Journal of Pediatric Nursing 66 (2022) 125–135

Contents lists available at ScienceDirect

Journal of Pediatric Nursing

journal homepage: www.pediatricnursing.org

Related factors associated with fear of hypoglycemia in parents of children and adolescents with type 1 diabetes - A systematic review

Lu Zhang [a], Huiwen Xu [a,b,1], Lin Liu [a], Yaxin Bi [a], Xiangning Li [a], Yinshi Kan [a], Hongyuan Liu [a], Shuang Li [a], Yan Zou [a], Yuan Yuan [c], Weijuan Gong [a], Yu Zhang [a,d,*]

[a] School of Nursing, Yangzhou University, Yangzhou, China
[b] Nagano College of Nursing, Komagane, Nagano 399-4117, Japan
[c] Affiliated Hospital of Yangzhou University, Yangzhou, China
[d] Jiangsu Key Laboratory of Integrated Traditional Chinese and Western Medicine for Prevention and Treatment of Senile Diseases, Yangzhou, China

ARTICLE INFO

Article history:
Received 21 January 2022
Revised 9 May 2022
Accepted 27 May 2022

Keywords:
Fear of hypoglycemia
Parents
Children/adolescents
Type 1 diabetes
Related factors

ABSTRACT

Problem: Fear of hypoglycemia is a significant concern for parents of children/ adolescents with type 1 diabetes. Although some studies have explained the parental fear of hypoglycemia, the related factors were yet to be determined. This systematic review aims to identify the related factors of fear of hypoglycemia in the parents of children and adolescents with type 1 diabetes and provide a theoretical basis for further intervention.
Eligibility criteria: PubMed, MEDLINE, EMBASE, Scopus, CINAHL, EBSCO, Web of Science, and Cochrane Library were systematically searched from 2010 to 2021. Studies evaluating the fear of hypoglycemia of parents and its associated factors were included.
Sample: Twenty-three observational articles met the criteria.
Results: Significant associations were found between fear of hypoglycemia and specific factors, including motherhood, nocturnal hypoglycemia, and the number of blood glucose monitoring. Psychological factors, including anxiety, depression, pediatric parenting stress, mindfulness, self-efficacy, quality of life, and sleep disorders, were conclusive and associations with parental fear of hypoglycemia.
Conclusions: Understanding parental fear of hypoglycemia can help parents prevent potential problems in diabetes management, thus promoting children's growth. According to current evidence, effective targeted interventions based on modifiable relevant factors can be developed to reduce the fear of hypoglycemia in parents while maintaining optimal blood glucose control in children/ adolescents.
Implications: Health professionals should pay more attention to the mental health of parents, and parents should be involved in the care plan and have the opportunity to discuss their fear of hypoglycemia in the most appropriate way to manage type 1 diabetes.

Introduction

Type 1 diabetes (T1D) is one of the most frequent chronic endocrine diseases in children and adolescents. Its incidence rates continue to increase worldwide (Patterson et al., 2019). Hypoglycemia is the most common acute complication in children with T1D and a significant obstacle to achieving optimal glucose control (Haynes et al., 2019). Children have a higher incidence of severe hypoglycemia when compared with adults with T1D (Sundberg & Forsander, 2014). Although Modern diabetes technology provides more flexible diabetes management (Brown et al., 2021), hypoglycemia still affects the lives of young patients and their parents, who play an essential role in the daily management of T1D (Sundberg & Forsander, 2014; Urakami, 2020). In addition, hypoglycemia events are distressing because they are unpredictable, accompanied by uncomfortable counter-regulatory and neuroglycopenic symptoms, increase the troublesome neurological sequelae, and can be life-threatening in severe cases (Sundberg & Forsander, 2014).

It is no surprise that fear of hypoglycemia (FOH) is common for children with T1D and their parents, given its frequent occurrence and potentially life-threatening consequences (Barnard et al., 2010). Furthermore, the 2018 American Diabetes Association and International Society for Pediatric and Adolescent Diabetes (ISPAD) guidelines recommend that glycated hemoglobin A_{1c} (HbA_{1c}) be kept below 7% (<53 mmol/mol) (Wolfsdorf et al., 2018). FOH was described as severe anxiety-like symptoms related to blood glucose management and

* Corresponding author at: School of Nursing, Yangzhou University, Jiangyang Road 136, Yangzhou, Jiangsu Province, China.
E-mail address: yizhangyu@yzu.edu.cn (Y. Zhang).
[1] Co-first author: Lu Zhang and Huiwen Xu contributed to this work equally.

https://doi.org/10.1016/j.pedn.2022.05.022
0882-5963/

hypoglycemic avoidance behavior (Abitbol & Palmert, 2021). The prevalence of FOH in parents is very high and can be higher than for the patients (Abitbol & Palmert, 2021; Barnard et al., 2010). For parents, concern about hypoglycemia episodes is a common unmet need related to increased emotional distress and poorer quality of life (Abitbol & Palmert, 2021; Barnard et al., 2010; Patton et al., 2007). Although psychological interventions for FOH have been extensively studied for adults with T1D, there is currently little evidence to support specific psychological interventions for parents experiencing FOH. To develop more effective interventions for this population, we must first understand the psychological processes and related influencing factors of parental FOH.

To our knowledge, three reviews examined the FOH in parents of children/ adolescents with T1D, but one of them was a systematic review (Barnard et al., 2010; Driscoll et al., 2016; Gonder-Frederick et al., 2011). Gonder-Frederick et al. (2011) and Driscoll et al. (2016) briefly summarized the literature on parental FOH, but lacked a systematic method to identify or analyze the data. Barnard et al. (2010) reviewed the factors associated with FOH in parents of children under 12 years of age with T1D, presenting the results of eight studies published before 2010. This review suggests that parental FOH was associated with parental gender, the severity of hypoglycemic episodes, location of hypoglycemic episodes, anxiety, and depression. However, most of the included studies were conducted in the United States, and only a few reports investigated this topic in Norway and Germany. Therefore, these reviews have limitations on the related factors of parental FOH globally. Up to date, much new literature has been published since 2010, some of which are consistent with previous evidence, others are controversial, and some new influencing factors have also been included to explore. All results are not always decisive and consistent because of different methodological designs, populations, and quality. It is necessary to update all the evidence to draw more definite conclusions.

Hence, the present study sought to expand on the findings of Barnard et al. (2010) by assessing the related factors of FOH in the parents of children and adolescents with T1D. Specifically, we systematically reviewed the literature in this area and analytically evaluated the relationship between parental FOH and sociodemographic factors, history of hypoglycemic episodes, disease and treatment factors, and psychological factors.

Methods

This systematic review has been registered in the international prospective register of systematic reviews (registration no. 42021271375). Results are reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards (Page et al., 2021) (Supplementary File 1).

Search strategy and selection

Eight databases (PubMed, MEDLINE, EMBASE, Scopus, CINAHL, EBSCO, Web of Science, and Cochrane Library) were searched from January 01, 2010 to August 01, 2021. A coherent search strategy was designed by combining medical subject heading (MeSH) terms with free text terms after consultation with a professional librarian to achieve maximum search citation retrieval. The search algorithm included all possible combinations of keywords from the four groups: fear (i.e., anxiety or afraid or scare or worry or burden or concern), hypoglycemia, parents (i.e., mothers or fathers or family or caregivers) and type 1 diabetes. Table 1 documents the search algorithm in PubMed.

The titles and abstracts of the literature were screened. The full text of papers that seemed to fulfill the inclusion and exclusion criteria were selected by two reviewers independently. Disagreements were rechecked and discussed with a third reviewer until a consensus was reached.

Table 1
Search terms used for literature searching in PubMed.

1	"Fear"[Mesh] or "Anxiety"[Mesh] or Fear* or Angst or Nervousness or Hypervigilance or Anxiousness or "Social Anxiety" or "Anxiety, Social" or "Social Anxieties" or Afraid or Scare or Worry or Burden or Concern
2	"Hypoglycemia"[Mesh] or "Postprandial Hypoglycemia" or "Hypoglycemia, Postprandial" or "Reactive Hypoglycemia" or "Hypoglycemia, Reactive" or "Fasting Hypoglycemia" or "Hypoglycemia, Fasting" or "Postabsorptive Hypoglycemia" or Glucopenia or Glycopenia or hypoglyc*
3	"Parents"[Mesh] or "Mothers"[Mesh] or "Fathers"[Mesh] or "Family"[Mesh] or "Caregivers"[Mesh] or Parent* or "Parenthood Status" or "Status, Parenthood" or "Step-Parents" or "Step Parents" or "Step-Parent" or Stepparent or Stepparents or "Parental Age" or "Age, Parental" or "Ages, Parental" or "Parental Ages" or mother* or "Mothers' Clubs" or "Mother's Clubs" or "Mothers Clubs" or "Mothers' Club" or Father* or Famil* or "Family Life Cycles" or "Life Cycle, Family" or "Family Life Cycle" or "Family Members" or "Family Member" or Stepfamily or Stepfamilies or "Family, Reconstituted" or "Reconstituted Families" or "Reconstituted Family" or Filiation or "Kinship Networks" or "Kinship Network" or "Network, Kinship" or "Networks, Kinship" or Relatives or "Extended Family" or "Extended Families" or "Families, Extended" or "Family, Extended" or "Family Research" or "Research, Family" or Caregiver or carer* or "Care Givers" or "Care Giver" or "Spouse Caregivers" or "Caregiver, Spouse" or "Caregivers, Spouse" or "Spouse Caregiver" or "Family Caregivers" or "Caregiver, Family" or "Caregivers, Family" or "Family Caregiver" or Maternal or paternal
4	"Diabetes Mellitus, Type 1"[Mesh] or "Diabetes Mellitus, Insulin-Dependent" or "Diabetes Mellitus, Insulin Dependent" or "Insulin-Dependent Diabetes Mellitus" or "Diabetes Mellitus, Juvenile-Onset" or "Diabetes Mellitus, Juvenile Onset" or "Juvenile-Onset Diabetes Mellitus" or IDDM Or "Juvenile-Onset Diabetes" or "Diabetes, Juvenile-Onset" or "Juvenile Onset Diabetes" Or "Diabetes Mellitus, Sudden-Onset" or "Diabetes Mellitus, Sudden Onset" or "Sudden-Onset Diabetes Mellitus" or "Type 1 Diabetes Mellitus" or "Diabetes Mellitus, Insulin-Dependent, 1" or "Insulin-Dependent Diabetes Mellitus 1" or "Insulin Dependent Diabetes Mellitus 1" or "Type 1 Diabetes" or "Diabetes, Type 1" or "Diabetes Mellitus, Type I" or "Diabetes, Autoimmune" or "Autoimmune Diabetes" or "Diabetes Mellitus, Brittle" or "Brittle Diabetes Mellitus" or "Diabetes Mellitus, Ketosis-Prone" or "Diabetes Mellitus, Ketosis Prone" or "Ketosis-Prone Diabetes Mellitus"
5	1 and 2 and 3 and 4

Inclusion and exclusion criteria

Participants: Studies involving parents/caregivers of children/adolescents aged 0–18 years with T1D were eligible. No restrictions on parental age, ethnicity, or geographic location.

