



Interventions to promote medication adherence among children with epilepsy: An integrative review

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ABSTRACT

Problem: Many children with epilepsy face challenges in adhering to their medication, leading to inadequate seizure control. However, the most effective intervention is still unclear. This integrative review's main goal was to examine and synthesize the existing literature on interventions for promoting medication adherence in children with epilepsy.

Eligibility criteria: This integrative review followed Whittemore and Knafl's five-stage framework. Four electronic databases (PubMed, ScienceDirect, Scopus, and CINAHL Complete) were systematically searched from 2013 until 2024 to identify eligible studies published in the English language. The key search terms included "Children with epilepsy" AND "medication adherence" AND "intervention." Studies reporting on the implementation and evaluation of medication adherence interventions in children with epilepsy were eligible. Quality assessment and narrative synthesis were subsequently undertaken.

Sample: A total of 17 studies were included in the review.

Results: Five interventions were found, including educational, behavioral, and mixed intervention types, using technology and family involvement. Promoting medication adherence is crucial, but tailored interventions for different age groups and sustained support are needed.

Conclusions: Promoting medication adherence is of utmost importance to enhance the knowledge of children who have epilepsy and their families, and to increase medication adherence. However, there is still a need to develop interventions that are appropriate for children of different ages and their families, which should be suitable and sustainable during treatment.

Implications: Pediatric nurses should consider socioeconomic factors, ethnicity, family functioning, and parental distress. Strategies include monitoring adherence, continuous communication, and technology support for children with epilepsy during treatment.

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Background

Epilepsy is one of the most prevalent neurological disorders globally, affecting approximately 50 million people worldwide, with children constituting a significant proportion of this population (Giussani et al., 2014; Lv et al., 2017). Characterized by recurrent unprovoked seizures,

epilepsy necessitates long-term management with anti-seizure medications (ASM) to prevent seizure recurrence and improve quality of life (Mohammed et al., 2022; Tang et al., 2014). Despite the critical importance of consistent medication adherence over 2–5 years for effective treatment, studies have indicated that 20–80% of children with epilepsy exhibit poor adherence to their prescribed regimens (Chauhan et al., 2018; Hovinga et al., 2008; Liu et al., 2013; Shetty et al., 2016).

Medication non-adherence in children with epilepsy can lead to inadequate seizure control (Hovinga et al., 2008), increased frequency of hospitalizations, higher healthcare costs (Belayneh & Mekuriaw, 2020), and a substantial reduction in the quality of life (Long et al., 2000). Moreover, non-adherence may result in severe complications, including cognitive impairments and psychosocial issues, which can extend into adulthood.

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Medication adherence, as defined by [World Health Organization \(2003\)](#), refers to the degree to which an individual's medication-taking behavior corresponds with agreed recommendations from a healthcare provider. In the context of epilepsy, medication adherence is consistent ASM medication-taking behavior according to a doctor's treatment plan, — that is, in the right drug, in the right dosage, and at the right time. The child, family, and healthcare provider need to commit and make decisions about the medication ([Alsous et al., 2018](#); [Cramer et al., 2008](#); [Dima & Shibeshi, 2022](#); [Gabr & Shams, 2015](#); [Hovinga et al., 2008](#); [Liu et al., 2013](#); [Modi et al., 2012](#); [Nazziwa et al., 2014](#); [Osterberg & Blaschke, 2005](#); [Shetty et al., 2016](#); [Smith et al., 2018](#); [Yang et al., 2018](#); [Yang et al., 2020](#)). Adherence is influenced by various factors, including socio-economic status, healthcare system factors, condition-specific factors, treatment-related factors, and patient-related factors. Among children with epilepsy, adherence is a critical indicator of treatment effectiveness and overall management success ([Driscoll & Modi, 2020](#); [Smith et al., 2020](#)). Research has consistently underscored the need for complete compliance with the treatment plan including good medication adherence.

