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REVIEW

Effectiveness of Family Systems Theory Interventions on Adolescents with Type 1 Diabetes: A Meta-analysis

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Abstract

The purpose of this review is to synthesize the evidence and determine the efficacy of interventions based on family systems theory in diabetes-related family conflict, self-management, and glycemic control among adolescents with type 1 diabetes. A systematic search of five English databases was conducted. Interventions based on family systems theory in adolescents with type 1 diabetes that reported diabetes-related family conflict, self-management, and glycemic control as outcome variables were included. A total of 14 articles from ten interventions were included. Meta-analysis results revealed that, compared to adolescents who received usual care, adolescents who received family systems theory interventions reported fewer diabetes-related family conflicts with a medium effect size of 0.32 ($p < 0.05$), but there was no significant improvement on self-management or glycemic control ($p > 0.05$). Family systems theory interventions appear to have beneficial effect on reducing diabetes-related family conflicts for adolescents with type 1 diabetes. Adolescents who have type 1 diabetes and their families may need multidimensional psychosocial programs accompanied by diabetes education to improve glycemic control.

Keywords Adolescents · Type 1 diabetes · Family systems theory · Conflict · Meta-analysis

Highlights

- The family systems theory interventions have a beneficial effect on decreasing family conflicts in adolescents with type 1 diabetes.
- Tangible suggestions considering the FST and developmental theory together to support families are offered.
- Adolescents who have type 1 diabetes and their families may need multidimensional psychosocial programs accompanied by diabetes education to improve glycemic control.

Type 1 diabetes (T1D) is a chronic autoimmune disease characterized by the destruction of pancreatic beta cells and by insulin deficiency, which have the potential to cause life-threatening complications (Marta et al., 2015). Worldwide, there are about 1.1 million youth with T1D under 20 year age-group (Federation, 2017). The annual incidence of youths with T1D is increasing globally: each year, approximately 15,000 youths aged 20 years or less are diagnosed with T1D (Fox et al., 2018). In the United States (US), there are about 14,593 adolescents living with T1D, which is the second only to asthma as the most common chronic disease of childhood (Foster et al., 2019; Miller et al., 2016).

Adolescence is a critical developmental stage with all adolescents experiencing significant physical, cognitive and psychosocial growth (Rechenberg et al., 2017). There are

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unique challenges in achieving glycemic targets during adolescence, with only 21% of whom meeting the goals for hemoglobin HbA1c (<7%) in the US (Wood et al., 2013). The pubertal hormonal changes related to insulin resistance (Markowitz et al., 2015) and poor diabetes self-management account for approximately 30–50% of overall poor glycemic control in Western countries (Schilling et al., 2006). Unfortunately, a large-scale study reported that a deterioration in diabetes self-management is common during adolescence in the US (Petitti et al., 2009). Thus, there is an increased risk of complications and additional health care costs during adolescence (Datye et al., 2015).

Family factors have been demonstrated to be powerful predictors of child health outcomes across chronic pediatric conditions (Hilliard et al., 2016). Psychosocially, adolescents begin to develop advanced critical thinking and reasoning skills (Rechenberg et al., 2017). They must navigate evolving social interactions with family members and peers, establish a sense of autonomy, and develop new self-conceptions (Jaser, 2011). For adolescents with T1D, diabetes self-management includes collaboration with parents, diabetes care activities, solving diabetes-related problems, communication on diabetes, and goal setting (Schilling et al., 2006). The conflicts between youth's striving for autonomy and parents' attempts to monitor or control their children's treatment, peer relations, diabetes burnout, risk taking are recognized barriers of diabetes self-management (Cameron et al., 2008; Datye et al., 2015; Floyd et al., 2017; von Schnurbein et al., 2018). Taken together, adolescents with T1D would need psychoeducational approaches to improve diabetes self-management.

Several studies from different countries have demonstrated that family conflicts around diabetes-related tasks are increasingly recognized as a major negative factor in diabetes self-management (Duke et al. 2008; Hilliard et al. 2013; Smith et al. 2013), and these conflicts account for over one-third of the variance in glycemic control (Katz et al., 2014; Naranjo et al., 2014; Tsiouli et al., 2013). Family conflicts around diabetes care probably affect parents' ability to monitor, youth's collaboration with parents, and diabetes care activities (Noser et al., 2017). Diabetes-related family conflicts could also worsen family dynamics and increase parents' stress (Moore et al., 2013). Therefore, interventions that decrease diabetes-related family conflicts have been advocated by providers of health care to adolescents with T1D.

Family interventions include family meetings, child or parent support groups, psychoeducation, family therapy, and collaboration with children's social services (Maybery & Reupert, 2009). There have been several systematic reviews of interventions in families of adolescents with T1D (Akhter et al., 2018; Feldman et al., 2018; Hilliard et al., 2016; McBroom & Enriquez 2009). These systematic reviews revealed that the interventions with parents' participation may have a small to large effect on diabetes self-management, glycemic control, and psychosocial variables (diabetes-specific conflict, parent-adolescent relationship, and family communication). The family interventions covered in these reviews were guided by two theories, including social ecological models (SEM) (Bronfenbrenner, 1979) and family systems theory (FST) (Kazak et al., 2002; von, 1951). According to SEM, the specific approach focuses on building a therapeutic triad within the broader social ecology, which aims to establish the patient, family, and health care team in a process to promote positive adaptation (Fingerman & Bermann, 2000). Although SEM approach demonstrates positive outcomes, high requirements on resources (e.g., financial support, time, health care system that supports flexible health care delivery during atypical hours and in community settings) limit its implementation (Hilliard et al., 2016). FST, which explains family processes through an understanding of the interactions between individuals and the structural aspects of the family, has been the theory most extensively used to design family-based behavioral interventions for youth with T1D (Duke et al., 2016; Riley et al., 2015). According to FST, children are viewed in the context of their broader family system where they live and function on a daily basis, while families are part of the solution to a child-focused problem and are engaged as "experts" in helping their children (Kazak et al., 2002). Among existing family interventions for adolescents with T1D guided by FST, at every different development stage of childhood and adolescence, the FST approach targets diabetes-related family conflicts, providing families with skills in diabetes management in the context of normative developmental processes, family involvement, communication, problem solving, and conflict prevention and resolution (Jaser, 2011). However, we did not find a systematic review of FST interventions in adolescents with T1D, thus the efficacy of FST interventions on this population has not been synthesized.

The aim of this review was to synthesize the current studies on FST interventions in adolescents with T1D and to determine the effectiveness of FST interventions in diabetes-related family conflicts, diabetes self-management, and glycemic control. The results of this review can then be used to guide future research or provide recommendations on family nursing practice for adolescents with T1D.

Methods

The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (Fig. 1). The PRISMA statement consists of a 27 items checklist and a four-phase flow diagram, as a basis for reporting systematic reviews of other types of research, particularly evaluations of interventions (Moher et al., 2009).

