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Family skill development for attention deficit hyperactivity disorder behavior problem alleviation model in at-risk preschool children: a mixed methods study

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ABSTRACT

Introduction: Attention Deficit Hyperactivity Disorder is the most prevalent childhood mental health problem. This study examined families caring for children with ADHD and created a model to alleviate behavior problems in at-risk preschoolers.

Methods: This exploratory sequential mixed-methods study comprised two phases. Phase 1 included a qualitative retrospective survey that examined family experiences in caring for ADHD children. This involved in-depth interviews with 14 family caregivers (FCGs) and utilized thematic content analysis. Phase 2 involved creating, implementing, and evaluating a family skill development model using a quasi-experimental design. Thirty FCG- ADHD at-risk preschool child dyads, utilizing services at two Child Development Clinics, were paired and equally divided into experimental and control groups. Data analysis used repeated measures ANOVA and covariances (ANCOVA).

Results: The study FCGs reported that family-child interactions and positive parenting alleviated the ADHD at-risk preschool child's behavior problems. The Family Skill Development for ADHD Behavior Problem Alleviation Model was constructed and validated. Results from within-group comparisons showed significant improvements in the experimental group, with reduced behavior problems ($p<0.05$, $\eta p^2=0.28$) in ADHD at-risk children, improved caregiver behaviors to alleviate the child's behavior problems ($p<0.01$, $\eta p^2=0.37$), and enhanced family functions ($p< 0.001$, $\eta p2=0.42$).

Conclusions: The model significantly aids families in alleviating behavior problems in ADHD at-risk children, improving family functions and caregivers' efforts to address the children's behavioral issues. It is a promising parental intervention model for fostering healthy families and reducing behavior problems in ADHD-at-risk preschool children in northeastern Thailand and similar contexts.

Keywords: ADHD at-risk preschool children, a family skill development model, behavior problems, executive function, family function, family-child interaction, positive parenting

Introduction

Attention deficit hyperactivity disorder (ADHD) is one of the most common neurodevelopment disorders in children, characterized by symptoms of impulsivity, hyperactivity, and inattention. ADHD is usually diagnosed in school-age children, but several studies indicate certain symptoms can manifest as early as preschool age, typically between three and seven years (American Psychiatric Association and Association, 2013; World Health Organization, 2013; Aghebati *et al.*,

2014). A longitudinal birth cohort study reported that pediatric predictors of ADHD were witnessed from the age of 17 months to 6-8 years, particularly high levels of hyperactive behaviors (Galra *et al.*, 2011). The global prevalence of ADHD ranged from 2.0% to 7.0% with an average of 5.0% (Sayal *et al.*, 2018), and it ranged from 4.2 to 8.1% in Thailand, with a maximum of one million affected children countrywide (Visanuyothin *et al.*, 2013). ADHD prevalence was higher in boys than girls, with a ratio of 2-3 : 1 (Sayal *et al.*, 2018), and increased with age (Danielson *et al.*, 2018). Childhood ADHD persisting into adolescence and adulthood increases the risk of mental health issues and negative long-term outcomes. Consequences include impaired working memory, daily living difficulties (Irwin *et al.*, 2021), academic underachievement (Arnold *et al.*, 2020; Condo, Chan and Kofler, 2022), problems with employment and relationships, and increased involvement in criminal activities (Sayal *et al.*, 2018). This can lead to family stress due to behavioral issues in affected children (Leitch *et al.*, 2019) and various burdens, particularly financial related problems (Lee *et al.*, 2019; Zhao *et al.*, 2019). Early intervention is crucial for understanding challenges in families with ADHD children and developing a model to alleviate behavior issues in at-risk preschoolers.

Early interventions, especially for preschoolers at higher risk, are vital for children with ADHD. Previous studies indicated that effective interventions significantly improved their behavioral problems (Charach *et al.*, 2013; Wolraich *et al.*, 2019). However, a key challenge lies in identifying ADHD in preschool children, as symptoms like inattention, hyperactivity, and impulsivity are often considered typical developmental traits, making early diagnosis challenging (Tarver, Daley and Sayal, 2015; Miller *et al.*, 2021). Early monitoring and screening are crucial to identify and treat behavioral problems in children before a full ADHD diagnosis. Delayed recognition can result in cumulative impairment in overall functioning and development (Cabral, Liu and Soares, 2020). ADHD is usually diagnosed around age six (Visser *et al.*, 2014). At-risk preschool children with unresolved ADHD-related behavior problems face a higher risk of future mental health issues (Bornstein, Hahn and Suwalsky, 2013). Caregivers' knowledge consistently influences the association of ADHD symptoms, as it is closely linked to ADHD-related problems (Dekkers *et al.*, 2021). In a comparative ADHD study, child caregivers had less knowledge than teachers (See *et al.*, 2021). Caregivers faced challenges handling children with impaired functioning due to ADHD symptoms. These difficulties present a unique caregiving challenge distinct from other childhood mental illnesses (Ching'oma *et al.*, 2022). Evidence-based parent training programs for preschoolers with ADHD, such as those modifying caring behaviors and improving symptoms and emotional, behavioral and social functioning (Feng *et al.*, 2023), are crucial. Essential support includes guidance on interacting with children based on understanding and using helpful information from caregiving experiences, providing good evidence to alleviate behavioral problems.

This study aims to develop a family skill training model to prevent and alleviate behavioral problems in ADHD at-risk preschool children. It combines research methods to modify caregiver behaviors using the unified theory of behavior (Lindsey *et al.*, 2013), positive parenting techniques (de Graaf *et al.*, 2008), and ecological concepts (Bornstein, Hahn and Suwalsky, 2013). Families significantly impact the well-being of ADHD at-risk preschool children both internally and externally. Changes in the family's immediate environment can lead to behavioral and developmental issues in the children, influenced by their ecological surroundings. Families are emotional bonding systems for all members. When dealing with preschool children experiencing ADHD-related behavioral problems, it impacts family emotional dynamics. All members play roles and fulfill duties to maintain their family system. FCG, as the key leader, is crucial in effectively addressing the behavioral problems of at-risk children with ADHD. This is achieved by having clear behavioral intentions and implementing appropriate strategies to alleviate the child's behavior problems. Consequently, families can foster positive development in vulnerable preschool children, helping them thrive and reach their full potential as capable adults, which are essential for the nation's future development. Implementing positive childcare practices early on promotes optimal child development and helps prevent potential complications. Positive parenting and the early adoption of effective childcare practices can mitigate behavior problems in ADHD at-risk preschool children, enhancing child development and preventing future issues.

Materials and Methods

Study Design

This mixed methods research study used an exploratory sequential design comprising two phases (Creswell and Clark, 2018).

