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Women in psychiatry ADHD 2023

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Women in psychiatry 2023: ADHD

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Editorial: Women in psychiatry 2023: ADHD

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Editorial on the Research Topic
Women in psychiatry 2023: ADHD

ADHD is a common neurodevelopmental condition affecting all ages (1, 2). It is associated with elevated risk of various co-occurring conditions, educational, occupational and social difficulties (3). In the last two decades recognition and treatment of ADHD has increased (4, 5) resulting in long waiting lists and treatment delays, making ADHD an unmet health need (6). Within this context, gender inequalities also exist with women waiting four years longer for diagnosis (7) and calls for research to consider female reproductive hormones (8). One factor that may contribute to this inequality is low representation of females in ADHD research (9). It is therefore timely that this Research Topic showcases research by women into ADHD.

Understanding the impact of ADHD

The impact of ADHD is explored in the review by French et al. who summarize three key risk domains: mental health, physical health, social and lifestyle factors. Mental health outcomes consistently associated with ADHD include increased rates of addictions, self-harm and suicidality, psychiatric and personality disorders and poor self-esteem. The authors suggested that emotional dysregulation may contribute to the overlapping conditions along with impulsivity, which may play a role in completed suicide and self-harm. However, they emphasized that further research is needed to determine whether outcomes associated with poor mental health arise as comorbidities which only emerge at specific points in life or whether ADHD is a precursor to and risk factor for poor mental health. Physical health outcomes associated with ADHD include poor sleep and oral health, obesity and higher risk of accidents and injuries, and various diseases, further demonstrating the burden experienced beyond the direct effects of ADHD. French et al. noted that the research for sleep lacked use of objective measures and that there was potential for a vicious circle to be created where poor sleep increased ADHD symptom expression and how improving sleep might benefit core symptoms. The poor oral health in ADHD was associated with the core symptoms of the condition, because those with ADHD

are more impulsive and impatient which may lead to poor teeth cleaning, along with consumption of more sugary food. Consumption of sugary food was not, however, linked to obesity in ADHD which appeared to be mediated by poverty, although the authors noted a need to develop more understanding of how the core symptoms of ADHD impact eating habits. The review outlined the type of accidents and injuries that typically occur but did not link these specifically to the core ADHD symptoms, although one could speculate that these play a role e.g. inattention and impulsivity may increase the risk of car accidents, which are greater in adults with ADHD. In terms of the diseases, a range of different conditions were identified as associated with ADHD including migraine and chronic pain. Mechanisms were not explored. For lifestyle and social factors strong links were evident between ADHD and criminality, poor educational attainment, relationship difficulties, and risky behaviours like driving-related incidents. For criminality, the authors reported that several reviews noted that ADHD was associated with criminal behaviour, offending and incarceration, but there was also a greater risk of those with ADHD being the victim of intimate partner and sexual violence. It is suggested that criminal activities reported are likely to have an impulsivity component, linking to the core symptoms of ADHD, and that different comorbid conditions such as Conduct Disorder may also play a role, suggesting that effectively treating these symptoms and comorbidities would reduce criminal outcomes. The authors noted that poor educational and occupational outcomes were associated with ADHD, especially when it was left untreated, and made a call for urgent research to be conducted into what support was effective for children with ADHD at school and adults in the workplace. The authors suggested that the difficulties in social relationships (peer and intimate) may be partially mediated by comorbid conditions such as Conduct Disorder which could result in social cognition difficulties. The risk-taking behaviours reviewed included those that linked to the early section on accidents and injuries e.g. driving outcomes, but this section included generally lower quality reviews, resulting in the authors emphasizing the need for further research and consideration of co-morbidities. Perhaps unsurprisingly given the various associations identified, ADHD was also consistently linked to reduced quality of life. In summary, this review emphasizes the wide implications of ADHD and the need for whole-person treatment approaches, which consider co-occurring conditions and tailored interventions. By identifying these risks and impairments, French et al. lay the foundations for future research to improve the negative outcomes associated with ADHD.

Improving understanding: tools to enhance clinical practice

Two studies in this topic have the potential help further understand ADHD and inform clinical practice. Firstly, Kochhar et al. address a key challenge in differential diagnosis, specifically distinguishing between ADHD and Autism Spectrum Disorders (ASD), using visual attention to social stimuli. They report that children with ASD (with or without comorbid ADHD) show reduced fixation to faces compared to children with ADHD alone. In addition, this fixation duration negatively correlated with severity of communication and repetitive stereotypy symptoms. This suggests that assessing visual attention to social cues might assist clinicians when considering diagnosis of ADHD and ASD. Secondly, Skliarova et al. explore self-efficacy in ADHD; a psychological protective factor thought to be reduced in the condition. Examining the applicability of a shortened version of the General Self-Efficacy scale in adults with ADHD, they report satisfactory content validity and good psychometric properties as well as positive correlations between self-efficacy and general well-being. This research offers the possibility of easily evaluating self-efficacy in adult ADHD, which could provide insights into mental health and well-being.

Managing ADHD: parents, experience, efficacy, and personalisation

The importance of multidisciplinary treatment, including parental interventions, is widely recognised (10). Behavioural parent training (BPT) provides parenting strategies to promote desirable behaviours and minimise unwanted ones in children with ADHD. Despite effectiveness, access to BPT is limited (11). Bado et al. conducted a needs assessment to understand the experiences and treatment needs of families with children showing ADHD symptoms in Brazil. Semi-structured interviews with parents, educators, and healthcare providers revealed several themes: parents often reported minimal involvement in their child's psychotherapy; a few parents learned behavioural management strategies from healthcare providers; many parents desired practical information on managing their children's behaviours daily and managing their stress when children did not follow directions. Furthermore, some parents and professionals suggested families would benefit from learning more about ADHD and practical parenting strategies. A second article on parenting emphasizes how ADHD symptoms in adults could interfere with parental functioning. In this paper Miklósi et al. highlight the importance of parental cognitions on child development and present a meta-analysis of 15 high-quality studies exploring the relationship between parental ADHD symptoms and parental cognitions. They found that parents with higher ADHD symptoms reported more negative cognitions. Their results suggested that stressful childrearing may trigger dysfunctional cognitions which results in a negative perception of the parental role, the child and co-parenting. Repeated parenting difficulties can then exacerbate parental stress and negatively impact parent-child relations. Addressing dysfunctional parental cognitions is therefore crucial in parents with ADHD symptoms. This work also highlights the need for multi-method, multi-informant research to better understand and support parents with ADHD.

Two articles focus on different approaches to managing ADHD. William et al. investigate Cognitive Behavioural Therapy (CBT), a recommended and well-established approach (12). They present

mixed methods research incorporating a survey and interviews, which were thematically analysed to show that individuals with ADHD may find CBT a negative experience when it is not tailored to ADHD, creating an unhelpful and overwhelming experience. Guimarães et al. examine the novel approach of transcranial direct current stimulation (tDCS) for ADHD, an approach that has shown some promise in preliminary research. In a triple blind study, they found no improvement in attention, working memory or response inhibition. The authors acknowledge limitations of the work, but the robust design presents a convincing argument for ineffectiveness.

The final two studies in this topic speak to the aforementioned gender inequality. Firstly, de Jong et al. present a case study exploring the effects of adjusting stimulant medication in the premenstrual week. Building on research indicating that stimulants are less effective in the luteal phase, they increased medication for nine women with ADHD by 41% on average. Women reported improvements which brought this week into alignment with others for symptom experience. The authors call for further work investigating this and consideration of hormones more broadly to support a personalised approach. Secondly, work by Praus et al. examined responsiveness to telemedicine, an approach that could reduce the crisis in ADHD care. They examined the characteristics of those who responded differently to this approach and revealed that those with higher depression scores, females and those living with children had a poorer outcome, again reinforcing the need to consider individual factors to optimise treatment. All articles in this topic point to the need for more research to ensure a deeper understanding of, and appropriate personalised management for, ADHD.

Author contributions

AB: Writing – original draft, Writing – review & editing. NF: Writing – original draft, Writing – review & editing. JF: Writing – original draft, Writing – review & editing. ED: Conceptualization, Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Needs assessment for behavioral parent training for ADHD in Brazil

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Introduction: Attention-Deficit/Hyperactivity Disorder (ADHD) is a debilitating condition affecting children and their families worldwide. Behavioral parent training is a recommended form of empirically supported non-pharmacological intervention for young children with mild to moderate ADHD. However, access to such treatment is limited in many countries. Here we identify the treatment needs of Brazilian families with children demonstrating symptoms of ADHD, and the barriers families face in accessing behavioral treatment.

Methods: A qualitative needs assessment was undertaken with parents (n = 23), educators (n = 15), and healthcare providers (n = 16). Semi-structured telephone interviews were conducted, and common themes were identified through inductive coding of participants' responses.

Results: Participants reported a lack of accessible behavioral treatment, and delays in accessing treatment when available. The majority of parents had not received behavioral parent training, despite it being a recommended form of treatment. Parents, educators and healthcare providers strongly endorsed a need for practical tools to manage the behavior of children with ADHD.

Conclusion: Existing services might not meet the needs of children with ADHD and their families in Brazil. Easily accessed behavioral parent training programs are recommended to address the identified treatment gap for Brazilian children with ADHD and their families.

KEYWORDS

ADHD, parent training, behavioral treatment, needs assessment, Brazil

1. Introduction

The availability of mental health treatment for children is limited worldwide, especially in low and middle-income countries (1). This is certainly the situation in Brazil. A recent study showed that in two large cities in southern Brazil, 80% of children who need mental health interventions do not receive them (2); the rate is likely even higher in other parts of the country with fewer resources. A lack of trained professionals and infrastructure has been identified as the main reasons for such unmet needs (3, 4). These figures reflect institutional service use across the range of neurodevelopmental and psychiatric disorders. Little is known about the *individual experiences* of families using or attempting to access support for their children.

Such unmet treatment needs are exemplified by Attention Deficit and Hyperactivity Disorder (ADHD), a common neurodevelopmental disorder with a reported prevalence ranging from 2% to 7.6% (5–9). Recommended treatments include medication and psychosocial

interventions. In Brazil, the most readily available treatment is pharmacotherapy; however, the published research indicates that less than 20% of children with ADHD are prescribed medication for symptom management (10). Little information is available regarding access to, and use of, empirically supported non-pharmacological interventions for ADHD (11).

Internationally, empirically supported behavioral parent training (BPT) (12, 13) alone, or in combination with other psychosocial treatments, e.g., classroom management or child skills groups (14), is recommended in the management of mild to moderate ADHD in children. A tiered approach is available and recommended in some countries; for example, group parent-training (for young children) and the provision of information about ADHD (causes and impact) together with parenting guidance and school liaison (for school-aged children), prior to more intensive individualized BPT.[1] BPT teaches parenting strategies to encourage appropriate behavior and reduce undesired behaviors in children (15). Strategies include communicating with children in ways to increase behavioral compliance, and when and how to reward children for desired behavior to increase the likelihood of it being repeated (16). To the best of our knowledge, access to BPT in Brazil is currently very limited, with the most commonly available non-pharmacological intervention being psychoanalysis, especially in public health services (11). It is also unclear whether Brazilian parents would be motivated to take part in BPT if available.

Missing from the literature on the management of ADHD in Brazil is an understanding of the *self-reported* needs of families of children with ADHD. To address this gap, we undertook a qualitative needs assessment with the aim of identifying barriers to Brazilian families accessing psychosocial interventions, especially behavioral treatment, as well as the desired content of such support and the preferred mode of delivery. The current study focused on the first-hand experiences of adults who care for children with ADHD (17) to inform the development of an accessible BPT program, delivered online. Semi-structured interviews were conducted with parents of children with ADHD, as well as educators and healthcare providers working with these families. Interviews explored (1) experiences of seeking/providing support for children with ADHD to understand the barriers to accessing treatment and (2) information and support families currently have, need, or want. Based on their responses, common themes were identified. By incorporating the voices of parents and professionals (18), we hoped to determine whether behavioral management training would be appropriate for, and accepted by, Brazilian families and how such skills could be delivered (19, 20).

2. Methods

The project was reviewed and approved by the IDOR ethics committee (CAAE: 39967020.8.0000.5249). All participants were volunteers and provided written consent.

2.1. Participants

2.1.1. Parents

Participants were parents of children previously diagnosed with ADHD by their physicians (78%) or demonstrating elevated symptoms of ADHD. The presence of comorbid conditions in the children did not exclude participation. The final sample comprised 23 parents (19 mothers, 4 fathers) with children aged 4 to 16 years, 30% girls. Most of the children received education (74%) and healthcare (78%) from the private sector. The participating families were mostly middle-class (ABEP classes B and C) (21), with the parents' years of education ranging from 10 to 20 years.

2.1.2. Educators and healthcare providers

Professionals participating in the study included 15 educators [6 education specialists (usually referred as pedagogues in Brazil), 5 teachers, 2 school principals, 2 school counselors/psychologists; 6 working in private, 6 in public and 3 in both settings], and 16 healthcare providers (5 psychiatrists, 5 psychologists, 3 speech therapists and 3 pediatricians, 7 working in private, 3 in public and 6 in both settings).

2.2. Procedures

Participating parents were recruited through three websites.[2] This sampling method was chosen to mirror the recruitment strategies for the planned online BPT program; i.e., participants in the current study would be similar to those expected to enroll in the online intervention. Parents expressing interest in participating were asked to complete the SNAP-IV, a widely used ADHD rating scale (22, 23), prior to taking part. Those reporting that their child frequently displays 6 or more symptoms of inattention and/or hyperactivity/impulsivity were invited to participate.

Professional participants (educators and healthcare providers) were recruited via existing professional contacts of the researchers, making sure that they represent diverse disciplines and those working in private and public sectors and serving socioeconomically diverse families. No screening procedures were included for professionals wishing to participate.

Prospective participants were sent an online consent form via Whatsapp. Upon completion of the consent form, they were contacted by the researchers to schedule a phone interview. Interviews were conducted from January to June 2021, by a team of three post-doctoral and -masters researchers, under the supervision of a senior psychiatrist (PM). The interviews lasted from 30 min (with professionals) to 1 h (with parents). Interviews were recorded and later transcribed.