Exposures: Studies assessing parental FOH and its associated factors were considered eligible.

Outcome: Outcomes of interest included change in parental FOH. Studies that did not include parental FOH as the primary result or did not provide data were excluded.

Type of Studies: All observational studies with a cohort, case-control, or cross-sectional design. Original research is written in English. Qualitative research and "non-research" articles, such as meta-analysis, systematic review, conference abstracts, letters, commentaries, case reports, protocol, and editorials, were excluded.

Quality assessment criteria

The quality of all articles included was evaluated using the Joanna Briggs Institute (JBI) critical appraisal tools for cross-sectional and prospective cohort studies by researchers independently (Institute, 2017). All entries on the list were ranked as "yes", "no", "unclear", or "not applicable". When there was disagreement about the quality of the article, a third reviewer was invited to participate in the discussion and create consensus. The studies were classified as high, medium, or low quality. The quality score was reduced if the paper did not report subjects and settings and inclusion criteria, the confounding factors were not identified, the questionnaire failed verification, or the appropriate statistical analysis was not used. The quality of the literature was divided as follows: high (> 5 times of "yes" score), moderate (3–5 times of "yes" score), or low (0–2 times of "yes" score) methodological quality (Liberali et al., 2021).

Data extraction and analysis

One reviewer independently extracted data on the characteristics of the studies, and a second reviewer analyzed the data. From the included articles, we recorded the general aspects (authors, publication date and state, primary objective, and design type) and characteristics of the study population (number, gender, age, course of disease, HbA_{1c}, and FOH measurement tools). Nearly half of the articles included in this review were correlation analysis and univariate analysis, lacking relevant data for meta-analysis. Secondly, it was not possible to make adequate comparisons between the studies and provide a quality assessment because of the heterogeneity of the studies in terms of design, objectives, variables, and outcome measures. Statistical pooling of data (meta-analysis) was not possible either. Therefore, the data synthesis is presented narratively. There was a significant correlation between parental FOH and potential factors or results if $p < 0.05$. The interpretations of the correlation strength were based on the correlation coefficients (r) for large ($r \geq 0.5$), medium ($r = 0.3$–0.49), and small ($r = 0.1$–0.29) correlations (Cohen, 1992).

Results

Study selection

Fig. 1 details the citation search and selection process. A total of 1607 articles were initially identified from databases, 857 were excluded because of duplication, and 638 papers were banned after the title and abstract screening. A total of 112 full-text articles were then scrutinized. After full-text evaluation, 23 articles met the eligibility criteria and were included in the review.

Study characteristics

Table 2 summarizes the main characteristics of the studies. The studies included cross-sectional studies ($n = 17$, 73.91%) and prospective cohort studies ($n = 6$, 26.09%). Most studies ($n = 16$, 69.57%) used multivariate analyses, while others involved univariate analyses ($n = 7$, 30.43%). These studies were conducted in America ($n = 8$, 34.78%), Europe (n = 8, 34.78%), Australia ($n = 4$, 17.39%), Asia ($n = 2$, 8.70%), and Canada (n = 1, 4.35%). Among the included studies, 95.65% ($n = 22$) included mostly mothers, and one included only mothers (Freckleton et al., 2014). The sample size in each study ranged from 16 to 549 parents. According to JBI critical appraisal tools, seven studies were classified as high quality (Aalders et al., 2018; Haugstvedt et al., 2010; Herbert, Monaghan, et al., 2015; Johnson, et al., 2013; Patton et al., 2011; Van Name et al., 2018; Viaene et al., 2017), 15 as medium quality (Abitbol & Palmert, 2021; Amiri et al., 2018; Burckhardt et al., 2019; Freckleton et al., 2014; Haugstvedt, et al., 2015; Herbert, Clary, et al., 2015; McConville et al., 2020; Muradoğlu et al., 2021; Ng et al., 2019; Pate et al., 2019; Patton et al., 2017; Sandy et al., 2019; Shepard et al., 2014; Van Gampelaere et al.,

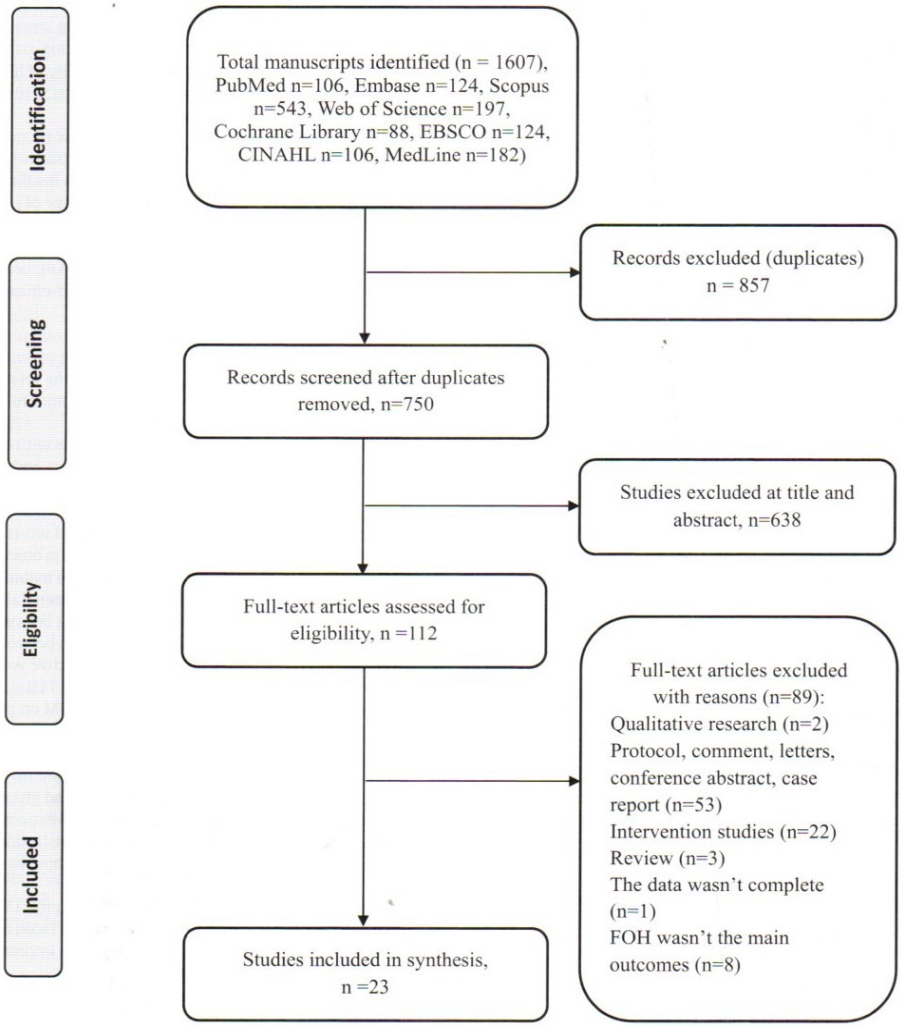

Fig. 1. Citation retrieval and handling process.

Table 2
characters of the included articles ($n = 23$).

Study characteristics	n
Type of study	
Cross-sectional	17
Prospective cohort	6
Data analyses	
Multivariate	16
Only univariate	7
Continent	
America	8
Europe	8
Australia	4
Asia	2
Canada	1
Gender of parents in the study	
Mothers and fathers	22
Only mothers	1
Number of parents in the study	
0–100	10
101–200	10
201–300	2
>300	1

2019; Youngkin et al., 2021), and one study as low quality (Hawkes et al., 2014). The study characteristics and demographic of the participants of the included studies of studies were shown in Tables 3 and 4.

Sociodemographic factors

The gender of the parents and children

No associations were found between children's gender and the parental FOH in five studies (Aalders et al., 2018; Hawkes et al., 2014; Van Gampelaere et al., 2019; Viaene et al., 2017; Youngkin et al., 2021). Results regarding differences in FOH levels between mothers and fathers were conflicting. Most studies noted that Hypoglycemia Fear Survey - parent (HFS-P) total and/or behavior subscale scores were higher in mothers ($p < 0.05$) (Amiri et al., 2018; Haugstvedt et al., 2015; Pate et al., 2019), and no difference in the worry subscale scores. Another study of children and adolescents (1–15 years old) reported that mothers' scores were higher in both subscales (HFS-Worry $p = 0.048$, HFS-Behavior $p < 0.001$) (Haugstvedt et al., 2010). Whereas the other three described a nonsignificant association or between-group difference between parental gender and FOH (Abitbol & Palmert, 2021; Hawkes et al., 2014; Viaene et al., 2017).

The age of parents and children

Only one study reported that the age of parents was negatively correlated with FOH ($p = 0.006$) (Aalders et al., 2018). The link between children/adolescents' age on parental FOH has been studied extensively ($n = 14$), but no consensus. Four studies found that parents of children take more actions to avoid hypoglycemia than parents of adolescents ($r = -0.21$ to -0.40, $p < 0.05$) (Haugstvedt et al., 2015; Herbert, Clary, et al., 2015; Pate et al., 2019; Shepard et al., 2014). Two studies reported that the younger the child, the higher worry scores ($r = -0.21$, $p < 0.05$) (Herbert, Monaghan, et al., 2015) or a tendency to be higher ($p = 0.07$) (Patton et al., 2017) in parents. In addition, Hawkes et al. (2014) mentioned that the FOH among parents of children aged 6–11 years was higher than that of parents of children/adolescents aged 0–5 ($p = 0.025$) and 12 years and older ($p = 0.003$). However, no difference in parental FOH associated with children's age was reported in seven studies (Aalders et al., 2018; Abitbol & Palmert, 2021; Haugstvedt et al., 2010; Van Gampelaere et al., 2019; Van Name et al., 2018; Viaene et al., 2017; Youngkin et al., 2021).

Socioeconomic factors

Four studies discussed whether or not parental FOH was associated with socioeconomic factors (Aalders et al., 2018; Abitbol & Palmert,

Table 3
General aspects of the included articles (n = 23).