Qualitative Study in Phase 1

Participants

In Phase 1, a qualitative retrospective study explored family experiences caring for children with ADHD. The study involved in-depth interviews (n=14) and focus group discussions (n=4) with the family caregivers (FCGs) of children aged 6-9 years diagnosed with ADHD by physicians based on the DSM-5 criteria for at least six months. Participants were recruited from Hospital A's Child Development Clinic (CDC) of the Outpatient Department. Inclusion criteria for family caregivers (FCGs) included: 1) being primary caregivers of children aged 6-9 years who had been diagnosed with ADHD by physicians without other behavioral illnesses such as autism and cerebral palsy, 2) being able to communicate well in the Thai language, and 3) being able to voluntarily participate in the research project.

Instrument and data collection

Data collection was carried out by one of the researchers (KK) using the in-depth interview guide, observation checklist, and field notes. The in-depth interview guide has two parts. Part 1 includes the general characteristics and background of a child with ADHD, his/her FCG, and family information. Part 2 contains four open-ended questions about the child's behavior problems and the family's responding behaviors. These questions include: 1) "What are the behavior problems of the child with ADHD from the initial past up to the present?"; 2) "What behaviors do you and your family perform to alleviate such behavior problems of the affected child from past to present?"; 3) "Is there any change in your responding behavior(s) to alleviate the child's behavior problems from past to present?" "If not, please explain why it is so happening." "If yes, please specify why it is so happening,"; and 4) "What are the effects/consequences or outcomes of the family's general and specific responding behaviors?".

Data analysis

Data analysis was conducted concurrently with data collection using thematic content analysis (TCA), in seven phases with the use of ATLAS.ti (Friese, Soratto and Pires, 2018).

Data trustworthiness

For data trustworthiness in the qualitative phase, we employed the following procedures: 1) establishing rapport with four selected FCGs through initial questions before in-depth interviews, 2) conducting member checking with four selected FCGs during a focus group discussion, 3) peer debriefing with one specialist, and 4) triangulation to verify consistency between derived conclusions and data from in-depth interviews, observation checklists, and field notes (Lincoln and Guba, 1985).

Quantitative study in Phase 2

Participants

In Phase 2, a quantitative approach was taken to develop, implement, and assess the Family Skill Development (FSD) for ADHD Behavior Problem Alleviation (BPA) Model. The FSD-ADHD-BPA model was developed based on Phase 1 findings and extensive reviews of effective programs for reducing behavioral problems in ADHD at-risk preschool children (refer to Table 1). The study used a quasi-experimental design to implement the FSD-ADHD-BPA model over eight weeks in an experimental group, while a control group received routine care. Assessments included pretest, posttest, and 6-week follow-up from June to September 2022. The sample size for model implementation was determined by comparing behavior problems before and after the model implementation among ADHD at-risk preschool children in northeastern Thailand, using a priori power analysis available in the G*Power software version 3.1.9.2. Parameters included 95% power, 95% confidence level ($\alpha<0.05$), and a medium effect size ($d=0.31$). The G*Power analytic result in a minimum sample size of 30 FCG-child dyads (n=15 dyads per group). The researcher selected two specific groups from two hospitals based on the availability of a CDC with at least one pediatric psychiatrist providing service and recruited the study participants based on the inclusion criteria. The researcher allocated fifteen dyads utilizing services at Hospital A to the experimental group (E) and fifteen dyads at Hospital C to the control group (C). Group assignment was based on matching pairs of ADHD at-risk preschool children by age and sex. The inclusion criteria of the ADHD at-risk children included: 1) having the Thai ADHD Screening Scale scores of more than 51 points; 2) being in good health, with no current illness, or uncomfortable condition such as fever or infection; 3) having an FCG who can communicate well in the Thai language; and 4) willing to voluntarily participate in the research project both FCG and ADHD at-risk child.

Instrument and data collection

Data collection used five research tools as following: 1) The general characteristic questionnaire comprises three parts: a) family background, b) general information about an ADHD at-risk preschool child, and

c) general information about FCGs: 2) The Thai ADHD screening scale (THAISS) (Pornnoppadol *et al.*, 2014) was used for ADHD screening in preschool children aged 3 to 5 years by caregiver. The instrument has 30 rating scale questions, scored from 0-3 (none, rarely, often, more often), evaluating hyperactivity/impulsivity (15Qs) and inattention (15Qs). The THAISS demonstrates strong internal consistency with a Cronbach's alpha coefficient of 0.96. Additionally, it exhibits good sensitivity (0.90) and specificity (0.88) in detecting ADHD symptoms. In the current study, Cronbach's alpha coefficient was 0.92; 3) The Executive Functions (EF), developed by Vechmongkholkorn and Surakarn (Vechmongkholkorn and Surakarn, 2019) were employed by caregivers to assess preschool children's executive function. The assessment form comprises 25 rating scale questions, ranging from least to most proficient (rated on a scale of 1-4). It evaluates five aspects, each with five questions: inhibition (5Qs), working memory (5Qs), flexibility (5Qs), emotional control (5Qs), and systematic planning (5Qs). The form's reliability has been validated with a high Cronbach's alpha coefficient of 0.90. In the current study, Cronbach's alpha coefficient was 0.86; 4) The Behaviors to Alleviate Behavioral Problems (BABP), developed by the research team (KK), was employed to examine the BABP of ADHD at-risk preschool children by FCGs. It consists of 30 rating scale questions, rated from not at all to performing regularly (1-5 points). The questions assess positive interaction behaviors (15 Qs) and behaviors to develop EF of the children (15 Qs). This tool's content validity index (CVI) was 0.92, reflecting strong content validity. The reliability, as measured by Cronbach's alpha coefficient, was 0.86; 5) The Chulalongkorn Family Inventory, or CFI, developed by Trangkasombat (Trangkasombat, 2001), is a self-report questionnaire for caregivers to assess family function. The assessment comprises 36 rating scale questions (rated on a scale of 1 to 4). The questions gauge various aspects of family functions, including problem-solving (6 Qs), communication (5 Qs), role performance (3 Qs), emotional response (5 Qs), emotional attachment (5 Qs), behavioral control (4 Qs), and general functions (8 Qs). This assessment tool's content validity index (CVI) was 0.92, reflecting strong content validity. The reliability, as measured by Cronbach's alpha coefficient, was 0.86. In the current study, Cronbach's alpha coefficient was found to be 0.81, indicating a reasonably good level of reliability.