Interviews with parents and professionals included questions addressing: (1) experiences of, and barriers to, families accessing psychosocial, in particular behavioral, treatment for ADHD; (2) parents' level of knowledge about ADHD, comorbid conditions and treatment options (for professionals, this referred to the knowledge of

1 https://www.nice.org.uk/guidance/ng87/chapter/Recommendations#managing-adhd

2 www.habitepais.com.br; https://www.rededorsaoluiz.com.br/instituto/idor; https://tdah.org.br/

the parents they interact with); and (3) information and support parents want and need to better assist their children and manage their children's ADHD symptoms. Parent interviews also included questions about the parenting strategies they currently use, difficulties experienced in managing their children's behavior, challenges experienced during the COVID-19 pandemic, and sources of information they access to learn about ADHD and parenting. Interview questions are presented in the Supplementary material.

An inductive coding strategy was used to explore narratives emerging from the data. Two rounds of coding were carried out using Delve software.[3] One of the researchers (PB) completed initial coding using a combination of *in vivo* coding (using participants' own words) and structural coding (codes limited by the topics introduced in the interview questions). Consistent with the goals of the study, the coder looked for words and phrases that indicated (1) experiences of and barriers to families accessing behavioral treatment, (2) information parents currently have, difficulties they and their children experience, and strategies they use, and (3) information and support families need and want, and the preferred modality for accessing them. Given the interviews were conducted during the COVID-19 related restrictions, the researcher separately coded pandemic specific responses, in terms of the difficulties families experienced with their child's behavior and accessing care. The codes generated through this process were organized into main categories and subcategories. Two additional researchers (RC, CB) subsequently reviewed the data. The three researchers discussed edits and additions to the codes until they reached consensus (see Supplementary material for the categories and main categories identified). Next, the primary coder carried out thematic analysis to identify common themes based on the codes that were frequently referenced in participants' responses. Research team members (PB, RC, CB, EF) discussed these themes until they reached consensus. There was no criteria as to the minimum number of participants mentioning a theme for the theme to be identified. Rather, efforts were made to create themes that are inclusive of participants' responses. These themes are presented in narrative form in the Results.

3 https://delvetool.com/

3. Results

Table 1 presents participant characteristics. While efforts were made to recruit parents of children receiving healthcare from the public and private sectors, with diverse socioeconomic backgrounds, the participants were mostly middle class and accessed healthcare from the private sector. This likely reflects the fact that the parents learned about the current study online and volunteered to participate; thus they were parents with greater access to resources. Efforts to recruit professional participants in different roles, who work in public and private sectors servicing diverse families, were more successful.

Qualitative narratives, generated based on the common themes identified via inductive coding, are presented below. The percentages of participants whose individual responses fit within these themes, and final codes and exemplar responses associated with the themes are presented in the Table 2.

TABLE 1 Participant characteristics.

	Parents		
	(*n* = 23)		
	M	SD	Range
Parent education (years)	16.9	2.9	10–20
Mothers *n*	19 (82%)		
Income (ABEP) class[a] *n*	A and B1 7 (30%), B2 7 (30%), C1 and C2 9 (40%)		
Services in private sector *n*	Health 18 (78%), education 17 (74%)		
Child's age (years)	9.3	2.8	4–16
Child with ADHD diagnosis *n*	18 (78%)		
SNAP inattention sum	21.4	3.1	15–27
SNAP hyperactivity/impulsivity sum	18.7	6.3	0–27
	Educators		
	(*n* = 15)		
Professional role *n*	Educational specialist 6 (40%), teacher 5 (33%), school principal 2 (13%), school counselor/psychologist 2 (13%)		
Services in private sector *n*	6 (40%) + 3 (20%) in both		
	Healthcare Providers		
	(*n* = 16)		
Professional role *n*	Psychiatrist 5 (31%), psychologist 5 (31%), speech therapist 3 (19%), pediatrician 3 (19%)		
Services in private sector *n*	7 (44%) + 6 (38%) in both		

[a]ABEP social economic strata based on average household income estimation (A and B1 > 10, B2: 5–10, C1: 3–5, C2: 1–2 x minimum wage).

TABLE 2 Codes and exemplar responses associated with the final themes generated from the needs assessment interviews, and the percentage of participants whose individual responses referenced each theme.

	Themes	Participants (%)	Codes	Exemplar responses
Barriers to accessing psychosocial treatment				
Difficulty obtaining a diagnosis prior to accessing treatment (as identified by parents and professionals)				
Parent	Takes a long time to receive an appropriate evaluation/diagnosis	74%	Months to see specialists for an evaluation	*"After a pediatrician, took 3 months to see a neurologist who told me to see a psychiatrist, which took 5 months. Still waiting for a psychologist to do a test."*
			Multiple professionals for a diagnosis (with long waits between appointments)	*"They all had different diagnoses for my son."*
	Waiting until recommendation/ pressure from school to get a diagnosis	57%	Sought a diagnosis after school suggestion	*"I knew my daughter was struggling, but I thought was just the phase. I talked to a doctor after school made me."*
			Hesitation due to possible discriminations (if diagnosed)	*"It's hard for me to accept."* *"I worry that she will not be able to stay in school."*
Educator	Parents' difficulty seeking, accepting, or sharing a diagnosis	93%	Long time between notifying a concern and family receiving a diagnosis	*"There are many families that are ashamed."* *"Some families are slow to accept the child has difficulties."* *"Families are afraid that children with ADHD will not be able to learn."*
			Difficulty seeking a diagnosis (financial, motivation, concern over medication)	
			Difficulty accepting child's difficulties or diagnosis	
			Hesitancy with 'disorder' label by families and professionals due to stigma	
			Families hiding a diagnosis	
Healthcare	Parents' difficulty seeking, receiving, or accepting a diagnosis	35%	Parents unable to identify child's difficulties	*"Instead of going to a doctor, families look for educational professionals for a diagnosis."* *"They think that the symptoms will disappear with time and that it is a learning problem."*
			Parents/schools not seeing ADHD as a clinical disorder	
A lack of availability of behaviorally oriented treatments, in particular BPT (as identified by parents and professionals)				
Parent	Has had difficulty receiving any non-pharmacological treatment	52%	No availability of professionals taking health insurance	*"It's a struggle to find professionals who takes health insurance."* *"There is a lack of specialists. When I find them, they do not have openings."*
			A lack of professionals or high-quality services	
			Difficulty getting to treatment due to a lack of transportation (e.g., bus fare)	
	Child has received some type of psychotherapy (vs. not)	43% (57%)	Psychotherapy (incl., CBT, general 'therapy', child plays a game with therapist)	*"My child had therapy - he played games and did drawings"* *"The therapist would talk to my child, but not sure what."*
	Parent involved in child's treatment (vs. not)	9% (91%)	Meet with a child's therapist regularly	*"The therapist usually meets with my child but talks to me sometimes."*
			Received some advice from professionals	
	Parent has received behavior management training (vs. not)	9% (91%)	Any mention of receiving behavior management or parent training	*"Yes, I participated in behavior management training."*
Educator	Families have difficulties accessing behavioral health care	86%	Parents do not have financial resources to pay for treatment	*"We can convince the families to look for help, sometimes manage to get an appointment at a clinic that accept public health insurance, but then families do not have money for bus ticket to get there."* *"For many families, getting food is their priority, and they do not think attending to the child's behavior problem is not that important."*
			Parents do not recognize the need for treatment (thus do not seek treatment)	
			Lack of appropriate and affordable services	
			Parents/families do not have time to attend treatment	
			Families do not have transportation to attend treatment	
Healthcare	Families have difficulties accessing behavioral health care	100%	Parents do not have financial resources to pay for treatment	*"Specialists do not have appointments available, till many months ahead."* *"They go to a doctor, who barely evaluates and gives medication that's free through public insurance - risperidone instead of Ritalin."* *"Parents go to 'psychopedagogues' for help, without knowing they specializes in learning problems."* *"Many ask about phytotherapies and homeopathy."* *"Parents do not accept the diagnosis and say, 'in my time there was no such thing' [as ADHD]."*
			Have never been offered other types of treatment than medication	
			Parents interested in medication only (due to lack of information on/availability of other interventions)	
			Lack of services in public health care settings	
			Parents do not recognize the need for treatment (thus do not seek treatment)	
			Lack of knowledge about what treatment is appropriate for ADHD	
			Parents/families do not have time to attend treatment	
			Families do not have transportation to attend treatment	

(Continued)

TABLE 2 (Continued)

	Themes	Participants (%)	Codes	Exemplar responses
Information parents want/need to better support their children				
Difficulties children experience (as identified by parents)				
Parent	ADHD-specific behavior difficulties	96%	Inattention	*"My child lacks focus and forgets what he was doing in the middle of the task."* *"He runs around and talks a lot - cannot sit still during a meal."* *"Does things without thinking. When we talk about it he knows what he did wrong, but then does it again."*
			Hyperactivity	
			Impulsivity	
	Emotional difficulties	43%	Irritability/emotional outbursts	*"My child is very emotional."* *"He gets hurt very easily." "He is very insecure."*
			Anxious/sensitive	
			Cries often	
	Learning/school difficulties	74%	Difficulty completing homework	*"It takes long time to do homework."* *"My child has problems at school, especially with writing."*
			Writing difficulties	
	Social difficulties	61%	Shy	*"My child gets angry at her friends with little things, and does not want to play with them anymore."* *"He is very happy, and sometimes over the top - this drives people away."*
			Difficulty making friends/getting along with others	
			Difficulty with social communication	
	Non-compliance/needing to repeat directions	30%	Do not follow rules/comply with directions	*"I have to repeat fifty thousand times and he still does not listen."* *"He never closes the door, never brings his towel to the shower - I told him so many times."* *"His opposition to rules is very stressful."*
			Repeat directions over and over	
			Frequent reminders required	
	Struggle with daily routines	65%	Difficulty starting homework	*"We argue about homework all the time - he procrastinates."*
			Difficulties during meal, bath, and bedtime	
Difficulties parents/families experience (as identified by parents)				
Parent	Disruption on family relationship	48%	Disturbs other family members' mood and everyday life	*"My child is loving, but his impulsivity disturbs the peace of the family."* *"He needs constant attention - wants to talk and show us things all the time."* *"His brother does not understand him - gets annoyed and fights with him a lot."* *"I do not have a social life anymore. We cannot even go to church because he will not sit still."*
			Frequent arguments	
			Constantly require parental attention (parents cannot do other tasks)	
			Cannot go out due to child's behavior	
	Parents experiencing stress	82%	Emotional burnout/exhaustion/despair	*"I cannot take it anymore."* *"I'm exhausted."* *"I sometimes think I'm horrible - it's not the way I was raised"* *"I have no escape valve at all, it's very hard."* *"Nobody takes care of me, it's hard."*
			Frustration	
			Insecurity/feeling lost	
			Guilt/frustration about self	
			Feeling sad/crying	
Information parents want/need to (as identified by parents and professionals)				
Parent	Knowledge about ADHD	52%	When and how ADHD is diagnosed/subtypes are determined (impulsive, inattentive or both)	*"We know that he has ADHD, but do not know exactly what ADHD is and how it is different from a disobedient child."*
			Which behaviors due to ADHD or something else (lack of interest, stubborn)	
	How to manage child's behavior	70%	Creating/dealing with everyday routine	*"We want practical information - on how to approach and deal with my child."* *"I want something simple - like how I can get my child get started on homework."*
			Dealing with child's frustration	
			Reducing screen time	
			Help child engage in homework	
	How to manage own behavior/ responses to child	60%	Do not know how to act/react to the child	*"When you as a parent lose your limit, what do you do?"* *"I get stressed and angry - do not know what else to do to get my child's attention."* *"I'm afraid to praise - it could have negative effects."*
			Managing own stress	
			Scream less	
			Be more patient	
			How much to praise the child	
	How to deal with other difficulties	78%	Help with learning/academics	*"I do not know how to help my child with his schoolwork."* *"My biggest concern is that if he does not learn how to deal with these symptoms, he will not be able to take care of himself as an adult."*
			Child cleaning/organizing their room	
			Communication with school	
			Protecting the child from stigma/discrimination	
			Concerns for future	

(Continued)

TABLE 2 (Continued)

	Themes	Participants (%)	Codes	Exemplar responses
Educator	Knowledge about ADHD	80%	How to identify ADHD	*"Parents need to know how to support their child outside school."* *"Parents need to understand that treatment takes time, and the child will need support throughout much of their school life."*
			Appropriate treatment	
			Differential diagnosis	
			Long-term consequences	
	How to assist their child	67%	Establishing daily routines	*"Parents need to know how to organize things at home and set up a routine."* *"Parents need to understand that a child with ADHD needs help, cannot do things alone."*
			Using positive reinforcement/praise	
			Practical parenting strategies	
			Learning strategies appropriate for the child	
Healthcare	Knowledge about ADHD	70%	Understanding ADHD	*"Families need to really understand what a child with ADHD is like."* *"We see a lot of ADHD children with parents thinking they are autistic."* *"Parents are worried about ADHD treatment, because they think medications are addictive, are used at parties and can kill the child."*
			Differential diagnosis	
			Difference between a clinical disorder and child's personality, motivation, will.	
			Reduce prejudice about ADHD and other diagnosis	
			Information about medication	
	How to assist their child	47%	Improve daily structure and organization	*"Parents need to learn how to react to their child and how to help the child differently."* *"Parents need to listen to how the child feels and build trust."*
			Improve parent–child interaction/communication	
Current parenting strategies employed (as identified by parents)				
Parent	General use of praise	78%	Praise often	*"Oh, I always praise him. I tell him you are wonderful, you are smart and all that."*
			Tell child 'I'm proud of you', 'good boy' etc.	
	General use of tangible rewards	17%	Buy things for good behavior	*"I buy him ice cream sometimes."* *"When he does something well, he asks for a toy, if it's in my budget, I buy it."*
	Selective use of positive reinforcement for appropriate behavior	4%	Use 'positive reinforcement' for specific behavior	*"It is amazing how well he responds to positive reinforcement."*
	Use of stimulus/environmental control	13%	Reduce distractions	*"Always try, when he has schoolwork, to take away stimuli, try to put him in a quieter place, away from the door and window."*
	Use of prompts	8%	Warnings and reminders	*"What I have learned in my daily life, which was a tip from the teacher, is how to give the command."*
	Organize environment	35%	House rules	*"I tell him to write down things he does not want to forget."* *"Try to have him use checklists and cell phone alarms."*
			Checklists	
			Notebook for reminders	
	Talk to the child	56%	Explain consequences	*"Usually, we try to explain what's right and what's wrong."* *"I tell him about consequences, like what happens when he does not do homework."*
			Explain that they have to do what's required of them, what's important	
			Explain how the child's behaviors make them (parents) feel	
	Negative punishment (take things away)	26%	Take away cell phones, video games	*"Sometimes I threaten him -'if you continue like this, I will take away the cell phone and video game'."*
	Negative punishment (time out)	13%	Give time out	*"I make her stand still and think for 5 min."*
	Negative punishment (grounding)	26%	Ground	*"I ask her to reflect and, depending on her behavior, I ground her."*
	Positive punishment (raised voice)	34%	Yell, scream at child	*"We end up yelling and fighting with him trying to show him that he is wrong."*
	Positive punishment (physical)	13%	Slap on the hand or in other parts of the body	*"Give a few slaps on the butt."* *"She cries, she hits, then I slap her too."*
	General strategies improve mood, family relationship	43%	Try to have fun together as a family	*"We are trying to connect better with him."*
			Provide care/tenderness	
Difficulties during COVID (as identified by parents)				
Parent	Treatment disruption	30%	Treatment interrupted	*"The therapist stopped treatment in person when the pandemic hit last year."* *"We are waiting for a psychologist to come back after this pandemic to do the test with him."*
			Difficulties with online therapy	
			Cannot start treatment	