Pediatric nurses play a pivotal role in promoting medication adherence ([Conway et al., 2016](#)). However, few interventions have been developed to enhance medication adherence among children with epilepsy ([Al-Aqeel et al., 2020](#)). There has been a notable paucity of developed interventions aimed specifically at enhancing medication adherence among children with epilepsy ([Smith et al., 2020](#); [Wagner, 2014](#)). While some educational and behavioral interventions exist ([Al-Aqeel et al., 2017, 2020](#)), their application in clinical practice, particularly in nursing, remains unclear ([Tan et al., 2020](#); [Wagner, 2014](#); [Wang et al., 2023](#)). This lack of comprehensive empirical summaries and clear clinical guidelines impedes the effective promotion of medication adherence in this population ([Yang et al., 2023](#)).

Given these gaps, this integrative review aims to systematically identify, analyze, and synthesize evidence regarding interventions designed to promote medication adherence among children with epilepsy. By doing so, it seeks to assess the effectiveness of these interventions and identify barriers to medication adherence intervention and solutions for improving adherence. Ultimately, enhancing medication adherence can lead to better health outcomes, reduce the burden on healthcare systems, and improve the overall well-being of children with epilepsy and their families.

Methods

Study design

This study was an integrative review conducted to determine: (a) what is known about existing interventions and the effectiveness of interventions to improve medication adherence in children with epilepsy; (b) How the interventions measure medication adherence among children with epilepsy; (c) and what recommendations should be addressed for future interventions to improve medication adherence in children with epilepsy. The five stages for conducting an integrative review, as outlined by [Whittemore and Knafl \(2005\)](#), include: 1) problem identification, 2) literature search, 3) data evaluation, 4) data analysis, and 5) presentation of findings.

Problem identification

What is known about existing interventions and the effectiveness of interventions to improve medication adherence in children with epilepsy? How do the interventions measure medication adherence among children with epilepsy? What recommendations should be addressed for future interventions to improve medication adherence in children with epilepsy?

Literature search

In the review, the literature search was conducted using the PubMed®, ScienceDirect®, Scopus®, and CINAHL Complete® databases. This study used 4 databases for coverage, recall, and to decrease the risk of missing eligible studies ([Ewald et al., 2022](#)), as a requirement to guarantee adequate and efficient coverage ([Bramer et al., 2017](#)). A literature search for this study was undertaken using the PICO framework as a guide for searching, with key search terms including “Children with epilepsy” AND “medication adherence” AND “intervention”. This search encompassed the period from 2013 to 2024. The search procedure and findings are represented in [Fig. 1](#).

Inclusion criteria for studies were: 1) Studies focusing on interventions to improve or promote medication adherence among children with epilepsy aged 0–18 years. 2) studies that included all types of study designs, including systematic reviews. Systematic review articles are particularly useful for summarizing multiple studies on important topics. They help authors to systematically review and appraise published studies, thus aiding evidence-based clinical decision-making ([Smith et al., 2011](#)) 3) were original full articles and were published in English. 4) were retrieved from 2013 to 2024. The exclusion criteria were: 1) the studies were not available in full text, 2) the data of children could not be extracted separately.

Data evaluation

The articles included for the review were critically appraised using the standardized Mixed Methods Appraisal Tool (MMAT) version 2018, which covered studies that used quantitative, qualitative, or mixed methods designs to assess quality ([Hong et al., 2018](#)). The efficacy and reliability of the MMAT checklists have been reported ([Hong et al., 2019](#); [Pace et al., 2011](#)).

Data analysis

In the data analysis process, the research team employed a structured data extraction method as outlined by [Whittemore and Knafl \(2005\)](#) for integrative reviews. The research team designed a data extraction table that captured key elements from each study, including the title, authors, year of publication, research objectives, research design, sample characteristics, intervention details, medication adherence measurement, medication adherence outcomes, and limitations of each intervention. We conducted a screening procedure. The titles, abstracts, and complete articles were screened separately using inclusion and exclusion criteria to narrow down the pool of potentially relevant studies. We omitted the articles that were not relevant. Studies that passed the first screening and were deemed relevant enough to warrant reading in full were subjected to a second screening. The full-text papers were checked by the authors to determine if they fulfilled the requirements for inclusion. Finally, the authors compared their findings and resolved their differences by reaching a consensus.

Results

The search strategy identified 787 articles. Eleven articles were excluded before screening as they were duplication records. After title and abstract screening, 759 were excluded due to they were not studying in humans or did not relate to medication adherence or did not study in children with epilepsy. The remaining 17 articles met the eligibility criteria and were entered in the final round for reviewing.