Data analysis

The study utilized SPSS Statistics version 22.0 for data analysis. Descriptive data include means, standard deviations (SD), frequencies, and percentages (%). General characteristic differences between experimental and control groups were compared using independent sample t-test and chi-square tests. The study examined differences in outcomes (behavioral problems, EF, BABP, and family functions) between groups at baseline using independent sample t-tests. Changes in outcomes within and between groups during three assessment phases (pretest, posttest, and 6-week follow-up) were assessed through repeated measures ANOVA with Bonferroni correction to account for time effects. For family function subscales (roles and behavioral control), analysis of covariance (ANCOVA) was employed, controlling for baseline values (pretest). Effect size interpretation followed Cohen's guidelines, with effect sizes (ηp^2) of 0.01, 0.06, and 0.14 considered small, moderate, and large, respectively (Field, 2013).

Ethical Clearance

This research was reviewed by the Research Ethics Committee of Mahasarakham University (Ref. No. 100-044/2021) and the research ethics committees of the three study hospitals: Hospital A Research Ethics Committee (Ref. No. MSKH_REC 64-02-007), Hospital B Research Ethics Committee (Ref. No. 007/2022E) and the Hospital C Research Ethics Committee (Ref. No. RE08/2565). The study was registered as a quasi-experimental Phase 2 trial with two groups (experimental and control), incorporating pretest, posttest, and follow-up assessments in the Thai Clinical Trials Registry (TCTR) (Ref. TCTR 20210921003).

Results

Qualitative study in Phase I

General characteristics of family caregivers of the children with ADHD

All caregivers of the children with ADHD were women (n=14), aged 22-60 years, with an average age of 42.0 years (SD=11.8). About 42.9% had secondary education, 57.0% were divorced, and 92.1% came from extended families. Children with ADHD (7 boys and 7 girls) were aged 6 years and 1 month to 8 years and 11 months, with an average age of 7 years and 1 month (SD=0.9). The average age of ADHD diagnosis was 5.6 years (SD=1.1), and the duration of diagnosis ranged from 8 months to 3 years, with an average duration of 1 year and 6 months (SD=0.6), as shown in Table 1.

Family experiences

Caregivers modified behaviors to alleviate behavioral problems in children with ADHD. In brief, it was found that the caregivers modified their behaviors to alleviate the behavioral problems of their children with ADHD by using family-child interaction and positive parenting, as shown in the following descriptions. Notably, detailed results of this part have been reported elsewhere. Based on the experiences of the caregiver's reflections, two themes emerged, namely: 1) Family-child interaction, and 2) Positive parenting.

Theme 1, family-child interaction, the caregivers reported modifying their behaviors to address the children's behavioral problems by engaging in activities together with them, aiming to improve family-child interaction and alleviate behavioral issues. The activities included: 1) promoting mindfulness and meditation by teaching the child to count from 1 to 10; 2) encouraging day-to-day self-help and household chores to involve the ADHD children in family activities and improve interaction; 3) promoting cognitive processes and creativity through playing with toys; and 4) promoting exercise as children with ADHD preferred to have physical activities with their families.

Theme 2, positive parenting, the caregivers acknowledged the need to modify their caregiving approach for children with ADHD by adopting the following positive parenting styles:1) promoting attachment through affection, closeness, and spending quality time with the child; 2) showing acceptance and respect by using polite language, apologizing when necessary, and encouraging the child's independence, particularly allowing them to perform daily activities without too closed supervision; 3) emphasizing proactive parenting by continuously self-studying child care topics and monitoring issues; 4) performing compassionate leadership by calmly admonishing wrongful behavior, showing sympathy, and providing reasons; and 5) implementing positive discipline by establishing family rules and avoiding physical punishment.

Quantitative study in Phase 2

Family skill development for ADHD behavior problem alleviation model

The FSD-ADHD-BPA model developed specifically for ADHD at-risk preschool children comprised three stages: 1) planning, 2) production, and 3) revision and completion.

Table 1 General characteristics of the primary caregivers of the children with ADHD and Children with ADHD (n=14)

General characteristics	n	%
General characteristics of primary caregivers of the children with ADHD		
Sex		
Female	14	100.0
Level of Education		
Elementary School	4	28.6
Secondary education	6	42.9
Diploma Degree	3	21.4
Bachelor Degree	1	7.1
Marital status		
Marriage	6	42.9
Divorce	8	57.1
Family characteristics		
Single family	1	7.1
Extended family	13	92.1
Average age family caregivers	42 years	SD=11.8
General characteristics of children with ADHD		
Sex		
Male	7	50.0
Female	7	50.0
Average age	7 years and 1 month	SD=0.9
Duration of diagnosis	1 years and 6 month	SD=0.6

Planning stage

The developed model in this stage is rooted in the ecological theory, incorporating the unified theory of behavior (Lindsey *et al.*, 2013). It views the family as a critical ecosystem for a child's psychological, emotional, and behavioral development (Haefner, 2014). Recognizing that the illness of one family member can impact the entire family, particularly the FCG, behaviors changes in the FCG can influence the behaviors of the entire family, including ADHD-at-risk preschool children. The FCG's intention to modify behaviors is complex and influenced by knowledge, environmental constraints, and habitual responses. Derived from qualitative research, the model underscores the necessity of enhancing FCGs' behavioral skills in family-child interactions and positive parenting. Engaging in activities with ADHD-at-risk preschool children is identified as crucial for their executive function development during this rapid developmental period (Anderson and Reidy, 2012). Positive parenting styles play a vital role in discipline and fostering strong relationships with children (Eanes, 2016). The model focuses on involving FCGs in family-based activities to promote positive parenting, alleviate behavioral problems, and enhance executive function skills in ADHD-at-risk children. Its goal is to empower FCGs with the knowledge and skills to effectively manage ADHD-related behavioral problems in preschool children while fulfilling their family responsibilities. The model

Table 2 The Family Skill Development for ADHD Behavior Problem Alleviation Model (FSD-ADHD-BPA Model) in ADHD at-risk preschool children