(Continued)

TABLE 2 (Continued)

	Themes	Participants (%)	Codes	Exemplar responses
	Increased difficulties/challenges of child	57%	Behavior regressed	*"He got worse during the pandemic."*
			Increased screen time	*"He has so much energy from being home and is out of control."*
			Decreased social contacts, extracurricular activities	*"I get stressed seeing him on the computer and cell phone all the time."*
	Increased parental stress	70%	Increased child-care responsibility	*"Making him pay attention to online classes is very stressful."*
			Disruption in daily routines	*"He cannot do online classes on his own, then I cannot do my work."*
			Decreased patience	*"The pandemic made it difficult for us to get along with each other."*
Sources and contents of online information accessed (as identified by parents)				
Parent	Sought information online on their own or after recommended by professionals	61%	Professional websites	*"I look for Instagram groups to try to understand my child's condition."*
			Google	*"I looked at the ABDA website and found some articles and books."*
			Instagram	*"I try to look around for information online. I feel that doctors and researchers know a lot, but it's not being passed on to those who really need it."*
			YouTube videos	
			WhatsApp parent groups	
	Access online information from computer	52%	Computer	
	Access online information from phone	100%	Phone	
	Difficulties finding practical information online	74%	Difficulty finding online information about practical strategies	*"I follow several websites that gives information about the disorder, but I already know all that. It's harder to find information that helps me with my child's everyday behavior."*

3.1. Barriers to accessing psychosocial interventions

Two major barriers to access were identified: (1) difficulty obtaining a diagnosis prior to accessing psychosocial interventions, and (2) a lack of availability of behaviorally oriented treatments, in particular BPT.

Many parents (57%) reported that school personnel initially raised concerns about their child's behavior, with parents seeking a diagnostic evaluation prior to receiving any treatment. Parents (74%) noted a long delay, and/or needing to see multiple professionals, before obtaining a diagnosis. The reports of educators (93%) and healthcare providers (35%) also reflected delays in children receiving a diagnosis, but also in parents seeking and then accepting their child's diagnosis. The responses of both parents and professionals were indicative of perceived stigma contributing to the delay in obtaining a diagnosis and subsequent treatment. Healthcare providers noted that parents are often afraid of their child receiving a diagnosis, believing that ADHD is like severe Autism Spectrum Disorder and their child would be excluded from regular education.

The responses of parents (52%) and professionals (86% educators and 100% healthcare providers) also indicated a lack of quality and affordable non-pharmacological services. Among the parents interviewed, while almost half reported their child had received some form of psychotherapy, most indicated no or minimal parental involvement in the treatment (i.e., treatment consisting of a child meeting with a psychologist/psychoanalyst alone). One parent indicated learning behavioral management strategies from professionals involved in the child's care, and another reported meeting regularly with the child's psychologist. Two parents reported they received, or were planning to participate in, behavioral management training. Both educators and healthcare providers raised concerns that parents often do not recognize the need for treatment or lack knowledge regarding appropriate treatment for ADHD.

While parents and professionals generally agreed that barriers to treatment access exist and are problematic, parents' responses focused on the lack of availability while professionals' responses focused on parents' reluctance in seeking and accepting support.

3.2. Information parents have and want/need to better support their children

The responses of both parents (52%) and professionals (58% educators and 70% healthcare providers) indicated that parents would benefit from having a better understanding of ADHD and its comorbid conditions. In particular, while correctly identifying the symptoms of ADHD and listing behaviors associated with the disorder (96%), parents struggled to identify which of their children's behaviors are due to ADHD, a comorbid condition, the child's personality or a lack of motivation. They reported a wide range of difficulties (43% emotional, 74% learning/school, 61% social difficulties, 30% non-compliance, and 65% daily routines). Healthcare providers further reported that many parents believe ADHD is a learning problem and look for a diagnosis and assistance from educational specialists, rather than doctors or psychologists. Educators reported confusion amongst parents regarding their child's difficulties and needs, also noting some avoidance by healthcare providers to use diagnostic labels.

The majority of parents (70%) referenced the need for information on how to manage their child's behavior, as well as their own behavior and emotions when interacting with their child (60%). They elaborated that their child's behavior negatively affected family relationships and that they experienced significant stress. They wanted to know how to make everyday routines easier and more pleasant, with fewer arguments and less frustration. Parents (78%) also noted wanting information on how to assist their child's learning and organizational difficulties, how to communicate their concerns to their child's school,

and how to prevent their child from experiencing future hardships and being discriminated against. Educators (67%) identified the importance of providing parents with practical strategies on how to assist their child at home. Healthcare providers (47%) reported that families would especially benefit from support to increase structure and to improve communication in the home.

Overall, parents and professionals seemed to agree on the need for parents to have a clearer understanding of factors that contribute to the child's behavioral difficulties and how to address them. However, even amongst professionals, there may not be consensus as to the specific nature of these difficulties.

3.3. Current parenting strategies employed

Parents were also asked about how they currently manage their children's behavior. One parent was well informed about behavior management techniques consistent with those taught in BPT programs, but others reported having very little knowledge about how to support their children beyond common, generic parenting strategies (e.g., being positive with my child). Many parents reported using rewards, such as praise (78%), food and toys (17%), for good behavior. However, the use of praise was usually non-specific, and some parents questioned the appropriateness or effectiveness of such rewards for behavior management (4% reporting selective use of positive reinforcement for appropriate behavior). Other strategies reported included talking to the child about their behavior (56%) and implementing consequences, e.g., taking things away (26%), and using time out (13%) or grounding (26%). Raising voices (yelling/screaming) was not uncommon (34%), while some reported hitting their child (13%). Many parents noted continued difficulties in managing children's behavior despite trying multiple strategies.

3.4. Difficulties during COVID-19

Interviews took place during the COVID pandemic when most schools were closed. Treatment and evaluation services were also interrupted during this time (30%). Parents reported increased behavioral and emotional difficulties in their children (57%). They also worried about their children spending more time on screen and not having opportunities for social interaction. Many parents (70%) reported increased stress for themselves, due greater demands on them, often juggling work, childcare and assisting with their children's online schooling.

3.5. Online information sources

As we were aware that many parents seek information about children's behavioral difficulties and parenting strategies online, we included questions about where and how parents seek such information. Parents (61%) reported using popular online platforms such as Instagram and Whatsapp parent groups, as well as accessing professional websites such as ABDA (Brazilian Association for Attention Deficit). All parents (100%) reported accessing such information using their cell phones. While able to access information on the nature of ADHD from these sites, many parents (74%) reported difficulty finding practical information on how to manage their children's difficulties in everyday life.

4. Discussion

A qualitative needs assessment was carried out to understand the experiences and behavioral treatment needs of families with children demonstrating ADHD symptoms. Semi-structured interviews were conducted with parents, educators, and healthcare providers. Common themes were identified via inductive coding of the interview responses. Given these themes are presented in a narrative form in the results, here we highlight those that are most relevant to the study aims.

Many of the parents who volunteered to take part in this study had sought some form of psychosocial treatment, in addition to medication. Among those whose children participated in psychotherapy, the majority reported their child meeting alone with the therapist with little parental involvement in the intervention. A small number of parents reported learning behavioral management strategies from healthcare providers. When parents were probed for the information and support they desired, many reported wanting practical information on how to manage their children's behaviors in everyday life. They also reported experiencing significant stress and wanting to know how they could better manage their own reactions when their child does not follow their directions. Healthcare providers and educators noted that many families would benefit from learning how to create structure and develop routines in the household, and how to assist and interact with their children with ADHD at home. Some parents and professionals reported that families would also benefit from learning more about ADHD generally. However, many parents reported that information about ADHD can be found online, but that it is more difficult to find information about practical parenting strategies that work with children with ADHD. This highlights the need for demonstrations of such strategies via easily accessible formats, such as short videos.

The need for a formal diagnosis delayed treatment access for many families. This was partly due to the lack of providers offering diagnostic services. However, parents' hesitancy in seeking and receiving a diagnosis also contributed to this delay. Many parents reported that they only sought out a diagnosis after their child's school asked them to do so. They noted that it was challenging for them to accept that their child's difficulties qualified for a diagnosis, or they were worried that having a diagnosis would result in discrimination and loss of educational opportunities. The responses of educators and healthcare providers confirmed that families are reluctant or afraid of seeking a diagnosis. Their responses also indicated that families are not usually aware of treatment options, with many thinking medication is the only choice. Other families prefer homeopathic treatment or educational assistance. Consistent with the literature (2, 3), educators and healthcare providers also described limited availability of accessible non-pharmacological treatment for ADHD.

These data highlight the need for increased availability of accessible non-pharmacological interventions for ADHD. These interventions should have empirical support to reduce commonly reported behavioral difficulties of children with ADHD and parental distress. Behavioral parent training fits this criteria. A pre-diagnostic, and/or post diagnosis, early behavioral intervention might be appropriate for Brazilian communities. Behavior management strategies can be useful for parents who have concerns about their child's behavior, but have not sought or received a diagnosis for the child. Such early intervention programs have been disseminated successfully in other countries (24–26); for example, specific treatment recommendations, or treatment itself, are provided at regular developmental check-ups and through schools. While a careful

diagnostic evaluation is important in developing individually tailored treatment plans, it is also important to reduce delays in families accessing accurate information about ADHD and behavioral strategies to help manage children's behavior.

Ease of access is critical in the uptake of such early intervention programs. One way to disseminate behavioral management strategies for free or at low cost to families may be via online platforms. Such an approach is foreshadowed in calls for tiered child mental health care involving digital tools in Brazil (27). BPT programs have been offered online in other countries with emerging empirical support (28–30). Many Brazilians access information online with cell phones, which are widely available even amongst low-income communities (31, 32). Phone-based digital platforms could be considered for dissemination of behavioral parent training for families of children with mild to moderate ADHD.

The current study provided an opportunity to hear directly from parents, and those working with families, what is needed to better support families of children with ADHD in Brazil, albeit with a relatively small sample. In recruiting parents, we relied on their reports of their children's symptoms. Thus, the sample includes those with a formal diagnosis of ADHD as well as those demonstrating elevated symptoms of ADHD, increasing the generalizability of the findings. The parents learned about the current study online and volunteered to participate; thus they were likely a sample of motivated parents with resources to access the study information and are not representative of the entire Brazilian population needing treatment for their children with ADHD. While this sampling method mirrored the recruitment strategy planned for the online program in development, this may have impacted the findings. Among the lower-resourced families, the availability of affordable treatment is likely even more scarce, and the acceptance and knowledge about behavioral disorders and treatment is likely more limited (33, 34). As a counterpoint, responses from educators and healthcare providers working in both private and public sectors provided diverse perspectives. As in all qualitative research, the influence of the researchers' viewpoints and experiences needs to be acknowledged. However, we used consensus among three researchers from different professional backgrounds (psychiatrist, psychologist, neuroscientist) in coding the data, which were then reviewed by two senior researchers (GT, PM) who were not involved in data collection.

The in-depth interviews with the stakeholders of a planned online BPT program provided important insights regarding necessary content and possible delivery strategies. The themes emerging from the current study, and the literature on psychosocial treatment for ADHD, also suggest behavioral parent training programs would be an important addition to child mental health services in Brazil. Such programs should be easily accessible, offer practical strategies for dealing with everyday life challenges, and provide support for parents. The dissemination of such programs would help address existing treatment gaps for Brazilian children with ADHD and their families. To support such dissemination, community wide educational programing may also be needed. Helping parents, educators, and healthcare providers understand the importance of recognizing ADHD and receiving caregiver-focused therapy would increase the acceptability of parent training programs. Given that school personnel are usually the first to raise concerns about the child's behaviors and act as facilitators for help seeking, schools may be particularly suited for such educational programming and for reaching the families who may benefit from an online BPT program.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

This study involving human participants was reviewed and approved by the D'Or Institute for Research and Education Ethics Committee (CEP #5249). The participants provided their written informed consent to participate in this study.

Author contributions

GT, PM, and EF contributed to the conception and design of the study. PB, RQ, and CB organized the database and performed the qualitative analysis. PB and EF wrote the first draft of the manuscript. All authors contributed to the manuscript revision, read, and approved the submitted version.

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Conflict of interest

PM has received research grant and speaker honoraria from Takeda in the last 3 years.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1191289/full#supplementary-material

SUPPLEMENTARY DATA SHEET 1
Interview questions.

SUPPLEMENTARY DATA SHEET 2
English translation of interview questions.

SUPPLEMENTARY DATA SHEET 3
Categories and subcategories for initial coding.

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Female sex and burden of depressive symptoms predict insufficient response to telemedical treatment in adult attention-deficit/hyperactivity disorder: results from a naturalistic patient cohort during the COVID-19 pandemic

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Background: Attention-deficit/hyperactivity disorder (ADHD) is a chronic neuropsychiatric disorder, that typically manifests itself during childhood and persists in a majority of the affected individuals into adulthood, negatively affecting physical and mental health. Previous studies have shown detrimental effects of the COVID-19 pandemic on mental health in individuals with ADHD. Thus, telemedicine could be a useful tool for optimizing treatment-outcomes in adult ADHD by improving treatment adherence and persistence. However, data on telemedical treatment outcomes in adult patients with ADHD is scarce.