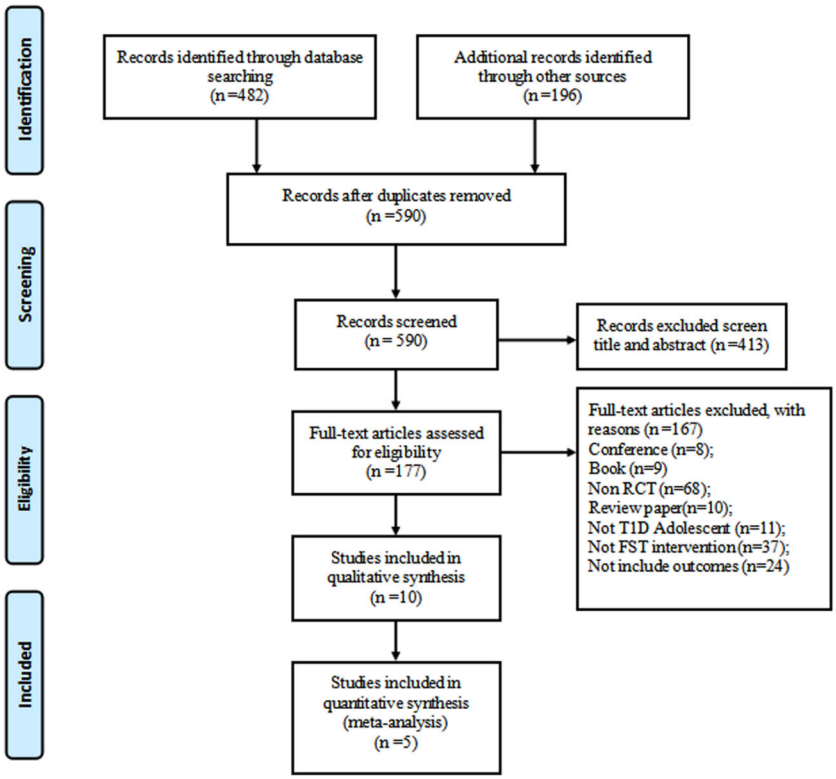

Fig. 1 Flow diagram of the study retrieval and selection process

Eligibility Criteria

We included studies with a clinical trial design that met the following inclusion criteria:

1. Study participants were youth who were under 20 years and had a confirmed diagnosis of T1D;
2. Participants received an FST treatment (or core elements of FST, e.g., were educated about developmentally appropriate self-management, developed a plan for sharing responsibility, were trained in communication skills learning, were trained in family communication, problem solving, conflict resolution, and cognitive restructuring);
3. Studies evaluated the effectiveness of the FST intervention and explored at least one of the following outcomes: diabetes-related family conflict, self-management, or glycemic control.

We excluded studies that used qualitative data as the outcome measure.

Search Strategy

A systematic review search strategy was developed with a medical librarian (YG). We searched for published studies and grey literature beyond reference lists (using the European Association for Grey Literature Exploitation). Five English databases were searched: PubMed, Cochrane Library, Web of Science, PsycINFO, Embase.

Search terms included: Type 1 diabetes (Type 1 Diabetes Mellitus OR IDDM OR Insulin Dependent Diabetes Mellitus 1) AND (adolescent OR child OR children OR young OR teenager OR puberty) AND (family OR group OR marital OR couples OR parent OR caregiver OR spouse OR siblings OR mother OR father OR stepmother OR stepfather) AND (intervention OR therapy OR psychotherapy OR psychoeducation OR treatment) AND (self-care OR self-management OR adherence OR compliance OR metabolic control OR glycemic control OR family conflict OR collaboration with parents OR diabetes care activities OR goal setting) AND (problem-solving AND diabetes communication AND cognitive reframing AND family restructuring) OR teamwork.

We did not restrict the search by year of publication or languages. Searches were exported to EndNote X9 to build a master file of all references. In addition to the database searches, the reference list of included articles was reviewed for relevant studies and previous reviews. A citation search was also carried out to identify papers cited, using Web of Science. A hand search was conducted of the four journals that generated the greatest number of relevant articles. A preliminary search was performed on 30 December 2018 and the final search was performed on 20 November 2019. The complete search strategy is shown in Additional file 1.

Study Selection

Based on the inclusion criteria, two reviewers (HJW, YYJ) independently selected potential articles by screening and reviewing their titles and abstracts and further assessing their full texts. The reference lists of eligible articles were reviewed to identify additional potentially eligible studies. Any discrepancies or disagreements about inclusion were resolved by discussion. Divergences were settled by the senior reviewer (JG) through a discussion.

Data Extraction

Two reviewers (HJW, YYJ) independently extracted the details of each eligible article by using standardized data extraction forms. The study design (setting, sample size, follow-up duration, and drop-out rate), characteristics of participants (age and race), characteristics of the FST interventions (delivery format, settings, core components, number of sessions, treatment provider, and dosage), and the control group of characteristics were extracted. The data on outcomes were extracted for meta-analysis to examine the effectiveness of FST interventions in diabetes-related family conflict, self-management, and glycemic control.

For the clinical trials with three arms that evaluated an FST intervention against two control groups, that is, Standard Care and Educational Support; data extraction and meta-analysis for the control group were conducted from standard care. Any disagreement between the two reviewers (HJW, YYJ) was resolved by discussion; otherwise, the senior reviewer (JG) was consulted. Data from different articles that were derived from the same study pool were extracted simultaneously to provide comprehensive information.

The Risk of Biased Assessment

The risk of bias for each study was assessed independently by two reviewers (HJW, YYJ) using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Randomised Control/Pseudo-randomised Trials (Institute 2014), which is used in JBI Systematic Reviews and Research Syntheses. It is a checklist with different items for methodological quality assessment of Randomised Clinical Trials design to determine the extent to which a study had addressed the possibility of bias in its design, conduct, and analysis. All items in the checklists were rated as "yes," "no," "unclear," according to the information provided by the included studies. Any disagreement was resolved by discussion. If consensus could not be reached, the third reviewer (JG) made the judgment.

Data Synthesis

Meta-analysis was conducted for the FST interventions by using Stata version 12.0 (Stata Corporation, Collage Station, Texas, USA). The mean difference (MD) with a 95% confidence interval (CI) was used for the pooled effects for the continuous variables assessed by the same instruments (i.e., objective outcomes, such as glycated hemoglobin), and the standardized mean difference (SMD) was calculated for the continuous variables that were assessed by various instruments (i.e., diabetes-related family conflicts and self-management) (Shuster, 2011). Effect sizes of less than 0.2 can be interpreted as small, those in the range of 0.2–0.5 are moderate, and effect sizes of greater than 0.5 are considered large (Cohen, 1988).

Heterogeneity was estimated using Cochran's Q test and I2 statistics. The statistical significance of heterogeneity was set at a p value < 0.10, and the amount of variance was estimated through I^2 values, with 75, 50, 25, and 0% indicating high, moderate, low, or no heterogeneity, respectively (Higgins et al., 2003). A fixed-effects model was used in the absence of any significant heterogeneity (a p value on the Q-test > 0.10 and an I^2 value $< 50\%$), while the random effects model was used if the statistical heterogeneity was significant (a p value on the Q-test < 0.10 and an I^2 value $>$ 50% value but $< 75\%$) (Dersimonian & Nan, 1986).

Results

Search Results

We did not find any eligible studies in the grey literature databases. An initial pool of 482 articles was identified from five databases. After removing 88 duplicate articles, 217 articles were excluded by reviewing titles and abstracts.