Article characteristics

A total of 17 studies were included in the review, including four pilot randomized controlled trials ([Modi et al., 2023](#); [Modi, Guilfoyle, et al.,](#)

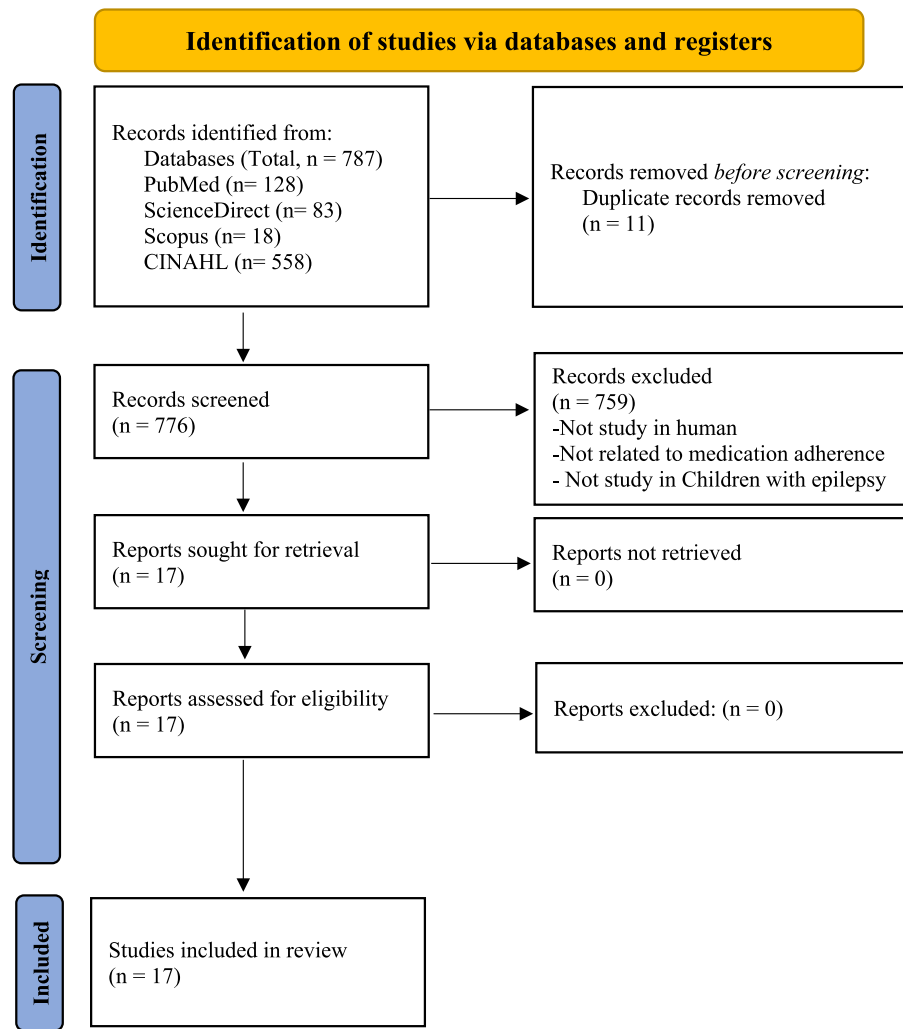


Fig. 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only.

Abbreviation: CINAHL: The Cumulative Index to Nursing and Allied Health Literature database.

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For more information, visit: <http://www.prisma-statement.org/>.

2016; Modi, Guilfoyle, et al., 2021; Saengow et al., 2018), two feasibility studies (Modi et al., 2013; Modi, Guilfoyle, et al., 2016), one editorial (Wagner, 2014), four systematic reviews (Al-Aqeel et al., 2017, 2020; Fleeman, Bradley, Panebianco, & Sharma, 2022; Godara et al., 2024), one quasi-experimental study (Ma et al., 2019), two studies on the development of interventions (Modi et al., 2020; Modi, Patel, et al., 2021), one exploratory analysis (Williford et al., 2023), one predictive factors study (Bakula, Junger, Guilfoyle, Mara, & Modi, 2022), and one brief communication (Winning et al., 2023). The studies mainly aimed to examine the feasibility, acceptability, and satisfaction with the interventions, and to determine the effectiveness of interventions aimed at improving adherence to anti-seizure medication in children with epilepsy. The selected studies were conducted around the world, including the USA, China, South Korea, and Thailand. Most of the studies involved children or adolescents with epilepsy and their families ($n = 11$). Two studies involved only children aged 0 to 14 years. Two studies involved only adolescents aged 13 to 17 years, and two studies involved adults and children with epilepsy.