Methods: We report here the sub-cohort analysis of a naturalistic cohort of adult patients (N = 254) recruited between April 2020–April 2021, comparing the effects of telemedical treatment on participants either clinically diagnosed with depression (N = 54) or ADHD (N = 67). Participants were asked to fill out the WHO-5 repetitively during >12 weeks of telemedical treatment. Furthermore scores of WHO-5, SCL-90R and BDI-II, psychopathology, psychosocial functioning, sociodemographic data, medical records and a feedback survey were analyzed for both groups and compared. Participants with ADHD were further stratified according to the development of well-being during the study period in order to identify factors associated with a satisfactory treatment outcome.

Results: Participants with depression reported a significant improvement of well-being during the course of the study, while no such effect could be seen in participants with ADHD on a group level. Despite the good outcome, participants with depression were more severely affected at baseline, with significantly worse psychopathology and a more precarious labor and financial situation. A detailed analysis of ADHD participants without clinical improvement revealed significantly higher BDI-II scores than for ADHD participants with a satisfactory

outcome (p = 0.03, Mann–Whitney-U-Test), suggesting successful treatment was hampered by the combination of ADHD and depressive symptoms. Furthermore, female sex among ADHD patients was correlated with an unfavorable treatment outcome during the course of the study (p = 0.001, Spearman correlation) as well as living with children (p = 0.02, Spearman correlation).

Conclusion: Besides screening for depressive symptoms before telemedical treatment, future research should address the specific needs of female ADHD patients as these patients may be at a particularly high risk of being overburdened with family work.

KEYWORDS

telemedicine, attention-deficit/hyperactivity disorder, depression, WHO well-being, COVID-19

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a common neuropsychiatric disorder comprising symptoms of inattention and hyperactivity-impulsivity, beginning during childhood and early adolescence and often persisting into adulthood (1, 2). Attention-deficit/hyperactivity disorder is highly heritable and of multifactorial etiology with environmental factors putatively contributing to the individual risk (3, 4). Prevalence estimates of ADHD in adulthood are flawed by methodological restrictions and the lack of large epidemiological studies of robust quality. In individual studies an estimated prevalence of, e.g., 4.4% could be demonstrated (5), whereas a meta-analysis and data from World Mental Health Surveys yielded a pooled prevalence of adult ADHD of 2.5% (6) and 2.8% (7) respectively.

The COVID-19 pandemic was associated with high rates of symptoms of insomnia, anxiety, depression and psychological distress in the general population (8), with younger age, female gender and the presence of chronic/psychiatric illnesses as prominent risk factors (9). In adolescents and young adults with ADHD the COVID-19 pandemic led to an exacerbation of psychosocial and mental health problems (10). Furthermore, there is compelling evidence that the pandemic, beyond co-occurring conditions, also exacerbated the core symptoms of ADHD (11, 12). In this line, there is evidence from a longitudinal Swiss cohort study that the prevalence of ADHD increased during the COVID-19 pandemic in a cohort of young adults, an effect that was exclusively seen among women (13). Additionally, adult individuals with ADHD in the US had a greater probability of hospitalization due to COVID-19. Comorbid substance use disorders significantly potentiated the risk of severe COVID-19 (14). Beyond that, perceived stress increased the risk for suicidal ideation in individuals with ADHD symptoms in an adult Japanese sample (15).

At the initial stages of the COVID-19 pandemic, telemedicine was - despite limited evidence - considered as an additional means of expanding the delivery of mental health services to patients with ADHD (16) and facilitating the remote monitoring of ADHD symptoms (17). Current findings, mainly relying on self-reports, suggest that digital interventions could improve medication adherence in children and adolescents with ADHD (18). Yet, the evidence remains inconclusive, due to risks of bias, heterogeneity of interventions and study designs, and low statistical power. In general, remote consultations via video, phone, or live-messaging are well accepted among people with mental health conditions (19), improving service quality from a patient perspective among adolescents and young adults (20). Likewise, videoconferencing seems to be an accessible and effective means of delivering behavioral and cognitive therapies to adults with mental health problems, e.g., post-traumatic stress disorder (PTSD), depression, anxiety disorders, eating disorders, and obsessive-compulsive disorder (OCD) (21). A recent systematic review (22) concluded that telemedicine had the potential to increase treatment availability, decrease diagnosis waiting times, and aid in symptom monitoring in patients with neurodevelopmental disorders (NDD), e.g., ADHD. Nevertheless, there is a preponderance of evidence for children and adolescents with NDD and their caregivers. In contrast, the evaluation of telemedical interventions for adult individuals with NDD is still underrepresented. Despite this nonetheless promising data situation, the response to the COVID-19 pandemic worsened problems with service provision to patients with ADHD in the United Kingdom, increasing the risk for negative long-term outcomes in these individuals (23). Meanwhile, data from Germany indicate an increase in pandemic-related symptoms of depression and anxiety and a decline of mental health in the general population during later stages of the pandemic (24). Even the rapid, yet initially somewhat uncoordinated widespread provision of telemedical psychiatric counseling and treatment options could not prevent this development. Correspondingly, we lately demonstrated an insufficient response of adult patients with ADHD to telemedical psychiatric treatment on a group level, compared to patients clinically diagnosed with a depressive disorder in a naturalistic, monocentric, exploratory trial during the first year of the COVID-19 pandemic in Germany (25). Therefore, in the light of the current shortcomings of evidence regarding the telemedical treatment of adults with ADHD, a better understanding of the determinants of telemedical treatment outcomes in this chronically affected group of patients is urgently needed.

The current analysis - building on the sample of the exploratory study mentioned above (25) – investigates clinically relevant characteristics of patients with ADHD, the group with the least favorable outcome during telemedical treatment in our study, by comparison with patients diagnosed with a depressive disorder, who reported the best response to telemedical treatment. Furthermore,

patients' subjective experiences with telemedical psychiatric treatment are compared.

2. Methods

2.1. Study design

Here, we report the analysis of a sub-cohort of our recently published study (25). This monocentric study was initiated during the first enforced Germany-wide lockdown (starting from March 22, 2020) due to the COVID-19 pandemic, when most services of the outpatient clinic at the Central Institute of Mental Health, Mannheim (CIMH), University of Heidelberg, Germany, had to be transformed into telemedical treatment options in order to maintain psychiatric services for patients with mental health issues despite severe contact restrictions. The study aimed at World Health Organization (1) observing how psychiatric symptoms of patients with mental health problems develop during the course of telemedical psychiatric treatment, American Psychiatric Association (2) identifying patient groups with favorable or less beneficial treatment outcomes, Thapar and Cooper (3) determining sociodemographic or related factors (sex, age etc.) with an impact on the effectiveness of telepsychiatric treatment, and Kim et al. (4) describing patients' experiences with telepsychiatric consultations compared to conventional face to face treatment by mental health experts. Due to organizational reasons within the institution, patients seeking appointments at the department of addictive behavior and addiction medicine, the memory clinic, and the department of psychosomatic medicine at the CIMH were not systematically asked for their participation and therefore excluded. Thus, the study sample was restricted to adult, non-geriatric general psychiatric patients.

Recently, we determined a robust and favorable response to telemedical treatment among patients with depressive disorders in this patient cohort, whereas patients with chronic neurodevelopmental disorders like ADHD did not experience significant improvement at a group level (25). Therefore, we analyzed these two sub-cohorts of patients, either clinically diagnosed with ADHD (N = 67) or depression (N = 54), in order to identify relevant factors that are associated with divergent treatment outcomes. N = 22 participants diagnosed with ADHD had a depressive syndrome as secondary diagnosis and N = 2 of the patients diagnosed with ADHD had previously been diagnosed with a depressive episode. N = 5 patients diagnosed with depression had a reported secondary diagnosis of ADHD in the past documented in their medical records. All patients (N = 254) were recruited between April 2020 and April 2021. After their request for a first medical consultation, patients received information about the study during the telephonic scheduling of their first psychiatric counseling. The latter were exclusively offered via telemedicine (all 254 patients recruited) due to pandemic-related restrictions. The study was mainly observational. Thus, only children and adolescents (patients under 18 years of age) were excluded. Due to the naturalistic and observational nature of the study, no other exclusion criteria were applied. The aims and purpose of the study were explained either by members of the study team who contacted interested patients or by the psychiatrist or psychologist who provided the first telemedical session. Telemedical treatment was administered via phone or video calls, according to patients' preferences, technical equipment as well as individual and legal data safety concerns. For initial telemedical appointments past and medical history of patients including current medical complaints as well as a history of psychiatric symptoms, treatments, medication, secondary diagnoses and social history were recorded comparable to an initial appointment in person except for the physical examination. Signs of psychopathology were also rated according to the AMDP system (26). During the following telemedical consultations, patients received psychiatric counseling with optimization of psychopharmacological treatment and/or psychotherapy. Between telemedical psychiatric consultations patients received scheduled appointments with strictly limited personal contact for blood tests, therapeutic drug monitoring (TDM), and physical as well as radiological examinations (e.g., MRI scans), if required. Participants were asked to complete three surveys during the course of the study: Before the first telemedical consultation, participants agreed that their medical record, which would be created during telemedical treatment, could be used for further analysis (see below) as a part of the study. Participants were also asked to fill out the WHO-5 well-being index (WHO-5) (27) and the symptom check-list-90-R (SCL-90R) (28), which were provided paper-based 4–6 and 8–12 weeks after the first telemedical session. Participants could either choose to take part in the second and third survey, according to their preference, via phone interview or by using online surveys on REDCap,[1] a secure web application for building and managing online surveys for research studies and operations supported by the National Institutes of Health (NIH/NCATS UL1 TR000445). During all three surveys patients were asked to score their well-being according to the WHO-5 Well Being Index (see below). Patients using the online survey system REDCap were also asked to complete Beck's depression inventory II (BDI-II) (29) during the second or third survey. At the end of the telemedical treatment patients could evaluate the psychiatric intervention either paper-based or via REDCap (see details below).

2.2. Acquisition of psychiatric history and sociodemographic data

All participants analyzed in this study (N = 67 with ADHD and N = 54 with depression) gave informed consent to analyze their medical records, including sex, age and sociodemographic data as well as their psychiatric history and standardized professional ratings of psychopathology for the purpose of the study. As described previously (25), all mental health experts providing telepsychiatric services in our outpatient clinic used a highly structured computerized rating of psychopathology provided by the electronic documentation system of our clinic (ORBIS, SAP, Walldorf Germany) during the first interview. Patients were screened for current psychiatric symptoms, psychiatric diagnoses according to the ICD-classification of the WHO (version 10), past psychiatric history and sociodemographic data, such as current living situation, education, professional training and labor situation, debts and history of criminal convictions. The demographic characteristics of the study sample are shown in Table 1. All psychiatrists and psychologists of our outpatient clinic were also

1 https://www.project-redcap.org/

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TABLE 1 Sociodemographic characteristics of the participants diagnosed with depression or attention-deficit/hyperactivity disorder (ADHD) assessing sex, age, marital status, children, living situation, education, professional training, labor and financial situation.

	Depression		ADHD		*p*
	N or M (SD)	(%)	N or M (SD)	(%)	
Total Number (N) of recruited patients	54		67		
Female	39	72	36	58	**0.038**
Male	15	28	31	46	
Age (years)					
Females	37.3 (13.0)		40.8 (12.7)		0.861
Males	41.6 (10.4)		37.8 (12.4)		>0.999
Marital status					
Single	21	46	24	42	0.730
Living with a partner	25	54	33	58	
Missing responses	8		10		
Living situation					
Living alone	20	59	16	46	0.424
Living with family or friends	8	24	16	41	
Living with a partner	4	12	3	8	
Living in supervised accommodation	2	6	2	5	
Missing responses	20		28		
Education					
No school graduation	2	6	0	0	0.529
9 years of school education completed	6	17	10	18	
10 years of school education completed	12	33	17	31	
>12 years of school education completed	15	42	27	49	
Education not specified	1	3	1	2	
Missing responses	18		12		
Professional training					
Completed apprenticeship	24	73	25	51	0.121
Completed academic studies	2	6	12	24	
No completed professional training	4	12	6	12	
Academic studies on-going	3	9	6	12	
Missing responses	21		18		
Children					
Children	2	4	11	17	**0.037**
No children	18	38	29	45	
Children not specified	28	58	25	38	
Missing responses	6		2		
Labor situation					
Unemployed	10	21	9	14	**0.006**
Employed	11	23	30	46	
Disables	10	21	2	3	
Retired	1	2	3	5	
Labor situation not specified	16	33	21	32	
Missing responses	6		2		
Financial situation					
Debts	15	31	7	11	**0.015**
No debts	10	21	24	38	
Financial situation not specified	23	48	33	52	
Missing responses	6		3		

N = number of participants for whom information was found in medical records. Percentages were calculated as (N/all N responded for a distinct category)*100. Results are presented in mean ± SD for age; a Chi-squared test was used to compare patients with depression and patients with ADHD for different sociodemographic characteristics. $p < 0.05$ was set to be significant. Significant differences between groups for a specific category are marked in bold. M = mean, SD = standard deviation.

requested to score patients according to the global assessment of functioning scale (GAF) and the clinical global impression scale (CGI) at baseline. During subsequent data analysis, electronic medical records were systematically queried for the number of telemedical treatment sessions participants received and possible hospitalizations during the course of the study. Medical records were additionally scrutinized for possible outpatient treatments during the year before March 2020, when outpatient psychiatric care was still provided personally.

2.3. Evaluation and follow-up of psychopathological symptoms

2.3.1. WHO-5 well-being index (WHO-5)

We used the WHO-5 for the assessment of overall well-being during telepsychiatric counseling. The WHO-5 is a short self-administered measure of well-being, covering the last 2 weeks before completion of the questionnaire (30). The WHO-5 consists of five positively worded items that are rated on a 6-point Likert scale, ranging from 0 (at no the time) to 5 (all of the time). We transformed the raw scores to a score from 0 to 100 (raw data*4), where lower scores indicated worse well-being. A score of ≤50 was considered as poor wellbeing and a score of 28 or below as indicative of depression. The WHO-5 has high clinimetric validity and can be used as an outcome measure for treatments. Moreover, the WHO-5 has proven its applicability across a wide range of study fields and is a valid screening tool for depression. For a comprehensive review of the psychometric properties and diagnostic accuracy of the WHO-5 see also Topp et al. (31).