Author/Date	Study objective	Design
Haugstvedt et al., 2010, Norway	Examine the association between parental FOH and (i) the prevalence of hypoglycemia and diabetes treatment factors in children with T1D and (ii) emotional distress in mothers and fathers.	Cross-sectional
Patton et al., 2011, USA	Examine pediatric parenting stress and psychological correlates of parenting stress in a sample of parents of young children with T1D.	Cross-sectional
Johnson et al., 2013, Australia	Evaluate the association between FOH, episodes of hypoglycemia, and quality of life in children with T1D and their parents.	Cross-sectional
Freckleton et al., 2014, Australia	Examine the relationship between maternal beliefs about diabetes, concerns about glycemic control, and adherence to recommended blood glucose levels in young children with T1D.	Prospective study
Shepard et al., 2014, USA	Explore underlying constructs of the HFS for parents (PHFS) and children (CHFS).	Cross-sectional
Hawkes et al., 2014, Ireland	Determine if parental FOH is associated with worse glycemic control and increased resource utilization and identify risk factors for increased FOH.	Cross-sectional
Herbert, Monaghan, et al., 2015, USA	Investigate sleep characteristics among parents of children with T1D and relationships among parents' sleep quality, hypoglycemia worry, and diabetes self-efficacy.	Cross-sectional
Herbert, Clary, et al., 2015, USA	Examine the relationship among child school/daycare functioning, parent FOH and parent T1D related quality of life.	Cross-sectional
Haugstvedt et al., 2015, Norway	Examine the psychometric properties of the HFS-P version	Cross-sectional
Patton et al., 2017, USA	Update the psychometric properties of the HFS-P-YC and measure parents' FOH for young children using an insulin pump.	Cross-sectional
Viaene et al., 2017, Belgium	Extend current knowledge of parenting stress and FOH in parents of children with T1D	Cross-sectional
Amiri et al., 2018, Iran	Determine the level of FOH, pediatric parenting stress, and self-efficacy in parents of children with T1D	Cross-sectional
Aalders et al., 2018, Netherlands	Identify the sociodemographic and clinical correlates of FOH among parents of children with T1D and examine the relationships between parental FOH, mindfulness, and mindful parenting.	Cross-sectional
Van Name et al., 2018, USA	Identify FOH associations with demographic and clinical characteristics and explore the influencing factors of parents' FOH.	Cross-sectional
Van Gampelaere et al., 2019, Belgium	The predictive role of parental mindfulness for daily diabetes-related worries was examined, its impact on protective parenting behaviors, and its buffering role in the relationship between daily worries and protective parenting behaviors.	Cross-sectional
Pate et al., 2019, Slovenia	Explored the association between parental FOH, anxiety, and subjective well-being in parents of children with T1D	Cross-sectional
Burckhardt et al., 2019, Australia	Evaluate the effect of CGM on psychosocial outcomes in a T1D pediatric population-based sample.	Prospective cohort study
Ng et al., 2019, UK	Evaluate the effects of CGM on patient and carer well-being, FOH, and glycemic control.	Prospective cohort study
Sandy et al., 2019, Australia	Determine patient/carer expectations of CGM and short-term satisfaction to assess the efficacy of CGM in improving: FOH and glycaemic control.	Prospective cohort study
Youngkin et al. 2021, USA	Examined parental HF in the T1D recent-onset period and evaluated whether CGM adoption relates to improved outcomes of parental HF.	Prospective cohort study
McConville et al., 2020, USA	Examined the trajectory of parental hypoglycemia worry in families of children with recent-onset T1D and the effects of	Prospective cohort study

Table 3 (*continued*)

Author/Date	Study objective	Design
	baseline parental depression on parents' trajectory of HFS-Worry.	
Muradoğlu et al., 2021, Turkey	Explore the associations between parental FOH and their general anxiety level, particularly their attitudes toward and thoughts on glucagon administration.	Cross-sectional
Abitbol & Palmert, 2021, Canada	Determine the extent of FOH among parents of children with T1D and to identify factors associated with greater FOH.	Cross-sectional

Abbreviations: FOH (fear of hypoglycemia); HbA_{1c} (Hemoglobin A_{1c}); HFS-P (Hypoglycemia Fear Survey-Parent); HFS-P-YC (Hypoglycemia Fear Survey-Young Children); CSII (continuous subcutaneous insulin infusion); T1D (type 1 diabetes); NBGM (Nocturnal blood glucose monitoring); CGM (Continuous Glucose Monitoring); HF (hypoglycemia fear).

2021; Amiri et al., 2018; Youngkin et al., 2021). Only one study found that parental FOH had an inverse relationship to education level ($p = 0.018$) (Aalders et al., 2018). In three studies that assessed the association between ethnicity and parental FOH (Aalders et al., 2018; Abitbol & Palmert, 2021; Youngkin et al., 2021), two indicated that parents with non- nationality predicted higher FOH ($p = 0.003$, $p = 0.022$) (Aalders et al., 2018; Abitbol & Palmert, 2021).

History of hypoglycemic episodes

Frequency and severity of hypoglycemic episodes

In total, seven studies examined the association between the frequency of children's hypoglycemic episodes and parental FOH. The majority ($n = 5$) reported a nonexisting association (Amiri et al., 2018; Haugstvedt et al., 2015; Hawkes et al., 2014; Shepard et al., 2014; Van Name et al., 2018). Two studies reported the frequency of hypoglycemia during the investigation was only positively correlated with the HFS-P total or worry subscale scores ($p < 0.05$) (Abitbol & Palmert, 2021; Haugstvedt et al., 2010).

Three studies have confirmed the relationship between the severity of children's hypoglycemic episodes and parental FOH (Abitbol & Palmert, 2021; Johnson et al., 2013; Pate et al., 2019). Parental FOH seems more likely to be triggered by the severity of hypoglycemic episodes, especially in children with seizures or unconsciousness ($p < 0.05$). However, five studies found no association between parental FOH and the severity of hypoglycemia (Aalders et al., 2018; Haugstvedt et al., 2010; Hawkes et al., 2014; Muradoğlu et al., 2021; Van Name et al., 2018).

Nocturnal hypoglycemia and hypoglycemia in public

Four papers investigated the association between the nocturnal hypoglycemia and parental FOH (Abitbol & Palmert, 2021; Haugstvedt et al., 2010; Pate et al., 2019; Van Name et al., 2018), three of which reported a moderate and significant correlation or a group difference ($p <$

Table 4
Numeric description of the study population of the included articles ($n = 23$).

First Author/Date	Sample characteristics						FOH measurement tools
	Number of Participants		Female parents/caregivers (%)	Children age (years)	Duration of child's diabetes (years)	HbA_{1c} (%)	
	Children	Parents/caregivers					
Haugstvedt et al., 2010, Norway	115	200	51	10.6 ± 3.6	3.9 ± 2.9	8.1 ± 1.0	HFS-P
Patton et al., 2011, USA	39	39	82	5.1 ± 1.1	unclear	8.6 ± 1.3	HFS-P-YC
Johnson et al., 2013, Australia	196	325	47	11.83 ± 3.7	4.79 ± 3.5	8.0 ± 0.9	HFS-98
Freckleton et al., 2014, Australia	71	71	100	8.0 ± 2.67	3.1 ± 2.35	8.1 ± 1.41	HFS-P
Shepard et al., 2014, USA	259	250	88	10.56 ± 3.31	5.24 ± 3.28	8.01 ± 0.97	HFS-P; HFS-C
Hawkes et al., 2014, Ireland	106	106	69	11.1 ± 3.7	4.8 ± 3.2	7.9 ± 0.8	HFS-P-YC
Herbert, Monaghan, et al., 2015, USA	134	134	90	5.33 ± 1.34	2.00 ± 1.24	8.13 ± 0.88	HFS-P-YC-W
Herbert, Clary, et al., 2015, USA	134	134	90	5.33 ± 1.34	2.00 ± 1.24	65.4 ± 9.0 (mmol/L)	HFS-P-YC
Haugstvedt et al., 2015, Norway	102	176	52	11.4 ± 2.9	3.9 ± 2.9	8.2 ± 1.0	HFS-P
Patton et al., 2017, USA	116	116	93	5.2 ± 1.3	unclear	8.2 ± 1.1	HFS-P-YC
Viaene et al., 2017, Belgium	63	63	84	12.36 ± 3.9	4.07 ± 2.61	8.28 ± 1.07	HFS-P
Amiri et al., 2018, Iran	61	101	59	9.2 ± 2.0	38.7 ± 24.5 (months)	9.4 ± 1.8	HFS-P
Aalders et al., 2018, Netherlands	194	421	85	11.3 ± 3.5	4.6 ± 3.7	7.8 ± 1.2	HFS-P-W
Van Name et al., 2018, USA	549	549	unclear	5.2 ± 1.2	2.4 ± 1.0	8.2 ± 1.1.	HFS-P-W
Van Gampelaere et al., 2019, Belgium	40	56	64	8.94 ± 2.3	48.4 ± 29.7 (months)	6.87 ± 0.63	HFS-P-YC (3-item)
Pate et al., 2019, Slovenia	125	199	60	12.4 ± 3.0	4.9 ± 2.8	7.6 ± 0.9	HFS-P
Burckhardt et al., 2019, Australia	38	60	unclear	13.3 ± 4.2	5.0 ± 4.4	8.4	HFS-C; HFS-P
Ng et al., 2019, UK	16	16	unclear	13.5	7.6	60.9 ± 14.6 (mmol/mol)	HFS-P
Sandy et al., 2019, Australia	15	40	unclear	14.4 ± 3.3	6.8 ± 5.1	8.8 ± 1.7	HFS-P
Youngkin et al. 2021, USA.	60	101	88	7.5 ± 1.4	7.0 ± 1.4	4.7 ± 3.3	HFS-P
McConville et al., 2020, USA.	128	128	87.5	7.46 ± 1.34	4.69 ± 3.24	7.58 ± 1.32	HFS-P-W
Muradoğlu et al., 2021, Turkey	68	68	51.5	9.5 ± 4.1	2.9 ± 2.2	7.6 ± 1.4	HFS-P
Abitbol & Palmert, 2021. Canada	264	207	38	12 ± 3.5	5.9 ± 3.9	8.0 ± 1.3	HFS-P

Abbreviations: HbA_{1C} (hemoglobin A_{1c}); FOH (fear of hypoglycemia); SLC (seizures or loss of consciousness); HFS-P (Hypoglycemia Fear Survey-Parent); HFS-P-W (The Worry subscale of Hypoglycemia Fear Survey-Parent); HFS-C (Hypoglycemia Fear Survey-Children); HFS-P-YC (Hypoglycemia Fear Survey-Young Children); HFS-P-YC-W (The Worry subscale of Hypoglycemia Fear Survey-Young Children).