Quality assessment

The studies met 80% to 100% of the quality criteria. However, we did not assess the quality of editorial, systematic reviews, and papers

related to the development of interventions. Despite this, we included all papers to provide a comprehensive understanding of interventions to promote medication adherence in children with epilepsy. Quality assessments for each article were completed and are displayed in Table 1

Interventions to promote medication adherence among children with epilepsy

Educational interventions, behavioral interventions, and mixed interventions were the medication adherence interventions which have most often been used in children with epilepsy in the past ten years (see Table 2). This review found that educational interventions have used video animation (Saengow et al., 2018), and verbal education (Ma et al., 2019) to provide epilepsy knowledge and anti-seizure medication (ASM) therapy knowledge to children with epilepsy and their families. Behavioral interventions often employ mobile health technology to improve medication adherence in children with epilepsy. This includes the use of reminder text messaging and application-based interventions (Modi, Guilfoyle, et al., 2016) to support adherence. Additionally, automated digital reminders from adherence electronic monitors and individualized adherence norm feedback reports (Modi

Table 1
Characteristics of included studies according to study design ($n = 17$).

No.	Author (year)	Country	Study Design/ MMAT	Aim/Objective	Sample
1	Modi et al. (2013)	United States	Feasibility study/*****	1) To report acceptability, feasibility, and preliminary efficacy from a RCT of a family-tailored adherence intervention (AI) targeting nonadherence to antiepileptic drugs in pediatric new-onset epilepsy. 2) To examine changes in adherence rates from baseline to post intervention for individuals in the AI and TAU groups.	children with new onset epilepsy aged between 2 and 12 years and their families.
2	Wagner (2014)	United States	Editorial/(-)	To explain Antiepileptic drug nonadherence in children with epilepsy in part outcomes and potential interventions	CWE
3	Modi, Guilfoyle, et al. (2016)	United States	Feasibility study/*****	To test the feasibility and acceptability of text messaging and application-based interventions to improve adolescent antiepileptic drug adherence	adolescents aged between 13 and 17 years and their caregivers
4	Modi, Guilfoyle, et al. (2016)	United States	RCT (a pilot) /*****	1) To examine the preliminary efficacy of a family-tailored problem-solving intervention to improve antiepileptic drug adherence in families of children with new-onset epilepsy. 2) To assess changes in targeted mechanisms and treatment feasibility and acceptability	children with new onset epilepsy aged between 2 and 12 years and their families.
5	Al-Aqeel et al. (2017)	around the world	Systematic review/(-)	To determine the effectiveness of interventions aimed at improving adherence to antiepileptic medication in adults and children with epilepsy.	PWE
6	Saengow et al. (2018)	Thailand	RCT/****	1) To create video animation to educate epilepsy patients and caregivers. 2) To evaluate impact on knowledge, antiepileptic drug adherence, severity of seizure and evaluate the benefits of this video.	CWE aged between 1 month to 15 years and their caregivers
7	Ma et al. (2019)	China	Quasi experiments /****	To assess the effect of education by pharmacists on medication adherence and percentage of Valproic acid (VPA) samples reaching therapeutic reference range in these patients	CWE aged <14 years
8	Al-Aqeel et al. (2020)	around the world	Systematic Review/(-)	To determine the effectiveness of interventions aimed at improving adherence to antiepileptic medication in adults and children with epilepsy.	PWE
9	Modi et al. (2020)	United States	Development of interventions/(-)	To describe the methodology, recruitment, design, and baseline participant characteristics of the Supporting Treatment Adherence Regimens (STAR) trial.	CWE 2–12 years and their caregivers
10	Modi, Guilfoyle, et al. (2021)	United States	RCT/(*****)	1) To examine the efficacy of a family-tailored education and problem-solving behavioral intervention, Supporting Treatment Adherence Regimens, in young children with new-onset epilepsy compared to an attention control intervention.	children with new onset epilepsy aged between 2 and 12 years and their families.
11	Modi, Guilfoyle, et al. (2021)	United States	Development of interventions/(-)	1) To identify the key themes needed to create a social norms intervention for adolescents with epilepsy via focus groups (Phase 1a). 2) To create an alpha version of the BEAT intervention and conduct usability studies of the BEAT platform to obtain feedback on user and design issues that required modifications (Phase 1b) prior to launching a pilot randomized controlled clinical trial (RCT)	adolescents with epilepsy between 13 and 17 years
12	Fleeman, Bradley, Panebianco, & Sharma (2022)	around the world	Systematic Reviews/(-)	To assess the effects of any specialized or dedicated intervention for epilepsy versus usual care in children and adolescents with epilepsy and their families.	adolescents, or children and their families.
13	Bakula, Junger, Guilfoyle, Mara, & Modi (2022)	United States	Predictive factors study/(*****)	To identify specific parent, family, child, and medical factors that predict which families most need family-based adherence interventions	children with new onset epilepsy aged between 2 and 12 years and their families.
14	Modi et al. (2023)	United States	RCT (a pilot) /(*****)	To examine the feasibility, acceptability, and satisfaction of a social norms adherence intervention in adolescents with epilepsy.	adolescents with epilepsy between 13 and 17 years
15	Williford et al. (2023)	United States	Exploratory data analysis /(*****)	To identify the adherence barriers and solutions chosen by families during intervention.	CWE aged 2–12 years and their caregivers
16	Winning et al. (2023)	United States	RCT/(*****)	To examine group differences (STAR vs. EO) in epilepsy-specific knowledge, barriers to medication adherence, problem-solving skills, caregiver emotional distress, and family functioning over time and whether these factors mediated group differences in adherence at 12-months post-intervention	CWE ages 2–12 years and their caregivers
17	Godara et al. (2024)	around the world	Systematic Reviews/(-)	To critically review the extant literature on strategies and intervention models for promoting medication adherence in pediatric epilepsy to assess the efficacy of these interventions and update the literature after the publication of the Cochrane review.	adolescents, or children and their families.

