avoiding high-risk behaviours common in adolescents such as alcohol abuse (Anderson, Ho, Brackett, Finkelstein, & Laffel, 1997; Bedrossian et al., 2016).

There are four essential self-management domains for persons with diabetes: (a) glucose monitoring, (b) insulin delivery, (c) diet, and (d) physical activity. More than 40% of adolescents with diabetes do not conduct scheduled glucose monitoring (Weissberg-Benchell et al., 1995). Over 25% of adolescents are reported to have missed at least one insulin injection per week (Weissberg-Benchell et al., 1995). Approximately 70% of adolescents fail to follow dietary guidelines (Heinrich, Schaper, & de Vries, 2010). Over 80% do not meet the recommended guidelines for physical activity (Shalev & Geffken, 2015). Given that self-management behaviours are not well followed during adolescence, there is a need to improve self-management behaviours for adolescents that involves not only developing the required skill sets, but also the motivation to self-manage.

The most recent comprehensive review of the effectiveness of psychoeducational interventions for the management of diabetes was conducted by Murphy, Rayman, and Skinner (2006). The results of this review were mixed in terms of overall intervention effectiveness. The rationale for conducting the current review of research for the last 12 years is threefold: basic research and program evaluations have grown more frequent and more sophisticated over the last 12 years with improvement in research methodology, individualization, and sophistication of methods used; creating psychoeducational interventions that consider the importance of development, as opposed to a generic intervention for all children or adults, has recently become recognized as a critical aspect of any form of psychoeducational intervention; and the advent of technology that includes smart phone use, improved communication methods (e.g., text reminders), automated medical interface, websites, as well as interactive and individualized instructional techniques (e.g., applications [apps]). As such, there is reason to believe that there may be both a quantitative and qualitative change in the nature of the research literature over the last 12 years. A review of this most recent literature is more likely to result in recommendations for implementation of psychoeducational interventions that is up-to-date and consistent with advances in technology.

The goal of this comprehensive literature review is to determine which psychoeducational interventions designed to improve management of diabetes in ad-

olescents are demonstrated to be most effective. The primary research question is: Do psychoeducational interventions result in improved medical outcomes and overall well-being? There are secondary questions to this literature review as well. Are there differential effects of the instructional mechanism used (i.e., technology-driven, family-focused, or individual or group behaviour change) for medical outcomes and overall well-being? Which outcome variables (i.e., quality of life measures, self-efficacy measures, HbA1c levels, behaviour problems, social acceptance, family conflict, body mass index, blood pressure, positive outcome expectations, perceive social supports, or blood glucose monitoring) are most affected by specific psychoeducational interventions? Do other design factors of the evaluative study (e.g., length of the intervention, pre-intervention blood glucose control, socioeconomic status, and ethnicity) lead to improved medical outcomes and overall well-being? Studies are evaluated based on the soundness of the research methodology and effect sizes.

METHODS

SCOPE OF THE REVIEW

The sections that follow summarize the steps involved in retrieving the literature for this review. The definitions and search strategies used are largely based on those employed by the authors of previous systemic reviews, namely Hampson and colleagues (2001) and Murphy, Rayman, and Skinner (2006).

SEARCH STRATEGY

Three electronic databases were searched for research published from January 2004 until October 2016). PsycINFO (1987-), MEDLINE and CINHAL were selected because of their emphasis on the disciplines relevant to the topic, that is, psychology, medicine, and nursing. The search strategy for this review was defined by condition, developmental period, intervention, and outcomes. The specific search terms entered into each database varied slightly depending on the structure of the database employed. However, at minimum, each search included the following terms: "diabetes," "adolescent/adolescence," and "intervention." The MEDLINE and CINHAL searches also included terms to define the type of intervention (e.g., "psychological," "social," "psychosocial," or "education"). Synonyms for diabetes, adolescent/adolescence and intervention were also employed. For example, the synonyms used for adolescent/adolescence included "teen," "youth," "child/children," "young person/people," and "puberty." All terms were searched as text words appearing in the title, abstract, or as a keyword. The database searches yielded a total of 1001 published articles as results (PsycINFO 587 results; MEDLINE 98 results; CINHAL 316 results), and all entries were exported into *Zotero*, a reference managing system.

A cited reference search of Hampson et al.'s 2001 systematic review was also performed in Google Scholar, which yielded a total of 235 results. Using this strategy, several papers were identified and stored as background literature; however, the majority of the studies were duplicates and no additional studies were identified for possible inclusion in this review.

INITIAL SCREENING – TITLE AND ABSTRACT CHECK

The titles and abstracts of all articles were then reviewed and an initial screening was performed using a set of broad inclusion and exclusion criteria outlined by Hampson et al. (2001). Specifically, articles were retained if the following criteria were met: (a) the article was primarily about diabetes; (b) adolescents were included in the study, and; (c) the psychoeducational interventions employed were evaluated. Similar to previous reviews of this nature, a broad definition of educational and psychosocial intervention was employed. This included programs aimed at changing diabetes-related knowledge and behaviour, the provision of psycho-social training or support, as well as individual or family counselling.

During the initial screening phase, any duplicate references were identified and removed from *Zotero*, leaving a total of 942 citations. The citations were organized into folders labelled as followed: excluded, background literature, or primary research studies. In total, 128 potential primary research studies were identified, and the full text articles were retrieved online (Figure 1).

DETAILED SCREENING – INITIAL PAPER REVIEW

Following the initial screening, the research articles were reviewed using a fine grained screening process in order to make a decision about including them in the review. The refined inclusion and exclusion criteria are outlined below:

Inclusion criteria. The key criteria for inclusion in this review were that the paper referred to: (a) type 1 diabetes, (b) adolescents aged 12 to 18 years, (c) educational and/or psychosocial interventions, and (d) measurement of the intervention's effect on participants (i.e., intervention outcomes).

Exclusion criteria. Papers were excluded for the following reasons:

1. The research was not an intervention evaluation; for example, studies discussing the epidemiology

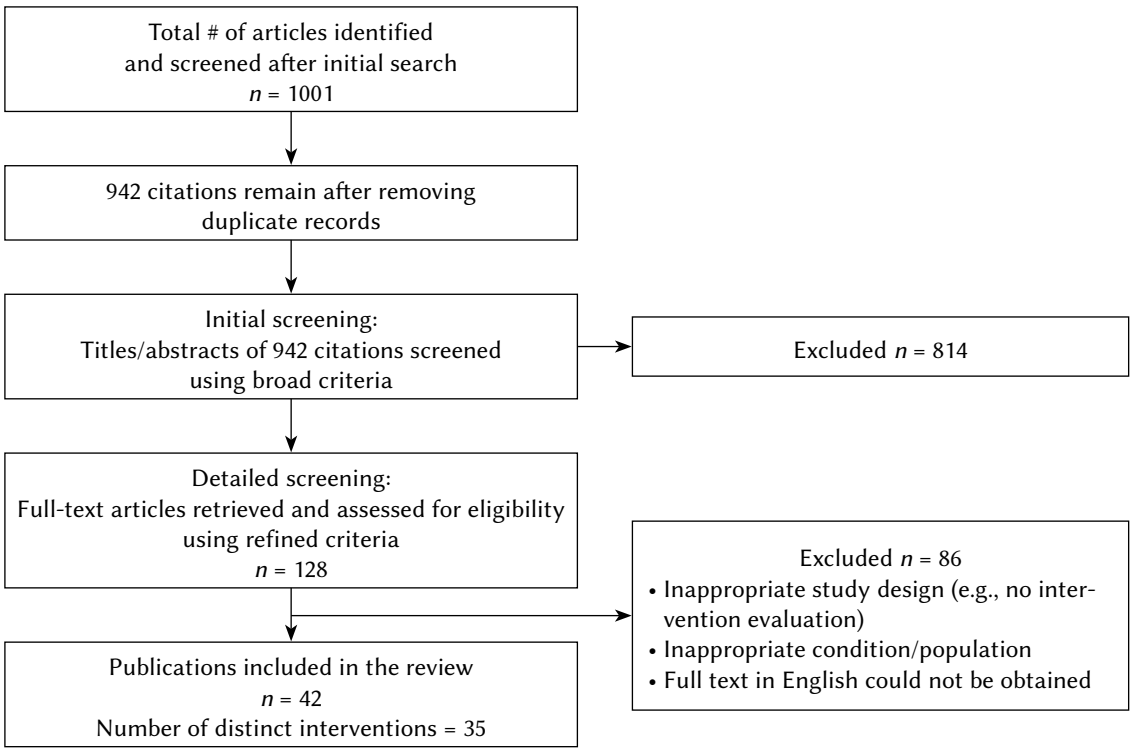

Figure 1. Literature Search Strategies and Decision Tree.

of diabetes in a given area or using non-human subjects were excluded.

2. Type 1 diabetes was not the exclusive focus of the paper; for example, those focusing on type 2 diabetes or gestational diabetes, or those discussing type 1 diabetes in relation to another health issue (e.g., sexual health) were excluded.
3. There was no clear investigation of the intervention's impact on adolescent participants. Studies exclusively investigating intervention outcomes for parents and medical staff of adolescents with type 1 diabetes were excluded. Those examining outcomes for participants of a wide age range (e.g., 2 to 18 years or 16 to 65 years), without stratifying by age or developmental period, were also excluded. However, outcomes discussed in relation to a more restricted age range consisting primarily of older children and adolescents were retained (e.g., 8 to 16 years).
4. The research was a small-scale pilot study ($N < 15$), formative evaluation (e.g., feasibility studies), or employed a purely qualitative design (including case studies and $N = 1$ methods).
5. Research was also excluded if there was no full text article available in English, or if there was insufficient information about the specific intervention employed, or the study participants, to determine whether the study met the criteria for inclusion.

After detailed screening, a total of 42 intervention studies describing 35 distinct interventions were retained for inclusion in the current review. The identified studies can be organized into three main categories: those describing technology-driven interventions, family-focused interventions, and other individual- or group-format behaviour change interventions. Although there is overlap across studies, interventions have been categorized according to their primary emphasis and delivery method.

RESULTS

Results and study characteristics are summarized in Table 1. Previous reviews have called for more research evaluating the effectiveness of psychological interventions for type 1 diabetes (Murphy, Rayman, & Skinner, 2006; Weissberg-Benchell et al., 1995). Over the last 12 years, there have been 42 detailed evaluative studies of psychoeducational interventions for adolescents with diabetes. The 42 studies identified represent a diversity of methods, goals, and outcomes. As such, a quantitative review of research, such as a meta-analysis, is not possible and a comprehensive literature review is most likely to yield useful information for clinicians and researchers involved in creating psychoeducational interventions for adolescents with type 1 diabetes.

TECHNOLOGY-DRIVEN INTERVENTIONS

In the present review, 10 of the published studies identified directly involve a technology-delivered

Table 1

Study Characteristics and Results

	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
1	Aguilar, Garcia, Gonzalez, Perez, & Padilla (2011)	Education intervention using One Touch UltraSmart Duration: approx. 7 months (1 educational session per month, which resulted in 7 hospital visits)	Technology	37	9-16 years	Quantitative	Students *t*-test for paired samples one-way ANOVAs Bonferroni tests	HbA_{1c} Questionnaire regarding eating and exercise habits	Significant average reduction of **HbA_{1c}** Significant improvement in **dietary habits**
2	Channon et al. (2007)	*Motivational Interviewing (MI)* Duration: 12 months	Behaviour change (Individual)	66 (38/28)	14-17 years	Quantitative	Repeated measures ANCOVA Pearson correlations coefficients (for exploratory analysis between changes in key psychosocial outcomes during treatment)	Mean HbA_{1c} Diabetes Quality of Life Measure for Youths The Child Health Locus of Control The Modified Health Care Climate Questionnaire The Diabetes Knowledge Scale The Self-Efficacy for Diabetes Scale The Well-being Questionnaire The Diabetes Family Behavior Scale The Personal Models of Diabetes Scale	At 12 months, mean **HbA_{1c}** in the MI group was significantly lower than in the control group after adjusting for baseline values Difference in **HbA_{1c}** was maintained at 24 months At 12 months, the MI group indicated a higher degree of **positive well-being** & improved **quality of life**; specifically, higher life satisfaction, lower life worry, less anxiety, and more positive well-being There were also differences in their **personal models of illness** (i.e., the MI group perceived their diabetes to be more serious and placed greater importance on controlling it. They also had stronger beliefs that certain actions were more likely to help prevent future complications of diabetes and perceived it to have a smaller degree of impact on their lives) Differences with respect to **life worry** and **anxiety** were maintained at 24 months

(Table 1 continues)

Table 1

(Table 1 continued)

	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
3	Christie et al. (2014)	*Child and Adolescent Structured Competencies Approach to Diabetes Education (CASCADE)*: An intensive competency driven, motivational, psychoeducational program involving patients and families in a standard clinic setting Duration: 4 intervention modules over 4 months (1 per month)	Family-focused	362 (181/181)	8-16 years	Mixed Method	Intention-to-treat comparisons of outcomes (at 12 and 24 months) using analysis of covariance Logistic regression used for binary outcomes	HbA_{1c} # of hypoglycemic episodes and hospital admissions Diabetes regimen Responsibility for diabetes management Compliance with intervention Clinic utilization Emotional and behavioural adjustment General and diabetes-specific QoL	The intervention did not improve **HbA_{1c}** at 12 months or 24 months Intervention group parents at 12 months and young people at 24 months had higher scores on **diabetes family responsibility** questionnaire Young people in the intervention group reported **reduced happiness in body weight** at 12 months *Note: Low intervention uptake due to difficulties organizing groups, and patient work and school commitments
4	de Wit et al. (2008)	*Health-Related Quality of Life (HRQoL) intervention*: Monitoring and discussing HRQoL with adolescent patients Duration: 3 regular scheduled visits in 12 months	Behaviour change (Individual)	91 (46/45)	13-17 years	Quantitative	Repeated measures ANOVA Multilinear regression (to examine possibility of interaction and confounding effects of demographic and diabetes-related variables)	HbA_{1c} Child Health Questionnaire (CHQ; physical and psychosocial well-being subscales) Center for Epidemiological Studies scale for Depression Diabetes-Specific Family Conflict Scale Patients' Evaluation of the Quality of Diabetes Care	No significant differences between groups over time for **HbA_{1c}** levels Means scores on the CHQ subscales of **psychosocial health**, **behaviour**, **mental health** and **family activities** improved in the HRQoL intervention group, except for adolescents with the highest HbA_{1c} Adolescents in the HRQoL intervention groups reported higher **self-esteem** at follow-up regardless of HbA_{1c}, and were more **satisfied with care** than control subjects