The full-text versions of the remaining 177 studies were then checked for eligibility and 167 were then excluded. Five authors were contacted for additional information, but no additional information was received. Finally, ten studies fulfilled the inclusion and exclusion criteria for the systematic review. Five studies were included in the meta-analysis. The five studies that did not report the required outcome data were not included in the meta-analysis. An overview of the methodology of the literature review is presented as a PRISMA flow diagram in Fig. 1

Risk of Biased Assessment

Eight out of the ten studies (80%) provided detailed information about random sequence generation (Anderson et al., 1999; Freeman et al., 2013; Harris et al., 2015; Laffel et al., 2003; Lehmkuhl et al., 2010; Murphy et al.,

Table 1 Risk of bias assessment of the included records

	Critical appraisal items									
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Anderson et al. 1999	√	√	?	×	?	√	√	√	√	√
Wysocki et al. 2000	√	×	?	×	?	√	√	√	√	√
Laffel et al. 2003	√	×	?	×	?	×	√	√	√	√
Murphy et al. 2007	√	√	?	√	?	?	√	√	√	√
Wysocki et al. 2007	√	?	?	×	?	√	√	√	√	√
Harris et al. 2009	×	×	?	×	?	?	√	√	√	√
Lehmkuhl et al. 2010	√	√	?	√	√	√	√	√	√	√
Murphy et al. 2012	?	?	?	√	?	√	√	√	√	√
Freeman et al. 2013	√	?	?	×	?	?	√	√	√	√
Harris et al. 2015	√	√	?	√	?	√	√	√	√	√

Note:

Item 1: Was the assignment to treatment groups truly random?; Item 2: Were participants blinded to treatment allocation?

Item 3: Was allocation to treatment groups concealed from the allocator?; Item 4: Were the outcomes of people who withdrew described and included in the analysis?

Item 5: Were those assessing outcomes blind to the treatment allocation? Item 6: Were the control and treatment groups comparable at entry?

Item 7: Were groups treated identically other than for the named intervention? Item 8: Were outcomes measured in the same way for all groups?

Item 9: Were outcomes measured in a reliable way? Item 10: Was appropriate statistical analysis used?

"√" = "Yes"; "×" = "No"; "?" = "Unclear"

2007; Wysocki et al., 2007; Wysocki et al., 2000), while four studies (40%) reported detailed information about allocation concealment (Anderson et al., 1999; Harris et al., 2015; Lehmkuhl et al., 2010; Murphy et al., 2007). Keeping the participants blind to the treatment group assignment is not possible in a behavioral intervention. The participants could easily identify the group to which they had been allocated due to the nature of the intervention. Four out of the ten studies (40%) conducted an intention-to-treat analysis, reliable measurements, and an appropriate statistical analysis (Harris et al., 2015; Lehmkuhl et al., 2010; Murphy et al., 2012; Murphy et al., 2007). Only one study (10%) clearly reported that outcome assessors were blind to the treatment group assignment(Murphy et al., 2012). The reported drop-out rate ranged from 3.8 to 28.9%. Six studies (60%) reported that there were no statistical differences at the baseline (Anderson et al., 1999; Harris et al., 2015; Lehmkuhl et al., 2010; Murphy et al., 2012; Wysocki et al., 2007; Wysocki et al., 2000). All studies used appropriate statistical analyses, such as estimating the sample size using a power analysis, recruiting sufficient participants, and reporting participants' compliance with the treatments. Table 1 summaries the methodological quality assessment and presents the risk of bias. Funnel plots for assessing publication bias were not performed due to the small number ($N = 4, 5$) (Higgins et al., 2019) for the analysis of each outcome variables included in this study.

Characteristics of the Selected Studies

The total sample size of the participants was 1039, ranging from 32 to 305 per study. The sample size for the treatment groups across all studies was 476, and for the control group it was 563. The age of participants ranged from 9 to 19 years, and the mean age was 13.5 years. The participants included Caucasian, African-American, and Hispanic youth. The studies were published between 1999 and 2015. Six studies were conducted in the US and four studies in the UK. The mean HbA1c was between 8.3 and 11.15% before treatment. The majority of studies (60%) reported a follow-up duration of 12 months (Anderson et al., 1999; Laffel et al., 2003; Murphy et al., 2012; Murphy et al., 2007; Wysocki et al., 2007; Wysocki et al., 2000), two studies did not report follow-up information (Freeman et al., 2013; Lehmkuhl et al., 2010), one study reported a 3-month follow-up (Harris et al., 2015), and one study reported 6–10 weeks follow-up (Harris et al., 2009). The characteristics of the included studies are summarized in Table 2.

Table 2 Characteristics of the included studies

Study characteristics (P)								Intervention process (I)					Control (C)	Outcomes (O)	
Study	Country	Setting	Sample size(n)			Age range	Race	Mean duration of intervention	Primary intervention strategy	Number of intervention sessions	Interventionist	Follow-up	Comparison group(s)	Assessment instrument	
			I	C										Self-management	Diabetes-specific family conflict
Anderson et al. 1999	UK	Clinic	28	27		10–15 years ($M = 12.6$)	NR	12 months	Team work	4 sessions	Research assistant	12 months	Standard diabetes care; Attention control:4 sessions of didactic traditional diabetes education	NR	DRC-15
Wysocki et al. 2000	USA	Clinic	BFTS 38	ES 40	CT 41	12–16.75 years ($M = 14.5$)	Caucasian, African-American, Hispanic.	3 months	BFST	10 sessions, each session lasted (1.5 h)	Psychologists	12 months	Standard diabetes care; Education and support	SCI	DRC-15
Laffel et al. 2003	UK	Clinic	50	50		8–17 years ($M = 12.1$)	NR	12 months	Teamwork	4 sessions	Research assistant	12 months	Standard diabetes care	DFRQ-17	DRC-15
Murphy et al. 2007	UK	Clinic	37	41		8–16 years	NR	12 months	Teamwork	4 sessions (1 h)	Multidisciplinary diabetes team	12 months	Standard diabetes care	DFRQ-17	NR
Wysocki et al. 2007	USA	NR	BFST 36	ES 36	SC 32	11–16 years ($M = 13.9$)	Caucasian, African-American, Hispanic.	6 months	BFST-D	12 sessions	Psychologists	12 months	Standard diabetes care; Educational support	DSMP-24	DRC-15
Harris et al. 2009	USA	NR	BFST 18	40		13–18 years ($M = 16$ years)	Caucasian, African-American	5–8 weeks	Home-based BFST	10 sessions (1.5 h)	Social worker, psychologists	6–10 weeks	Standard diabetes care; Educational support	NR	DRC-15
Lehmkuhl et al. 2010	USA	NR	18	14		9–17 years ($M = 13.7$	Caucasian, African-American, Hispanic.	3 months	BFST telehealth behavioral Therapy	36 sessions (15–20 min)	Research assistant	NR	Standard diabetes care	DFRQ-17	NR
Murphy et al. 2012	UK	NR	158	147		11–16 years ($M = 13.1$)	NR	6 months	Teamwork	6 sessions (1.5 h)	Multidisciplinary health professionals	12 months	Standard diabetes care	DFRQ-17	NR
Freeman et al. 2013	USA	Skype	Skype 47	Clinic 45		12–19 years ($M = 15.1$)	Caucasian, biracial/multiracial, Hispanic	3 months	BFST-D via Skype	10 sessions (1–1.5 h)	Psychologists	NR	BFST-D in clinic	NR	DRFC
Harris et al. 2015	USA	Skype	Skype 46	Clinic 44		12–18 years ($M = 15.04$)	Caucasian, Hispanic, Latin, biracial, multiracial	3 months	BFST-D via Skype	10 sessions (1–1.5 h)	Psychologists	3 months	BFST-D in clinic	DSMP-25	NR

Note: *SCI* the 14-item Self-care Inventory, *DRC-15* the Diabetes Responsibility and Conflict Scale, *DRFC* Diabetes Responsibility and Family Conflict Scale, *DFRQ-17* Diabetes Family Responsibility Questionnaire, *DRC-15* Diabetes Responsibility and Conflict Scale, *DSMP-24* Diabetes Self-management Profile, *DSMP-25* Diabetes Self-management Profile-Child and Parent Versions, *BFST* Behavioral Family Systems Therapy, *BFST-D* Behavioral Family Systems Therapy-Diabetes, *SC* Standard Care, *ES* Educational Support, *I* Intervention, *C* Control, *NR* Not Reported

The Treatment Group

Three treatments (30%) were conducted via technology (Internet-based video conferencing, Teleheath, or social media) (Freeman et al., 2013; Harris et al., 2015; Lehmkuhl et al., 2010), while six studies included clinic-based treatments (60%) (Anderson et al., 1999; Laffel et al., 2003; Murphy et al., 2012; Murphy et al., 2007; Wysocki et al., 2007; Wysocki et al., 2000), and there was one home-based treatment (Harris et al., 2009). Five FST treatments were delivered by psychologists (Freeman et al., 2013; Harris et al., 2009; Harris et al., 2015; Wysocki et al., 2007; Wysocki et al., 2000), three treatments were delivered by research assistants (Anderson et al., 1999; Laffel et al., 2003; Lehmkuhl et al., 2010), and two treatments were delivered by multidisciplinary health professionals (Murphy et al., 2012; Murphy et al., 2007).