Abbreviations: RCT: Randomized control trial, ***** = 100% quality criteria met, **** = 80% quality criteria met, MMAT = mixed methods appraisal tool, PWE = people with epilepsy, CWE = children with epilepsy, BEAT = the final Behavioral Economic Adherence for Teens intervention, EO = education only intervention, AI = Adherence intervention, TAU = treatment as usual group.

et al., 2023; Modi, Patel, et al., 2021) have provided further support for medication adherence. Mixed interventions have combined educational strategies with family-tailored adherence problem-solving approaches (Bakula, Junger, Guilfoyle, Mara, & Modi, 2022; Modi et al., 2013; Modi et al., 2020; Modi, Guilfoyle, et al., 2016; Modi, Guilfoyle, et al., 2021; Winning et al., 2023).

The effect of interventions to promote medication adherence among children with epilepsy

Educational interventions are viewed as essential for promoting health (Godara et al., 2024). In this review, educational interventions, including verbal- and video-based animation methods, have shown

Table 2
An analysis and summary of the interventions designed to enhance medication adherence among children with epilepsy.

Name of intervention, duration	References	Target population sample size (n)*	Medication adherence measures	Intervention details	Outcome (Medication adherence)	Limitation
Educational intervention Epilepsy video animation, (Saengow et al., 2018), 1 day	Verbal educational intervention by a pharmacist, (Ma et al., 2019)	Children aged between 1 month to 15 years and their parents (214)	MMAS-8	E: Epilepsy video animation and counseling by the clinician. C: TAU F/U: 3 months	• Post-test: E: improve from baseline** • f/u 3 months E: improve from baseline**	: may be bias of inclusion criteria and way to randomize. - not mention of intervention psychometric properties - not clear of the intervention : confounding factors, such as co-medications that affect VPA levels, genetic polymorphisms and memory of patients/families may affect SMAQ assessment
		Children aged <14 years (2165)	SMAQ+ a VPA blood concentration	E: Verbal education and consultation at initial and follow-up clinic visits and at each TDM blood draw. C: TAU F/U: 12 months	SMAQ and % VPA samples reaching therapeutic range increased**	: the small sample size, the groups were not equivalent may not be generalizable : electronic monitors are limitations include lack of confirmation that the ASM was ingested, technical difficulties, and costs.
Behavioral intervention Text messaging and applications-based adherence interventions in adolescents with epilepsy (Modi, Mann, et al., 2016)	Adolescents aged between 13 and 17 years and their caregivers (25)	Adolescents aged between 13 and 17 years and their caregivers (25)	MEMS™ or SimpleMed™	E: receive text messaging and application-based reminder systems. 5 E: 1) adolescent text only, 2) adolescent and caregiver text plus communication, 3) adolescent application only, 4) adolescent and caregiver application plus communication, and 5) epilepsy application for adolescents only. F/U: 30 days	1) Texting for Teens resulted in better adherence. 2) Over time, both teens and parents receiving text messages or an adherence app showed a declining trend in adherence. 3) Application for Teens and Parents had lower overall adherence, with parental involvement reducing adherence and text messaging improving it compared to the application. E: increase medication adherence	