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
5	de Wit et al. (2010)	*Health-related Quality of Life (HRQoL) intervention:* Monitoring and discussing HRQoL with adolescent patients Duration: 3 regular scheduled visits in 12 months * *1 year follow-up study*	Behaviour change (Individual)	41	13-17 years	Quantitative	Repeated measures ANOVA using General Linear Modeling Forward multilinear regression (to examine predictors of change in scores)	HbA_{1c} Child Health Questionnaire (CHQ; physical and psychosocial well-being subscales) Diabetes-Specific Family Conflict Scale Center for Epidemiological Studies scale for Depression Patients' Evaluation of the Quality of Diabetes Care	12 months post-intervention, **HbA_{1c}** values had increased significantly Mean scores on the CHQ subscales: **behaviour, mental health** and **self-esteem** had significantly decreased, whereas **family activities**, subscale remained stable Adolescents were also less **satisfied with their care**
6	Ellis et al. (2005)	*Multi-Systemic Therapy (MST)*: Intensive, family centered and community-based intervention Duration: ~ 6 months	Family-focused	127 (64/63)	10-17 years	Quantitative	Intent-to-treat approach; 2 × 2 (treatment × time) mixed-design analysis of variance; Structural equation modeling	Diabetes Stress Questionnaire Frequency of blood glucose testing Total HbA_{1c}	Participation in MST (compared to standard care) was associated with significant reductions in **diabetes related stress** MST improved **HbA_{1c}** through **regimen adherence** (mediator)
7	Garcia-Perez, Perestelo-Perez, Serrano-Aguilar, & Trujillo-Martin (2010)	Psycho-educative intervention implemented in a summer camp, consisting of medical, educational and psychosocial components (e.g., interactive seminars about diet, hygiene, recognition and management of hypo- and hyperglycemia, as well as relax seminars and games, etc.) Duration: 8 days	Behaviour change (Group)	55 (34/21)	11-18 years	Quantitative	*t*-tests for independent samples & the normative metric Kolmogorov-Smirnov Z test Pearson correlations	HbA_{1c} BMI Knowledge about diabetes management (using a questionnaire based on a Spanish validated questionnaire for adults) STAI (state anxiety) STAI-C (trait anxiety) TAMI (adaptability)	No significant changes in **HbA_{1c}**, **BMI, diabetes knowledge**, **anxiety**, **medical visits** or **hospital admission** from pre- to post-intervention

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
8	Graue, Wentzel-Larsen, Hanestad, & Sovik (2005)	Structured educational and counselling program combining group visits and individual computer-assisted consultations Duration: 15 months	Technology	101 (55/46)	11-17 years	Quantitative	2-sample *t*-tests Regression analyses (with covariates: baseline scores, randomization group, age, gender and HbA1c)	HbA_{1c} Diabetes Quality of Life Questionnaire Child Health Questionnaire – well-being Age, gender, BMI, diabetes duration and treatment, injection technique, acute complications	No significant effect on mean **HbA_{1c}** Significant age by group interactions for diabetes related impact, worries, mental health and general behaviours, implying that intervention was effective for adolescents above 13/14 years
9	Grey et al. (2013)	*TEENCOPE*: Internet-based Coping Skills Training (CST) Theory: Social Cognitive Theory *Managing Diabetes*: Internet-based diabetes education and problem solving program (comparison group) Duration: 12 months (1 group) – 18 months (2 groups)	Technology	320 (167/153)	11-14 years	Quantitative	A series of mixed effects models (repeated measures linear regression with arbitrary within-subject correlation structures)	HbA_{1c} Pediatric Quality of Life Inventory Perceived Stress Scale Responses to stress Questionnaire Self-Efficacy for Diabetes Scale Self-Management of Diabetes – Adolescents Self-Perception Profile for Adolescents Scale (Social acceptance subscale) Diabetes Family Conflict Scale	At 12 months, there was no significant differences between intervention groups in terms of HbA_{1c} and QOF. Youth in both groups had stable **QOF** (i.e., no change pre to post-intervention) and minimal increases in **HbA_{1c}** At 18 months, lower **HbA_{1c}**, and higher **QOL**, **social acceptance** and **self-efficacy**, as well as lower **perceived stress** and **diabetes family conflict** for youth completing both groups versus just one intervention
10	Hanberger, Ludvigsson, & Nordfeldt (2013)	*Diabit Web 2.0 portal*, including diabetes-related information and the possibility to communicate with diabetes peers and health care professionals Duration: 1 year	Technology	484 (230/254)	Mean age: 13.2 years	Quantitative	Mann-Whitney *U* test & Wilcoxon signed rank test; Students *t*-test, paired and unpaired; Chi square	DISABKIDS chronic-generic module, short form (Health-related QoL) Quality from the Patients Perspective (QPP) – quality of care Swedish Diabetes Empowerment Scale	**QOL** and **diabetes empowerment** did not differ between intervention and control groups Patients who had someone in the family visiting the portal 5 times or more had shorter diabetes duration, were younger, more often girls, and had lower **HbA_{1C}** after 1 year

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
11	Harris, Harris, & Mertlich (2005)	In-home *Behavioural Family Systems Therapy (BFST)* Theory: Systems theory Duration: 5-8 weeks	Family-focused	18 adolescents (and primary caregivers)	13-18 years	Quantitative (descriptive)	*t*-tests	HbA_{1c} Self-Care Inventory Diabetes Mismanagement Questionnaire Diabetes Responsibility and Conflict Scale Adjustment to Illness Scale Diabetes Family Behaviour Checklist Child Behavior Checklist Conflict Behaviour Questionnaire	**HbA_{1c}** remained unchanged from baseline to initial post-treatment and at 6 months At initial post-treatment follow-up, there were significant decreases in **general family conflict**, **diabetes-related family conflict** & **behaviour problems** *At 6 month follow-up (*N* = 17), initial post-treatment improvements were no longer present
12	Holmes, Chen, Mackey, Grey, & Streisand (2014)	*Coping program:* Individualized, intensive family teamwork coping skills training *Education program*: Psychologically supportive education program to maintain parental involvement and disease care throughout early adolescence Duration: 4 sessions in total	Family-focused	226 families (137/89)	11-14 years	Quantitative	Growth Curve Analysis	HbA_{1c} Diabetes Behaviour Rating Scale Parental Monitoring of Diabetes Care Scale Diabetes Family Conflict Scale Revised Self-Efficacy for Diabetes Self-Management Scale Pediatric Quality of Life-Diabetes subscales	Rate of change in **HbA_{1c}** over time was significantly better for the Education versus Usual Care (UC) group, and for the Education versus Coping group (i.e., glycemic control improved in the education group over time compared with the other two groups). HbA_{1c} of the Coping and UC groups did not differ from one another Education group improved in **diabetes adherence** across all follow-ups and improved more over time relative to the Coping group. The Coping groups demonstrated sustained diabetes adherence Both groups showed lower levels of **parental monitoring** over time, although the Education group tended to have more parental monitoring than the Coping group over time Both groups had **positive parental expectations about involvement** No significant changes in **diabetes-related and general family conflict**, as well as **self-efficacy**