The core components of all FST interventions included communication training; six out of ten studies included problem-solving, cognitive restructuring, family restructuring, and behavioral contracting; and four out of ten studies included responsibility sharing and goal setting. The dosage of the treatments varied. Four studies (40%) (Freeman et al., 2013; Harris et al., 2009; Harris et al., 2015; Wysocki et al., 2000) included 10 sessions, and each session lasted about 1.5 h. One tele-health intervention included 36 phone sessions (15–20 min each) (Lehmkuhl et al. 2010), one intervention included 12 sessions (a 45-minute lecture and 45 min of family interaction about a topic led by the facilitator) (Wysocki et al. 2007), and four interventions included 4–6 in-person sessions (of 1–1.5 h each) (Anderson et al., 1999; Laffel et al., 2003; Murphy et al., 2012; Murphy et al., 2007). The duration of the interventions ranged between 5–8 weeks and 12 months. Three interventions were 12 months in length (Anderson et al., 1999; Laffel et al., 2003; Murphy et al., 2007), two interventions lasted six months (Murphy et al., 2012; Wysocki et al., 2007), four interventions lasted three months (Freeman et al., 2013; Harris et al., 2015; Lehmkuhl et al., 2010; Wysocki et al., 2000), and one intervention was 5–8 weeks in duration (Harris et al., 2009).

The Control Group

Four studies had two control arms, including standard care and educational support (Anderson et al., 1999; Harris et al., 2009; Wysocki et al., 2007; Wysocki et al., 2000). Four studies had one control arm that received standard care (Laffel et al., 2003; Lehmkuhl et al., 2010; Murphy et al., 2012; Murphy et al., 2007). Two studies included FST in-person interventions for the control group, while the intervention group was subjected to FST interventions via technology (Freeman et al., 2013; Harris et al., 2015). Standard care in these studies included physical examination, diabetes education, and annual evaluation for diabetic complications. Participants who received educational support completed 10–12 sessions of diabetes education and social support. Each session included a 45-minute educational presentation by a diabetes professional on one of 10–12 topics, followed by 45 min of family interaction about that topic led by the facilitator (Anderson et al., 1999; Harris et al., 2009; Wysocki et al., 2007; Wysocki et al., 2000).

Evaluation of Efficacy

Three studies reported 12-month outcomes (Anderson et al., 1999; Laffel et al., 2003; Murphy et al., 2007), two studies reported 6-month outcomes (Murphy et al., 2012; Wysocki et al. 2007), four studies reported 3-month outcomes (Freeman et al., 2013; Harris et al., 2009; Harris et al., 2015; Wysocki et al., 2000), and only one study reported a 5–8 weeks outcome (Harris et al., 2009). However, outcome data upon completion of the treatment were available in all ten studies.

Glycemic control was measured by HbA1C in all studies. In six studies, diabetes-specific family conflict was evaluated by two validated measures of the Diabetes Responsibility and Conflict Scale (DRC-15) (Rubin et al., 1989) and the Diabetes Responsibility and Family Conflict Scale (DRFC) (Rubin et al., 1989). Self-management was assessed by four different tools, including the Diabetes Self-management Profile (DSMP-24) (Hanson et al., 1987), the Diabetes Self-management Profile-Child and Parent Versions (DSMP-25) (Harris et al., 2000), the 14-item Self-care Inventory (SCI) (Greco et al., 1990), and the Diabetes Family Responsibility Questionnaire (DFRQ-17) (Anderson et al., 1990).

The Results of the Meta-analysis of FST Treatments

The effect of FST on diabetes-related family conflicts

Six studies measured the scores for diabetes-related family conflicts upon completion of the intervention (Anderson et al., 1999; Freeman et al., 2013; Harris et al., 2009; Laffel et al., 2003; Wysocki et al., 2007; Wysocki et al., 2000), while two studies did not extract data (Freeman et al., 2013; Harris et al., 2009) and thus could not be pooled into the meta-analysis (Freeman et al., 2013; Harris et al., 2009). The four studies included in the meta-analysis evaluated the results for a total of 302 participants. A random effects model and the SMD were used as the summary statistic because different diabetes-related family conflicts scales were used (Shuster, 2011). The four FST interventions were conducted in person. The efficacy of FST interventions in

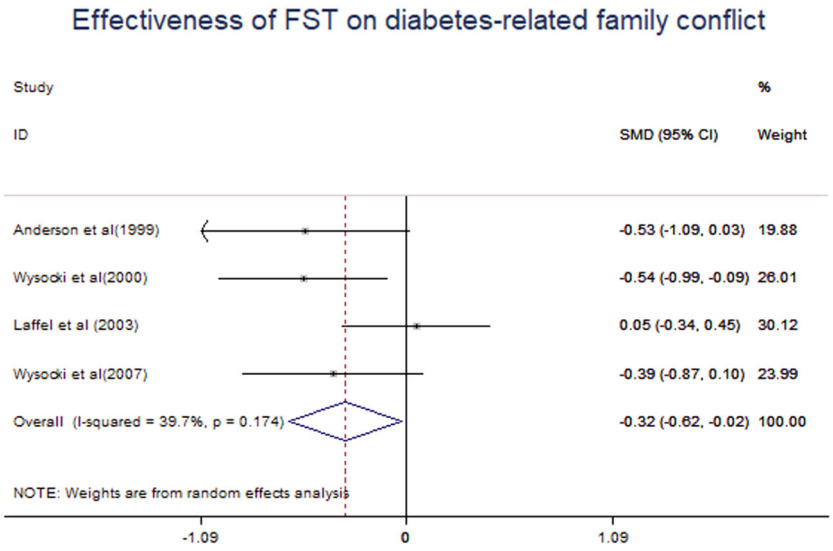

Fig. 2 Forest plot: The effectiveness of FST interventions in diabetes-related family conflict compared with the effectiveness of standard care in the control group