2.3.2. Symptom checklist-90-R

The SCL-90-R by Derogatis (32) measures the subjective perception of physical and mental symptoms a person has experienced during the past 7 days. All 90 symptoms are scored on a Likert scale consisting of 5 steps, ranging from 0 (no symptom at all) to 4 (very strong impairment due to the symptom). We analyzed the data according to the instructions provided by Derogatis and Franke for the German Version of the SCL-90-R (2nd Edition, Beltz Test, 2000). T values equal to and above 60 were considered as a relevant deviation from the respective symptom or global standard scores. The German version of the SCL-90-R has been validated in psychosomatic outpatients and primary care patients (33, 34). Despite the strong interdependence of its subscales the results of these studies indicated that the SCL-90-R is a useful tool for screening for mental disorders as well as measuring psychological status and change in outcome studies. However, due to a lack of factorial validity, the availability of representative norms for the German population are restricted to the global scores of the SCL-90-R (35). These three global indices (GSI: Global Severity Index, PST: Positive Symptom Total, PSDI: Positive Symptom Distress Index) provide measures of overall psychological distress by focusing on general psychological distress (GSI), the intensity (PSDI) and the number (PST) of symptoms.

2.3.3. Beck's depression inventory-II

During the second or third online survey via REDCap participants could also complete the BDI-II. 19 (35.2%) of the participants diagnosed with depression and 33 (49.3%) of the participants diagnosed with ADHD completed the BDI-II. The BDI-II is a widely used 21-item instrument, validated for the self-report of depressive symptoms experienced during the past 2 weeks (29, 36). Individual item scores (0 to 3) sum up to a total BDI-II score ranging from 0 to 63. BDI-II scores <13 were interpreted as indicative of minimal depressive symptoms without clinical relevance. Higher scores suggested a mild (14–19), moderate (20–28) or severe (29–63) burden of depressive symptoms. The German version of the BDI-II has recently been shown to be a reliable and valid screening tool for depressive disorders and episodes in the adult German population with high internal consistency (37).

2.3.4. Clinical global impression scale (CGI) and global assessment of functioning scale (GAF)

While the WHO-5, SCL-90-R and the BDI-II are self-report questionnaires focusing on the subjective perception of overall well-being and different symptom domains, the GAF and CGI were used as clinician-rated scales to document the global impairment due to patients' (mental) health conditions. CGI (38) scores indicate the severity of symptoms, ranging from 1 to 7 (1 = normal/not at all affected; 7 = very severely ill). The GAF (39) indicates the global functioning of a patient taking into account the psychiatric, social and professional level of functioning. The scale ranges from 0 (very sick) to 100 (healthy).

2.3.5. Evaluation of telemedical treatment by participants

Thirty-two (59.3%) of the participants with depression and 45 (67.2%) of the participants with ADHD completed an evaluation questionnaire asking for feedback concerning technical details (e.g., if patients chose phone calls or video conferences or both, and if interruptions occurred due to technical problems). Moreover, patients were asked for their overall satisfaction with telepsychiatric consultations. Participants were asked how helpful they found the telemedical interventions during the study period and if they were comparable to conventional face to face consultations. Patients were also requested to state their preference about using telepsychiatry in the future again. Participants were also asked if and how the COVID-19 Pandemic had influenced their mental well-being.

2.4. Data analysis

All data acquired during surveys and from medical records were entered into an Excel master file and then translated to SPSS Version 27 and R Version 4.2.0.1. for further analysis. The descriptive statistics of the sample were computed for the sociodemographic characteristics, consisting of frequencies and percentages for categorical values and mean and standard deviations (SD) and for scale variables. Differences between two groups of patients (patients with depression vs. ADHD patients or ADHD patients with or without improvement on the WHO-5 well-being index) were assessed using the Mann-Witney-U test for the different non-parametric clinical scale variables or the Chi-Square tests for frequencies of the categories in the sociodemographic parameters.

A paired Wilcoxon signed-rank test was used to assess differences in the levels of mental health variables, e.g., the results of the WHO-5

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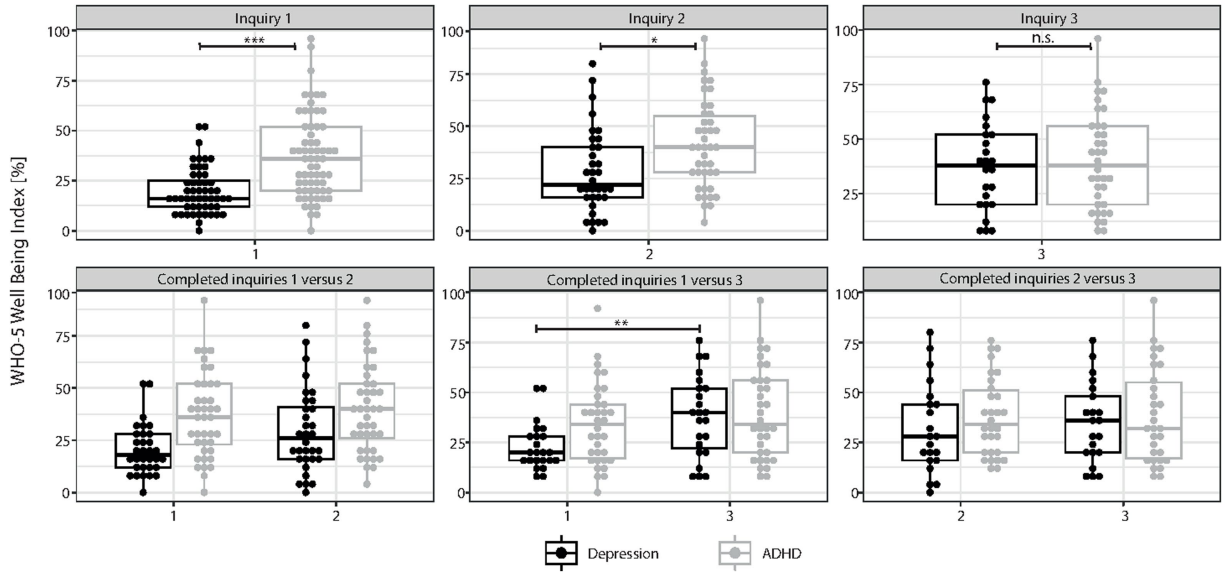

FIGURE 1
Results of self-report assessment using WHO-5. Results of the WHO-5 well-being index: Boxplots with scoring details of all individuals who participated in the different surveys of the study (inquiry 1 = survey before the beginning of telemedical treatment; inquiry 2 and 3 = surveys 4–6 and 8–12 weeks after the start of telemedical counseling, respectively) are shown for patients with depression and attention-deficit/hyperactivity disorder (ADHD). In the upper panel, all responses of patients, either diagnosed with ADHD or depression, are indicated for each of the three inquiry time points. In the lower panel, only results of participants who completed either inquiry 1 and 2 (N = 32 participants with depression and N = 40 participants with ADHD), inquiry 1 and 3 (N = 23 participants with depression and N = 34 participants with ADHD) or inquiry 2 and 3 (N = 21 participants with depression and N = 30 participants with ADHD) are shown. Statistical analyses could only be performed if the results of at least two subsequent inquiries could be compared. We found a significant improvement of WHO-5 scores during the course of telemedical treatment for participants diagnosed with depression (inquiry 1 vs. 2 and inquiry 1 vs. 3, $p < 0.001$, Wilcoxon-test) while this was not the case for participants diagnosed with ADHD. Results of individual study subjects are shown in percentages (0% indicates extremely impaired well-being while 100% represents perfect well-being). Results are presented in mean ± SD; asterisks indicate significances: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

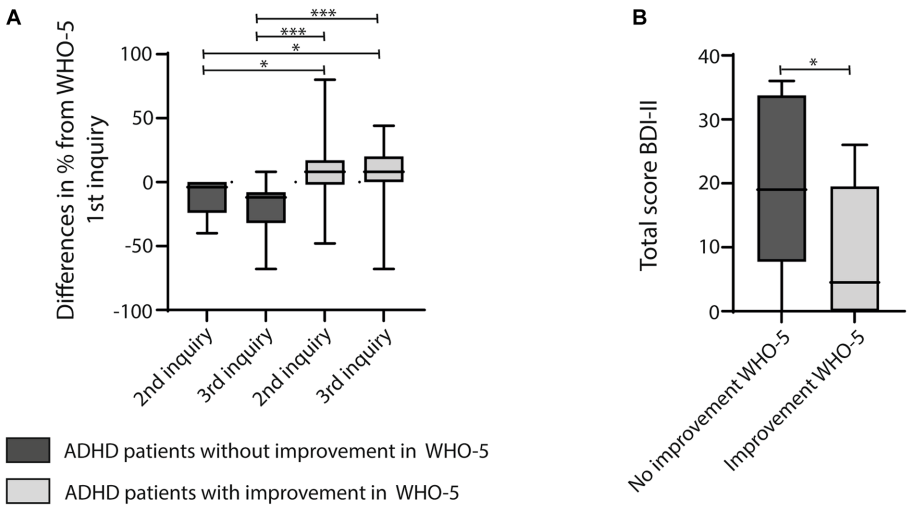

FIGURE 2
(A) Graph showing boxplots calculating differences in percentages of the WHO-5 scores between the 1st and 2nd inquiry or the 1st and 3rd inquiry of participants diagnosed with ADHD. The graph reveals one sub-cohort of participants with no improvement or even a decline in well-being on the WHO-5 during telemedical treatment, while another other sub-cohort of participants with ADHD reported enhanced well-being. The latter was significantly different from the sub-cohort without improvement. For statistical analysis the Kruskal-Wallis Test, multiple comparison with a Tukey *post-hoc* was used. **(B)** Participants with no improvement on the WHO-5 scored significantly higher on the BDI-II than participants who reported an improvement of well-being on the WHO-5 during the course of the telemedical intervention. Results were compared using the Mann–Whitney-U-Test; asterisks indicate significances: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

during subsequent inquiries. To this end, only data from subjects was included, who had participated in all inquiries ("complete cases;" Figures 1, 2). Correlations between variables (e.g., sex and outcome on the WHO-5) were assessed via Spearman's correlation coefficient *r*. For all tests, a value of *p* of less than 0.05 was considered statistically significant.

2.5. Ethics approval and consent to participate

Written informed consent was obtained from all participants. The study design and data acquisition were presented to the ethics committee II of the medical faculty Mannheim, University of Heidelberg and approved (No. 2020-562 N).

3. Results

We previously reported that telemedical treatment in a naturalistic patient cohort (N = 254) during the COVID-19 pandemic supported mental well-being as measured by the WHO-5 well-being index and the SCL-90-R (25). The largest group of this patient cohort (35.3%) consisted of patients with neurodevelopmental disorders like ADHD and tic disorders, while almost a quarter of the study population (24.6%) was primarily diagnosed with a depressive episode or recurrent depressive disorder according to the ICD-10 classification. We now present sub-cohort analyses of these two patient cohorts, either diagnosed with depression (N = 54) or ADHD (N = 67). Wherever informed consent was given, sex, age and sociodemographic data as well as participants' psychiatric history and standardized professional ratings of psychopathology from medical records were additionally evaluated.

3.1. Comparisons between patients with depression and patients diagnosed with attention-deficit/hyperactivity disorder

3.1.1. Well-being, sociodemographic and sex-specific characteristics

Although participants with depression scored significantly lower on the WHO-5 than participants with ADHD at baseline (WHO-5 mean 20 ± 12 for participants with depression vs. mean 37 ± 21 for participants with ADHD, $p < 0.001$, Mann–Whitney-U-Test; Figure 1), depressive participants reported an increase in well-being after 4–6 weeks (2nd inquiry, 1st vs. 2nd inquiry $p = 0.074$) and 8–12 weeks [3rd inquiry,1st (23 ± 12) vs. 3rd inquiry (38 ± 20), $p = 0.009$; Figure 1] of telemedical treatment, respectively. In contrast, well-being scores of ADHD patients plateaued around 40% in all three inquiries (1st inquiry 37 ± 21, 2nd inquiry 41 ± 21, 3rd inquiry 40 ± 22), indicative of poor well-being and revealing almost no beneficial effect of the telemedical intervention. Comparing sociodemographic data of both participant groups revealed a similar distribution of both sexes and age (Table 1). No significant difference between groups was also reported for marital status, living situation, education and professional training. However, we found a significantly different distribution of specifications regarding children, labor and financial situation (comparing the distribution of the different categories using Chi-squared test; Table 1): More participants with ADHD lived together with children (17% vs. 4% for participants with depression), while depressive participants were more likely to be unemployed (21%) or disabled (21%) or had financial problems (31% of participants with depression vs. 11% of participants with ADHD with financial debt). As the sub-cohort with depression consisted of significantly more female subjects (Table 1), we also performed a sex-specific analysis searching for sex-specific sociodemographic characteristics in the patient cohorts either diagnosed with depression or ADHD (Table 2). While in the sub-cohort with depression most male subjects were single (85%), the majority of male subjects diagnosed with ADHD lived together with a partner (65%; Table 2). More than a third (37%) of females participating in our study and diagnosed with ADHD had children, while this was not the case for females diagnosed with depression (only 1 female participant with depression was found to have children; Table 2). However, more females with depression also reported a precarious financial situation (Table 2). For all other sociodemographic data assessed no sex-specific differences were found.

3.1.2. Clinician-rated psychopathology, mental distress, global functioning, and load of depressive symptoms

Psychopathological symptoms were plausibly distributed according to the two distinct syndromic diagnoses: Significantly more participants with ADHD showed attentional and concentration deficits (Table 3, for attention $p < 0.001$, for concentration $p = 0.009$, Chi-squared test), while the ability to experience joy and the lack of drive was particularly disturbed in depressive patients (Table 3, $p < 0.001$, Chi-squared test). Significantly more depressive participants also reported a history of suicidal attempts (Table 3, $p < 0.001$, Chi-squared test).