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
13	Jaser, Patel, Rothman, Choi, & Whittemore (2014)	*Check-It!:* A positive psychology intervention designed to increase positive affect (PA) through gratitude, self-affirmation, small gifts, and parental affirmations Attentional control (education) condition – mailed diabetes educational materials Duration: Every 2 weeks over an 8-week period	Behaviour change (Individual)	39 (20/19)	13-17 years	Quantitative	Mixed effects models Bivariate correlations (to examine the association between PA and measures of adherence)	HbA_{1c} Mean frequency of BG monitoring over previous week Positive and Negative Affect Scale Children's Depression Inventory Self-Care Inventory (adherence) Diabetes Family Conflict Scale Pediatric Quality of Life Inventory Type 1 Diabetes Module	No main effects for treatment were observed at 6 months follow-up A significant association between adolescents level of **positive affect** and measures of **adherence** (including self-report and meter downloads of BG monitoring) was found
14	Jaser et al. (2014)	*TEENCOPE:* Internet-based CST Theory: Social Cognitive Theory *Managing Diabetes*: Internet based diabetes education and problem solving program Duration: 12 months	Technology	320 (167/153)	11-14 years	Quantitative	Mediation analyses for within subjects designs (Judd, Kenny, & McClelland, 2001)	HbA_{1c} Pediatric Quality of Life Inventory Responses to Stress Questionnaire Self-Efficacy for Diabetes Scale Self-Management of Diabetes – Adolescents Self-Perception Profile for Adolescents Scale (Social acceptance subscale) Diabetes Family Conflict Scale	No significant effects of either intervention on **HbA_{1c}** Both groups showed significant improvements in **QOL** over time No significant between-group intervention effects **Self-efficacy** mediated the effects on quality of life in both interventions *TEENCOPE:* Stress reactivity, primary control coping, and secondary control coping mediated treatment effects *Managing Diabetes:* Social acceptance mediated treatment effects

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
15	Katz, Volkening, Butler, Anderson, & Laffel (2014)	Family-based psychoeducation and care ambassador (CA) intervention Duration: 2 years	Family-focused	153 youth (50/52/51)	8-16 years	Quantitative	MANOVA using the Tukey method for multiple comparisons within the same model (for continuous outcomes) Linear regression (for binary outcomes)	HbA_{1c} Diabetes Family Responsibility Questionnaire Diabetes Family Conflict Scale Pediatric Quality of Life Inventory – generic core scales	No differences in **HbA_{1c}** across treatment groups Among youth with suboptimal baseline A_{1c}, more youth in the CA+ psychoeducation group maintained or improved their A_{1c}, and maintained or increased **parent involvement**, than in the other groups (i.e., standard care or CA alone) without negative impact on youth **QOL**, or increased **diabetes-specific family conflict**
16	Kichler, Kaugars, Marik, Nabors, & Alemzadeh (2013)	*K.I.D.S project intervention*, including a synthesis of treatment strategies from diabetes education, behaviour therapy, and family therapy; separate group sessions conducted for adolescents and parents	Family-focused	30 (15/15)	13-17 years	Quantitative	Repeated measures MANOVA (used to compare psychosocial and diabetes-related outcome variables between baseline, posttreatment and 4 months follow up)	HbA_{1c} The Brief Symptom Inventory Behavior Assessment Scale for Children – 2 Pediatric Quality of Life Inventory – Generic Core Scales Pediatric Quality of Life Family Impact Module Readiness to Change the Balance of Responsibility Scale Self-Care Inventory Diabetes Family Responsibility Peds QL-Diabetes Module	At 4 months posttreatment, parents and youth reported increased **parent responsibility** and parents reported improved **youth diabetes-specific quality of life** No statistically significant changes in **HbA_{1c}** and **health care utilization** from 6 months prior to 6 months posttreatment

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
17	Lawson, Cohen, Richardson, Orrbine, & Pham (2005)	Regular standardized telephone contact with a diabetes nurse educator, including a review of blood glucose results and insulin dose adjustments, problem-solving and diabetes education Duration: 6 months	Technology	46 adolescents with poorly controlled diabetes (23/23)	13-17 years	Quantitative	Repeated measures ANCOVA (with adjustment for the baseline outcome measure)	HbA_{1c} Compliance with Diabetes Management Scale Diabetes Quality of Life Scale for Youth Family Environment Scale Total daily insulin dose BMI Occurrence of adverse events (i.e., severe hypoglycemia and Diabetes Ketoacidosis)	Intervention had no immediate effect on any outcome measure However, 6 months post-treatment, **HbA_{1c}** levels decreased in 6 out of 21 individuals of the study group) and 0/18 of the control group, while HbA_{1c} increased in 4/21 study subjects and 8/18 control subjects
18	Løding, Wold, & Skavhaug (2008)	Adolescent and parent groups providing peer support and the opportunity to solve problems. Duration: once a month for 1 year	Family-focused	19 (11/8)	13-17 years	Quantitative	Paired sample *t*-tests (for whole sample and each gender)	HbA_{1c} Diabetes Quality of Life Questionnaire	Across the total group there was no significant difference in mean A_{1C} from baseline to 24 month follow-up. However, there was a significant decrease in **HbA_{1c}** values in the **girls** studied
19	Maranda, Lau, Stewart, & Gupta (2015)	Structured care of a *Betta splendens* fish (*participants were instructed to check glucose readings and review glucose logs at times corresponding to the care of the Betta fish)	Behaviour change (Individual)	28 (16/12)	10-17 years	Quantitative	Repeated measures ANOVA	HbA_{1c} Pediatric Quality of Life Scale – Generic Core and Diabetes Modules Self-Management of Type 1 Diabetes for Adolescents (SMOD-A)	After 3 months, participants in the intervention group showed a significant decrease in **HbA_{1c}** level compared to controls who had an increase Younger adolescents (10-13 years) demonstrated a significantly greater response to the intervention compared with older adolescents (14-17 years) No significant effects for the **Pediatric QoL** modules or subscales on the SMOD-A questionnaire

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
20	Monaghan et al. (2015)	*Checking In:* A physician delivered intervention to increase parent-adolescent communication Duration: 12 weeks	Family-focused	30 families	11-15 years	Mixed Method	Intent-to-treat analyses (when possible) Paired *t*-tests	Insulin regimen, HbA_{1c}, daily BG monitoring frequency & mean BG level Self-Care Inventory (Diabetes Management Behaviours) Parental Monitoring of Diabetes Care Scale Collaborative Parent Involvement Scale Diabetes Family Conflict Scale Revised	Participants who reported adhering to the intervention plan (n = 15) demonstrated a significant increase in **BG monitoring frequency** Parent-reported **conflict surrounding diabetes management** significantly decreased from pre- to post-intervention
21	Mulvaney, Anders, Smith, Pittel, & Johnson (2012)	*SuperEgo*: Text messaging intervention providing a combination of guidance and choice for users via individually tailored messages Duration: 3 months	Technology	46 (23/23)	13-17 years	Mixed Method	One-way repeated measures analysis of variance	Mean HbA_{1c}	Mean **HbA_{1c}** remained unchanged in the intervention group, but significantly increased in the control group
22	Murphy, Wadham, Hassler-Hurst, Rayman, & Skinner (2012)	*Families and Adolescents Communication and Teamwork Study (FACTS):* A family-centred group education program Theory: Social Learning Theory Duration: 1 session per month over 6 months	Family-focused	305 (158/147)	11-16 years	Quantitative	Intention-to-treat analysis Repeated measures ANOVA (for continuous variables) Wilcoxon's test (for single item measures)	HbA_{1c} (measured every 3 months from baseline) Episodes of severe hypoglycemia Diabetes Quality of Life Youth Scale WHO Health Behavior in School Children PAID DFRQ Proactivity in adjusting insulin	12 months post-intervention, there was no significant difference in **HbA_{1c}** in either group and no between group differences over time Adolescents perceived no changes in **parental input** at 12 months *Note: Poor attendance of group education sessions was a major challenge