0.05) (Abitbol & Palmert, 2021; Pate et al., 2019; Van Name et al., 2018), while another described a nonsignificant association or between-group difference (Haugstvedt et al., 2010). One study found that 54% and 47% of parents were "frequently" or "almost always" concerned about their child having a low blood glucose while asleep and their child not recognize a low glucose (Van Name et al., 2018), suggesting that parents were most worried about children's hypoglycemia at night (Abitbol & Palmert, 2021; Van Name et al., 2018).

Abitbol and Palmert (2021) examined parental FOH in association with the location of hypoglycemia episodes, which unanimously showed that parental FOH was higher when children experienced hypoglycemia episodes in particular social situations and public. Nearly one in five parents would rather keep their children's blood glucose levels high when the children were alone.

Disease and treatment factors

The course of type 1 diabetes, complications, and number of blood glucose monitoring

No association between the course of T1D and parental FOH has been reported in six studies (Aalders et al., 2018; Freckleton et al., 2014; Haugstvedt et al., 2010; Haugstvedt et al., 2015; Shepard et al., 2014; Viaene et al., 2017). However, Pate et al. (2019) reported that parents of children with a longer duration of T1D worry more about hypoglycemia ($r = 0.21, p < 0.05$), and two other studies said similar results ($p < 0.05$) (Amiri et al., 2018; Van Gampelaere et al., 2019). Haugstvedt et al. (2010) have reported that the worry subscale scores were related to comorbid physical diseases or mental disorders in children with T1D.

To date, the relationship between the number of blood glucose monitoring and parental FOH has been confirmed more extensively ($p < 0.05$) (Aalders et al., 2018; Abitbol & Palmert, 2021; Haugstvedt et al., 2010; Haugstvedt et al., 2015; Herbert, Monaghan, et al., 2015; Pate et al., 2019; Van Name et al., 2018). Two studies reported that HFS-P behavioral subscale scores were significantly higher among mothers who measured blood glucose more than 7 times/day compared with those who counted 4–6 times or less than 3 times a day (Haugstvedt et al., 2010; Haugstvedt et al., 2015), which may indicate that FOH caused parents to take more action to prevent severe hypoglycemia. Additionally, four studies reported that the worry subscale score was related to the number of daily blood glucose monitoring ($p < 0.05$) (Aalders et al., 2018; Herbert, Monaghan, et al., 2015; Pate et al., 2019; Van Name et al., 2018).

Glycemic control

In total, 14 out of 23 studies assessed the link between children's glycemic control and parental FOH, and almost all studies used HbA_{1c} as the primary indicator of children's glycemic control. Nevertheless, the associations were often contradictory; three studies separately proved that children's HbA_{1c} was positively related to parental HFS-P worry subscale scores ($p < 0.05$) (Haugstvedt et al., 2010; Pate et al., 2019) or total scales scores ($r = 0.28, p < 0.05$) (Hawkes et al., 2014; Pate et al., 2019), whereas other studies failed (Aalders et al., 2018; Abitbol & Palmert, 2021; Amiri et al., 2018; Haugstvedt et al., 2015; Johnson et al., 2013; Shepard et al., 2014; Van Gampelaere et al., 2019; Van Name et al., 2018). One study found that the relationship between parental FOH and HbA_{1c} was mediated by parental stress (Viaene et al., 2017). Two papers explored the association between average blood glucose level and parental FOH (Freckleton et al., 2014; Patton et al., 2017). Freckleton et al. (2014) found a significant positive correlation between parental HFS-P behavioral subscale scores of children under 13 years of age and children's average blood glucose level ($r^2 = 0.257$, $p = 0.01$), prompting parents to take more actions to prevent hypoglycemia. Another study found that the HFS-P worry subscale scores were significantly negatively associated with children's average blood glucose ($r = -0.267, p = 0.01$) and the percentage of extremely high glucose levels (>13.9 mmol/L, $r = -0.227, p = 0.03$), and positively associated with the percentage of glucose levels within the target range (3.9 to 10.0 mmol/L, $r = 0.274, p = 0.008$) (Patton et al., 2017), indicating parents of children with better blood glucose control have greater FOH.

New diabetes technology and treatment

The relationship between continuous glucose monitoring (CGM) and parental FOH remains controversial. Three found that the FOH of parents and children was significantly reduced when CGM was used ($p < 0.05$) (Burckhardt et al., 2019; Ng et al., 2019; Sandy et al., 2019). Contrastingly, two reported that parents of children who used CGM reported a higher tendency to worry about their children's blood glucose levels during sleep (Abitbol & Palmert, 2021; Van Name et al., 2018). Interestingly, one study also found that after using CGM, parental behavioral subscale scores of HFS-P were significantly reduced, while the worry subscale scores were even higher (Youngkin et al., 2021).

The link between the insulin infusion system and parental FOH has been studied extensively. Three cross-sectional studies that assessed families treated with insulin pumps have found that HFS-P behavior subscale scores were lower than those of children with multiple daily injections (MDI) ($p < 0.05$) (Haugstvedt et al., 2010; Haugstvedt et al., 2015; Patton et al., 2017). No relationship was demonstrated between HFS-P total scores and continuous subcutaneous insulin infusion (CSII) in four studies (Hawkes et al., 2014; Muradoğlu et al., 2021; Shepard et al., 2014). However, two other studies reported that parents who used insulin pumps were more concerned about their children developing hypoglycemia ($p < 0.05$) (Patton et al., 2017; Van Name et al., 2018).

Amiri et al. (2018) have shown a positive relationship between insulin injection dose and HFS-P behavioral scores ($r = 0.30, p = 0.044$), while the other three studies reported no relationship (Aalders et al., 2018; Abitbol & Palmert, 2021; Haugstvedt et al., 2010).

Psychological factors

Anxiety

The association between trait anxiety and parental FOH was investigated in two papers, which found that trait anxiety was positively correlated with the HFS-P total or worry subscale scores (Abitbol & Palmert, 2021; Shepard et al., 2014). Three studies examined the correlation between anxiety and parental FOH, and described significant moderate correlations ($r = 0.33$ to 0.42, $p < 0.01$) (Haugstvedt et al., 2010; Muradoğlu et al., 2021; Pate et al., 2019). In addition, gender differences were found in the relationship between the anxiety subscale of the Hopkins Symptom Checklist – 25item (HSCL-25) and the HFS-P score in one study (Haugstvedt et al., 2015). Among the mothers, HSCL-25 anxiety subscale scores were statistically significantly associated with HFS-P worry subscale scores ($r = 0.42, p < 0.001$), but no significant correlation with the HFS-P behavior subscale score. However, there was no significant correlation between the father's HSCL-25 anxiety subscale score and HFS-P subscale score.

Depression

Two studies described significant small or moderate correlations ($r = 0.24$ to 0.35, $p < 0.05$) between depression and HFS-P worry subscale score (Haugstvedt et al., 2015; Shepard et al., 2014). McConville et al. (2020) found that baseline depression reported by parents seems to affect the trajectory of HFS-P, and parents with worse depressive symptoms reported significantly higher worry levels than parents without depressive symptoms across the 18-month study period ($p < 0.05$). Moreover, Haugstvedt et al. (2015) reported that the HFS-P worry subscale scores were significantly correlated with HSCL-25 depression subscale scores in both mothers ($r = 0.35, p = 0.001$) and fathers ($r = 0.24, p = 0.031$). Statistically significant differences between HFS-P behavior subscale scores and depression subscale scores were

found in fathers ($r = 0.26$, $p = 0.018$), but no significant correlation in mothers.

Pediatric parenting stress and mindfulness

There was consistent evidence that FOH was significantly positively associated with pediatric parenting stress ($r = 0.33$ to 0.43, $p < 0.05$) (Amiri et al., 2018; Patton et al., 2011; Viaene et al., 2017), and parents who had more FOH reported greater pediatric parenting pressure. The regression model of child parenting stress difficulties constructed by Patton showed that parental depressive symptoms and FOH were both significantly associated ($r^2 = 0.68$, $p < 0.001$) (Patton et al., 2011). Mindfulness may be a factor that helps parents adapt to FOH. Aalders et al. (2018). constructed a linear regression model of sociodemographic factors, clinical characteristics, general mindfulness, and mindfulness in parenting and found that parents with low mindfulness have higher FOH ($r = -0.23$, $p < 0.01$). Similarly, Van Gampelaere et al. (2019) found that mindfulness parenting was negatively correlated with both the worry ($r = -0.26$, $p = 0.005$) and behavior subscale scores ($r = -0.23$, $p = 0.032$) of HFS-P.

Quality of life, self-efficacy, and sleep disorders

Two studies reported a significant relationship between parental FOH and quality of life (Herbert, Clary, et al., 2015; Johnson et al., 2013), and one described a moderate correlation between quality of life and worry ($r = -0.49$, $p < 0.001$) and behavioral subscale score ($r = -0.33$, $p < 0.001$) (Herbert, Clary, et al., 2015), in which patients with more severe FOH reported worse quality of life. Parents who expressed lesser life satisfaction or self-efficacy reported higher FOH ($r = -0.30$ to -0.32, $p < 0.05$) (Herbert, Monaghan, et al., 2015; Pate et al., 2019). Furthermore, sleep quality in association with parental FOH was investigated in two studies (Abitbol & Palmert, 2021; Herbert, Monaghan, et al., 2015). Herbert, Monaghan,et al. (2015) noted that the worry subscale score of HFS-P has a significant but poor positive correlation ($r = 0.19$, $p < 0.05$) with the Pittsburgh Sleep Quality Index (PSQI) score, and another study supported this result ($p < 0.001$) (Abitbol & Palmert, 2021).

Discussion

FOH in parents of children with T1D is a common and severe obstacle to self-care. This review provides a narrative summary of twenty-three cross-sectional and prospective quantitative studies of FOH in the parents of children/adolescents with T1D.

This systematic review has identified inconsistencies across studies as to whether sociodemographic factors were associated with parental FOH. Mothers may express more fear, reflecting differences in the emotional experience produced by gender roles from multiple interactions between physiological, neurobiological, environmental, and sociocultural factors (Bangasser & Cuarenta, 2021; Velasco et al., 2019). In addition, mothers were more involved in the daily management of their children's T1D, and the higher level of responsibility for children's management was related to increased parental FOH and negative emotion (Pate et al., 2019). The review identified that involved fathers used fewer preventive behaviors to avoid hypoglycemia. Although fathers were usually not the primary caregivers of the children with T1D, their contribution to the family through insights, knowledge, adaptation, and behavior may be relevant to disease management outcomes. Mothers and fathers may respond differently to their roles in managing T1D, and perceptions of their involvement may be differently associated with their children's T1D (Hansen et al., 2012). Therefore, it may be necessary for health care providers to recognize gender differences in FOH when advising parents on glycemic control in children with T1D.