Participants suffering from depression were also more severely affected in the majority of symptoms assessed by the SCL-90R compared to participants with ADHD at baseline (Table 4): At the beginning of the study, depressive participants scored with a value >60 in all nine symptom categories, indicating clinically relevant global mental distress (Table 4). In contrast, mean values for five out of nine sub-categories and all global scores were significantly lower in ADHD patients (all values of $p < 0.05$, Mann–Whitney-U-Test) at baseline. Except for one category (somatization) ADHD patients also crossed the mean threshold of 60, suggesting a relevant burden of psychiatric symptoms in this sub-cohort as well. Matching with patients' self-reports, clinician-rated scales of global impairment (GAF and CGI) were also significantly different between participants with depression and ADHD (Table 5, $p < 0.002$ for both scales, Mann–Whitney-Test). Depressive participants were clinically more severely affected by mental distress (Table 5). In addition, participants with depression scored significantly higher on the BDI-II (Table 5, $p = 0.01$, Mann–Whitney-Test).

3.1.3. Utilization of mental health services and satisfaction with telemedical treatment

Participants with depression received on average 6.4 ± 8.0 outpatient doctoral appointments (Table 5). 4.2 ± 5.0 of which were telemedical interventions, while participants with ADHD participated in less doctoral appointments (3.9 ± 3.4) of which the majority where telemedical treatments (3.2 ± 2.2; Table 5). However, this difference was not statistically significant ($p > 0.05$, Mann–Whitney-U-Test). Despite their different treatment outcomes in well-being (Figure 1), both patient cohorts were satisfied with the telemedical interventions they received (77.7% of participants with depression vs. 75.0% of participants with ADHD; Table 6). Both groups evaluated telemedical treatment to be as effective as face to face therapy (51.7% of participants with depression vs. 52.3% of participants with ADHD) and were willing to engage in telemedical treatment in the future again (48.4% of participants with depression vs. 58.6% of participants with ADHD; Table 6). A sex-specific difference regarding outcomes on the WHO-5, BDI-II scores and satisfaction with telemedical treatment could not be identified for both sub-groups.

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TABLE 2 Table depicting sex-related differences of sociodemographic characteristics of participants, either diagnosed with depression or ADHD.

	Depression	ADHD	*p*
	N (%)	N (%)	
Marital status			
Female			0.138
Single	10 (30%)	15 (48%)	
Living with a partner	23 (70%)	16 (52%)	
Missing responses	6	5	
Male			**0.003**
Single	11 (85%)	9 (35%)	
Living with a partner	2 (15%)	17 (65%)	
Missing responses	2	5	
Living situation			
Female			0.786
Living alone	11 (48%)	9 (43%)	
Living with family or friends	6 (26%)	8 (38%)	
Living with a partner	4 (17%)	2 (10%)	
Living in supervised accommodation	2 (9%)	2 (10%)	
Missing responses	16	15	
Male			0.213
Living alone	9 (82%)	9 (50%)	
Living with family or friends	2 (18%)	8 (44%)	
Living with a partner	0 (0%)	1 (6%)	
Living in supervised accommodation	0 (0%)	0 (0%)	
Missing responses	4	13	
Education			
Female			0.592
No completed education	2 (7%)	0 (0%)	
9 years of school education completed	6 (21%)	4 (14%)	
10 years of school education completed	7 (25%)	8 (29%)	
>12 years of school education completed	12 (43%)	15 (54%)	
Not specified	1 (4%)	1 (4%)	
Missing responses	11	8	
Male			0.206
No completed education	0 (0%)	0 (0%)	
9 years of school education completed	0 (0%)	6 (22%)	
10 years of school education completed	5 (62%)	9 (33%)	
>12 years of school education completed	3 (38%)	9 (33%)	
Not specified	0 (0%)	6 (22%)	
Missing responses	7	4	
Professional training			
Female			0.286
Completed apprenticeship	15 (62%)	12 (50%)	
Completed academic studies	2 (8%)	7 (29%)	
No completed professional training	4 (17%)	2 (8%)	
Academic studies on-going	3 (12%)	3 (12%)	
Missing responses	15	12	
Male			0.083

(Continued)

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TABLE 2 (Continued)

	Depression	ADHD	*p*
	N (%)	N (%)	
Completed apprenticeship	9 (100%)	13 (52%)	
Completed academic studies	0 (0%)	5 (20%)	
No completed professional training	0 (0%)	4 (16%)	
Academic studies on-going	0 (0%)	3 (12%)	
Missing responses	6	6	
Children			
Female			**0.033**
Children	1 (3%)	8 (23%)	
No children	13 (37%)	13 (37%)	
Children not specified	21 (60%)	14 (40%)	
Missing responses	4	1	
Male			0.576
Children	1 (8%)	3 (10%)	
No children	5 (38%)	16 (53%)	
Children not specified	7 (54%)	11 (37%)	
Missing responses	2	1	
Labor situation			
Female			0.076
Unemployed	6 (17%)	3 (9%)	
Employed	9 (26%)	17 (49%)	
Disables	5 (14%)	0 (0%)	
Retired	1 (3%)	1 (3%)	
Labor situation not specified	14 (40%)	14 (40%)	
Missing responses	4	1	
Male			0.055
Unemployed	4 (31%)	6 (20%)	
Employed	2 (15%)	13 (43%)	
Disables	5 (38%)	2 (7%)	
Retired	0 (0%)	13 (43%)	
Labor situation not specified	2 (15%)	7 (23%)	
Missing responses	2	1	
Financial situation			
Female			**0.049**
Debts	11 (31%)	3 (9%)	
No debts	8 (23%)	13 (37%)	
Financial situation not specified	16 (46%)	19 (54%)	
Missing responses	4	1	
Male			0.236
Debts	4 (31%)	4 (14%)	
No debts	2 (15%)	11 (38%)	
Financial situation not specified	7 (54%)	14 (48%)	
Missing responses	2	2	

Marital status, children, living situation, education, professional training, labor and financial situation were assessed. N = number of participants for whom information was found in medical records. Percentages were calculated as (N/all N responded for a distinct category)*100. A Chi-squared test was used to compare sex-specific differences for the distinct categories and both patient sub-cohorts. Significant differences ($p < 0.5$) between groups are marked in bold.

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TABLE 3 Table depicting psychopathological features drawn from the medical records of study participants at the beginning of telemedical treatment, comparing participants with depression and ADHD.

Signs of psychopathology	Depression		ADHD		*p*
	N	Abnormal	N	Abnormal (%)	
Vigilance	34	3 (9%)	55	0 (0.0%)	0.066
Orientation	34	3 (9%)	55	0 (0.0%)	0.074
Memory	34	6 (18%)	54	14 (26%)	0.489
Perception	34	0 (0.0%)	55	2 (4%)	0.296
Attention	34	9 (26%)	55	36 (65%)	**<0.001**
Concentration	34	18 (53%)	55	41 (75%)	**0.009**
Thought process	34	24 (71%)	54	32 (59%)	0.412
Thought content	34	2 (6%)	55	3 (5%)	0.976
Tricks of the senses	34	1 (3%)	55	0 (0.0%)	0.281
Self-disorder	34	4 (12%)	55	0 (0.0%)	**0.015**
Changes in mood	34	29 (85%)	54	37 (69%)	0.135
Ability to experience joy	34	24 (71%)	55	15 (27%)	**<0.001**
Lack of drive	34	25 (74%)	55	18 (33%)	**<0.001**
Worries, anxiety or fear	34	23 (68%)	55	25 (45%)	0.124
Intrusions	30	2 (7%)	46	2 (4%)	0.553
Compulsive behavior	33	2 (6%)	55	4 (7%)	0.965
Psychomotor function	34	7 (21%)	54	15 (28%)	0.683
Changes in eating habits	34	7 (21%)	55	5 (9%)	0.279
Sleep	34	22 (65%)	55	28 (51%)	0.332
Libido	34	11 (32%)	55	9 (16%)	0.152
Social interaction	34	3 (9%)	55	2 (4%)	0.171
Self-harming behavior	34	2 (6%)	55	3 (5%)	0.932
History of suicidal attempts	45	10 (22%)	61	0 (0.0%)	**<0.001**

N = number of participants for whom information was found in the medical records. The percentage of participants with abnormal psychopathological features was calculated as (N/all N responded for a distinct category)*100 and presented as N(%) with N being the number of subjects with abnormal features for a distinct category. Results for the different psychopathological features among participants with depression or ADHD were compared using Chi-squared tests. $p < 0.05$ was set to be significant. Significant differences between groups for a specific category are marked in bold.

3.2. Determinants of treatment outcomes among patients with attention-deficit/hyperactivity disorder

3.2.1. Psychopathology, sociodemographic data, psychological burden, global functioning, well-being, and service utilization

Despite their clinically worse condition at baseline, participants with depression reported a significantly improved well-being during the course of the study. No such effect could be demonstrated for participants with ADHD on a group level. Thus, differences in sociodemographic data, signs of psychopathology, SCL-90-R scores, and overall satisfaction with telemedical treatment were investigated between patients with ADHD, that reported improved well-being during telemedical treatment, and participants diagnosed with ADHD without significant improvement on the WHO-5 (Figure 2A). No significant differences among the two subgroups were found for sociodemographic data (Supplementary Table 1), signs of psychopathology (Supplementary Table 2), the SCL-90-R sub-scales and global scores (Supplementary Table 3), and the level of satisfaction with the telemedical intervention (Supplementary Table 4). Clinicians' ratings of the overall clinical severity of psychiatric symptoms and the ability to participate in daily life using the GAF and CGI also showed no significant difference between both groups at baseline (CGI mean: 5 ± 0 for the group without improvement, mean: 5 ± 0.43 for the group with improvement; GAF mean: 61 ± 0 for the group without improvement, mean: 60.2 ± 10.64 for the group with improvement). Participants diagnosed with ADHD either with or without improvement on the WHO-5 index received an equal amount of telemedical interventions (3.1 ± 1.88 sessions for participants with improvement and 3.4 ± 2.1 sessions for participants without improvement).

3.2.2. Depressive symptoms, sex and familial status

Thirty-three patients with ADHD (49.3% of the participants diagnosed with ADHD) also completed the BDI-II. Participants with ADHD and no improvement or even a further decline on the WHO-5 during the course of the study (Figure 2A), had significantly higher BDI-II scores than participants with ADHD with a more favorable outcome (Figure 2B, $p = 0.03$, Mann–Whitney-U-Test). Thus,

TABLE 4 Detailed initial results of the SCL90-R before the beginning of psychiatric treatment via telemedicine, comparing results of participants diagnosed with depression and ADHD.

	Depression			ADHD			*p*
	N	T Value ≥ 60 (N/%)	Mean ± SD	N	T Value ≥ 60 (N/%)	Mean ± SD	
GSI	52	49 (94.2)	72 ± 7.8	66	50 (75.8)	66 ± 8.4	**<0.001**
PST	52	41 (78.8)	66 ± 9.2	66	42 (63.6)	62 ± 9.1	**0.010**
PSDI	52	50 (96.2)	69 ± 6.1	66	51 (77.3)	65 ± 7.4	**0.001**
Somatization	50	40 (76.9)	66 ± 8.1	63	27 (42.9)	57 ± 11	**<0.001**
Obsessive-Compulsive	50	46 (92.0)	72 ± 7.2	62	56 (90.3)	70 ± 7.9	0.224
Interpersonal Sensitivity	49	42 (85.7)	69 ± 9.2	63	41 (65.1)	64 ± 10	**0.015**
Depression	43	43 (100.0)	74 ± 5.8	58	45 (77.6)	66 ± 9.2	**<0.001**
Anxiety	50	41 (82.0)	70 ± 9.1	63	39 (61.9)	66 ± 10	**0.002**
Hostility	49	38 (77.6)	66 ± 9.4	62	37 (59.7)	63 ± 11	0.156
Phobic Anxiety	50	33 (66.0)	65 ± 11	64	35 (54.7)	60 ± 11	0.072
Paranoid Ideation	48	32 (66.7)	64 ± 10	63	31 (49.2)	61 ± 9.6	0.061
Psychoticism	50	43 (86.0)	67 ± 8.1	64	44 (68.8)	62 ± 8.7	**0.001**

The table provides the results of the three major SCL-90-R indices of distress (GSI, PDSI and PST) as well as the subscales of the nine psychopathological features including the number (N) of participants, the number of subjects with t-values above 60 for the respective subcategory and their percentage relative to all participants (N/all N responded for a distinct category)*100. We also compared the means between both patient groups, using Mann–Whitney-U-Test, revealing significantly higher scores for almost all categories in participants with depression. $p < 0.05$ was set to be significant. Significant differences between groups for a specific category are marked in bold. SD = standard deviation.

TABLE 5 Table revealing the frequency of psychiatric counseling 12 months before the pandemic and during the course of the study during the COVID-19 pandemic, indicating the number of face to face and telemedical counseling sessions.

Out-patient treatment (Mean # of doctoral appointments)	Depression		ADHD		*p*
	N (%)	M (SD)	N (%)	M (SD)	
Within 12 months before the pandemic	4 (7.4)	9 (± 10.4)	3 (4.5)	1.7 (± 1.2)	0.3429
During the pandemic	51 (94.4)	6.4 (± 8.0)	65 (97.0)	3.9 (± 3.4)	0.1830
Via telemedicine	51 (94.4)	4.2 (± 5.0)	65 (97.0)	3.2 (± 2.2)	0.8783
GAF	16 (30.0)	50.6 (± 9.5)	25 (37.3)	62.6 (± 9.7)	**<0.0001**
CGI	24 (44.4)	5.4 (± 0.7)	33 (49.3)	4.7 (± 0.8)	**0.0002**
BDI	19 (35.2)	29.9 (± 16.7)	23 (34.3)	17.8 (± 10.2)	**0.0105**

N = number of participants for whom information was found in the medical records. The table is also depicting the mean scores of the GAF, CGI and BDI-II at the beginning of telemedical treatment for patients diagnosed with depression vs. ADHD. Percentages were calculated as [N/total N of depressive patients (N = 54) or ADHD patients (N = 67)]*100. M = mean, SD = standard deviation. The Mann–Whitney-U-Test was used to assess statistically significant differences between both diagnostic groups. $p < 0.05$ was set to be significant. Significant differences between groups for a specific category are marked in bold.

predominantly ADHD patients reporting an elevated burden of depressive symptoms were not likely to profit from the telemedical intervention. Furthermore, a sex specific analysis of sociodemographic data revealed that the number of female subjects living with family was higher in the group of patients with a less favorable outcome in the WHO-5 (Table 7). Female sex in general was correlated with the worst outcome in the group of ADHD patients with no improvement on the WHO-5 during the course of the study [Table 7, $r = -0.675$, p (two-tailed) = 0.001, Spearman correlation]. In contrast, ADHD patients without children benefited more from telemedical treatment during the COVID-19 pandemic than ADHD patients who were living together with children during the study period [$r = 0.466$, p (two-tailed) = 0.02, Spearman correlation]. Further analyses, examining correlations between the outcome on the WHO-5 and different sociodemographic factors (e.g., age, marital status, education, professional training, labor and financial situation) were not conclusive (Table 8).