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
23	Murphy, Wadham, Rayman, & Skinner (2007)	*Families and Adolescents Communication and Teamwork Study (FACTS)*: A family-centred group education program Theory: Social Learning Theory Duration: 4 educational sessions over 1 year	Family-focused	78 children and adolescents (40/38)	6-11 or 12-16 years	Quantitative	Intention-to-treat analysis	HbA_{1c} Pediatric Quality of Life Problem Areas in Diabetes (PAID) Diabetes Family Responsibility Questionnaire (DFRQ)	No significant difference in **HbA_{1c}** or **parental responsibility** between participants randomized to the immediate or delayed program (control group) At 12 month follow-up, families who attended 2 or more sessions reported a significant increase in **parental involvement** For children/adolescents who attended 2 or more sessions, HbA_{1c} fell by 0.29% compared with an increase in non-attenders
24	Nansel, Iannotti, & Liu (2012)	*WE-CAN manage diabetes*: A clinic-integrated behavioural intervention designed to help families improve diabetes management by facilitating problem solving skills, communication skills, and appropriate responsibility sharing Theory: Social Cognitive Theory, self-regulation theory and system theory Duration: 2 years	Family-focused	390 families (201/189)	9-15 years	Quantitative	Mixed effect linear quadratic model	HbA_{1c} Diabetes Self-Management Profile (Adherence) Blood glucose metre data	Significant overall intervention effect on change in **HbA_{1c}** from baseline to 24 month interval A significant intervention by age interaction; among participants **aged 12 to 14**, a significant effect on **glycemic control** was observed, but there was no effect among those aged 9 to 11 No intervention effect on child or parent report of **adherence**

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
25	Nansel et al. (2007)	Diabetes "Personal Trainer" intervention – designed to enhance motivation and capability for diabetes management Theory: Guided by principles of Motivational Interviewing, applied behaviour analysis and problem solving Duration: 6 sessions over 2 months	Behaviour change (Individual)	81 (40/41)	11-16 years	Quantitative	ANCOVA (with baseline value of the outcome variable and age as covariates)	HbA_{1c} Modified version of the Diabetes Self-Management Profile Self-Efficacy for Diabetes Self-Management Positive and Negative Scales Diabetes Quality of Life Scale	At both short-term and 1 year follow-up, there was a significant intervention-by-age interaction, indicating a greater effect on **HbA_{1c}** among older than younger youth; No treatment group differences among pre-/early adolescents (11-13 years) but a significant difference among middle adolescents (14-16 years) No treatment group differences in parent or youth report of adherence
26	Nansel et al. (2009)	Diabetes "Personal Trainer" intervention – designed to enhance motivation and capability for diabetes management Theory: Guided by principles of Motivational Interviewing, applied behaviour analysis and problem solving Duration: 6 sessions over 2 months	Behaviour change (Individual)	81 (40/41)	11-16 years	Quantitative	Repeated measures ANOVA ANCOVA with baseline HbA1c and age as covariates	HbA_{1c}	A significant overall intervention effect on **HbA_{1c}** and a significant intervention-by-age interaction, indicating a greater effect among older than younger youth No significant group differences for pre-/early adolescents but a significant difference in HbA_{1c} for middle adolescents

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
27	Nansel et al. (2015)	Family-based behavioural intervention integrating motivational interviewing, active learning, and applied problem solving to improve dietary intake of youth with diabetes Duration: 12 months	Family-focused	136 (66/70)	8-16 years	Quantitative	Intent-to-treat analyses using multiple imputation for missing data	3-day food records – The Healthy Eating Index & Whole Plant Food Density (Diet quality) HbA_{1c}	There was a positive intervention effect across the study duration for **diet quality** No significant difference between groups in **HbA_{1c}** across the study duration
28	Nansel, Thomas, & Liu (2015)	*WE-CAN manage diabetes*: A clinic-integrated behavioural intervention designed to help families improve diabetes management by facilitating problem solving skills, communication skills, and appropriate responsibility sharing Theory: Social cognitive Theory, self – regulation models, and systems theory Duration: 21 months	Family-focused	390 families (201/189)	9-15 years	Quantitative	ANOVA	HbA_{1c} Demographic and disease-related characteristics	Significant overall effect of treatment group on change in **HbA_{1c}** from baseline to follow up Baseline HbA_{1c} was significantly poorer in the low-income group Interaction for treatment-by-income was not significant

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
29	Newton & Ashley (2013)	*Diabetes Teen Talk*: Web-based intervention that provides teens with opportunities to discuss solutions to psychosocial problems that make treatment compliance difficult. Theory: Bandura's Self-Efficacy Theory Duration: 7 weeks	Technology	50 (25/25)	13-18 years	Quantitative	2 (intervention vs. control) × 2 (pre-post) mixed model MANOVA	Diabetes Quality of Life for Youths Self-Efficacy of Diabetes Self-Management Outcome Expectations of Diabetes Self-Management	Marginally significant difference between groups on combined outcome measures; Effect of the treatment condition was predominantly carried by a significant difference between treatment conditions on the **Positive Outcomes Expectations** (with those in the control group reported higher outcome expectations) **Note*: Low power due to small *n* (participant attrition)
30	Newton, Wiltshire, & Elley (2009)	Use of an open pedometer & motivational text messages reminding users to wear the pedometer and be active. Duration: 12 weeks	Technology	78 (38/40)	11-18 years	Quantitative	Linear Regression	Daily step count Physical Activity Questionnaire (self-reported physical activity over 7 days) HbA_{1c} Blood pressure BMI z score Comprehensive Quality of Life Scale – School Version	At 12 weeks, there was no significant difference in change in **physical activity** measures between the groups No significant differences in secondary measures: **HbA_{1c}**, **blood pressure**, **BMI**, or **QoL** **Note*: Study was underpowered due to limited number of adolescents with Type 1 Diabetes in the region
31	Nicholas et al. (2012)	Online education and support website intervention combining 3 key components: diabetes-based information, interactive learning activities, and discussion topics relevant to adolescents Duration: 8 weeks	Technology	31 (15/16)	12-17 years	Mixed Method	Non-parametric statistical tests (with the small sample, the data violated the normality assumption)	Children's Inventory of Social Support	Pre-post intervention gains approaching significance (at .05 level) in **perceived social support** (i.e., awareness of relationships with others outside of participants' family)

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
32	Serlachius et al. (2016)	*Best of Coping (BOC) program*: A cognitive behaviour-therapy based program to improve glycemic control and psychosocial well-being Duration: Five 2-hour long weekly sessions	Behaviour change (Group)	147 (73/74)	13-16 years	Quantitative	Intention to treat analyses Mixed effects regression	HbA_{1c} Diabetes Stress Questionnaire for Youths (Stress) Self-Efficacy for Diabetes Scale (Self-efficacy) Diabetes Quality of Life for Youth (Quality of Life)	No difference in **HbA_{1c}** between groups at follow-up **Psychosocial well-being** improved in the intervention group compared to the control group
33	Spiegel et al. (2012)	Nutrition education intervention, which involved attending an educational class offered by a register dietician/certified diabetes educator and keeping 3-day food records Duration: One interactive 90-minute class, and the completion of 2 sets of 3-day food records	Behaviour change (Group)	66 (33/33)	12-18 years	Quantitative	Repeated measures models	HbA_{1c} Carbohydrate counting accuracy	At 3 month follow-up, the overall intervention effect was not statistically significant for change in **HbA_{1c}** or **carbohydrate counting accuracy**
34	Stanger et al. (2013)	A multicomponent motivational intervention including family-based contingency management Duration: 1 hour sessions each week over 14 weeks	Family-focused	17 families of adolescents with poorly controlled T1D	12-17 years	Quantitative	Linear repeated measures mixed models with random intercepts and fixed treatment effects	Blood glucose monitoring frequency (downloaded weekly from glucometer) HbA_{1c} Self-Care Inventory (adherence)	Adolescents significantly increased their **blood glucose monitoring** and showed significantly improved **HbA_{1c}** levels from pre- to post-treatment