				E: reminders, individualized and social norms adherence feedback C: reminders and individualized adherence feedback F/U: at 9th month		: limited sample size : Covariance COVID-19 situation, SES : with increased technology use, it is important to be mindful of alarm fatigue that is inherent with cell phone use and understand how this contributes to mHealth engagement and outcomes.
An adherence social norms intervention for adolescents with epilepsy (Modi, Patel, et al., 2021; Modi et al., 2023), 7 months	Adolescents with epilepsy between 13 and 17 years and their caregivers (40)	Adolescents with epilepsy between 13 and 17 years and their caregivers (40)	AdhereTech™ pill bottles or Vaica SimpleMed +™ pillboxes	E: 4 sessions- provide education and problem-solving intervention C: TAU (pilot) : education only (RCT) F/U Pilot: 3 months RCT: 3, 6, and 12 months	• Post-test: improve from baseline* • f/u 3 months NS RCT • Post-test: improve from baseline* • f/u 3.6 months: NS • f/u 12 months: *	
Mixed intervention The STAR, (Bakula, Junger, Guilfoyle, Mara, & Modi, 2022; Modi et al., 2013; Modi et al., 2020; Modi, Mann, et al., 2016; Modi, Patel, et al., 2021; Winning et al., 2023)	Pilot: 2 months RCT: 12 months	Children aged 2–12 years with new-onset epilepsy and their caregivers (Pilot: 30 RCT: 56)	MEMS™	E: 4 sessions- provide education and problem-solving intervention C: TAU (pilot) : education only (RCT) F/U Pilot: 3 months RCT: 3, 6, and 12 months	• Post-test: improve from baseline* • f/u 3 months NS RCT • Post-test: improve from baseline* • f/u 3.6 months: NS • f/u 12 months: *	

Abbreviations: TAU: treatment as usual, The STAR: the Supporting Treatment Adherence Regimens, E: Experimental group, C: Control group, * = $p < .05$, ** = $p < .001$, NS: not significant, MMAS-8 = MEMS = Medication Event Monitoring System, SMAQ: the simplified medication adherence questionnaire, RCT: Randomize control trial F/U: Follow-up, % VPA: % Valproic Acid, COVID-19: a global pandemic of coronavirus disease 2019, SES: Socioeconomic status, ASM: anti-seizure medication.

significant improvements in medication adherence immediately after the intervention and at 3-month and 6-month follow-ups (Ma et al., 2019; Saengow et al., 2018). Text messaging and application-based interventions initially appeared promising for adolescents with epilepsy, but experienced a decline in adherence over time. Parental involvement in application-based groups was linked to lower medication adherence, while text messaging positively impacted medication adherence (Modi, Guilfoyle, et al., 2016). In contrast, mobile health interventions were found feasible and acceptable, leading to improvements in adherence compared to a control group (Modi et al., 2023). A mixed intervention was feasible and acceptable for families, but significant differences in adherence were only seen at the 12-month follow-up (Modi et al., 2013).