4. Discussion

The data presented here builds on an earlier exploratory study that aimed at describing the changes of symptoms of psychiatric outpatients during telemedical treatment during the COVID-19 pandemic, identifying patient groups with beneficial or less favorable treatment outcomes, determining sociodemographic factors with an impact on the effectiveness of telepsychiatric treatment, and specifying patients' experiences with telepsychiatric consultations compared to conventional face to face treatment by mental health experts. The objective of the current analysis was to identify factors that distinguish

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TABLE 6 Results of the evaluation of telemedical psychiatric counseling by study participants, either diagnosed with depression or ADHD.

Telemedical treatment	Depression	ADHD	*p*
	N (%)	N (%)	
Via phone	30 (93.7)	43 (95.6)	0.675
Via video chat	0 (0)	0 (0)	
Via phone and video chat	2 (6.3)	2 (4.4)	
Technical problems during the telemedical treatment			
Yes	4 (12.9)	6 (13.3)	0.435
No	27 (87.1)	39 (86.6)	
Satisfaction with telemedical treatment			
Strongly disagree	0 (0)	0 (0)	0.692
Disagree	0 (0)	2 (4.5)	
Undecided	6 (22.2)	9 (20.5)	
Agree	8 (29.6)	11 (25.0)	
Strongly agree	13 (48.1)	22 (50.0)	
Telemedical treatment was experienced as effective as therapy in person			
Strongly disagree	2 (6.5)	4 (9.1)	0.979
Disagree	8 (25.8)	9 (20.4)	
Undecided	5 (16.1)	8 (18.2)	
Agree	6 (19.4)	7 (15.9)	
Strongly agree	10 (32.3)	16 (36.4)	
Patients will consider telemedical treatment in the future again			
Strongly disagree	5 (16.1)	8 (18.6)	0.806
Disagree	5 (16.1)	6 (14.0)	
Undecided	6 (19.4)	5 (11.6)	
Agree	4 (12.9)	7 (16.3)	
Strongly agree	11 (35.5)	17 (39.5)	
COVID-19 pandemic influenced mental well-being?			
Agree	18 (60.0)	23 (51.1)	0.637
Disagree	12 (40.0)	22 (48.8)	
How deeply were patients mentally affected by the COVID-19 pandemic?			
Not at all	1 (5.6)	0 (0)	0.322
Slightly	1 (5.6)	2 (8.7)	
Moderate	3 (16.6)	8 (34.8)	
Strong	10 (55.6)	9 (39.1)	
Very strong	3 (16.6)	4 (17.4)	

Feedback considering the mode of telemedical treatment, problems that emerged during telemedical treatment, overall satisfaction and willingness to use telemedical treatment options in the future were evaluated. Participants were also asked to score how deeply their mental health was influenced by the COVID-19 pandemic. N = number of participants that provided feedback at the end of telemedical treatment. Percentages were calculated as (N/all N responded for a distinct category)*100. The Mann–Whitney-U-Test was used to assess statistically significant differences between both diagnostic groups for the different categories, but no significant differences ($p < 0.05$) were found.

patients with a depressive disorder, who experienced the best treatment outcome, from patients with poorer treatment results on a group level, namely patients with ADHD. Secondly, the data was screened for factors that allowed for a better differentiation between ADHD patients with a satisfactory treatment outcome and ADHD patients with a stagnating or even worsening mental health status.

Comparing the two groups of patients that experienced the highest and the least improvement in well-being during telemedical psychiatric treatment in our study, namely patients with either clinically confirmed depression or ADHD, patients with depression more frequently reported financial debt and unemployment. At the same time patients with ADHD were more likely to have children. Nevertheless, sociodemographic characteristics could not explain the significant difference in treatment outcomes between both groups. Clinical diagnoses of depression and ADHD were mirrored by clinicians' standardized ratings of psychopathology, substantiating the validity of diagnostic procedures during telemedical treatment. Patients with depression reported a significantly greater impairment

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TABLE 7 Table depicting sex-related differences of sociodemographic characteristics of participants diagnosed with ADHD and with or without an improvement in the WHO-5.

	ADHD		
	No improvement	Improvement	*p*
	N (%)	N (%)	
Marital status			
Female			0.696
Single	5 (50%)	5 (42%)	
Living with a partner	5 (50%)	7 (58%)	
Missing responses	0	3	
Male			0.893
Single	2 (25%)	2 (22%)	
Living with a partner	6 (75%)	7 (78%)	
Missing responses	2	2	
Living situation			
Female			**0.04**
Living alone	2 (25%)	5 (62%)	
Living with family or friends	5 (62%)	0 (0%)	
Living with a partner	1 (12%)	1 (12%)	
Living in supervised accommodation	0 (0%)	2 (25%)	
Missing responses	2	7	
Male			0.368
Living alone	2 (50%)	4 (57%)	
Living with family or friends	1 (25%)	3 (43%)	
Living with a partner	1 (25%)	0 (0%)	
Living in supervised accommodation	0 (0%)	0 (0%)	
Missing responses	6	4	
Education			
Female			0.825
No completed education	0 (0%)	0 (0%)	
9 years of school education completed	1 (11%)	1 (9%)	
10 years of school education completed	3 (33%)	3 (27%)	
>12 years of school education completed	5 (56%)	6 (55%)	
Not specified	0 (0%)	1 (9%)	
Missing responses	1	4	
Male			0.062
No completed education	0 (0%)	0 (0%)	
9 years of school education completed	0 (0%)	5 (50%)	
10 years of school education completed	3 (38%)	2 (20%)	
>12 years of school education completed	5 (62%)	3 (30%)	
Not specified	0 (0%)	0 (0%)	
Missing responses	2	1	
Professional training			
Female			0.856
Completed apprenticeship	4 (50%)	5 (63%)	
Completed academic studies	3 (38%)	2 (25%)	
No completed professional training	0 (0%)	0 (0%)	
Academic studies on-going	1 (12%)	1 (12%)	
Missing responses	2	7	
Male			0.094

(Continued)

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TABLE 7 (Continued)

	ADHD		
	No improvement	Improvement	*p*
	N (%)	N (%)	
Completed apprenticeship	4 (44%)	6 (67%)	
Completed academic studies	4 (44%)	0 (0%)	
No completed professional training	0 (0%)	2 (22%)	
Academic studies on-going	1 (11%)	1 (11%)	
Missing responses	1	2	
Children			
Female			0.098
Children	2 (20%)	1 (7%)	
No children	6 (60%)	4 (29%)	
Children not specified	2 (20%)	9 (64%)	
Missing responses	0	1	
Male			0.403
Children	2 (20%)	1 (10%)	
No children	4 (40%)	7 (70%)	
Children not specified	4 (40%)	2 (20%)	
Missing responses	0	1	
Labor situation			
Female			0.356
Unemployed	1 (10%)	0 (%)	
Employed	6 (60%)	7 (50%)	
Disables	0 (%)	0 (%)	
Retired	0 (%)	0 (%)	
Labor situation not specified	3 (30%)	7 (50%)	
Missing responses	0	1	
Male			0.566
Unemployed	2 (20%)	2 (20%)	
Employed	2 (20%)	5 (50%)	
Disables	1 (10%)	0 (%)	
Retired	1 (10%)	1 (10%)	
Labor situation not specified	4 (40%)	2 (20%)	
Missing responses	0	1	
Financial situation			
Female			0.883
Debts	1 (10%)	1 (7%)	
No debts	5 (50%)	6 (43%)	
Financial situation not specified	4 (40%)	7 (50%)	
Missing responses	0	1	
Male			0.472
Debts	1 (10%)	3 (30%)	
No debts	5 (50%)	3 (30%)	
Financial situation not specified	4 (40%)	4 (40%)	
Missing responses	0	1	

Marital status, children, living situation, education, professional training, labor and financial situation were assessed. N = number of participants for whom information was found in medical records. Percentages were calculated as (N/all N responded for a distinct category)*100. A Chi-squared test was used to compare sex-specific differences for the distinct categories and both patient sub-cohorts. Significant differences ($p < 0.5$) between groups are marked in bold.

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TABLE 8 Table revealing the results of the correlation analysis (Spearman correlation) between different sociodemographic characteristics and the results of the WHO-5 inquires (1–3) in patients diagnosed with ADHD, with or without improvement in the WHO-5.

	ADHD			
	Improvement in WHO-5		No improvement in WHO-5	
	Correlation coefficient *r*	*p*	Correlation coefficient *r*	*p*
Sex	0,05754	0,7,801	−0,675	**0.001**
Age	0,06731	0,7,439	0,2098	0,3,746
Marital status	0,3,447	0,126	−0,2,164	0,3,885
Living situation	−0,2,664	0,3,352	−0,2,727	0,3,852
Education	0,1816	0,4,308	0,1,581	0,5,381
Professional training	0,1,158	0,6,173	−0,2,444	0,3,283
Children	0,4,655	**0,0219**	−0,1,648	0,4,875
Labor situation	−0,05997	0,7,807	0,1,025	0,6,672
Financial situation	−0,01829	0,9,324	0,1,223	0,6,076

For both sub-groups absolute differences between results of the 2nd and 3rd WHO-5 inquiry were compared to the results of the 1st inquiry and correlated to sex, age, marital status, living situation, education, professional training, children, labor and financial situation. Provided are the correlation coefficients r for each category and the corresponding *p* values. The level of significance was set to $p < 0.5$.

in well-being on the WHO-5 index and a higher burden of psychopathology on the SCL-90-R in combination with a lower clinician-rated global functioning on the GAF and CGI scales at baseline. However, during the course of the study, patients with depression experienced a substantial improvement of well-being, while ADHD patients' well-being scores stagnated or even deteriorated on a group level. There was a statistically non-significant tendency of patients with ADHD to engage in less telemedical appointments than their depressed counterparts. However, patients with depression and participants with ADHD were equally satisfied with the treatment they received. Stratification of patients with ADHD according to the development of well-being during the study period revealed no differences in well-being, psychopathology and global functioning at baseline between patients with an improvement in well-being and those without. Hence, patients with ADHD who experienced improvement during telemedical treatment were not already less impaired at the beginning of treatment. The frequency of telemedical consultations was also evenly distributed between both groups of patients. Yet, ADHD patients with a lack of improvement or even a further decline of well-being during the study reported a higher load of depressive symptoms on the BDI-II than ADHD patients with a favorable treatment outcome. Furthermore, female patients with adult ADHD and patients living with children were more likely to experience an unfavorable treatment outcome.

Generally, quality of life is significantly reduced in patients with ADHD compared to their healthy peers (40). Depressive symptoms and traumatic childhood experiences seem to be important mediators of impairments of well-being among individuals with ADHD. Quality of life can be sustainably improved by evidence-based treatments in adult patients with ADHD, especially after early diagnosis (41). Correspondingly, in a recent, relatively small randomized controlled trial, a combination treatment with CBT and medication was superior in improving quality of life in adult patients with ADHD (42). However, another study found the negative impact of ADHD on quality of life was not significantly reduced in the presence of psychosocial treatment and/or medication among college students with ADHD (43). Whether quality of life can sustainably be enhanced by evidence based treatments in patients with ADHD over their entire lifespan is still an open question. In this context, it has to be noted, that ADHD patients referred to CIMH outpatient services are usually consistently offered evidence based treatments like psychoeducation, stimulant and non-stimulant medication, and/or cognitive behavioral therapy (CBT). Although ADHD is a chronic condition, these treatments reliably alleviate core symptoms of ADHD and improve patients' psychosocial functioning in the short term. Therefore, despite the chronic nature of ADHD, a stagnation or further decline of well-being among patients with ADHD on a group level in our study was somewhat unexpected. Roughly, one third of the ADHD patients in our sample had a comorbid depressive disorder. This might have had a considerable, detrimental impact on the recovery of these ADHD patients, as ADHD patients without improvement reported a higher burden of depressive symptoms on the BDI-II. Moreover, ADHD has been identified as a relevant factor concerning treatment resistance to antidepressants among patients with major depression and comorbid ADHD (44). Our analyses provide evidence that depressive disorders and a high burden of depressive symptoms might be important contributors to resistance to telemedical treatment among adult patients with ADHD. However, this has to be confirmed in larger, prospective trials.

Attention-deficit/hyperactivity disorder research on psychiatric treatment and support during the COVID19 pandemic has largely neglected adults, older adults and females as well as minority groups (12). On the contrary, especially among young adults and racially and ethnically minoritized subpopulations increases in mental-health related emergency department visits were seen during the COVID-19 pandemic (45). Of note, only recently specific needs as well as differences in psychopathology, social functioning, and developmental trajectories of girls and women with ADHD have been recognized more broadly (46).

On a general level, our findings basically corroborate results from an earlier study that found female children and adolescents with a mental illness during the COVID-19 pandemic to be at a higher risk for psychological burden than their mentally healthy peers (47). Yet, in contrast to their adult counterparts in our study, this effect was less

pronounced in individuals with ADHD compared to patients with a depressive disorder. This highlights the need for future studies, specifically addressing the needs of adult female patients with ADHD, since they had the worst treatment outcome in our study. Current long-term data suggest that women diagnosed with ADHD during childhood had impairing problems 17 to 20 years later while rates of remission were relatively low (48). This also confirms results of earlier studies (49–51). Moreover, women with ADHD are at an increased risk of accidents and unintentional injuries, with a higher risk for mild incidents and the same pattern of severe incidents throughout the lifespan compared with men affected by ADHD (52). Women with ADHD display dynamics of emotional dysregulation comparable to female patients with borderline personality disorder, featuring similar levels of symptom intensity and psychopathological instability (53). In fact, severe emotional dysregulation characterizes a cluster of adult ADHD patients associated with significant impairments like depressive mood, negative affect, and elevated psychological distress (54). Remarkably, these patients reported a significantly higher global impairment on the SCL-90-R and elevated BDI scores. Lastly, women were overrepresented in this cluster of adult patients with ADHD. Although we did not screen for emotional dysregulation, this is in line with major findings in our own sub-cohort of adult ADHD patients with insufficient response to telemedical treatment. Therefore, it may be speculated that emotional dysregulation could be a crucial transdiagnostic factor, predicting negative treatment outcomes in women with ADHD. However, prospective studies in larger cohorts of patients with neuropsychiatric disorders are needed to validate this hypothesis.