Most studies have shown that parental FOH did not seem to be affected by the age of the children, which also increases the possibility that FOH may have a long-term impact on the parent's quality of life (Aalders et al., 2018; Abitbol & Palmert, 2021; Haugstvedt et al., 2010; Van Gampelaere et al., 2019; Van Name et al., 2018; Viaene et al., 2017; Youngkin et al., 2021). Conversely, some have identified that the parents of young children took more actions to prevent hypoglycemia (Haugstvedt et al., 2015; Herbert, Clary et al., 2015; Pate et al., 2019; Shepard et al., 2014). T1D is more complex to manage in children younger than seven years due to a variety of unique physical, behavioral, and developmental factors (Fuchs & Hovorka, 2021). Young children were also more prone to hypoglycemia due to their unpredictable behaviors and eating patterns and more sensitivity to insulin (Dovc et al., 2019). In addition, these factors and the resulting concerns lead to a heavy management burden for parents and carers, negatively impacting the family's quality of life (Harrington et al., 2017). Hawkes et al. (2014) found that parents of children aged 6–11 had higher FOH than other age groups. The potential explanation was that high worry associated with the children leaving their parents to start school and being in the care of others for the first time. Therefore, longitudinal studies need to be further conducted to explore the trend of parental FOH with children's age.

No clear bivariate associations were identified between parental FOH and socioeconomic status factors (Aalders et al., 2018; Abitbol & Palmert, 2021). Two studies demonstrated that non-Caucasian/non-nationality parents predict higher FOH (Aalders et al., 2018; Abitbol & Palmert, 2021). Ethnic minorities who did not understand official languages would face more unique challenges in understanding their conditions, following recommendations, and obtaining resources for managing T1D (Webster, 2018). This also reminds researchers that when screening parental FOH, they should pay attention to minority groups and need to consider the impact of these unalterable demographic factors on FOH. In addition, research on the effects of other sociodemographic factors, such as children's gender, parental age, educational level, economic and social status on parental FOH of children with T1D, should still be confirmed.

Results on the associations between history of hypoglycemia episodes and parental FOH appear to be conflicting. Most studies found that the frequency of hypoglycemia in children did not predict parental FOH, and parents of children who had experienced severe hypoglycemic episodes in the past year, especially hypoglycemic coma or convulsions, might have greater FOH and stress (Johnson et al., 2013; Viaene et al., 2017). This suggested that the qualitative characteristics of the hypoglycemia experience may have a greater impact on parental FOH than the quantitative frequency of episodes. Whereas others reported severe hypoglycemia in children within the last 12 months was not associated with parental FOH. The possible explanation was that the level of parental fear of hypoglycemic events (i.e., problematic hypoglycemia according to their definition or hypoglycemic events in the absence of the parents) might outweigh the medical severity of hypoglycemia (i.e., needing glucagon injections/ hospitalization) was more strongly correlated with parental FOH (Aalders et al., 2018; Haugstvedt et al., 2010).

The risk of nocturnal hypoglycemic episodes was particularly worrying for parents who were actively involved in the daily management of their children with T1D (Bachmann et al., 2016; Macaulay et al., 2020). Some parents prefer to keep their children's blood glucose levels higher at night because it's harder to detect hypoglycemia when the children fall asleep (Abitbol & Palmert, 2021; Jaser et al., 2017). Advances in diabetes technology, such as electroencephalogram spectral, predictive low-glucose suspend (PLGS) system, CGM, and closed-loop systems, enable real-time monitoring of blood glucose levels in children and automatically adjust insulin infusion doses, thus reducing the incidence of nocturnal hypoglycemia and addressing some of the difficulties managing children's T1D during sleep (Bachmann et al., 2016; Buckingham et al., 2015; Dovc & Battelino, 2020; Ngo et al., 2020; Tauschmann et al., 2019). The occurrence of hypoglycemia in social situations may cause parental avoidance behaviors (Aalders et al., 2018), thus interfering with their children's treatment plan and normal psychosocial development, consistent with previous research results (Clarke et al., 1998;

Gonder-Frederick et al., 2006). However, it remains significant only in the few existing studies, and further studies are needed to clarify its mechanisms. A recent study suggests that school staff's knowledge of T1D, as well as their concerns and fears about children/adolescents with T1D during school time, can be improved through educational programs (Gurunathan et al., 2021). Therefore, appropriate diabetes care in school for children with T1D is significant for their personal and social development (Stefanowicz & Stefanowicz, 2018).

The causal direction of the correlation between HFS-P and the number of blood glucose monitoring was unclear and needed to be further explored (Haugstvedt et al., 2010; Haugstvedt et al., 2015). Children's longed disease course, comorbidities, and complications may be risk factors for parental FOH (Amiri et al., 2018; Haugstvedt et al., 2010; Pate et al., 2019). This also reminds healthcare workers to pay more attention to the psychological problems of parents who take care of children with T1D for a long time and teach them to cope with their children's complex conditions (Amiri et al., 2018; Pate et al., 2019).

Results on the associations between glycemic control (i.e., HbA_{1c} and blood glucose monitoring levels) and parental FOH appear to be conflicting. Although HbA_{1c} was a valuable indicator of average blood glucose level, it cannot always reflect the glycemic variability, which may obscure the potentially significant relationship between blood glucose and FOH. The wide application of CGM makes it possible to accurately present the blood glucose fluctuations throughout the day (Heimbürger et al., 2021). Compared with HbA_{1c}, time in range (TIR) is an intuitive indicator that denotes the proportion of time that glucose level is within the desired target range (usually 3.9–10.0 mmol/L) (Advani, 2020). Therefore, longitudinal studies should be conducted to prospectively measure children's real-time blood glucose levels, hypoglycemia exposure, and parental FOH levels.

The most convincing evidence for factors related to parental FOH was found for anxiety, depression, pediatric parenting stress, mindfulness, quality of life, self-efficacy, and sleep disorders. The link between higher FOH and parental negative emotions emphasizes that parents might benefit from psychological screening for anxiety and depressive symptoms (Abitbol & Palmert, 2021; Shepard et al., 2014). Understanding the current psychological state of parents can predict parents' maladaptive thoughts and behaviors, and help educators tailor educational measures for parents. In addition, further study of the development of FOH and its relationship to other psychological disorders (i.e., anxiety, depression) will help to understand the trajectory of FOH and inform interventions targeting FOH and other components of psychological distress.

The review has found that half of the mothers and nearly 40% of fathers of children with T1D were experiencing considerable parenting stress and symptomatic emotional distress (Amiri et al., 2018). As previously reported by Viaene et al. (2017), parental FOH was positively associated with increased frequency and difficulty of child pediatric parenting stress. The association between higher levels of parental FOH and stress emphasizes the need for programs to support and guide parents, who would benefit from interventions targeting pediatric parenting stress or psychological distress issues.

In terms of psychological factors, less mindful parents reported greater FOH. Aalders et al. (2018) found that the previous contribution of general mindfulness to parental FOH was negated after adding mindfulness parenting to the model, suggesting that lower mindful parenting was associated with higher FOH. Similarly, Van Gampelaere et al. (2019) found mindfulness makes parents less self-critical about experiencing hypoglycemia and less impulsive about the FOH, use more adaptive coping strategies, make more benign stress assessments, and thus parents may be better able to deal with their concerns about the risk of hypoglycemia in their children (Van Gampelaere et al., 2019). Since general mindfulness and mindful parenting are modifiable factors (de Bruin et al., 2015), training parents to become more aware and respond more mindfully, especially within the parenting context, may address a great demand for effective interventions to make parents more resilient to FOH (Haugstvedt et al., 2010). Specifically, the ability to be less judgmental in their functioning as a parent and less reactive to parental emotions may function as a buffer to parental FOH.

Furthermore, this present systematic review has found that high parental FOH was significantly associated with quality of life and sleep quality (Herbert, Clary, et al., 2015; Herbert, Monaghan, et al., 2015; Johnson et al., 2013). Self-efficacy was also a key factor affecting parental FOH (Herbert, Monaghan, et al., 2015). According to a recent study, parental perceptions are relevant variables related to guiding and modulating parenting emotions in interactions with their children (Di Riso et al., 2020). The latest research suggests that if parents feel more competent, they are more effective in managing their emotions and behaviors to support their children (Cardinali et al., 2021).

Although FOH, particularly at high levels, may have a detrimental effect on the quality of life and well-being of parents, there were few interventions specifically targeting parental FOH. More intervention measures need to be developed and implemented to minimize the adverse effects of FOH. The expansion of diabetes-specific technology, such as CGM and automatic insulin delivery systems (AIDS), makes blood glucose management more flexible, and the effect on FOH has been confirmed in adults (Charleer et al., 2020; Pontow et al., 2020); however, the impact on parental FOH remains controversial. Some studies identified that parents of children who use insulin pumps or CGM were more concerned about hypoglycemia during sleep (Abitbol & Palmert, 2021; Van Name et al., 2018; Youngkin et al., 2021). One potential explanation was that new technology might increase awareness of previously unknown hypoglycemia levels, increasing parental FOH. Conversely, the combination of remote monitoring and new diabetes technology seems to be more able to stabilize blood glucose levels, increase parental confidence in managing T1D, and improve parental psychosocial outcomes (Bisio et al., 2021; Patton et al., 2020; Verbeeten et al., 2021). Patient education, empowerment, evidence-based management of T1D, and support from healthcare workers were identified as effective. Cognitive-behavioral therapy (CBT), blood glucose awareness training (BGAT), exposure therapy, and peer support have been found to reduce FOH and improve blood glucose control in adults with T1D (Dehghankar et al., 2021; Martyn-Nemeth et al., 2019; O'Donnell et al., 2019; Pontow et al., 2020). Several existing interventions have found that new diabetes technology combined with remote monitoring/insulin and individualized family strategies can reduce parental FOH (Burckhardt et al., 2018; Cobry et al., 2022; Ferrito et al., 2019; Gupta et al., 2018), but more research is needed to support and evaluate the effectiveness of interventions targeting FOH. The goal of FOH treatment should not necessarily be to eliminate fear entirely but to reduce high levels and use the remaining fear as a motivation for parents to manage T1D.

In summary, parental FOH may become an important clinical problem in treating their children's diabetes and psychosocial development. Proper alertness is a reasonable and healthy response to actual threats, but excessive fear can have counterproductive consequences. Parental FOH may impact diabetes treatment and glycemic control, which affect the parenting style and the children's physical and mental health. The review results underline the complexity of FOH in parents; multiple factors appear to be related to parental FOH. Results on factors such as gender, age, socioeconomic status, history of hypoglycemia, HbA_{1c}, CGM, and CSII were uncertain and were sometimes contradictory. Significant correlations were found between FOH and certain factors, including motherhood, nocturnal hypoglycemia, and the number of blood glucose monitoring. Although research on mental processes was limited, some factors, including anxiety, depression, pediatric parenting stress, mindfulness, parental self-efficacy, quality of life, and sleep disorders, were conclusive and showed small-to-strong associations with parental FOH. Longitudinal research is needed to clarify further the causal relationship between parental FOH and various related factors. Based on summarizing the related factors, targeted intervention measures should be taken to prevent or reduce parental FOH. Mental health support for

patients (i.e., mindfulness training or interventions for pediatric parenting stress or psychological distress) or new diabetes technology (i.e., CGM or closed-loop systems) represent novel developments in the field and future research directions.