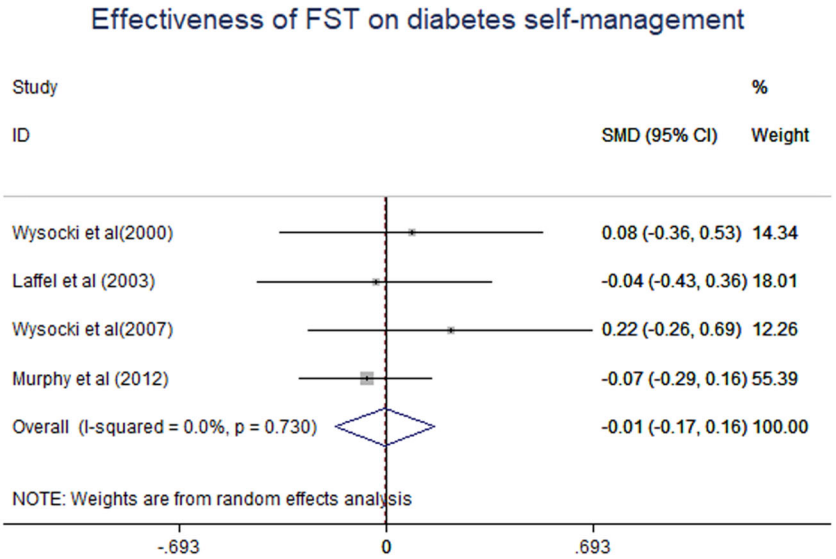

Fig. 3 Forest plot: The effectiveness of FST interventions in diabetes self-management compared with the effectiveness of standard care in the control group

decreasing diabetes-related family conflict was statistically significant, with a medium effect size, compared with the efficacy of standard care in the control group [effect size = −0.32, 95% CI = (−0.62, −0.02), $z = 2.12$, $p = 0.03$]. (see Fig. 2).

The effect of FST on diabetes self-management

Using four different tools, seven studies compared the self-management scores of FST intervention groups upon completion of the treatment to those of the control groups (Harris et al., 2015; Laffel et al., 2003; Lehmkuhl et al., 2010; Murphy et al., 2012; Murphy et al., 2007; Wysocki et al., 2007; Wysocki et al., 2000). Three out of the seven studies could not be pooled for meta-analysis as they did not report the means and standard deviations of the self-management values. Thus, a meta-analysis of the remaining four studies was conducted. It evaluated the results of a total of 552 participants. The effect of FST interventions on the improvement of diabetes self-management was not significantly different from the effect of diabetes self-management for the control group [effect size = 0.006, 95% CI = (−0.17, 0.16), $z = 0.07$, $p = 0.95$]. (see Fig. 3).

The effect of FST on glycemic control

All ten studies included in this review reported glycated hemoglobin levels. Five studies could not be pooled for meta-analysis as they did not report the mean HbA1c values

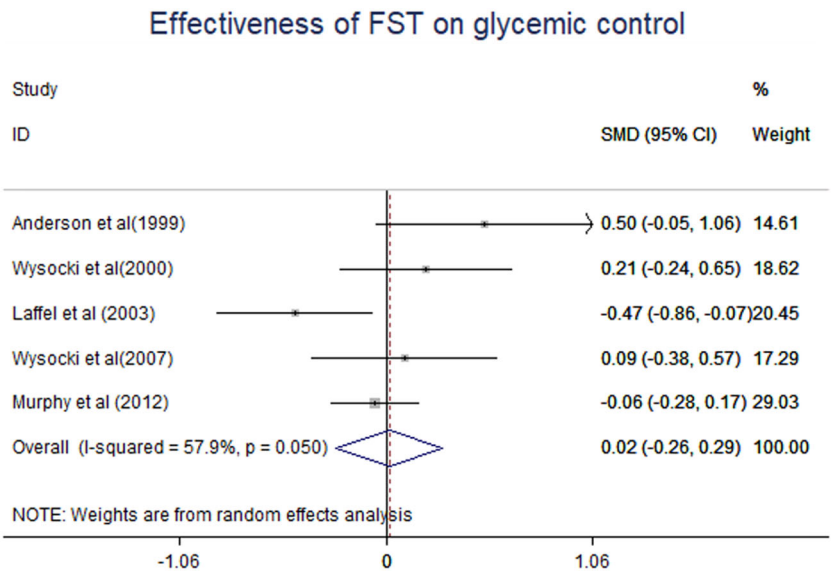

Fig. 4 Forest plot: The effectiveness of FST interventions in glycemic control compared with the effectiveness of glycemic control in the control group

and their standard deviations upon completion of the FST interventions. The remaining five studies were pooled into the meta-analysis; data from a total of 607 participants were included. The comparison of HbA1c values was based on the SMD in a random effects model. The pooled results indicated a non-significant difference in HbA1c between the FST intervention group and the control group ($n = 5$) [effect size = 0.02, 95% CI = (−0.26, 0.29), $z = 0.12$, $p = 0.905$]. (see Fig. 4).

Discussion

To the best of our knowledge, this is the first meta-analysis to quantify the magnitude of change in diabetes-related family conflicts, self-management, and glycemic control associated with FST treatments for youth with T1D. The FST interventions were more effective, at a statistically significant level, in decreasing diabetes-related family conflicts than was standard care, yet effects of FST on diabetes self-management and metabolic control in adolescents with T1D were not demonstrated.

Detection bias was also a concern, because studies predominantly failed to contain sufficient detail on keeping assessors blind to the experimental conditions. There was a small number of studies on various outcomes. The studies reported a variety of methodological and clinical problems. In sum, the findings on the efficacy of the FST interventions need to be interpreted with caution. It should also be noted that all studies were performed in two countries, the US and the UK, which might indicate little attention has been paid on family management among youths with T1D in other countries. More large-scale, high-quality, and rigorously conducted randomized control trials are needed to generate scientific evidence on adolescents with T1D globally.

In the meta-analysis, we found that FST interventions could reduce diabetes-related family conflicts, with a medium-strength effect. This result echoes studies that show the positive effects of FST interventions to be a powerful adjunct to substance use treatment for adolescent substance users (Rowe, 2012; Slesnick & Zhang, 2016). FST focuses on both adaptive and maladaptive family interactions related to the child's disease management, aiming at addressing and altering family members' irrational beliefs, attitudes, and attributions that could impede effective parent-adolescent interactions; thus the role of parents can shift from completing tasks to partnering with their child to monitor and provide support (Kazak et al., 2002). There are many components of FST interventions targeting at improving family interaction characteristics that might help reduce family conflicts, such as communication, parental involvement and monitoring, and parental support (Jaser, 2011). The FST interventions can help avoid conflicts that undermine diabetes management in families of adolescents with T1D (Hilliard et al., 2016).

In this meta-analysis, there was no significant improvement of self-management upon the completion of the FST interventions. This may be due to various factors. First, we extracted the data on the effect of diabetes self-management right after intervention. However, self-management, as a dynamic, interactive, and daily behavioral process, needs time to develop and to be maintained. Second, the mechanism of FST interventions could potentially improve some aspects of diabetes self-management, such as communication and collaboration with parents, and even diabetes care activities, but it might nonetheless not be able to improve the ability to solve diabetes-related problems or

goal setting in diabetes self-management by improving family interaction and decreasing family conflict (Anderson et al., 2002).

Accordingly, this meta-analysis did not find a consistent effect of FST interventions on glycemic control. The glycemic control of adolescents with T1D can be influenced by numerous factors (Rapoff, 1999), such as diabetes self-management (McCarthy and Grey 2018), growth and hormonal shifts (Markowitz et al., 2015), and psychosocial status (Rechenberg et al., 2017). First, since FST interventions did not show efficacy on diabetes self-management improvement in this meta-analysis, it is not surprising the glycemic control was not improved. Second, according to developmental theory, dramatical physical change during adolescence, such as growth and hormonal shifts, could cause significant insulin resistance (Markowitz et al., 2015), thus it is difficult to improve metabolic control of adolescents. Third, as children reach adolescence, they experience psychosocial changes that could impact their self-management or metabolic control, such as increased self-management autonomy (Anderson et al., 2002), not being seen different from peers, higher risk for depression (Iturralde et al., 2017), and conflict with parents (Markowitz et al., 2015) in glycemic control. A single FST intervention model cannot address all the factors inhibiting glycemic control. Compared to single-component interventions, a multicomponent treatment (a psychosocial program and a diabetes education program) for adolescents with T1D yielded a significant difference in improving glycemic control (Whittemore et al., 2012). Thus, we suggest that adolescents who have T1D and their families may need multidimensional psychosocial programs accompanied by diabetes education to improve glycemic control.