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
35	Viklund, Ortqvist, & Wikblad (2007)	Empowerment education program involving group sessions Duration: Six, 2-hour sessions over approximately 6 weeks	Behaviour change (Group)	32 (18/14)	12-17 years	Quantitative	Repeated measures ANOVA	HbA_{1c} Swedish version of the Diabetes Empowerment Scale Option for parent involvement in groups	**HbA_{1c}** and **empowerment** were similar in the intervention and control group 6 months after the intervention HbA_{1c} was significantly higher among adolescents in the intervention at 6 and 12 months follow-up, but returned to baseline 18 months after the program Adolescents felt more **ready for changes** post-intervention compared to before the program Among youth that involved their parents in the group, there was a significant decrease in HbA_{1c} 12 and 24 months after the intervention
36	Von Sengbusch et al. (2005)	Provision of a mobile diabetes education and care team to families who have limited access to specialized diabetes care in rural areas	Family-focused	104 children/adolescents, and 95 parents	8-16 years	Quantitative	Friedman Test & Wilcoxons Test McNemar Test Spearman Bank correlation coefficients Mann-Whitney *U*-test	HbA_{1c} Severe hypoglycemia Hospital admissions Diabetes knowledge Health-related quality of life	**HbA_{1c}** values significantly improved, and **rate of hospitalization** fell, from baseline to follow-up Youth reported significantly better **diabetes-specific quality of life** and higher **self-esteem** after the intervention Theoretical **diabetes knowledge** increased at both short- and long-term follow-up

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
37	Waller et al. (2008)	*Kids in Control of Food (KICk-OFF)*: A modular educational program providing information on carbohydrate counting and insulin adjustment Duration: 6 courses delivered over 5 school days	Behaviour change (Group)	48	11-16 years	Mixed Method	Series of independent *t*-tests and & one-way between-measures ANOVAs	HbA_{1c} BMI Episodes of hypoglycemia and ketosis Pediatric Quality of Life Inventory Version 4.0 – parent and child forms Pediatric Quality of Life Diabetes Module – parent/child Diabetes Treatment Satisfaction Questionnaire – parent/child Diabetes Family Responsibility Questionnaire – parent/child Self-Efficacy for Diabetes Diabetes Family Conflict Scale – parent/child	No changes in **HbA_{1c}**, **BMI** or **episodes of hypoglycemia**, but youths and their parents reported significantly improved **quality of life** (generic and diabetes-specific) as well as **satisfaction with treatment** 6 months after completing the program Youth reported improved **self-efficacy**, and both youth and their parents reported greater child responsibility for a range of management tasks No significant changes in either youth- or parent-reported **family conflict**
38	Wang et al. (2010)	#1) *Motivational Interviewing (MI)* in Education #2) *Structured Diabetes Education (SDE)* Duration: 2-3 sessions over a 3-4 month period	Behaviour change (Group)	43 (21/22)	12 – 18 years	Quantitative	Mixed-model procedures of PROC MIXED (in SAS version 9.2)	HbA_{1c} Center for Epidemiologic Studies Depression Scale Epidemiology of Diabetes Interventions Complications Quality of Life Questionnaire Summary of Diabetes Self-Care Activities	At 6 month follow-up, youth participating in SDE had significantly lower mean **HbA_{1c}** than youths in the MI group No overall time period effect and no treatment group by time interaction was found No between-group differences on any of the psychosocial measures

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
39	Whittemore et al. (2012)	*TEENCOPE*: Internet-based CST Theory: Social Cognitive Theory *Managing Diabetes*: Internet- based diabetes education and problem solving program Duration: 6 months	Technology	320 (167/153)	11-14 years	Quantitative	A series of mixed effects linear regression models (repeated measures ANOVA with arbitrary within-subject correlation structures Moderation effects tested using a longitudinal effect model adjusted for covariates	HbA_{1c} Pediatric Quality of Life Inventory Self-Management of Type 1 Diabetes in Adolescence Perceived Stress Scale Responses to Stress Questionnaire Self-Efficacy for Diabetes Scale Self-Perception Profile for Adolescence (social acceptance subscale) Diabetes Family Conflict Scale (revised)	**HbA_{1c}** significantly increased in the *Managing Diabetes* group No significant between-group treatment effects 6 months post-intervention on HbA_{1c} or adolescent QoL Over time, youth in both groups showed a decrease in **collaboration with parents**, and an increase in **diabetes self-efficacy.** For *Managing Diabetes*, there was an increase in **social acceptance**, and **diabetes QOL**. For *TEENCOPE,* there was a decrease in **perceived stress** and an increase in **primary control coping** No significant change over time for **family conflict** in both groups Youth in the *Managing Diabetes* showed a significant increase in social competence compared to youth in *TEENCOPE*
40	Wysocki et al. (2007)	*Behavioural Family Systems Therapy for Diabetes (BFST-D)*: A modified BFST intervention to achieve greater impact on diabetes-related family conflict, treatment adherence and metabolic control *Multifamily educational support (ES)* Duration: 12 sessions over 6 months	Family-focused	104 families (36/36/32)	11-16 years	Quantitative	Repeated measures ANOVA	HbA_{1c} Diabetes Self-Management Profile The Diabetes Responsibility and Conflict Scale	BFST-D was superior to ES and standard care in the effects on **HbA_{1c}** A significantly higher percentage of BFST-D youth achieved moderate or greater improvement in **treatment adherence** compared with the standard care group at each follow-up and the ES group at 6 and 18 months Change in treatment adherence correlated significantly with change in HbA_{1c}

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	Citation	Intervention(s)	Delivery method	*N* (I/C)	Age range	Study design	Primary statistical analyses	Measures (outcome variables)	Main results
41	Wysocki et al. (2008)	*Behavioural Family Systems Therapy for Diabetes (BFST-D) Multifamily educational support (ES)* Duration: 12 sessions over 6 months	Family-focused	104 families (36/36/32)	11-16 years	Quantitative	Repeated measures ANOVA	HbA_{1c} The Diabetes Responsibility and Conflict Scale Diabetes Self-Management Profile	BFST-D improved individual **communication of adolescents and mothers**, but not fathers BFST-D significantly improved **quality of family interaction** compared to ES and standard care Changes in family communication were differentially associated with changes in glycemic control, adherence, and family conflict
42	Wysocki et al. (2006)	*Behavioural Family Systems Therapy for Diabetes (BFST-D) Multifamily educational support (ES)* Duration: 12 sessions over 6 months	Family-focused	104 families (36/36/32)	11-16 years	Quantitative (randomized trial)	Repeated measures ANOVA	HbA_{1c} The Parent-Adolescent Relationship Questionnaire The Diabetes Responsibility and Conflict Scale Diabetes Self-Management Profile	BFST-D significantly improved **family conflict** and **adherence** compared to ES and standard care, especially among those with poorer metabolic control BFST-D and ES significantly improved **HbA_{1c}** compared to standard care **among those with poorer metabolic control** at baseline