Medication adherence measurement

Almost all of the studies used electronic monitors to measure medication adherence (Al-Aqeel et al., 2017, 2020; Bakula, Junger, Guilfoyle, Mara, & Modi, 2022; Modi et al., 2013; Modi et al., 2020; Modi, Guilfoyle, et al., 2016; Modi, Guilfoyle, et al., 2021; Williford et al., 2023; Winning et al., 2023). Only one study (Saengow et al., 2018) used the Morisky Medication Adherence Scale (MMAS-8), a standard and validated questionnaire used to measure medication adherence in patients with chronic diseases worldwide, including epilepsy. Furthermore, one study combined the simplified medication adherence questionnaire (SMAQ) and Valproic Acid (VPA) blood concentration to measure medication adherence (Ma et al., 2019).

Barriers to medication adherence intervention and specific solution in children with epilepsy

The included studies found various adherence barriers experienced by families during interventions, which included issues like forgetting to take medication, changes in routine, competing activities, medication taste, and transitions of responsibility (Williford et al., 2023). Moreover, families with lower socioeconomic status, children of color, lower general family functioning, and more parental distress were more likely to have suboptimal adherence to interventions (Bakula, Junger, Guilfoyle, Mara, & Modi, 2022).

To address these barriers, specific solutions were identified, including environmental cuing, medication/refill tracking, reward systems, backup doses, caregiver modeling of adherence behavior, practicing pill swallowing techniques, caregiver reminders, and consultations with the medical team. Some solutions targeted the child's behavior, some targeted the caregiver, and others were joint solutions addressing both the child and the caregiver (Williford et al., 2023).

Discussion

The aim of the present integrative review was to synthesize and evaluate the current evidence on interventions to promote improved medication adherence among children with epilepsy. The findings of the review are organized into: Interventions to Promote Medication Adherence Among Children with Epilepsy, The Effect of Interventions to Promote Medication Adherence Among Children with Epilepsy, Medication Adherence Measurement, and Barriers to Medication Adherence Intervention and Specific Solutions in Children with Epilepsy.

A total of 17 studies were included. Five interventions to promote medication adherence in children with epilepsy were presented in the integrative review. Typically, these interventions included education, behavioral interventions, and mixed interventions.

In this review, we found that educational interventions showed significant improvements in medication adherence (Ma et al., 2019; Saengow et al., 2018). These results support earlier research indicating that knowledge plays a vital role in enhancing medication adherence (Li et al., 2013; Smith et al., 2020). Also, the method for providing

knowledge is important. The utilization of video animations demonstrated a significant advantage in bolstering long-term memory and aiding children with epilepsy, families, and communities in retaining video content. This effectiveness is due to the engaging and easily understandable presentation style, which outperforms other approaches (Saengow et al., 2018). In addition, active verbal education during each encounter correlates with medication adherence (Gabr & Shams, 2015; Kyngäs, 2000).

The behavioral interventions encompassed the use of technology to provide text messages and app-based medication reminders either with or without parental involvement (Modi, Guilfoyle, et al., 2016), and to receive automated digital reminders from an adherence electronic monitor and individualized adherence norm feedback reports through mobile health (mHealth) (Modi et al., 2023; Modi, Patel, et al., 2021). These interventions initially led to significantly improved medication adherence. It may be that automated digital reminders, such as texts and alerts, help overcome this important challenge (Park et al., 2014), and feedback about other people's behavior related to one's own behavior may increase motivation and improve adherence behaviors in adolescents (Stevens, 2014). The mHealth offers a practical, feasible, developmentally acceptable, and cost-effective solution, especially since adolescents are major consumers of smartphones (Edwards et al., 2021; Huang et al., 2019). However, both teenagers and parents who received text messages or used the adherence app showed a gradual decline in adherence over time. This may be because adolescents often feel annoyed when parents remind them about their medication (Smith et al., 2018).

The mixed intervention, which combined education and a family-tailored adherence problem-solving approach, was feasible and acceptable by participating families (Modi, Guilfoyle, et al., 2021). Surprisingly, medication adherence was not significantly improved in post-intervention. However, at the 12-month follow-up, significant improvements in medication adherence were seen. This may be due to short-term attention effects.

Globally, the lack of universally recognized gold standard methods for assessing medication adherence poses a significant challenge (Mason et al., 2022). In order to address this, researchers have explored various methods, including indirect approaches such as self-reports, pill counts, and seizure frequency, and indirect approaches such as plasma or serum anti-seizure medication levels (Paschal et al., 2008).