Limitations

Some limitations in this review should be addressed. First, all the included studies were published in English; there is a possibility that studies with negative results remain unpublished, which may indicate language and publication biases (Shuster, 2011). We did not search databased in other languages than English for the two reasons. On one hand, the aim of the meta-analysis was not to explore the intervention efficacy in certain population who don't use English as first languages (such as Chinese population). On the other hand, we understand the ideal situation is to search databases or articles in all languages, but the authors are not able to read databases in all languages (for example, Finnish, Japanese, Germany). More importantly, if we included only one or two languages databases other than English databases, it could increase bias to draw conclusions especially among the populations speaking the languages we did not search.

Second, the included clinical trial studies had some methodological weaknesses, such as a lack of clear information on allocation concealment and the inability to keep the outcome assessors blind. Third, since there are few studies available, only the short-term efficacy of FST interventions in diabetes-related family conflict, self-management, and glycemic control was reported; the long-term effectiveness is unknown.

Implications for Practice and Research

The FST interventions were all conducted in developed countries, thus studies from other countries with different socio-economic backgrounds are needed. Most FST treatments were delivered by psychologists. Future research could explore how to provide the treatments with less specialized personnel. FST interventions that evaluate the long-term effectiveness are needed. There is a great need to explore the effectiveness of psychosocial programs that accompany diabetes education on diabetes self-management and glycemic control among adolescents with T1D.

To apply our results concretely, first, in the light of the special lifespan development stage of adolescence, when health care providers see families with many diabetes-related conflicts, an FST intervention could be considered as a strategy for alleviating the conflicts. For early adolescence (11–15 yrs) when adolescents face the challenges of puberty, changes in family relationships and communication barriers (Schilling et al., 2006; Steinberg et al., 2018), families are suggested to learn how to identify communication difficulties and generate better alternatives, then families are taught diabetes problem-solving and diabetes-related family conflicts resolution skills. For mid-adolescence (15–17 yrs), when parent involvement in T1D care being fertile ground for family conflicts, it will be important that adolescents and parents participate fully in order to learn how to restructure family rules and roles in a way that family members can grow as individuals without disrupting the stability of family. Parent role in care shifts from completing tasks to partnering with child to monitoring and providing support. For late adolescence (17–19 yrs) when adolescents become increasingly autonomous and progress toward consolidating their personal identities (Schilling et al., 2006), family members should communicate with calm, nonjudgmental conversational style with adolescents on diabetes-related topics is critical. Second, those who work with families – not just psychologists, such as family nurse, social workers, and pastoral counselors may be a more resource-efficient approach that can facilitate broader translation to

practice settings. Third, the current FST interventions showed the emergence of rapid technological development that obtained positive rehabilitation effects; this could represent a potential to support families with T1D with a cost-effective model in clinical practice.

Conclusions

FST interventions in reducing diabetes-related family conflicts among adolescents with T1D was statistically significant. However, the effect of FST interventions on self-management and glycemic control was not demonstrated. Tangible suggestions considering the FST and developmental theory together to support families are offered. There is a great need for long-term follow-up studies from other cultures on FST interventions in adolescents with T1D.

Author Contributions JG designed the study, obtained the grant, and HJW assisted in data selection, data synthesis and drafting the manuscript, YG, WCL. assisted in search studies, YYJ assisted in risk of bias assessment. JG, RW conceptualized the study and critically reviewed the manuscript. All authors approved the final manuscript as submitted. JG is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Compliance with Ethical Standards

Conflict of Interest The authors declare no competing interests.

Ethical Approval This meta-analysis was deemed exempt by the (masked) Institutional Review Board. For this type of study informed consent is not required. This article does not contain any studies with human participants or animals performed by any of the authors.

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References

Articles included in the meta-analysis are marked by an*

Akhter, K., Turnbull, T., & Simmons, D. (2018). A systematic review of parent/peer-based group interventions for adolescents with type 1 diabetes: interventions based on theoretical/therapeutic frameworks. *British Journal of Diabetes*, *18*(2), 51–65. https://doi.org/10.15277/bjd.2018.177.

Anderson, B. J., Auslander, W. F., Jung, K. C., Miller, J. P., & Santiago, J. V. (1990). Assessing family sharing of diabetes responsibilities. *J Pediatr Psychol*, *15*(4), 477–492. https://doi.org/10.1093/jpepsy/15.4.477.

*Anderson, B. J., Brackett, J., Ho, J., & Laffel, L. M. (1999). An office-based intervention to maintain parent-adolescent teamwork in diabetes management. Impact on parent involvement, family conflict, and subsequent glycemic control. *Diabetes Care, 22*(5), 713–721. https://doi.org/10.2337/diacare.22.5.713.

Anderson, B. J., Vangsness, L., Connell, A., Butler, D., Goebel-Fabbri, A., & Laffel, L. M. (2002). Family conflict, adherence, and glycaemic control in youth with short duration Type 1 diabetes. *Diabet Med*, *19*(8), 635–642. https://doi.org/10.1046/j.1464-5491.2002.00752.x.

Bronfenbrenner, U. (1979). *The Ecology of Human Development: Experiments by Nature And Design*. https://doi.org/10.1080/00131728109336000.

Cameron, F. J., Skinner, T. C., de Beaufort, C. E., Hoey, H., Swift, P. G., Aanstoot, H., Aman, J., Martul, P., Chiarelli, F., Daneman, D., Danne, T., Dorchy, H., Kaprio, E. A., Kaufman, F., Kocova, M., Mortensen, H. B., Njolstad, P. R., Phillip, M., Robertson, K. J., Schoenle, E. J., Urakami, T., Vanelli, M., Ackermann, R. W., & Skovlund, S. E. (2008). Are family factors universally related to metabolic outcomes in adolescents with Type 1 diabetes? *Diabet Med*, *25*(4), 463–468. https://doi.org/10.1111/j.1464-5491.2008.02399.x.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences*. Academic Press. https://doi.org/10.1016/B978-0-12-179060-8.50012-8.

Datye, K. A., Moore, D. J., Russell, W. E., & Jaser, S. S. (2015). A review of adolescent adherence in type 1 diabetes and the untapped potential of diabetes providers to improve outcomes. *Curr Diab Rep*, *15*(8), 51 https://doi.org/10.1007/s11892-015-0621-6.

Dersimonian, R., & Nan, L. J. C. C. T. (1986). Meta-Analysis in Clinical Trials. *Control Clin Trials*, *7*(3), 177–188. https://doi.org/10.1016/0197-2456(86)90046-2.

Duke, D. C., Geffken, G. R., Lewin, A. B., Williams, L. B., Storch, E. A., & Silverstein, J. H. (2008). Glycemic control in youth with type 1 diabetes: family predictors and mediators. *J Pediatr Psychol*, *33*(7), 719–727. https://doi.org/10.1093/jpepsy/jsn012.

Duke, D. C., Wagner, D. V., Ulrich, J., Freeman, K. A., & Harris, M. A. (2016). Videoconferencing for Teens With Diabetes: Family Matters. *J Diabetes Sci Technol*, *10*(4), 816–823. https://doi.org/10.1177/1932296816642577.