format to children and families. The use of web-based, app-based, or text-delivered cues to support appropriate self-management behaviours allow professionals to reinforce skills outside of in-person training or office visits (Rajkumar et al., 2015). The trend toward using technology is likely to have the greatest effect on the generalization of information provided from the office or personal intervention to different times of day, locations, environments, and other situations in which the acquisition of new knowledge does not necessarily result in changes of behaviour (Minges et al., 2016). Moreover, the transmission of information through technology reflects a cohort change in how adolescents acquire information, making technology a more salient approach to information transmission to adolescents than written or face-to-face interventions (Bedrossian et al., 2016). However, technology only refers to the means by which information is transmitted and not the content of the information. Of the 10 technology-driven interventions identified, the majority identified small or no effects on patient outcomes. Only one intervention demonstrated a moderate effect. In this study, 37 young people with type 1 diabetes participated in a series of educational workshops related to glycemic control, and the software application *One Touch Ultra-Smart System* (a commercial medical product from Johnson & Johnson) was provided to all patients to record their daily blood glucose levels. Patients also completed a questionnaire to assess their use and satisfaction with the software application, as well as their progress in following a balanced diet and engaging in regular physical activity. From pre- to post-intervention, there was a significant average reduction in HbA1c ($p < .001$), and positive effects were also noted in terms of patients' dietary habits and physical activity levels.

FAMILY-FOCUSED INTERVENTIONS

The majority of studies identified in this review described family-centered interventions. Specifically, 18 intervention studies focused on family involvement and changing parental knowledge and behaviours around diabetes care. For example, emphasis was placed on improving parent-child interactions (i.e., increased communication and reduced conflict), parental monitoring, and the development of structured family routines around diabetes management (e.g., regular meal times). Several of the identified interventions employed family therapy techniques, such as Multi-Systemic Therapy (MST), standard Behavioural Family Systems Therapy (BFST), as well as a modified therapeutic approach termed Behavioural Family Systems Therapy for Diabetes (BFST-D). Looking across these interventions studies, the results are mixed in terms of intervention design and effectiveness. In some studies, small but statistically significant positive effects are noted, especially for adolescents with poorer glycemic control (e.g., Katz, Volkening, Butler, Anderson, & Laffel, 2014; Stanger et al., 2013; Wysocki et al., 2006; Wysocki et al., 2007; Wysocki et al., 2008).

INDIVIDUAL AND GROUP BEHAVIOUR CHANGE INTERVENTIONS

The remainder of the identified studies, 14 in total, described a range of other individual- or group-format behaviour change interventions. These interventions were delivered by an interventionist or program facilitator such as a psychologist, nurse, or physician. Although there is some overlap between these interventions and the studies previously described, the use of technology and family involvement was not the primary focus of such programs. The majority of interventions included in this category (i.e., 13 studies) focused on psychological aspects of behaviour change, while one study described a purely behavioural intervention (Maranda, Lau, Stewart, & Gupta, 2015). Targeted psychological variables included patient knowledge, motivation, empowerment, and health-related quality of life. For example, four studies described behaviour change interventions applying the principles of motivational interviewing (Channon et al., 2007; Nansel et al., 2007; Nansel et al., 2009; Wang et al., 2010), and one applied Cognitive Behavioural Therapy (Serlachius et al., 2016). In general, intervention effectiveness was mixed. Positive effects, when noted, were small, with the exception of one intervention (Channon et al., 2007), which had a moderate effect on patient outcomes. In this study, 66 adolescents with type 1 diabetes received individual motivational interviewing sessions over a 12-month period. Immediately following the intervention, those receiving motivational interviewing had significantly lower HbA1c values than those who did not ($p = .040$), and this difference was maintained at a 24-month follow-up ($p = .003$). Those receiving motivational interviewing also reported better psychosocial functioning compared to controls following the intervention, including improved quality of life and positive well-being ($p = .010$).

OUTCOMES

A variety of outcome measures were used to assess the effectiveness of psychoeducational interventions. The most common dependent variable was haemoglobin A1c (HbA1c). Measures of HbA1c were used in 40 of the 42 studies. In the 35 studies that assessed pre-test–post-test reductions based on the psycho-

educational intervention, 16 studies demonstrated a statistically significant decrease in blood levels of HbA1c, and 19 studies showed no significant difference. There are some concerns that HbA1c may not be the best outcome variable of interest because it is often related to medical outcomes, is often resistant to change, and may be an unreliable variable (Millar, Perry, & Phillips, 2015). In addition, the means of achieving HbA1c levels are just as important as the final glycemic outcomes (Lipska & Krumholz, 2017). According to Lipska and Krumholz (2017), "Trials that use outcomes based solely on glycemic parameters are no longer acceptable for clinical decision making" (p. E2). Self-report checklists and parent reports also resulted in mixed effects. Over 70 different measures were investigated in the reviewed studies. There were consistent findings only among two variables: self-reports of quality of life and frequency of monitoring blood glucose levels. Studies that included these variables evaluated a variety of programs and consistently demonstrated significant and positive effects.

METHODOLOGICAL ISSUES

Clinical research carries a host of methodological challenges (Elwyn, Wieringa, & Greenhalgh, 2016). A review of the 42 studies indicates three methodological themes. The use of control groups is an important aspect of any intervention study. Thirty-three of the 42 studies reported the use of control groups matched for at least one variable. All of these studies used a wait list or no intervention condition as the control group. Active control groups involving an alternative intervention (such as academic tutoring and providing information through written material) are typically superior control groups because often any type of intervention, change, or action can result in a positive change (the Hawthorne effect). In addition, 15 studies used random assignment to control and experimental groups. Studies without random assignment may indicate pre-intervention differences that influence the interpretation of the effect size.

The second methodological issue is that in 22 studies the sample used comprised adolescents considered to have poorly controlled diabetes. Such a sample may not be representative of all children with diabetes. In addition, 18 of the 22 studies of children with poor metabolic control demonstrated positive outcomes due to psychoeducational interventions. This is as opposed to one out of 11 studies of adolescents with relatively well-controlled diabetes demonstrating positive outcomes due to psychoeducational interventions. This result may be due to regression to the mean effects for adolescents with poor metabolic control. Therefore, generalization of the effectiveness of interventions to all adolescents with diabetes may be limited.

The third methodological issue concerns power. In many fields, interpretation of studies is hampered by low powered research designs. Yet, 30 of the 42 studies identified had adequate power (i.e., > .80). Despite these studies with adequate power, overall results were still mixed concerning the ability to identify a statistically significant change on a variety of dependent variables due to the psychoeducational interventions. Moreover, even for studies that demonstrated a statistically significant change in any outcome variable, there were only small effect sizes. Only two studies demonstrated an effect size that would be considered in the moderate range (i.e., .25 to .50). Although there are heterogeneous interventions and a variety of outcome measures, the measurable effect of psychoeducational interventions is modest.

DISCUSSION

There is a large and rapidly growing body of literature describing psychoeducational interventions designed to improve management of diabetes for adolescents (Goodall & Kim, 1991; Hart, Reaper, Pugh, & Phillips-Salimi, 2015). The majority of the studies evaluating the effects of a psychoeducational intervention on behaviour were underpowered, failed to control for the factor of development, had questionable dependent variables, and may not have used adequate control or comparison groups (Cheraghi et al., 2015; Heinrich et al., 2010). However, there are also many high-quality studies that provide strong evidence of the proof of concept for application to larger populations of adolescents with diabetes. Comprehensive literature reviews with ramifications for directing clinical practice require more than a valuation of the size of the effect created by the intervention and the quality of the research design.