Practice and research implications

Health professionals should regularly screen parents for mental health conditions and FOH as part of routine care, with early intervention as the goal. Importantly, parents should participate in care planning with the opportunity to discuss their FOH. Involvement in care planning would provide the parents with greater guidance on the most appropriate ways to manage T1D.

The influence of specific demographic and clinical factors on parental FOH, such as motherhood, history of hypoglycemic episodes, and nocturnal hypoglycemia, should be considered based on screening. Information provision about the prevention, recognition, and treatment of hypoglycemia to families with T1D may avoid or reduce parental FOH during diabetes education. Blood glucose awareness training (BGAT) has been identified to reduce the frequency of severe hypoglycemia and to improve the FOH in patients of children/adolescents with T1D (Schachinger et al., 2005). The DAFNE-HART (Hypoglycemia Awareness Restoration Training) pilot study also showed significant improvement in severe hypoglycemia in patients and a trend toward less concern about hypoglycemia (de Zoysa et al., 2014). However, there is currently a lack of evaluation of the effect of these interventions on changes in FOH among parents/caregivers, as future studies need to be validated. At the same time, more attention should be paid to the mental health and quality of life of parents. Mental health support may be an essential part of a multi-pronged approach to reducing parental FOH. For example, suppose parents were experiencing high levels of FOH; in that case, they may spend more time reviewing the symptoms and treatment of hypoglycemia, and T1D educators can explain their children's glucose patterns to parents to relieve fear. More specifically, psychological support, such as mindfulness training and CBT, especially within the parenting context, may reduce parental self-criticism about experiencing hypoglycemia to make parents more resilient to FOH (Aalders et al., 2018; Haugstvedt et al., 2010). This will help parents cope with any concerns about the children's risk of hypoglycemia, promote the management of T1D, and improve sleep quality and quality of life.

In addition, our understanding of the relationship between diabetes technology and FOH is constantly evolving as an increasing number of individuals adopt technology to assist with T1D management (Foster et al., 2019). Additional support provided by diabetes technology should also be further explored. Although there is no conclusive evidence that diabetes technology improves parent-reported FOH, most studies identified that there were many advantages and few disadvantages for parent-reported outcomes. New technology (i.e., insulin pumps, continuous glucose monitoring, and closed-loop systems) may help alleviate parental FOH and improve glycemic control in children/adolescents with T1D (Bisio et al., 2021; Mauras et al., 2012; Verbeeten et al., 2021). It is possible that diabetes technology, such as CGMs and their constant source of data about blood glucose levels, significantly improved parents' experience of managing T1D. More research is needed to determine the interaction between increased burden and reduced anxiety in families with T1D and to explore further the impact of new diabetes technology in combination with other interventions, such as psychological support interventions or remote monitoring, on psychosocial outcomes in families with T1D.

Study strength and limitations

The current review has some strengths and limitations. We conducted a comprehensive search of eight medical databases to review the literature over the last decade, updating the factors associated with FOH in parents of children/adolescents with T1D, and providing new guidance and evidence for developing targeted interventions. Nevertheless, this literature review also has some limitations. Given the practical limitations of resources, this review excluded gray literature, such as unpublished papers or research published in languages other than English. The gray literature may extend or clarify the factors associated with parental FOH and its use in families with T1D. In addition, the studies included were limited to small samples and cross-sectional studies, so more large-sample multicenter prospective studies/ randomized controlled trials are needed to explore the underlying mechanisms of FOH in parents of children with T1D.

Conclusions

Parental FOH is an important clinical problem in T1D that warrants more attention in research and clinical practice. Significant correlations were found between FOH and certain factors, including motherhood, nocturnal hypoglycemia, and the number of blood glucose monitoring. Although research on mental processes was limited, some factors, including anxiety, depression, pediatric parenting stress, mindfulness, parental self-efficacy, quality of life, and sleep disorders, were conclusive and showed small-to-strong associations with parental FOH. Further research examining modifiable factors is required to enhance understanding of the psychological processes involved in developing and maintaining FOH in parents of children with T1D. Investigating modifiable factors will provide evidence and guide the development of appropriate and effective interventions for this population. Mental health support for patients (i.e., mindfulness training or interventions for pediatric parenting stress or psychological distress) or new diabetes technology (i.e., CGM or closed-loop systems) represent novel developments in the field and future research directions.

Author statement

I would like to declare on behalf of my co-authors that the work described was original research that has not been published previously, and is not under consideration for publication elsewhere. All authors have completed the ICMJE disclosure form and declare that: (i) no support, financial or otherwise, has been received from any organization that may have an interest in the submitted work; and (ii) there are no other relationships or activities that could appear to have influenced the submitted work.

Funding

National Natural Science Foundation of China (82100870); Yangzhou science and technology planning project 2020 (YZ2020095); 2020 "Huxin Fund" project of Jiangsu Key Laboratory of Zoonoses (HX2001).

Author contributions statement

Lu Zhang and Huiwen Xu: Conceptualization, Methodology, Formal analysis and Writing - Original Draft. Yaxin Bi, Xiangning Li, Yinshi Kan, Hongyuan Liu and Shuang Li: Literature search, data analysis and check the spelling and grammar. Lin Liu, Yan Zou and Yuan Yuan: Resources. Wei-Juan Gong: Writing - Review & Editing. Yu Zhang: Drafting and critical revision.

Declaration of Competing Interest

None declared.

Acknowledgments

The authors sincerely are grateful for the network equipment support policy of the School of Nursing, Yangzhou University, China.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pedn.2022.05.022.

References

Aalders, J., Hartman, E., Nefs, G., Nieuwesteeg, A., Hendrieckx, C., Aanstoot, H. -J., Winterdijk, P., van Mil, E., Speight, J., & Pouwer, F. (2018). Mindfulness and fear of hypoglycaemia in parents of children with Type 1 diabetes: Results from Diabetes MILES Youth—The Netherlands. *Diabetic Medicine : A Journal of the British Diabetic Association*, *35*(5), 650–657 PubMed https://doi.org/10.1111/dme.13594.

Abitbol, L., & Palmert, M. R. (2021). When low blood sugars cause high anxiety: Fear of hypoglycemia among parents of youth with type 1 diabetes mellitus. *Canadian Journal of Diabetes*, *45*(5) Article 5. PubMed https://doi.org/10.1016/j.jcjd.2020.08.098.

Advani, A. (2020). Positioning time in range in diabetes management. *Diabetologia*, *63*(2), 242–252 PubMed https://doi.org/10.1007/s00125-019-05027-0.

Amiri, F., Vafa, M., Gonder-Frederick, L., Vajda, K., Khamseh, M., Abadi, A., & Salehpour, A. (2018). Evaluating fear of hypoglycemia, pediatric parenting stress, and self-efficacy among parents of children with type 1 diabetes and their correlation with glycemic control. *Medical Journal of the Islamic Republic of Iran*, *32*, Article 119 PubMed http://doi.org/10.14196/mjiri.32.119.

Bachmann, S., Hess, M., Martin-Diener, E., Denhaerynck, K., & Zumsteg, U. (2016). Nocturnal hypoglycemia and physical activity in children with diabetes: New insights by continuous glucose monitoring and accelerometry. *Diabetes Care*, *39*(7), e95–e96 PubMed https://doi.org/10.2337/dc16-0411.

Bangasser, D. A., & Cuarenta, A. (2021). Sex differences in anxiety and depression: Circuits and mechanisms. *Nature Reviews. Neuroscience*, *22*(11), 674–684 PubMed https://doi.org/10.1038/s41583-021-00513-0.

Barnard, K., Thomas, S., Royle, P., Noyes, K., & Waugh, N. (2010). Fear of hypoglycaemia in parents of young children with type 1 diabetes: A systematic review. *BMC Pediatrics*, *10*, 50 PubMed https://doi.org/10.1186/1471-2431-10-50.

Bisio, A., Brown, S. A., McFadden, R., Pajewski, M., Yu, P. L., DeBoer, M., ... Gonder-Frederick, L. (2021). Sleep and diabetes-specific psycho-behavioral outcomes of a new automated insulin delivery system in young children with type 1 diabetes and their parents. *Pediatric Diabetes*, *22*(3), 495–502 PubMed https://doi.org/10.1111/pedi.13164.

Brown, S. A., Forlenza, G. P., Bode, B. W., Pinsker, J. E., Levy, C. J., Criego, A. B., ... Ly, T. T. (2021). Multicenter trial of a tubeless, on-body automated insulin delivery system with customizable glycemic targets in pediatric and adult participants with type 1 diabetes. *Diabetes Care*, *44*(7), 1630–1640 PubMed. https://doi.org/10.2337/dc21-0172.

de Bruin, E. I., Blom, R., Smit, F. M., van Steensel, F. J., & Bögels, S. M. (2015). MYmind: Mindfulness training for youngsters with autism spectrum disorders and their parents. *Autism : The International Journal of Research and Practice*, *19*(8), 906–914 PubMed https://doi.org/10.1177/1362361314553279.

Buckingham, B. A., Raghinaru, D., Cameron, F., Bequette, B. W., Chase, H. P., Maahs, D. M., ... Beck, R. W. (2015). Predictive low-glucose insulin suspension reduces duration of nocturnal hypoglycemia in children without increasing ketosis. *Diabetes Care*, *38*(7), 1197–1204 PubMed https://doi.org/10.2337/dc14-3053.

Burckhardt, M. -A., Abraham, M. B., Mountain, J., Coenen, D., Paniora, J., Clapin, H., ... Davis, E. A. (2019). Improvement in psychosocial outcomes in children with type 1 diabetes and their parents following subsidy for continuous glucose monitoring. *Diabetes Technology & Therapeutics*, *21*(10), 575–580 PubMed https://doi.org/10.1089/dia.2019.0149.

Burckhardt, M. -A., Roberts, A., Smith, G. J., Abraham, M. B., Davis, E. A., & Jones, T. W. (2018). The use of continuous glucose monitoring with remote monitoring improves psychosocial measures in parents of children with type 1 diabetes: A randomized crossover trial. *Diabetes Care*, *41*(12), 2641–2643 PubMed https://doi.org/10.2337/dc18-0938.