Component	Activity
Developing early family skills for ADHD detection	Workshop 1: Significance of appropriate child rearing in a family, assessing problems and risks of ADHD in preschool children. 1. A health education session on the significance of appropriate child rearing in a family. 2. A health education session on assessment of problems and risks of ADHD in preschool children. 3. Demonstrations and practice. Time: The workshop on Day 1 of Week 1 lasts for 60 minutes. Material: 1. A handbook entitled "Developing Family Skills to Alleviate Behavioral Problems in ADHD At-risk Preschool Children." 2. The Thai ADHD Screening Scales (THAISS).
Enhancing family skills for behavior problem alleviation	Workshop 2: Appropriate solutions to alleviate behavioral problems of the ADHD at-risk preschool children. 1. A health education session on appropriate solutions to alleviate behavioral problems of ADHD at-risk children. 2. Demonstrations and practice at the workshop. Time: The workshop on Day 1 of Week 1 lasts 60 minutes. Material: 1. A handbook entitled "Developing Family Skills to Alleviate Behavioral Problems in ADHD At-risk Preschool Children" on solutions to alleviate behavioral problems in ADHD at-risk children.
Promoting positive parenting through family-child interactions	Workshop 3: Promotion of positive interactions between families and children to enhance positive parenting skills. 1. Health education session on the development of positive parenting skills. 2. Health education on the development of children's executive functions (EF) through 4 activities: a) "Bottle of mindfulness," b) "Talented person can help oneself," c) "Think about what color," d) "Exercise to keep pace with the colors." 3. Demonstrations and practice at the workshop. 4. Practice at home. Time: 1. The workshop on Day 1 of Week 1 lasts for 120–180 minutes, with each activity lasting 30–45 minutes. 2. Continuous home-based practice Activities 1–4 during Week 1–Week 4, totaling 240–360 minutes or more. Spend 30-45 minutes on each activity per week, or more often if needed. All four activities are to be practiced. 3. Repeated home-based practice Activities 1-4 during Weeks 5-8, accumulating at least 240–360 minutes. Allocate 30-45 minutes per week to each activity or more frequently as desired. Choose activities flexibly. Material: 1. An activity book entitled, "Being mindful-Help-Cognition-Exercise." 2. Equipment 1 is a "Khuad-Hang-Sati," or mindfulness bottle, a DIY item. 3. Equipment 2 is a set of "Nine Square Step Exercises" consisting of a home-based exercise sheet, an exercise song, and a demonstration video.
Monitoring and assessing behavior progress	Activity: Self-review and home practice. 1. Review activities in Components 1, 2, and 3. 2. Caregivers monitor behaviors and record results. 3. Home visits or virtual support via video or phone calls. Time: 1. The pretest, posttest, and 6-week follow-up assessment are set in Week 1, Week 8, and Week 14, respectively, at the CDC. 2. The home visit activity in Week 4 was replaced by a phone call or video call, resulting from the COVID-19 social distancing regulations. Material: 1. A handbook for developing family skills toward the alleviation of behavioral problems in ADHD at-risk preschool children; 2. The Thai ADHD Screening Scales (THAISS). 3-5. Activity book and Equipment 1 and 2. 6. Equipment 3 is a free digital program application called "Happy Family Awareness of ADHD," created by KK. It was available on smartphone and the website, allowing easy download onto family caregivers' smartphones from the first day of the workshop training until Week 14.

emphasizes four intervention components for family caregivers, as outlined in Table 2.

Production stage

In this stage, the research team prepared for four workshop training activities to implement the model. The materials included: 1) A handbook titled "Developing Family Skills to Alleviate Behavioral Problems in ADHD At-risk Preschool Children"; 2) An activity book, "Sati-Chuay-Kid-Aoug" or "Being Mindful-Help-Cognition-Exercise"; 3) Equipment 1, mindfulness bottle named "Khuad-Hang-Sati"; 4) Equipment 2, a "Nine Square Step Exercise" set with a home-based exercise sheet featuring colorful squares. Additionally; 5) Equipment 3, a free digital program application named "Happy Family Awareness of ADHD," detailed in Table 2.

Revision and completion stage

During the revision and completion stage, the FSD-ADHD-BPA model underwent validation by five experts, including psychiatrists, maternal and child professional nurses, and special child educators, through a demand survey. They evaluated the model's objectives, content,

Table 3 Comparisons of general characteristics of the family caregivers (FCGs) and ADHD at-risk preschool children in experimental and control groups, 15 for each group (n=30)

General characteristics	Experimental group (n = 15)	Control group (n = 15)	*p*-value
	mean (SD) or frequency (%)	mean (SD) or frequency(%)	
Family caregivers (FCGs)			
Age (years)	39.06(11.18)	38.93(13.84)	0.977[a]
Sex			0.409[c]
Male	5(33.3)	3(20.0)	
Female	10(66.7)	12(80.0)	
Education level			0.202[c]
Primary education	4(26.7)	4(26.7)	
Secondary education	3(20.0)	8(53.3)	
Diploma	4(26.7)	1(6.7)	
Bachelor's degree	4(26.7)	2(13.3)	
Marital status			0.166[c]
Married	10(66.7)	1(66.7)	
Separated	1(6.7)	4(26.7)	
Divorced or widowed	4(26.6)	1(6.7)	
Relationships with children			1.000[b]
Parents	10(66.7)	10(66.7)	
Grandparents	5(33.3)	5(33.3)	
ADHD at-risk preschool children			
Age (years)	5.23(0.81)	4.87(0.63)	0.189[a]
Sex			1.000[c]
Male	12(80.0)	12(80.0)	
Female	3(20.0)	3(20.0)	
History of past illnesses			1.000[c]
No	14(93.3)	14(93.0)	
Yes	1(6.7)	1(6.7)	
Family characteristics			0.885[c]
Nuclear family	2(13.3)	3(20.0)	
Extended family	12(80.0)	11(73.3)	
Single-parent family	1(6.7)	1(6.7)	

Note: Statistics: a *t*-test; b Chi-square test; c Fisher's exact test

language, design, and usability. Content validity, assessed by the CVI, was 0.93, meeting the acceptable threshold (0.70 or higher). After incorporating expert suggestions, the model was tested with five families at Hospital B's CDC by the research (KK) to ensure the appropriateness and clarity of content, activities, and time duration. Post-trial, the final activities and content of the model were fully developed.

Effects of model and impact evaluation

Baseline analysis

General characteristics of the study participants: The study focused on the FCG and ADHD at-risk preschool child dyads. Among the 30 FCGs, the majority were women (22 out of 30) with ages ranging from 21 to 60, with an average age of 39.0 years (SD=12.3). More than half were parents, and a significant portion had completed secondary education. On average, FCGs had been providing care for ADHD at-risk children for 4.03 years (SD=1.17), with a duration spanning from 1 to 6 years.

In the group of ADHD at-risk preschool children, the majority came from extended families (23 out of 30), with more girls than boys (20 vs. 10). Their ages ranged from 3 to 6 years, averaging 5.06 years (SD=0.74). Significantly, a substantial proportion of these children had mobile phones (24 out of 30), and among them, 24 used phones regularly for at least one hour daily.

Participants were divided into an experimental group (E) receiving the FSD-ADHD-BPA model and a control group (C) receiving standard care. Baseline characteristics in Table 3 indicate comparable demographics for both groups. Key factors such as age, sex, education level, marital status, and relationship with children for the FCGs, as well as age, sex, past illness history, and family characteristics of the ADHD at-risk children, showed no significant differences between the experimental and control groups (all p>0.05), as shown in Table 3.