Do psychoeducational interventions result in improved medical outcomes and overall well-being? The results are decidedly mixed. Only two of the 42 studies considered demonstrated moderate effect sizes. One of the studies involved motivational interviewing (Channon et al., 2007) and the other study involved the use of *One Touch UltraSmart System*, a commercial glucose monitoring method (Aguilar, García, González, Perez, & Padilla, 2011). Other studies involving motivational interviewing demonstrated consistent, but small, effect sizes. Motivational interviewing studies used both individual and family components.

Are there differential effects of the instructional mechanism used (i.e., technology driven, family focused, or individual or group behaviour change) for medical outcomes and overall well-being? The 10 tech-

nology-based studies were also of mixed outcomes. However, as a mechanism of delivering psychoeducational interventions, technology-based interventions were the most likely to influence medical outcomes such as HbA1c. The consensus of the research literature shows that an educational program that contains a family-focused intervention results in small, but positive, effects. Given the influence that family support and management of the household environment has on the behaviour of children and adolescents, this is an intuitive outcome. However, the variables most affected by family-focused interventions were self-reports of quality of life and overall positive well-being. Medical outcomes were not positively influenced by family interventions. Individual and group behaviour change efforts, such as counselling procedures, were also mixed. Clearly, motivational interviewing shows the most consistently positive outcomes, even though the outcomes are small. Rather than consider which mechanism of delivery works best, a reasonable assumption is that technology, family, individual- and group-format behaviour change efforts can work together in order to create a comprehensive intervention plan with multiple delivery mechanisms that affects multiple outcomes. However, this remains a hypothesis to be tested.

Which outcome variables (i.e., quality of life measures, self-efficacy measures, HbA1c levels, behaviour problems, social acceptance, family conflict, body mass index, blood pressure, positive outcome expectations, perceived social support, or blood glucose monitoring) are most affected by the specific psychoeducational interventions? There were consistent positive effects for self-reports of quality of life and frequency of monitoring blood glucose levels. However, independent outcome measures such as HbA1c levels, blood pressure, body mass index, and other medical variables did not consistently show positive effects. Social issues such as family conflict, positive outcome expectations, perceived social support, and social acceptance demonstrated small positive effects.

Do other design factors of the evaluative study lead to improved medical outcomes and overall well-being (e.g., length of the intervention, pre-intervention blood glucose control, socioeconomic status, and ethnicity)? Most design factors did not seem to play a major role in determining whether there was a positive outcome. The exception is in the case of quality of blood glucose control prior to the intervention. For participants with poorly controlled diabetes there was more likely to be a positive outcome as result of psychoeducational interventions. Whether these results are due to simple regression to the mean, increased motivation to change behaviour, or other factors, is unclear.

The need for formalized instruction of skills required for adherence to medical, educational, and behavioural management of diabetes is clear from the literature. Quality of life is profoundly affected by the effective management of the four major factors: (a) glucose monitoring, (b) insulin delivery, (c) diet, and (d) physical activity. The effectiveness of psychoeducational interventions for promoting short- and long-term behaviour changes remains unclear. Yet, there are promising advances and evidence of behaviour change in adolescents using intensive educational interventions in conjunction with technology to ensure self-directedness, salience, convenience, and cues. To this point, there is not a specific intervention with universally positive outcomes; however, there is enough evidence to provide a menu of options for clinicians to assist adolescents in their management of diabetes. There has clearly been a growth in well-designed evaluative studies and in the development of innovative interventions.

One of the most important challenges for psychoeducational interventions for adolescents with diabetes is the development of independence skills as they move from parent-focused to self-focused diabetes management (Anderson, Ho, Brackett, Finkelstein, & Laffel, 1997). However, 12 of the 42 studies had among their goals to increase parent participation in the intervention process. Ten of these 12 studies demonstrated positive outcomes by increasing parent quality and quantity of involvement in their child's treatment adherence plan. Yet, there were no studies focusing on increasing independent self-care of adolescents. Equally, if not more, important are the messages and information transmitted to adolescents as they take full responsibility for their medical management. This area has the potential to be a valuable area of research to facilitate effective transition from family care to self-care.

RECOMMENDATIONS FOR CLINICIANS

Although the outcomes of evaluation studies on psychoeducational interventions to improve adolescents' medical management of diabetes are not conclusive, a foundation is beginning to emerge that provides tentative recommendations for clinicians. Interventions aimed at supporting intrinsic motivation with multiple forms of support are more effective than communication of knowledge and information, setting external reminders, addressing emotions underlying resistance to implementing psychoeducational interventions, and traditional counselling methods. Among the most promising interventions is motivational interviewing. Motivational interviewing is a collaborative, goal-oriented method of communication between the adolescent and a clinician. A particular focus of the interaction is on the language of change. The purpose is to support an individual's motivation and movement toward specific goals by

exploring the person's own arguments for change. Motivational interviewing may be especially appropriate for adolescents, who are exploring and exercising independence. The advantage of motivational interviewing is that it allows adolescents to have ownership of their own treatment in a collaborative therapeutic activity. The motivational interviewing is based on three components: collaboration between the clinician and the adolescent; evoking or drawing out the adolescent's ideas about change; and emphasizing the autonomy of the adolescent. The evidence supports working towards increasing adolescents' autonomy in their management of diabetes over an expert presentation of information that must be adhered to and is communicated via expertise alone.

Motivational interviewing is likely to be enhanced by involving multiple channels of information. Including families and technology as supports in a motivational interviewing approach may hold the most promise for effective psychoeducational interventions. For example, a therapeutic approach that includes individual motivational interviewing with a clinician, families as supports of the motivational interviewing process, and text reminders may combine to create a generalizable method of improving the motivation of adolescents to adhere to the prescribed medical management procedures. This remains a tentative recommendation that requires evaluative research.

RECOMMENDATIONS FOR RESEARCHERS

Well-organized outcome measures are extremely helpful. The four outcomes for management of diabetes include: (a) glucose monitoring, (b) insulin delivery, (c) diet, and (d) physical activity. It is possible that different outcomes may respond better to different types of psychoeducational interventions. Ensuring that psychoeducational interventions affect all four primary management goals and medical outcomes can be most productive.

Clinical research has been called into question as being almost completely useless and lacking credibility for clinicians (Ioannidis, 2016). This can be overcome by considering aspects of implementation in conducting research. For any research to be credible and useful for effective implementation with patients, more than the knowledge of what works is required. Therefore, all studies evaluating psychoeducational interventions should also be evaluated on context placement; information gain; pragmatism; patient-centredness; cultural and familial context; cost-effectiveness (e.g., time required and materials); feasibility; transparency; and acceptability to professionals, patients, and other educators (Ioannidis, 2016). Knowing what works is simply a proof of concept, but implementation of clinical research also requires information about how it can be implemented in real life situations (Shaw, 2016). Ultimately, the purpose is to provide recommendations to healthcare providers, educators, and families as to the strongest methods of providing psychoeducational interventions to improve management and treatment adherence for adolescents with diabetes. In this fashion, the emphasis on motivational interviewing and evidence of positive outcomes supports a pragmatic and patient-centred approach to psychoeducational interventions with flexible and detailed implementation strategies. Future clinical research would benefit from considering the elements required for implementation with diverse resources, access to medical care, control of diabetes status, culture, and adolescent acceptability, in addition to demonstrating the effectiveness of an intervention under a singular set of conditions. This level of research design is expensive, time-consuming, and pragmatically difficult. However, for the standard of evidence-based practice to be met, these are components required for future research development and clinical relevance.

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