Federation, I. D. (2017). IDF Diabetes Atlas 8th ed, Brussels, [accessed 18th January 2021]. http://www.diabetesatlas.org.

Feldman, M. A., Anderson, L. M., Shapiro, J. B., Jedraszko, A. M., Evans, M., Weil, L. E. G., Garza, K. P., & Weissberg-Benchell, J. (2018). Family-based interventions targeting improvements in health and family outcomes of children and adolescents with type 1 diabetes: a systematic review. *Curr Diab Rep*, *18*(3), 15 https://doi.org/10.1007/s11892-018-0981-9.

Fingerman, K. L., & Bermann, E. (2000). Applications of family systems theory to the study of adulthood. *Int J Aging Hum Dev*, *51*(1), 5–29. https://doi.org/10.2190/7tf8-wb3f-tmwg-tt3k.

Floyd, B. D., Block, J. M., Buckingham, B. B., Ly, T., Foster, N., Wright, R., Mueller, C. L., Hood, K. K., & Shah, A. C. (2017). Stabilization of glycemic control and improved quality of life using a shared medical appointment model in adolescents with type 1 diabetes in suboptimal control. *Pediatr Diabetes*, *18*(3), 204–212. https://doi.org/10.1111/pedi.12373.

Foster, N. C., Beck, R. W., Miller, K. M., Clements, M. A., Rickels, M. R., DiMeglio, L. A., Maahs, D. M., Tamborlane, W. V., Bergenstal, R., Smith, E., Olson, B. A., & Garg, S. K. (2019). State of type 1 diabetes management and outcomes from the T1D exchange in 2016-2018. *Diabetes Technol Ther*, *21*(2), 66–72. https://doi.org/10.1089/dia.2018.0384.

Fox, D. A., Islam, N., Sutherland, J., Reimer, K., & Amed, S. (2018). Type 1 diabetes incidence and prevalence trends in a cohort of Canadian children and youth. *Pediatr Diabetes*, *19*(3), 501–505. https://doi.org/10.1111/pedi.12566.

*Freeman, K. A., Duke, D. C., & Harris, M. A. (2013). Behavioral health care for adolescents with poorly controlled diabetes via Skype: does working alliance remain intact? *J Diabetes Sci Technol, 7*(3), 727–735. https://doi.org/10.1177/193229681300700318.

Greco, P., Greca, L., Auslander, W. F., Spetter, D., & Fisher, E. J. D. (1990). Assessing adherence in IDDM: A comparison of two methods [Abstract. 40].

Hanson, C. L., Henggeler, S. W., & Burghen, G. A. (1987). Social competence and parental support as mediators of the link between stress and metabolic control in adolescents with insulin-dependent diabetes mellitus. *J Consult Clin Psychol*, *55*(4), 529–533. https://doi.org/10.1037/0022-006x.55.4.529.

*Harris, M. A., Freeman, K. A., & Beers, M. (2009). Family therapy for adolescents with poorly controlled diabetes: initial test of clinical significance. *J Pediatr Psychol, 34*(10), 1097–1107. https://doi.org/10.1093/jpepsy/jsp009.

*Harris, M. A., Freeman, K. A., & Duke, D. C. (2015). Seeing Is Believing: Using Skype to Improve Diabetes Outcomes in Youth. *Diabetes Care, 38*(8), 1427–1434. https://doi.org/10.2337/dc14-2469.

Harris, M. A., Wysocki, T., Sadler, M., Wilkinson, K., Harvey, L. M., Buckloh, L. M., Mauras, N., & White, N. H. (2000). Validation of a structured interview for the assessment of diabetes self-management. *Diabetes Care*, *23*(9), 1301–1304. https://doi.org/10.2337/diacare.23.9.1301.

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557.

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., & Welch, V. A. (2019). *Cochrane Handbook for Systematic Reviews of Interventions*.

Hilliard, M. E., Powell, P. W., & Anderson, B. J. (2016). Evidence-based behavioral interventions to promote diabetes management in children, adolescents, and families. *Am Psychol*, *71*(7), 590–601. https://doi.org/10.1037/a0040359.

Hilliard, M. E., Wu, Y. P., Rausch, J., Dolan, L. M., & Hood, K. K. (2013). Predictors of deteriorations in diabetes management and control in adolescents with type 1 diabetes. *J Adolesc Health*, *52*(1), 28–34. https://doi.org/10.1016/j.jadohealth.2012.05.009.

Institute, J. B. (2014). *Joanna Briggs Institute Reviewers' Manual: 2014 Edition*. Australia: The Joanna Briggs Institute.

Iturralde, E., Weissberg-Benchell, J., & Hood, K. K. (2017). Avoidant coping and diabetes-related distress: pathways to adolescents' Type 1 diabetes outcomes. *Health Psychol*, *36*(3), 236–244. https://doi.org/10.1037/hea0000445.

Jaser, S. S. (2011). Family interaction in pediatric diabetes. *Curr Diab Rep*, *11*(6), 480–485. https://doi.org/10.1007/s11892-011-0222-y.

Katz, M. L., Volkening, L. K., Butler, D. A., Anderson, B. J., & Laffel, L. M. (2014). Family-based psychoeducation and Care Ambassador intervention to improve glycemic control in youth with type 1 diabetes: a randomized trial. *Pediatr Diabetes*, *15*(2), 142–150. https://doi.org/10.1111/pedi.12065.

Kazak, A. E., Simms, S., & Rourke, M. T. (2002). Family systems practice in pediatric psychology. *J Pediatr Psychol*, *27*(2), 133–143. https://doi.org/10.1093/jpepsy/27.2.133.

*Laffel, L. M., Vangsness, L., Connell, A., Goebel-Fabbri, A., Butler, D., & Anderson, B. J. (2003). Impact of ambulatory, family-focused teamwork intervention on glycemic control in youth with type 1 diabetes. *J Pediatr, 142*(4), 409–416. https://doi.org/10.1067/mpd.2003.138.

*Lehmkuhl, H. D., Storch, E. A., Cammarata, C., Meyer, K., Rahman, O., Silverstein, J., Malasanos, T., & Geffken, G. (2010). Tele-health behavior therapy for the management of type 1 diabetes in adolescents. *J Diabetes Sci Technol, 4*(1), 199–208. https://doi.org/10.1177/193229681000400125.

Markowitz, J. T., Garvey, K. C., & Laffel, L. M. (2015). Developmental changes in the roles of patients and families in type 1 diabetes management. *Curr Diabetes Rev*, *11*(4), 231–238. https://doi.org/10.2174/1573399811666150421114146.

Marta, N., Stepan, P., Zdenek, B., Erika, L., & Jana, D. J. M. O. I. (2015). Periodontal diseases and dental caries in children with type 1 diabetes mellitus. *Mediators of Inflammation*, *2015*, 1–8. https://doi.org/10.1155/2015/379626.

Maybery, D., & Reupert, A. (2009). Parental mental illness: a review of barriers and issues for working with families and children. *J Psychiatr Ment Health Nurs*, *16*(9), 784–791. https://doi.org/10.1111/j.1365-2850.2009.01456.x.

McBroom, L. A., & Enriquez, M. (2009). Review of family-centered interventions to enhance the health outcomes of children with type 1 diabetes. *Diabetes Educ*, *35*(3), 428–438. https://doi.org/10.1177/0145721709332814.

McCarthy, M. M., & Grey, M. (2018). Type 1 diabetes self-management from emerging adulthood through older adulthood. *Diabetes Care*, *41*(8), 1608–1614. https://doi.org/10.2337/dc17-2597.