At baseline, ADHD at-risk children exhibited a minimal to mild risk of having ADHD symptoms. The experimental group had slightly higher average scores (58.7 points, SD=9.8) compared to the control group (54.8 points, SD=10.2). Attention-related behavioral issues were slightly more prominent than hyperactivity/impulsiveness in both groups. Both groups displayed good to very good executive functions (EF). Regarding behavior to alleviate behavioral problems (BABP), the control group (118.8 points, SD=17.9) had a slightly higher total BABP than the experimental group (114.2 points, SD=19.8), indicating a high adoption of BABP strategies. FCGs reported moderate levels of performing family functions (71-110 points) in both groups.

Baseline measurements indicated no significant differences between ADHD at-risk children's behavior problems, total EF and EF subscales, BABP and BABP subscales, total family functions, and most family function subscales (including problem-solving, communication, affective responsiveness, affective involvement, and general functioning), except for roles and behavior control. These differences were not statistically significant (all p>0.50). However, FCGs in the experimental and control groups significantly differed in

Table 4 Comparisons of behavioral problems, executive functions (EF), behavior to alleviate behavior problems (BABP), and family functions in FCG-ADHD at-risk preschool child dyads at baseline (pretest) in experimental and control groups, 15 for each group (n=30)

Variables	Experimental group (n=15)	Control group (n=15)	t(df)	p-value
	mean(SD)	mean(SD)		
Behavioral problems				
Hyperactivity/impulsiveness	1.77(0.36)	1.60(0.42)	1.180(28)	0.248
Inattention	2.15(0.38)	2.05(0.42)	0.633(28)	0.532
Total	58.73(9.82)	54.80(10.26)	1.072(28)	0.293
Executive functions (EF)				
Inhibition	2.88(0.67)	2.62(0.60)	1.087(28)	0.286
Working memory	3.13(0.59)	2.87(0.42)	1.407(28)	0.171
Cognitive flexibility	3.12(0.42)	3.25(0.60)	-0.700(28)	0.490
Emotional control	3.33(0.55)	3.28(0.46)	0.284(28)	0.778
Planning and organization	3.13(0.94)	2.80(0.56)	1.168(28)	0.253
Total	78.00(12.07)	74.13(7.81)	1.042(28)	0.306
Behavior to alleviate behavioral Problems (BABP)				
Positive interaction development	4.03(0.53)	4.15(0.60)	-0.622(28)	0.539
EF skill development	3.73(0.76)	3.75(0.63)	-0.087(28)	0.932
Total	114.27(19.89)	118.80(17.97)	-0.566(28)	0.518
Family functions assessed using the CFI				
Problem-solving	3.13(0.28)	2.92(0.45)	1.273(28)	0.213
Communication	3.10(0.36)	2.92(0.52)	1.284(28)	0.280
Roles	3.76(0.34)	3.27(0.53)	2.966(28)	0.006**
Affective responsiveness	3.06(0.37)	3.05(0.40)	0.094(28)	0.926
Affective involvement	2.13(0.39)	2.27(0.33)	-0.993(28)	0.329
Behavior control	2.82(0.35)	2.47(0.35)	2.695(28)	0.012*
General functioning	3.20(0.41)	3.13 (0.49)	0.403(28)	0.690
Total	108.67(7.48)	104.00(10.70)	1.384(28)	0.177

Note: CFI, the Chulalongkorn Family Inventory; FCG, family caregiver; Scoring for subscales: Behavioral problems, 0-3; EF (Executive functions), 1-5; BABP (Behavior to alleviate behavioral problems), 1-5; and Family functions, 1-4; Data are significant at * p<0.05, ** p<0.01, *** p<0.001

family function subscales, specifically roles (p<0.01) and behavior control (p<0.05), as shown in Table 4.

Effects and impacts of the model

As per the Activity Book checklist, all FCGs in the experimental group consistently adhered to specified activities, engaging in play sessions with their young children at least four times a week. Consequently, the attendance rate for these intervention activities reached 100%. Data analysis revealed statistically significant main effects of time across three assessment phases for ADHD at-risk preschool children. This included total behavioral problems ($F(2,56)=4.65$, $p=0.013$, $\eta p^2=0.143$) and all subscales, such as hyperactivity and impulsiveness ($F(2,56)=4.65$, $p=0.012$, $\eta p^2=0.193$) and inattention ($F(2,56)=9.69$, $p=0.002$, $\eta p^2=0.257$). Significant effects were also observed in some EF subscales, namely inhibition ($F(2,56)=65.658$, $p<0.001$, $\eta p^2=0.701$), cognitive flexibility ($F(2,56)=13.827$, $p=0.001$, $\eta p^2=0.331$), and emotional control ($F(2,56)=4.268$, $p=0.04$, $\eta p^2=0.132$). However, there was no significant main effect of time on total EF ($F(2,56)=2.793$, $p=0.079$, $\eta p^2=0.171$) and some EF subscales, namely working memory ($F(2,56)=2.481$, $p=0.122$, $\eta p^2=0.081$), planning and organization ($F(2,56)=3.054$, $p=0.083$, $\eta p^2=0.098$).

For FCGs, significant main effects of time were identified on BABP ($F(2,56)=4.658$, $p=0.038$, $\eta p^2=0.143$) and all the subscales, including positive interaction development ($F(2,56)=16.585$, $p<0.001$, $\eta p^2=0.372$) and EF skill development ($F(2,56)=6.181$, $p=0.012$, $\eta p^2=0.181$). A significant main effect of time was also found on total family functions ($F(2,56)=8.764$, $p=0.004$, $\eta p^2=0.238$), and certain family function subscales such as problem-solving ($F(2,56)=4.697$, $p=0.03$, $\eta p^2=0.144$), affective involvement ($F(2,56)=10.832$, $p<0.001$, $\eta p^2=0.279$), behavioral control ($F(2,56)=8.123$, $p=0.001$, $\eta p^2=0.225$), and general functioning ($F(2,56)=10.296$, $p=0.003$, $\eta p^2=0.269$). However, there was no significant main effect of time on family functions concerning communication ($F(2,56)=0.153$, $p=0.726$, $\eta p^2=0.005$), roles ($F(2,56)=2.422$, $p=0.13$, $\eta p^2=0.08$), and affective responsiveness ($F(2,56)=1.980$, $p=0.155$, $\eta p^2=0.066$), with detail not shown.