In this review, the most common medication adherence measurement in children with epilepsy was electronic monitoring devices, which have been employed (Al-Aqeel et al., 2017, 2020; Bakula, Junger, Guilfoyle, Mara, & Modi, 2022; Modi et al., 2013; Modi et al., 2020; Modi et al., 2023; Modi, Guilfoyle, et al., 2016; Modi, Guilfoyle, et al., 2021; Modi, Patel, et al., 2021; Williford et al., 2023; Winning et al., 2023). However, the widespread adoption of these devices in clinical practice faces challenges, primarily due to high costs and limited availability (Wagner, 2014). Some studies have used standardized tools like the MMAS-8 (Saengow et al., 2018) and SMAQ (Ma et al., 2019), which are simple and cost-effective methods (Brodtkorb et al., 2016). Nonetheless, the unique nature of epilepsy treatment adherence poses a significant problem due to the lack of standardized and validated measures. This deficiency can be attributed to the fact that parents are often the ones answering the questionnaire, which can introduce inaccuracies (Paschal et al., 2008). Only one study combined two indirect and direct methods: the SMAQ questionnaire and VPA blood concentration (Ma et al., 2019). Nonetheless, the utilization of direct measures remains a subject of concern due to invasiveness and potential measurement variability attributed to event, patient factors, and drug types, particularly in monotherapy cases.

Finally, previous literature suggested various adherence barriers experienced by families during interventions, including issues like forgetting, changes in routine, competing activities, medication taste, and transitions of responsibility (Williford et al., 2023). Socioeconomic status, children of color, family functioning, and parental distress were

more likely to result in suboptimal adherence to interventions (Bakula, Junger, Guilfoyle, Mara, & Modi, 2022). Similarly, younger children with chronic illnesses also faced similar challenges (El-Rachidi et al., 2017). The healthcare team should take an active approach to promote adherence through collaborative interventions (Kardas et al., 2021), emphasizing individualized approaches to address barriers, considering age and duration of medication use in research, promoting early follow-up, incorporating educational interventions and technology, involving families and healthcare professionals, and tailoring strategies based on age. Additionally, interventions should account for socioeconomic disparities, racial diversity, family functioning, and parental distress, and consider the potential use of incentives to motivate adherence. The precise role of nurses in these interventions remains to be determined.

Limitations and strengths

There are limitations in this integrative review. The exclusion of studies from the 'gray' literature, such as conference proceedings or abstracts, and the restriction to English-language studies may have introduced publication bias. This study encompassed various types of research, guided by the recommendations for conducting an integrative review (Whittemore & Knafl, 2005). However, it is important to note that using The Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018) to assess the included studies also had its own set of limitations. The evidence in this review cannot exceed the quality of the included papers.

This integrative review provided comprehensive searching, validation process by experts, and an audit trail was maintained, using established tools to ensure the findings were reproducible and robust. Additionally, it incorporated empirical research from 2013 to 2024 to ensure the findings effectively answered the research question.

Implications to practice

Pediatric nurses should consider socioeconomic factors, ethnicity, family functioning, and parental distress. Strategies include monitoring adherence, continuous communication, and technology support for children with epilepsy during treatment.

Conclusion

Medication adherence is critical to controlling or preventing the recurrence of seizures in children with epilepsy. The present integrative review aimed to examine and synthesize the existing literature on interventions for promoting medication adherence in children with epilepsy, a goal that could be applied in clinical practice. Five existing interventions were found to promote medication adherence among children with epilepsy. In the future, there is a need for pediatric nurses or healthcare teams to develop new interventions tailored to children of various ages and their families. These interventions should meet the criteria of being both appropriate and sustainable during treatment by utilizing technology and involving families. This development is a crucial aspect of a nurse's role in enhancing medication adherence in children with epilepsy.

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CRediT authorship contribution statement

Chutimaporn Kangwal: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ratsiri Thato:** Writing – review & editing, Validation, Supervision,

Conceptualization. **Noraluk Ua-kit:** Writing – review & editing, Supervision. **Anannit Visudtibhan:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare no potential competing interests.

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