Miller, G. F., Coffield, E., Leroy, Z., & Wallin, R. (2016). Prevalence and Costs of Five Chronic Conditions in Children. *J Sch Nurs*, *32*(5), 357–364. https://doi.org/10.1177/1059840516641190.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*, *339*, b2535 https://doi.org/10.1136/bmj.b2535.

Moore, S. M., Hackworth, N. J., Hamilton, V. E., Northam, E. P., & Cameron, F. J. (2013). Adolescents with type 1 diabetes: parental perceptions of child health and family functioning and their relationship to adolescent metabolic control. *Health Qual Life Outcomes*, *11*, 50 https://doi.org/10.1186/1477-7525-11-50.

*Murphy, H. R., Wadham, C., Hassler-Hurst, J., Rayman, G., & Skinner, T. C. (2012). Randomized trial of a diabetes self-management education and family teamwork intervention in adolescents with Type 1 diabetes. *Diabet Med, 29*(8), e249–254. https://doi.org/10.1111/j.1464-5491.2012.03683.x.

*Murphy, H. R., Wadham, C., Rayman, G., & Skinner, T. C. (2007). Approaches to integrating paediatric diabetes care and structured education: experiences from the Families, Adolescents, and Children's Teamwork Study (FACTS). *Diabet Med*, *24*(11), 1261–1268. https://doi.org/10.1111/j.1464-5491.2007.02229.x.

Naranjo, D., Mulvaney, S., McGrath, M., Garnero, T., & Hood, K. (2014). Predictors of self-management in pediatric type 1 diabetes: individual, family, systemic, and technologic influences. *Curr Diab Rep*, *14*(11), 544 https://doi.org/10.1007/s11892-014-0544-7.

Noser, A. E., Huffhines, L., Clements, M. A., & Patton, S. R. (2017). Diabetes conflict outstrips the positive impact of selfefficacy on youth adherence and glycemic control in type 1 diabetes. *Pediatr Diabetes*, *18*(7), 614–618. https://doi.org/10.1111/pedi.12471.

Petitti, D. B., Klingensmith, G. J., Bell, R. A., Andrews, J. S., Dabelea, D., Imperatore, G., Marcovina, S., Pihoker, C., Standiford, D., & Waitzfelder, B. (2009). Glycemic Control in Youth with Diabetes: The SEARCH for Diabetes in Youth Study. *J Pediatr*, *155*(5), 668–672. e1-3. https://doi.org/10.1016/j.jpeds.2009.05.025.

Rapoff, M. A. (1999). Adherence to Pediatric Medical Regimens. *31*(6), 476. https://doi.org/10.1007/978-1-4419-0570-3.

Rechenberg, K., Whittemore, R., Holland, M., & Grey, M. (2017). General and diabetes-specific stress in adolescents with type 1

diabetes. *Diabetes Res Clin Pract*, *130*, 1–8. https://doi.org/10.1016/j.diabres.2017.05.003.

Riley, A. R., Duke, D. C., Freeman, K. A., Hood, K. K., & Harris, M. A. (2015). Depressive symptoms in a trial behavioral family systems therapy for diabetes: a post hoc analysis of change. *Diabetes Care*, *38*(8), 1435–1440. https://doi.org/10.2337/dc14-2519.

Rowe, C. L. (2012). Family therapy for drug abuse: review and updates 2003-2010. *J Marital Fam Ther*, *38*(1), 59–81. https://doi.org/10.1111/j.1752-0606.2011.00280.x.

Rubin, R. R., Young-Hyman, D., & Peyrot, M. J. D. (1989). Parent-child responsibility and conflict in diabetes care. *38*(Suppl 2), 28A.

Schilling, L. S., Knafl, K. A., & Grey, M. (2006). Changing patterns of self-management in youth with type I diabetes. *J Pediatr Nurs*, *21*(6), 412–424. https://doi.org/10.1016/j.pedn.2006.01.034.

Shuster, J. (2011). Review: Cochrane handbook for systematic reviews for interventions, Version 5.1.0, published 3/2011. Julian P.T. Higgins and Sally Green, Editors. *Research Synthesis Methods*, 2. https://doi.org/10.1002/jrsm.38

Slesnick, N., & Zhang, J. (2016). Family systems therapy for substance-using mothers and their 8- to 16-year-old children. *Psychol Addict Behav*, *30*(6), 619–629. https://doi.org/10.1037/adb0000199.

Smith, J. D., Dishion, T. J., Moore, K. J., Shaw, D. S., & Wilson, M. N. (2013). Effects of video feedback on early coercive parent-child interactions: the intervening role of caregivers' relational schemas. *J Clin Child Adolesc Psychol*, *42*(3), 405–417. https://doi.org/10.1080/15374416.2013.777917.

Steinberg, D. M., Anderson, B. J., de Wit, M., & Hilliard, M. E. (2018). Positive well-being in youth with type 1 diabetes during early adolescence. *J Early Adolesc*, *38*(9), 1215–1235. https://doi.org/10.1177/0272431617692444.

Tsiouli, E., Alexopoulos, E. C., Stefanaki, C., Darviri, C., & Chrousos, G. P. (2013). Effects of diabetes-related family stress on glycemic control in young patients with type 1 diabetes: Systematic review. *Can Fam Physician*, *59*(2), 143–149. https://doi.org/10.2298/VSP110719030B.

von, B. L. (1951). General system theory; a new approach to unity of science. 1. Problems of general system theory. *Hum Biol*, *23*(4), 302–312. https://doi.org/10.1016/0011-9164(84)87005-8.

von Schnurbein, J., Boettcher, C., Brandt, S., Karges, B., Dunstheimer, D., Galler, A., Denzer, C., Denzer, F., Vollbach, H., Wabitsch, M., Roenneberg, T., & Vetter, C. (2018). Sleep and glycemic control in adolescents with type 1 diabetes. *Pediatr Diabetes*, *19*(1), 143–149. https://doi.org/10.1111/pedi.12538.

Whittemore, R., Jaser, S. S., Jeon, S., Liberti, L., Delamater, A., Murphy, K., Faulkner, M. S., & Grey, M. (2012). An internet coping skills training program for youth with type 1 diabetes: six-month outcomes. *Nurs Res*, *61*(6), 395–404. https://doi.org/10.1097/NNR.0b013e3182690a29.

Wood, J. R., Miller, K. M., Maahs, D. M., Beck, R. W., DiMeglio, L. A., Libman, I. M., Quinn, M., Tamborlane, W. V., & Woerner, S. E. (2013). Most youth with type 1 diabetes in the T1D exchange clinic registry do not meet american diabetes association or international society for pediatric and adolescent diabetes clinical guidelines. *Diabetes Care*, *36*(7), 2035–2037. https://doi.org/10.2337/dc12-1959.

*Wysocki, T., Harris, M. A., Buckloh, L. M., Mertlich, D., Lochrie, A. S., Mauras, N., & White, N. H. (2007). Randomized trial of behavioral family systems therapy for diabetes: maintenance of effects on diabetes outcomes in adolescents. *Diabetes Care, 30*(3), 555–560. https://doi.org/10.2337/dc06-1613.

*Wysocki, T., Harris, M. A., Greco, P., Bubb, J., Danda, C. E., Harvey, L. M., McDonell, K., Taylor, A., & White, N. H. (2000). Randomized, controlled trial of behavior therapy for families of adolescents with insulin-dependent diabetes mellitus. *J Pediatr Psychol, 25*(1), 23–33. https://doi.org/10.1093/jpepsy/25.1.23.