Results from within-group comparisons showed that ADHD at-risk children in the experimental group significantly decreased in total behavioral problems ($p<0.05$, $\eta p^2=0.28$) and all subscales, including hyperactivity/impulsiveness ($p<0.05$, $\eta p^2=0.25$) and inattention ($p<0.05$, $\eta p^2=0.25$). Two out of five EF subscales, inhibition ($p<0.001$, $\eta p^2=0.71$) and cognitive flexibility ($p<0.01$, $\eta p^2=0.41$), also showed significant

Table 5 Comparisons of the mean scores of each outcome measure in FCG-ADHD at-risk preschool child dyads within- and between groups in three assessment phases in experimental and control groups, 15 for each group (n=30)

Variables	Group	Assessment phases			Within-group comparison		Between-group comparison[a, b]	
		Pretest	Posttest	6-week Follow-up				
		mean (SD)	mean (SD)	mean (SD)	*p*-value	ηp^2	*p*-value	ηp^2
Behavioral problems								
Hyperactivity/ impulsiveness	E	1.77(0.36)	1.33(0.56)	1.26(0.57)	0.02*	0.252	0.672a	0.007
	C	1.60(0.42)	1.46(0.35)	1.45(0.34)	0.720	0.026		
Inattention	E	2.15(0.38)	1.60(0.72)	1.51(0.78)	0.02*	0.250	0.688a	0.006
	C	2.05(0.42)	1.72(0.65)	1.70(0.65)	0.25	0.098		
Total	E	58.73(9.82)	43.87(17.72)	41.60(19.35)	0.01*	0.286	0.640a	0.008
	C	54.80(10.26)	47.73(13.07)	47.26(13.12)	0.35	0.074		
Executive functions (EF)								
Inhibition	E	2.88(0.67)	4.31(0.64)	2.87(0.99)	<0.001	0.716	0.300a	0.038
	C	2.62(0.60)	4.22(0.67)	2.60(0.64)	<0.001	0.759		
Working memory	E	3.13(0.59)	3.57(1.08)	3.49(1.05)	0.107	0.153	0.056a	0.125
	C	2.87(0.42)	2.83(0.66)	2.91(0.63)	0.891	0.008		
Cognitive flexibility	E	3.12(0.42)	3.68(0.72)	3.81(0.65)	0.001**	0.415	0.799a	0.002
	C	3.25(0.60)	3.60(0.51)	3.63(0.55)	0.142	0.135		
Emotional control	E	3.33(0.55)	3.77(0.80)	3.75(0.73)	0.093	0.161	0.165a	0.068
	C	3.28(0.46)	3.41(0.45)	3.43(0.40)	0.739	0.022		
Planning and organization	E	3.13(0.94)	3.73(0.80)	3.64(0.72)	0.070	0.179	0.002a**	0.295
	C	2.80(0.56)	2.81(0.52)	2.87(0.47)	0.795	0.017		
Total	E	78.00(12.07)	88.20(19.50)	88.70(17.61)	0.068	0.180	0.034a*	0.151
	C	74.13(7.81)	76.73(8.07)	77.13(8.10)	0.569	0.041		
Behavior to Alleviate Behavioral Problems (BABP)								
Positive interaction dvp	E	4.03(0.53)	4.54(0.34)	4.66(0.35)	<0.001***	0.519	0.275a	0.042
	C	4.15(0.60)	4.15(0.66)	4.35(0.57)	0.022*	0.246		
EF skill dvp	E	3.73(0.76)	4.31(0.43)	4.24(0.48)	0.008**	0.302	0.221a	0.053
	C	3.75(0.63)	3.92(0.62)	3.93(0.69)	0.65	0.031		
Total	E	114.27(19.89)	132.87 (10.84)	133.40(10.82)	0.002**	0.379	0.265a	0.044
	C	118.80(17.97)	120.27 (19.29)	124.20(17.87)	0.205	0.111		
Family functions assessed using the CFI								
Problem-solving	E	3.13(0.28)	3.54(0.55)	3.40(0.63)	0.002**	0.361	0.012a*	0.207
	C	2.92(0.45)	3.02(0.48)	2.90(0.45)	0.119	0.146		
Communication	E	3.10(0.36)	3.26(0.47)	3.20(0.48)	0.157	0.128	0.020a*	0.178
	C	2.92(0.52)	2.82(0.42)	2.81(0.39)	0.643	0.032		
Roles	E	3.76(0.34)	3.78(0.32)	3.78(0.32)	0.971	0.002	0.803b	0.002
	C	3.27(0.53)	3.47(0.61)	3.44(0.58)	0.131	0.140		
Affective responsiveness	E	3.06(0.37)	3.12(0.48)	3.28(0.36)	0.076	0.174	0.573a	0.011
	C	3.05(0.40)	3.07(0.43)	3.13(0.43)	0.636	0.033		
Affective involvement	E	2.13(0.39)	2.15(0.33)	2.55(0.48)	0.026*	0.236	0.248a	0.047
	C	2.27(0.33)	2.20(0.35)	2.64(0.38)	0.027*	0.237		
Behavior control	E	2.82(0.35)	2.45(0.49)	3.00(0.77)	<0.001***	0.433	0.812b	0. 058
	C	2.47(0.35)	2.38(0.55)	2.70(0.52)	0.081	0.170		
General functioning	E	3.20 (0.41)	3.64 (0.44)	3.60 (0.43)	0.015*	0.26	0.048a*	0.133
	C	3.13 (0.49)	3.22 (0.51)	3.20 (0.51)	0.82	0.01		
Total	E	108.67(7.48)	114.53(11.35)	118.07(12.02)	<0.001**	0.429	0.021a*	0.177
	C	104.00(10.70)	104.87(9.96)	107.87(10.39)	0.015*	0.269		

Note: CFI, the Chulalongkorn Family Inventory; dvp, development; FCG, family caregiver; Group, E=experimental group, C=control group. Scoring for subscales: Behavioral problems, 0-3; EF (Executive functions), 1-5; BABP (Behavior to alleviate behavioral problems), 1-5; and Family functions, 1-4. Statistics: a Two-way repeated measures ANOVA to compare means between- and within-group variations, b Repeated measures ANCOVA to perform some mean between-group comparisons, while controlling for the baseline values(pretest); Data are significant at * p<0.05, ** p<0.01, *** p<0.001; Effect sizes: ANOVA and ANCOVA analysis used partial eta square (ηp^2) and categorized into small = 0.01, medium = 0.06, large >0.14.

improvement with large effect sizes. However, from the model implementation until the end of the 6-week follow-up, the experimental group did not differ in total EF and EF subscales (working memory, emotional control, planning, and organization), all p >0.05. For the control group, there were no statistically significant differences in mean scores between the pretest, posttest, and 6-week follow-up, except for one EF subscale, inhibition (p<0.001, ηp^2=0.75).