Cardinali, P., Rapetti, E., & Migliorini, L. (2021). Fear of hypoglycemia in Italian mothers of children with type 1 diabetes: The mediating role of resilience. *Health Psychology Research*, *9*(1), Article 27439 PubMed http://doi.org/10.52965/001c.27439.

Charleer, S., De Block, C., Nobels, F., Radermecker, R. P., Lowyck, I., Mullens, A., ... Gillard, P. (2020). Sustained impact of real-time continuous glucose monitoring in adults with type 1 diabetes on insulin pump therapy: Results after the 24-month RESCUE study. *Diabetes Care*, *43*(12), 3016–3023 PubMed https://doi.org/10.2337/dc20-1531.

Clarke, W. L., Gonder-Frederick, A., Snyder, A. L., & Cox, D. J. (1998). Maternal fear of hypoglycemia in their children with insulin dependent diabetes mellitus. *Journal of Pediatric Endocrinology & Metabolism : JPEM*, *11*(Suppl. 1), 189–194 (PubMed).

Cobry, E. C., Bisio, A., Wadwa, R. P., & Breton, M. D. (2022). Improvements in parental sleep, fear of hypoglycemia, and diabetes distress with use of an advanced hybrid closed loop system. *Diabetes Care*, *45*(5), 1292–1295 PubMed https://doi.org/10.2337/dc21-1778.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155–159 (PubMed).

Dehghankar, L., Namdar, P., Yekefallah, L., Hosseini, N., & Moradi, M. (2021). The effect of peers support on fear of hypoglycemia in Iranian patients with type 1 diabetes: A clinical trial study. *Iranian Journal of Nursing and Midwifery Research*, *26*(2), 162–167 PubMed https://doi.org/10.4103/ijnmr.IJNMR_277_19.

Di Riso, D., Bassi, G., Mancinelli, E., Zaffani, S., Salcuni, S., & Maffeis, C. (2020). Mothers and fathers parenting stress and their perception of Children's psychosocial functioning in Paediatric diabetes: A pilot study. *International Journal of Environmental Research and Public Health*, *17*(13), Article 13 PubMed https://doi.org/10.3390/ijerph17134734.

Dovc, K., & Battelino, T. (2020). Closed-loop insulin delivery systems in children and adolescents with type 1 diabetes. *Expert Opinion on Drug Delivery*, *17*(2), 157–166 PubMed https://doi.org/10.1080/17425247.2020.1713747.

Dovc, K., Boughton, C., Tauschmann, M., Thabit, H., Bally, L., Allen, J. M., ... Hovorka, R. (2019). Young children have higher variability of insulin requirements: Observations during hybrid closed-loop insulin delivery. *Diabetes Care*, *42*(7), 1344–1347 PubMed https://doi.org/10.2337/dc18-2625.

Driscoll, K. A., Raymond, J., Naranjo, D., & Patton, S. R. (2016). Fear of hypoglycemia in children and adolescents and their parents with type 1 diabetes. *Current Diabetes Reports*, *16*(8), 77 PubMed https://doi.org/10.1007/s11892-016-0762-2.

Ferrito, L., Predieri, B., Pjetraj, D., Alessandrelli, M. C., Pagnini, M., Iannilli, A., ... Cherubini, V. (2019). Weekend-based parent-group intervention to reduce stress in parents of children and adolescents with Type 1 diabetes: a pilot study. *Journal of Diabetes Research*, *2019*, 7935945 PubMed https://doi.org/10.1155/2019/7935945.

Foster, N. C., Beck, R. W., Miller, K. M., Clements, M. A., Rickels, M. R., DiMeglio, L. A., ... Garg, S. K. (2019). State of type 1 diabetes management and outcomes from the T1D exchange in 2016-2018. *Diabetes Technology & Therapeutics*, *21*(2), 66–72 PubMed https://doi.org/10.1089/dia.2018.0384.

Freckleton, E., Sharpe, L., & Mullan, B. (2014). The relationship between maternal fear of hypoglycaemia and adherence in children with type-1 diabetes. *International Journal of Behavioral Medicine*, *21*(5), 804–810 PubMed https://doi.org/10.1007/s12529-013-9360-8.

Fuchs, J., & Hovorka, R. (2021). Benefits and challenges of current closed-loop technologies in children and young people with Type 1 diabetes. *Frontiers in Pediatrics*, *9*, Article 679484 PubMed https://doi.org/10.3389/fped.2021.679484.

Gonder-Frederick, L., Nyer, M., Shepard, J. A., Vajda, K., & Clarke, W. (2011). Assessing fear of hypoglycemia in children with type 1 diabetes and their parents. *Diabetes Management (London, England)*, *1*(6), 627–639 (PubMed).

Gonder-Frederick, L. A., Fisher, C. D., Ritterband, L. M., Cox, D. J., Hou, L., DasGupta, A. A., & Clarke, W. L. (2006). Predictors of fear of hypoglycemia in adolescents with type 1 diabetes and their parents. *Pediatric Diabetes*, *7*(4), 215–222 (PubMed).

Gupta, O. T., MacKenzie, M., Burris, A., Jenkins, B. B., Collins, N., Shade, M., ... White, P. C. (2018). Camp-based multi-component intervention for families of young children with type 1 diabetes: A pilot and feasibility study. *Pediatric Diabetes*, *19*(4), 761–768 PubMed https://doi.org/10.1111/pedi.12624.

Gurunathan, U., Prasad, H. K., White, S., Prasanna, B., & Sangaralingam, T. (2021). Care of children with type 1 diabetes mellitus in school—An interventional study. *Journal of Pediatric Endocrinology & Metabolism : JPEM*, *34*(2), 195–200 PubMed https://doi.org/10.1515/jpem-2020-0334.

Hansen, J. A., Weissbrod, C., Schwartz, D. D., & Taylor, W. P. (2012). Paternal involvement in pediatric type 1 diabetes: Fathers' and mothers' psychological functioning and disease management. *Families, Systems & Health : The Journal of Collaborative Family Healthcare*, *30*(1), 47–59 PubMed https://doi.org/10.1037/a0027519.

Harrington, K. R., Boyle, C. T., Miller, K. M., Hilliard, M. E., Anderson, B. J., Van Name, M., ... Laffel, L. M. (2017). Management and family burdens endorsed by parents of Youth <7 years old with Type 1 diabetes. *Journal of Diabetes Science and Technology*, *11*(5), 980–987 PubMed https://doi.org/10.1177/1932296817721938.

Haugstvedt, A., Wentzel-Larsen, T., Aarflot, M., Rokne, B., & Graue, M. (2015). Assessing fear of hypoglycemia in a population-based study among parents of children with type 1 diabetes—Psychometric properties of the hypoglycemia fear survey—Parent version. *BMC Endocrine Disorders*, *15*, 2 PubMed https://doi.org/10.1186/1472-6823-15-2.

Haugstvedt, A., Wentzel-Larsen, T., Graue, M., Søvik, O., & Rokne, B. (2010). Fear of hypoglycaemia in mothers and fathers of children with Type 1 diabetes is associated with poor glycaemic control and parental emotional distress: A population-based study. *Diabetic Medicine : A Journal of the British Diabetic Association*, *27*(1), 72–78 PubMed https://doi.org/10.1111/j.1464-5491.2009.02867.x.

Hawkes, C. P., McDarby, V., & Cody, D. (2014). Fear of hypoglycemia in parents of children with type 1 diabetes. *Journal of Paediatrics and Child Health*, *50*(8), 639–642 PubMed https://doi.org/10.1111/jpc.12621.

Haynes, A., Hermann, J. M., Clapin, H., Hofer, S. E., Karges, B., Jones, T. W., ... Holl, R. W. (2019). Decreasing trends in mean HbA are not associated with increasing rates of severe hypoglycemia in children: A longitudinal analysis of two contemporary population-based pediatric type 1 diabetes registries from Australia and Germany/Austria between 1995 and 2016. *Diabetes Care*, *42*(9), 1630–1636 PubMed https://doi.org/10.2337/dc18-2448.

Heimbürger, S. M. N., Hoe, B., Nielsen, C. N., Bergmann, N. C., Hartmann, B., Holst, J. J., ... Knop, F. K. (2021). The effect of 6-day subcutaneous glucose-dependent insulinotropic polypeptide infusion on time in glycaemic range in patients with type 1 diabetes: A randomised, double-blind, placebo-controlled crossover trial. *Diabetologia*, *64*(11), 2425–2431 PubMed https://doi.org/10.1007/s00125-021-05547-8.

Herbert, L. J., Clary, L., Owen, V., Monaghan, M., Alvarez, V., & Streisand, R. (2015). Relations among school/daycare functioning, fear of hypoglycaemia and quality of life in parents of young children with type 1 diabetes. *Journal of Clinical Nursing*, *24*(9–10), 1199–1209 PubMed https://doi.org/10.1111/jocn.12658.

Herbert, L. J., Monaghan, M., Cogen, F., & Streisand, R. (2015). The impact of parents' sleep quality and hypoglycemia worry on diabetes self-efficacy. *Behavioral Sleep Medicine*, *13*(4), 308–323 PubMed https://doi.org/10.1080/15402002.2014.898303.

Institute, J. B. (2017). *The Joanna Briggs Institute Critical Appraisal Tools.*

Jaser, S. S., Foster, N. C., Nelson, B. A., Kittelsrud, J. M., DiMeglio, L. A., Quinn, M., ... Simmons, J. H. (2017). Sleep in children with type 1 diabetes and their parents in the T1D exchange. *Sleep Medicine*, *39*, 108–115 PubMed https://doi.org/10.1016/j.sleep.2017.07.005.

Johnson, S. R., Cooper, M. N., Davis, E. A., & Jones, T. W. (2013). Hypoglycaemia, fear of hypoglycaemia and quality of life in children with Type 1 diabetes and their parents.

Diabetic Medicine : A Journal of the British Diabetic Association, *30*(9), 1126–1131 PubMed https://doi.org/10.1111/dme.12247.

Liberali, R., Del Castanhel, F., Kupek, E., & de Assis, M. A. A. (2021). Latent class analysis of lifestyle risk factors and association with overweight and/or obesity in children and adolescents: systematic review. *Childhood Obesity (Print)*, *17*(1) Article 1. PubMed https://doi.org/10.1089/chi.2020.0115.

Macaulay, G. C., Boucher, S. E., Yogarajah, A., Galland, B. C., & Wheeler, B. J. (2020). Sleep and night-time caregiving in parents of children and adolescents with type 1 diabetes mellitus—A qualitative study. *Behavioral Sleep Medicine*, *18*(5), 622–636 PubMed https://doi.org/10.1080/15402002.2019.1647207.