Results from within-group comparisons over three assessment phases for FCGs showed significant improvement in the experimental group. They demonstrated enhanced BABP with a significant decrease in total BABP with a significant decrease in total BHBP (p<0.01, ηp^2=0.37) and improvements in all

its subscales, including positive interaction development ($p<0.001$, $\eta p^2=0.51$), and EF skill development ($p<0.01$, $\eta p^2=0.30$).

The experimental group also experienced significant improvement in total family functions ($p<0.001$, $\eta p^2=0.42$), and four out of seven family function subscales, specifically problem-solving ($p<0.01$, $\eta p^2= 0.36$), affective involvement ($p<0.05$, $\eta p^2=0.23$), behavioral control ($p<0.001$, $\eta p^2=0.43$), and general functioning ($p<0.05$, $\eta p^2=0.26$). However, there were no differences in some family function subscales, such as communication, roles, and affective responsiveness, after completing the model implementation up to the 6-week follow-up, all $p>0.05$.

For the control group, there were no statistical differences in mean scores between the pretest, posttest, and 6-week follow-up, except for one BABP subscale, positive interaction development ($p<0.05$, $\eta p^2=0.24$), and total family functions ($p<0.05$, $\eta p^2=0.26$), along with one family function subscale, affective involvement ($p<0.05$, $\eta p^2=0.26$).

Between-group comparisons showed a significant main effect of the experimental group on the repeated measure averaged across time in total family functions ($p<0.05$, $\eta p^2=0.17$). Subscales, such as problem-solving ($p<0.05$, $\eta p^2=0.20$, large effect size), and general functioning ($p<0.05$, $\eta p^2=0.13$, medium effect size), also showed notable differences among FCGs in the experimental group compared to the control group. This effect was observed from the intervention through the end of the 6-week follow-up assessment phase, as presented in Table 5.

Results from data analyses indicated significant interaction effects of time (pretest, posttest, and 6-week follow-up) across groups (E, C) on total BABP ($F(2,56)=5.02$, $p=0.022$, $\eta p^2=0.152$), and BABP subscale, positive interaction development ($F(2,56)=7.64$, $p = 0.002$, $\eta p^2=0.214$).

Discussions

This was a mixed methods research study, employing an exploratory sequential design and utilizing a retrospective qualitative approach to investigate the experiences of families caring for children with ADHD. Additionally, a quantitative approach was used to develop, implement, and evaluate "The Family Skill Development for ADHD Behavior Problem Alleviation Model," abbreviated as the FSD-ADHD-BPA Model. This intervention model aims to tackle the challenges and requirements of ADHD at-risk preschool children and their families.

In phase 1, the qualitative phase, in-depth interviews and focus group discussions involved 14 caregivers of children aged 6-9 years diagnosed with ADHD for at least six months by a physician following DSM-5 criteria. This engagement took place at an outpatient clinic in a hospital setting. The study revealed two key themes contributing to model construction. First, caregivers adapted their behaviors through behavioral modification to address issues in children with ADHD. This was achieved through positive family-child interaction and effective parenting strategies. Second, caregivers described adapting their behaviors to improve family-child interaction and alleviate behavior problems in their children. This study uncovered how caregivers adjusted their approaches to support children with ADHD, showcasing the use of appropriate strategies in northeastern Thailand. Examples include 1) encouraging the involvement of ADHD children in day-to-day tasks, engaging in shared household chores, 2) introducing mindfulness and meditation techniques, 3) using playtime with toys to stimulate cognitive processes and creativity, and 4) promoting physical exercise, given the preference of ADHD children for such activities involving their families.

According to the caregivers, family-child interactions have a role in children's EF development. Prior research has suggested that children with higher EF appear to have fewer behavioral issues, while children with lower EF appear to have more behavioral external problems (Romero-Lopez *et al.*, 2017).

In phase 2, the quantitative phase, the model development integrated the ecological theory and the unified theory of behavior (UTB), viewing the family as a dynamic system close to preschool children. Informed by qualitative findings and effective interventions, the FSD-ADHD-BPA model was designed for ADHD at-risk preschool children and families, addressing their specific needs. The model included four key components: 1) developing early family skills for ADHD detection; 2) improving family skills to address behavioral issues; 3) promoting positive parenting through family-child interactions; and 4) monitoring progress. Implemented over eight weeks, the model involves pretest, posttest, and 6-week follow-up assessments. It serves as a tool for early detection by empowering the first-contact guardians such as FCGs, providing methods to address behavioral challenges in preschool children. The model also enhances FCG skills through positive interaction, emphasizing healthy relationships and effective parenting. With workshop training and resources, specifically a handbook, toys, and digital tools, the

model has high potential to enable FCGs to assess changes in family behaviors related to alleviating behavior problems in at-risk preschool children.

Activities within the FSD-ADHD-BPA model were carefully examined. Preschool children with ADHD have deficits in multiple functions, activity level impairments, and significant executive functions (EF) impairments (Biele *et al.*, 2022). Interactions with families and other members were enriched by "Being mindful-help-cognition-exercise" activities, including: 1) "Bottle of mindfulness" aimed to calm emotions and enhance emotional control through mindfulness, crucial for early learning (Jean, 2020); 2) "Talented person can help oneself" activity fostered memory, cognitive flexibility, and routines, essential to counter ADHD-related memory deficits (Irwin *et al.*, 2021); 3) "Think about what color" encouraged memory and discernment, using the Stroop-effect concept, crucial for cognitive development, especially in ADHD at-risk preschool children (Okuzumi *et al.*, 2015); and 4) "Exercise to keep pace with the colors" therapy was designed to improve inhibition, movement control, memory, and emotional regulation, aligning with exercise's benefits in ADHD management (Sun, Yu and Zhou, 2022). Preschool children's behaviors evolve with cognitive development, becoming curious about their surroundings and interactions as they learn (Piaget, 1976; Aytkaliyevna, 2023). Contextual encouragement also aids learning and behavior adjustment.

In the FSD-ADHD-BPA model, caregivers acquire practical skills for addressing behavior problems of preschool children through workshops and education on understanding ADHD risks. Health education and practical exercises facilitate positive parenting and EF development. Resources like the "Handbook for Developing Family Skills," "Being Mindful-Help-Cognition-Exercise," and the "Happy Family Awareness of ADHD" program applications provide practical assistance. Equipped with knowledge, caregivers willingly tackle behavioral problems (Lindsey *et al.*, 2013). Parent training in behavior management supports the idea that parent and family environments influence ADHD symptoms. Reducing parenting challenges and increasing access to resources may improve children's long-term developmental health (Claussen *et al.*, 2022). Positive family interactions, as indicated by studies, effectively decrease children's behavioral issues (Rincon *et al.*, 2018). Positive interactions between caregivers and children counter early ADHD (r=-0.58) (Taghizade *et al.*, 2022). Positive family parenting supports ADHD children, enhances family well-being, relieves stress, and improves overall care (Aghebati *et al.*, 2014).