Martyn-Nemeth, P., Duffecy, J., Quinn, L., Park, C., Mihailescu, D., & Penckofer, S. (2019). A cognitive behavioral therapy intervention to reduce fear of hypoglycemia in young adults with type 1 diabetes (FREE): Study protocol for a randomized controlled trial. *Trials*, *20*(1), 796 PubMed https://doi.org/10.1186/s13063-019-3876-4.

Mauras, N., Beck, R., Xing, D., Ruedy, K., Buckingham, B., Tansey, M., ... Kollman, C. (2012). A randomized clinical trial to assess the efficacy and safety of real-time continuous glucose monitoring in the management of type 1 diabetes in young children aged 4 to <10 years. *Diabetes Care*, *35*(2), 204–210 PubMed https://doi.org/10.2337/dc11-1746.

McConville, A., Noser, A. E., Nelson, E. -L., Clements, M. A., Majidi, S., & Patton, S. R. (2020). Depression as a predictor of hypoglycemia worry in parents of youth with recent-onset type 1 diabetes. *Pediatric Diabetes*, *21*(5), 909–916 PubMed https://doi.org/10.1111/pedi.13039.

Muradoğlu, S., Yeşiltepe Mutlu, G., Gökçe, T., Can, E., & Hatun, Ş. (2021). An evaluation of glucagon injection anxiety and its association with the fear of hypoglycemia among the parents of children with type 1 diabetes. *Journal of Clinical Research in Pediatric Endocrinology*, *13*(3), 285–292 PubMed https://doi.org/10.4274/jcrpe.galenos.2021.2020.0191.

Ng, S. M., Moore, H. S., Clemente, M. F., Pintus, D., & Soni, A. (2019). Continuous glucose monitoring in children with type 1 diabetes improves well-being, alleviates worry and fear of hypoglycemia. *Diabetes Technology & Therapeutics*, *21*(3), 133–137 PubMed https://doi.org/10.1089/dia.2018.0347.

Ngo, C. Q., Chai, R., Nguyen, T. V., Jones, T. W., & Nguyen, H. T. (2020). Electroencephalogram spectral moments for the detection of nocturnal hypoglycemia. *IEEE Journal of Biomedical and Health Informatics*, *24*(5), 1237–1245 PubMed https://doi.org/10.1109/JBHI.2019.2931782.

O'Donnell, H. K., Berget, C., Wooldridge, J. S., & Driscoll, K. A. (2019). Graduated exposure to treat fear of hypoglycemia in a young adult with type 1 diabetes: A case study. *Pediatric Diabetes*, *20*(1), 113–118 PubMed https://doi.org/10.1111/pedi.12791.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ (Clinical Research Ed.)*, *372*, n71 PubMed https://doi.org/10.1136/bmj.n71.

Pate, T., Klemenčič, S., Battelino, T., & Bratina, N. (2019). Fear of hypoglycemia, anxiety, and subjective well-being in parents of children and adolescents with type 1 diabetes. *Journal of Health Psychology*, *24*(2), 209–218 PubMed https://doi.org/10.1177/1359105316650931.

Patterson, C. C., Karuranga, S., Salpea, P., Saeedi, P., Dahlquist, G., Soltesz, G., & Ogle, G. D. (2019). Worldwide estimates of incidence, prevalence and mortality of type 1 diabetes in children and adolescents: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Research and Clinical Practice*, *157*, 107842 PubMed https://doi.org/10.1016/j.diabres.2019.107842.

Patton, S. R., Clements, M. A., Marker, A. M., & Nelson, E. -L. (2020). Intervention to reduce hypoglycemia fear in parents of young kids using video-based telehealth (REDCHiP). *Pediatric Diabetes*, *21*(1), 112–119 PubMed https://doi.org/10.1111/pedi.12934.

Patton, S. R., Dolan, L. M., Henry, R., & Powers, S. W. (2007). Parental fear of hypoglycemia: Young children treated with continuous subcutaneous insulin infusion. *Pediatric Diabetes*, *8*(6), 362–368 (PubMed).

Patton, S. R., Dolan, L. M., Smith, L. B., Thomas, I. H., & Powers, S. W. (2011). Pediatric parenting stress and its relation to depressive symptoms and fear of hypoglycemia in parents of young children with type 1 diabetes mellitus. *Journal of Clinical Psychology in Medical Settings*, *18*(4), 345–352 PubMed https://doi.org/10.1007/s10880-011-9256-1.

Patton, S. R., Noser, A. E., Clements, M. A., Dolan, L. M., & Powers, S. W. (2017). Reexamining the hypoglycemia fear survey for parents of young children in a sample of children using insulin pumps. *Diabetes Technology & Therapeutics*, *19*(2), 103–108 PubMed https://doi.org/10.1089/dia.2016.0389.

Pintow, I. -M., Theil, J., & Diefenbacher, A. (2020). Comorbidity of hypoglycaemia anxiety and panic disorder in a patient with type-1 diabetes—Combined treatment with cognitive-behavioral therapy and continuous glucose monitoring (CGM) in a psychosomatic day-treatment center. *Deutsche Medizinische Wochenschrift (1946)*, *145*(5), 314–317 PubMed https://doi.org/10.1055/a-1038-9291.

Sandy, J. L., Nyunt, O., Woodhead, H. J., Youde, L. S., Ramjan, K. A., Jack, M. M., ... Hameed, S. (2019). Sydney diabetes centre's experience of the Australian Government's roll out of subsidised continuous glucose monitoring for children with type 1 diabetes mellitus. *Journal of Paediatrics and Child Health*, *55*(9), 1056–1062 PubMed https://doi.org/10.1111/jpc.14340.

Schachinger, H., Hegar, K., Hermanns, N., Straumann, M., Keller, U., Fehm-Wolfsdorf, G., ... Cox, D. (2005). Randomized controlled clinical trial of blood glucose awareness training (BGAT III) in Switzerland and Germany. *Journal of Behavioral Medicine*, *28*(6), 587–594 (PubMed).

Shepard, J. A., Vajda, K., Nyer, M., Clarke, W., & Gonder-Frederick, L. (2014). Understanding the construct of fear of hypoglycemia in pediatric type 1 diabetes. *Journal of Pediatric Psychology*, *39*(10), 1115–1125 PubMed https://doi.org/10.1093/jpepsy/jsu068.

Stefanowicz, A., & Stefanowicz, J. (2018). The role of a school nurse in the Care of a Child with diabetes mellitus type 1—The perspectives of patients and their parents. *Literature Review. Zdravstveno Varstvo*, *57*(3), 166–174 PubMed https://doi.org/10.2478/sjph-2018-0021.

Sundberg, F., & Forsander, G. (2014). Detection and treatment efficacy of hypoglycemic events in the everyday life of children younger than 7 yr. *Pediatric Diabetes*, *15*(1), 34–40 PubMed https://doi.org/10.1111/pedi.12057.

Tauschmann, M., Allen, J. M., Nagl, K., Fritsch, M., Yong, J., Metcalfe, E., ... Hovorka, R. (2019). Home use of day-and-night hybrid closed-loop insulin delivery in very young children: A multicenter, 3-week, randomized trial. *Diabetes Care*, *42*(4), 594–600 PubMed https://doi.org/10.2337/dc18-1881.

Urakami, T. (2020). Severe hypoglycemia: Is it still a threat for children and adolescents with type 1 diabetes? *Frontiers in Endocrinology*, *11*, 609 PubMed https://doi.org/10.3389/fendo.2020.00609.

Van Gampelaere, C., Luyckx, K., Van Ryckeghem, D. M. L., van der Straaten, S., Laridaen, J., Goethals, E. R., ... Goubert, L. (2019). Mindfulness, worries, and parenting in parents of children with type 1 diabetes. *Journal of Pediatric Psychology*, *44*(4), 499–508 PubMed https://doi.org/10.1093/jpepsy/jsy094.

Van Name, M. A., Hilliard, M. E., Boyle, C. T., Miller, K. M., DeSalvo, D. J., Anderson, B. J., ... Tamborlane, W. V. (2018). Nighttime is the worst time: Parental fear of hypoglycemia in young children with type 1 diabetes. *Pediatric Diabetes*, *19*(1), 114–120 PubMed https://doi.org/10.1111/pedi.12525.

Velasco, E. R., Florido, A., Milad, M. R., & Andero, R. (2019). Sex differences in fear extinction. *Neuroscience and Biobehavioral Reviews*, *103* PubMed https://doi.org/10.1016/j.neubiorev.2019.05.020.

Verbeeten, K. C., Perez Trejo, M. E., Tang, K., Chan, J., Courtney, J. M., Bradley, B. J., ... Lawson, M. L. (2021). Fear of hypoglycemia in children with type 1 diabetes and their parents: Effect of pump therapy and continuous glucose monitoring with option of low glucose suspend in the CGM TIME trial. *Pediatric Diabetes*, *22*(2), 288–293 PubMed https://doi.org/10.1111/pedi.13150.

Viaene, A. -S., Van Daele, T., Bleys, D., Faust, K., & Massa, G. G. (2017). Fear of hypoglycemia, parenting stress, and metabolic control for children with type 1 diabetes and their parents. *Journal of Clinical Psychology in Medical Settings*, *24*(1), 74–81 PubMed https://doi.org/10.1007/s10880-017-9489-8.

Webster, P. (2018). Language barriers restricting access to health care for indigenous populations. *CMAJ : Canadian Medical Association Journal = Journal de L'Association Medicale Canadienne*, *190*(24), E754–E755 PubMed https://doi.org/10.1503/cmaj.109-5613.

Wolfsdorf, J. I., Glaser, N., Agus, M., Fritsch, M., Hanas, R., Rewers, A., ... Codner, E. (2018). ISPAD clinical practice consensus guidelines 2018: Diabetic ketoacidosis and the hyperglycemic hyperosmolar state. *Pediatric Diabetes*, *19*(Suppl. 27), 155–177 PubMed https://doi.org/10.1111/pedi.12701.

Youngkin, E. M., Majidi, S., Noser, A. E., Stanek, K. R., Clements, M. A., & Patton, S. R. (2021). Continuous glucose monitoring decreases hypoglycemia avoidance behaviors, but not worry in parents of youth with new onset type 1 diabetes. *Journal of Diabetes Science and Technology*, *15*(5), 1093–1097 PubMed https://doi.org/10.1177/1932296820929420.

de Zoysa, N., Rogers, H., Stadler, M., Gianfrancesco, C., Beveridge, S., Britneff, E., ... Amiel, S. A. (2014). A psychoeducational program to restore hypoglycemia awareness: The DAFNE-HART pilot study. *Diabetes Care*, *37*(3), 863–866 PubMed https://doi.org/10.2337/dc13-1245.