Results from the quasi-experimental study showed that the FSD-ADHD-BPA model effectively enhanced the family functions of the FCGs, aiding them in better managing ADHD at-risk preschool children in northeastern Thailand. Notably, significant improvements were observed in the main effects from baseline (pretest) to posttest and 6-week follow-up in the experimental group. Specifically, significant effects were detected for total family functions (ηp^2=0.17) and family function subscales, such as problem-solving (ηp^2=0.26), with a medium effect identified for general functioning subscale (ηp^2=0.13).

Contrary to expectations, the results revealed no statistically significant main effect of the intervention model on behavior problems, behavior problem subscales, and EF and EF subscales among ADHD at-risk preschool children. Similarly, no statistically significant effects were observed in BABP and all BABP subscales among the FCGs, with all p-values exceeding 0.05. Additionally, significant interaction effects were noted between the assessment time and the group. These interaction effects indicated that 15.2% and 21.4% of the variation in error scores of the BABP and the BABP subscale, specifically positive interaction development, were attributed to the model intervention, demonstrating large effect sizes. However, the other variables, such as behavior problems and EF, along with their subscales, did not show significant improvement compared to those in the control group at the end of the intervention (posttest) and 6-week follow-up.

Although no significant interaction effects were observed between the assessment time and the group, within-group comparisons indicated significant improvements in the experimental group. These improvements were evident in total behavior problems ($p<0.05$, ηp^2=0.246), and all associated subscales, including hyperactivity/impulsiveness ($p<0.05$, ηp^2=0.252), and inattention ($p<0.05$, ηp^2=0.250). Notably, EF subscales such as cognitive flexibility ($p< 0.01$, ηp^2=0.415), total BABP ($p< 0.01$, ηp^2=0.379), and BABP subscale such as positive interaction development ($p<0.001$, ηp^2=0.519) and EF skill development ($p<0.01$, ηp^2=0.302), as well as total family functions ($p<0.05$, ηp^2=0.429), family function subscales, such as affective involvement ($p<0.05$, ηp^2=0.236), and behavior control ($p<0.001$, ηp^2=0.433), all significantly improved from baseline to posttest and the 6-week follow-up. These improvements, all with large effect sizes, suggest that, while the experimental group did not significantly differ

from the control group in the specified outcomes, the observed enhancements within the experimental group indicate promising potential for the FSD-ADHD-BPA model to achieve the desired study outcomes.

Our observed significant changes in outcomes through both between- and within-group comparisons, along with the identified interaction effects between the assessment time and the group, align with findings from many parenting intervention studies. Notably, an 8-week group-based behavioral parent training (BPT) intervention, carried out among 132 dyads of parent-ADHD at-risk preschool children aged 3-6 years, showed improvements in family functions, mirroring the results of our current study. However, the BPT intervention in the previous study also revealed additional significant improvements in peer and parental relationships, self-esteem, behavior, academic progress, and ADHD symptoms. These effects varied in size, from small to large (Risley *et al.*, 2020).

Based on a meta-analysis of 100 experimental studies spanning from 1980 to 2020 and focusing on children aged 2-12 years with behavior problems, parent-child interaction therapy (PCIT) demonstrated effective in treating issues such as disruptive, hyperactive, negative, and externalizing behaviors, showcasing large effect sizes (Valero Aguayo *et al.*, 2021). Additionally, in a randomized control trial titled "Incredible Years Parenting Intervention" (Overbeek *et al.*, 2021), which assessed immediate and long-term effects over a 2.5-year follow-up, involving 387 parent-child dyads (197 intervention, 190 control) with children aged 4-8 years experiencing conduct problems, through 15-week group sessions, parents learned relationship-building techniques, positive reinforcement methods, and non-violent discipline strategies to shift their focus from negative to positive child behavior. Results revealed that parents in the intervention group reported lower behavior problems in their children at a 2.5-year follow-up, with a medium effect size.

In this study, notable enhancements were observed among the FCGs in the control group, particularly in the BABP subscale focused on positive interaction development ($p<0.05$, $\eta p^2=0.246$), as well as in total family functions ($p<0.05$, $\eta p^2=0.269$), and family function subscale of affective involvement ($p<0.05$, $\eta p^2=0.237$). These improvements were significant, implying that the standard care services provided by the Child Development Clinic (CDC) in a Hospital Outpatient Department could have influenced the observed changes among FCGs in the control group. Furthermore, the progress in BABP and family functions within the control group could be attributed to an increased ability to foster positive interactions with their children, as highlighted by the FCGs in phase 1. These outcomes could be linked to external factors or heightened awareness of positive parenting practices.

There are limitations in this study that should be acknowledged. The unified theory of behavior underscores self-efficacy as a key factor influencing family caregivers' (FCGs) practices in addressing behavior problems and managing family functioning. Nevertheless, factors such as income and marital status may either hinder or motivate family caregivers in addressing behavior problems among preschool children. The duration of model implementation and follow-up might not have been sufficiently long to initiate or sustain desired behavioral changes. Despite this limitation, the study utilized a control group and conducted repeated measures analysis of variance, enhancing the applicability of the results to ADHD at-risk preschool children and families in similar sociocultural contexts.

While existing literature often reports a higher prevalence of boys affected by ADHD. our study recruited a higher proportion of girls in the at-risk group. However, researchers employed the matching technique to assign participants to experimental and control groups, ensuring data to maintain comparable conditions between groups.

This study introduces a model that improves family caregivers' capacity to recognize ADHD symptoms in at-risk preschoolers. Early detection helps minimize potential mental health effects on children, enabling caregivers to adapt and find suitable solutions for families and society. Utilizing assessments from different sources, such as teachers or health volunteers, can enhance accuracy. Researchers should collaborate to identify barriers hindering specific groups from adopting desired behaviors, with the goal of tailoring solutions to individual family needs and challenges.

Conclusion

The FSD-ADHD-BPA Model helps families in modifying and enhancing their functions and behaviors to alleviate behavior problems in ADHD at-risk preschool children. The observed improvements in the experimental group, including total behavior problems and specific executive function (EF) subscales, such as inhibition and cognitive flexibility, make the FSD-ADHD-BPA a promising parental intervention model. It shows potential for establishing healthy families while reducing troublesome behavior problems in ADHD at-risk

preschool children, not only in northeastern Thailand but also in regions with similar sociocultural contexts.

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Authors' contributions

KK and PH developed the research design. KK collected and analyzed the data. PH and KK wrote the first version of the manuscript. Both authors contributed to writing and completing the manuscript.

Conflicts of interest

The authors have no conflicts of interest.

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Disclosure statement

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