In this context, it has to be emphasized that the presence of depressive symptoms on the BDI-II does not necessarily imply the clinical diagnosis of depression (55). Furthermore, perceived stress could be an important mediator between ADHD symptomatology and the emergence of depressive symptoms on the BDI-II (56). This could partly explain the correlation of negative treatment outcomes with elevated BDI-II scores in the absence of clinically diagnosed depression in adult patients with ADHD under pandemic conditions in our sample. Conversely, we cannot exclude the possibility, that patients diagnosed with a depressive disorder during telemedical treatment also suffered from hitherto undiagnosed ADHD, which could not easily be confirmed according to current guidelines during acute depression. However, the prevalence of ADHD among patients with the main clinical diagnosis of a depressive disorder was very low in our sample. As ADHD has a strong genetic foundation, it is often present throughout multiple generations of a family (57). Thus, it can be hypothesized, that patients with ADHD in our study might have had a higher risk of having children affected by ADHD as well. Conversely, during the COVID-19 pandemic, caring for children with ADHD could have contributed to a deterioration of parental mental health (58). This could partially explain why adult ADHD patients living without children were less susceptible to a negative response to telemedical treatment in our sample. Furthermore, several studies have shown, that in particular women were affected by a heavy overburden of domestic and family care during the COVID-19 pandemic (1). In part, this could also explain the unfavorable outcome for women and other participants of our study living with children, resulting in reduced time resources for self-care and telemedical psychiatric counseling sessions.

Finally, the results of our study overall corroborate earlier findings that remote communication for psychiatric assessment and treatment during the COVID-19 pandemic was found useful, effective, reliable and satisfactory by adult patients with ADHD (59), albeit "less deep" (60). Nevertheless, subjective satisfaction with telemedical treatment did not correspond with successful treatment in our patient cohort.

There are several limitations that have to be taken into account concerning the interpretation of the above mentioned data. Due to the pandemic situation, a randomization of participants to different treatment modalities (face to face vs. telemedicine) was not feasible. Furthermore, treatment choices were purely guided by patients' preferences and experienced clinicians' advice and experience. Thus, heterogeneity in treatment modalities during the course of telemedical treatment, e.g., the administration of behavior-therapy oriented and mindfulness-based interventions vs. generic counseling in combination with psychopharmacological treatment, cannot be excluded. Furthermore, women with mental disorders may have higher odds of COVID-19 infection than males with the strongest gender disparity for ADHD (61). Participants in our study were not routinely screened for their history of confirmed COVID-19. Thus, we cannot rule out that female patients with ADHD in our sample were more often exposed to COVID-19 infections and possible sequelae like long COVID-19 (62). As patients had to give informed consent before enrollment in the study, the sample might not be fully representative of a naturalistic patient cohort due to selection effects. The considerable amount of missing values found in our study is also suggestive of selection effects. In this line, it cannot be excluded that patients with the highest burden of symptoms and the lowest level of functioning dropped out of our study at an early stage of treatment, enriching the study population for individuals with less psychopathology and a higher level of functioning. Although the latter does not apply for the ADHD patients of our sample, it may, on the other hand, be speculated that ADHD patients who experienced a rapid improvement stopped treatment and therefore were not available for follow-up surveys. Lastly, the results of our study need to be replicated in larger patient samples, although our findings are currently plausibly extending previous data. With respect to our findings in patients with ADHD, the limited number of cases precludes any definite conclusions concerning the effectiveness of telemedical interventions in this group of patients.

5. Conclusion

When assigning adult patients with ADHD to telemedical treatment options in clinical practice, special attention needs to be paid to monitoring the development of symptomatology and treatment outcomes. A change to face to face treatment should be a low-threshold offer despite patients' subjective satisfaction with telemedical treatment modalities. Women with ADHD, patients living with children and ADHD patients with a high load of depressive symptoms and/or diagnosed with a depressive disorder might not respond adequately to telemedical treatment. Therefore, such treatment options should be considered with caution during the treatment of patients with the aforementioned characteristics.

Future cross-sectional and longitudinal research should focus on sex differences in ADHD symptoms and treatment outcomes and the development of responsive interventions (63), aiming at more individualized treatment plans in terms of a "precision medicine" (64). Furthermore, prospective investigations should examine the effects of telemedical treatment in larger, representative samples of patients. Especially the transdiagnostic evaluation of treatment effects, e.g., comparing participants with Autism Spectrum Disorder (ASD) to individuals with anxiety disorders, could be of particular interest. This could also substantiate our current findings in a still relatively low number of cases.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Ethics committee II of the medical faculty Mannheim, University of Heidelberg approved under license no. 2020-562 N. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

A-SW and PP designed the study. TR, PP, and A-SW acquired the data. AB developed the online survey tool. A-SW and TP analyzed the data. OH, HT, and AM-L advised and discussed the data. PP, TP, and A-SW wrote the manuscript with the help of all authors. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1193898/full#supplementary-material

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The construct validity of an abridged version of the general self-efficacy scale for adults with attention-deficit/hyperactivity disorder

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Objectives: The General Self-Efficacy (GSE) scale is a validated self-rated questionnaire increasingly used in mental health research. However, despite several psychometric advantages of the GSE scale, its validity in those diagnosed with attention-deficit/hyperactivity disorder (ADHD) has not yet been examined. Moreover, a shorter version of the GSE scale would contribute to a more rational use of resources in extensive multivariate studies. Therefore, as self-rated scales to measure self-efficacy in this population are lacking, the current study aims to develop a condensed version of the GSE for adults with ADHD.

Methods: A group of patient collaborators (user representatives) from an ADHD organization and health professionals shortened the original 10-item GSE scale to six items and evaluated the content validity of the revised scale. Second, 525 potential participants were invited to participate in a cross-sectional study conducted in 2021 (between January 19th and February 7th). Of them, 403 filled out the GSE-6 for ADHD and two scales measuring psychological well-being and mental health (the five-item World Health Organization Well-Being Index, WHO-5, and the four-item Patient Health Questionnaire, PHQ-4). The psychometric properties of the new scale were examined, testing *a priori* formulated hypotheses.

Results: The brief GSE-6 for ADHD displayed good internal consistency with a Cronbach's α of 0.907. No floor or ceiling effect was detected. Exploratory and confirmatory factor analyses supported a one-factor structure. The GSE-6 also showed a moderate positive correlation with the WHO-5 ($r_s = 0.578$) and a moderate negative correlation with the depression and anxiety rating scale PHQ-4 ($r_s = -0.595$).

Conclusion: The 6-item GSE for ADHD was evaluated to have good content validity. The scale demonstrated good psychometric properties. The results indicate that the GSE-6 may help assess self-efficacy in adults with ADHD.

KEYWORDS

attention deficit disorder with hyperactivity (ADHD), self-efficacy, mental disorders, reliability, validation, psychometrics, adults

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopment condition characterized by inattention, impulsivity and hyperactivity (1). In addition, recent studies have shown that the prevalence of this disease among children is, on average 2.2%, with a wide range of the country's income level from 0.1 to 8.1% (2). At the same time, the prevalence of ADHD among adults was even higher and amounted to 2.8% (the prevalence also depended on the country's income level), and 57% of the adults surveyed had a history of ADHD in childhood (2). However, despite these indicators, adult ADHD in Europe is still underdiagnosed and undertreated (3, 4). Moreover, ADHD is associated with psychosocial impairment, including a lower likelihood of finishing higher education, and work-related difficulties (5, 6). People with ADHD have a higher risk of accidents and drug and alcohol abuse (7, 8). Further, ADHD has a high comorbidity with other psychiatric conditions, such as anxiety and depression (9). Evidence indicates that those with ADHD also have lower psychological protective factors, such as self-efficacy (10, 11).

Self-efficacy is understood as a person's belief in the ability to control the complex demands of the environment through adaptive actions (12). Self-efficacy may be conceptualized as a protective factor when facing stressors. Studies have shown that self-efficacy strongly predicts self-management abilities, such as coping behaviors, performance, and perseverance in complex challenges (13, 14). Furthermore, higher self-efficacy may be associated with less psychological distress following daily stress (15). Therefore, an individual's perceived self-efficacy may be critical for how well they cope with psychiatric symptoms or mental disorders. In support of this, self-efficacy has also been found to predict better physical health outcomes (16) and mediate the association between stressful life events and depression (17). Higher self-efficacy in those with chronic diseases has also been found to reduce the risk of depression, and a longitudinal study revealed that those with high self-efficacy were less likely to have had a major depressive disorder over the 6-year study period (18).

For adults with ADHD, higher self-efficacy is also associated with lower parenting stress (19). Self-efficacy may also be vital for individuals with ADHD seeking treatment or other mental health care. For individuals with ADHD, increased self-efficacy may lead to an increased belief that one can deal with everyday challenges frequently experienced by adults with ADHD through one's actions (10). Self-efficacy has a critical role in changing lifestyle, such as adopting a new behavior, maintaining motivation and reinforcing new behavior, including overcoming possible failures (12). For clinicians, these are all critical processes in clinical work with patients with ADHD (11).

Self-report questionnaires with good psychometric abilities are needed to measure self-efficacy. According to Mokkink et al. (20), psychometric assessment of instruments is critical, as it affects the results that determine treatment tactics, and the use of invalid instruments can lead to distorted results (21). The General Self-Efficacy (GSE) questionnaire was initially developed by Jerusalem and Schwarzer in 1979 as a self-assessment scale with 20 items. Later the scale was reduced to 10 items (GSE-10) (22). The GSE-10 has been translated into several languages and displays good psychometric properties (23). The GSE-10 has been validated in mental health settings among psychiatric outpatients in Spain (24) and individuals with schizophrenia in China (25). In addition, the GSE scale has been demonstrated as a positive predictor of improved mental health (26) and a mediator between self-management (health literacy) and healthy habits (27).

The GSE-10 has been used to measure self-efficacy in mental health settings (24, 25) and in adults with ADHD (28, 29). However, due to the attention difficulties experienced by those with ADHD, short scales with as few items as possible are preferable in clinical contexts. Moreover, in research settings, response burden is frequently mentioned as a concern when conducting studies, suggesting the pragmatic need to reduce the number of items (30). Item reduction is also crucial because participants must often complete multiple self-report measures to save time and reduce their burden (30, 31).

Previous studies have reduced the number of items of the GSE. Romppel et al. (31) developed a six-item version of the GSE scale validated in a nonclinical sample and a sample of patients at risk for heart failure. The results of the research demonstrated good internal consistency of the scale (Cronbach's alpha was between 0.79 and 0.88), good test–retest reliability ($r = 0.50$ and 0.60 after 12 and 28 months, respectively), a positive correlation of the scale with social support and mental health, and a negative correlation with symptoms of depression and anxiety. Bonsaksen et al. (32) developed a seven-item version of the GSE scale and tested its validity on adult Norwegians suffering from morbid obesity. These validation studies demonstrated adequate psychometric properties (31, 32), which support that the GSE is suitable as a brief scale. Even though a short version of the GSE could serve as a valuable, brief, and easily administered self-report scale to measure self-efficacy in adults with ADHD, studies which include the patients' view of burden concerning the answering the GSE are lacking. In addition, there are no studies to support whether adults with ADHD consider the GSE-scale valuable.

However, in order to adapt a brief version of the GSE-10 tailored to individuals with ADHD, we used an expert panel of adults with ADHD and health professionals to guide the selection of appropriate items. The first aim of this study is to develop and validate a short six-item version of the GSE by involving adults with ADHD and user representatives from the Norwegian user-led ADHD organization. The second aim is to examine the construct validity and scale internal consistency of the revised GSE-6 questionnaire in a sample of adults diagnosed with ADHD.

2. Methods

2.1. Study 1: Development of an abridged version of general self-efficacy-6 for attention-deficit/hyperactivity disorder

When planning and conducting this validation study, we followed the methodology proposed by the Consensus-based Standards for the Selection of Health Measurements Instruments, COSMIN (20), and the Strengthening the Reporting of Observational Studies in Epidemiology, STROBE (33). The development of the condensed version of the GSE-6 for the ADHD scale followed two phases.

2.1.1. Phase 1

In the first phase, we reduced the number of items from 10 to six. This stage was conducted in collaboration with five health professionals (two nurses, one psychiatrist and two psychologists) and user representatives from Norwegian ADHD organization – Vårres Regional User-led Center Mid-Norway. The reduction of items was based on consensus reached through group discussions by the health professionals and the user representatives (34). The role of user representatives was to explore the content validity of the items on the brief scale, review their relevance, and provide feedback about the scale's language, ease of use, and interpretability.

2.1.2. Phase 2

In the second phase, adults diagnosed with ADHD evaluated the experience of answering the GSE-6 by completing the QQ-10. In this phase, 18 adults from the Norwegian ADHD user-led organization were invited to participate, and 16 participants completed the questionnaires.

2.1.3. Participants, procedures, and measures

The 16 recruited adults completed a paper version of the GSE-6 scale and QQ-10. On average, the testing group took 1 to 2 min to complete the GSE-6 scale. Data collection did not include names or other direct identifiers to ensure anonymity and confidentiality. Data were stored as an anonymous SPSS file. The SPSS file was accessible to authorized researchers and was protected with a two-factor authentication login system.

2.1.4. QQ-10

The QQ-10 is a10-item questionnaire designed to assess the opinion of patients about their experience using questionnaires during medical care. It includes a five-point Likert scale relating to the subject's agreement with statements about their experience using the questionnaire (35). In the present study, two responses are produced with this tool: positive value (communication, relevance, ease of use, comprehensiveness, pleasantness and willingness to repeat) and negative burden (excessively long, too simple questions, complicated, and upsetting). The score ranges from 0 to 4 for both domains. Then, raw scores are converted on a scale from 0 to 100 (where 0 is defined as the worst value, and 100 is defined as the best possible representation of the questionnaire) (36). In this research, Cronbach's $\alpha = 0.866$ for the "value" domain and 0.760 for the "burden" domain.

TABLE 1 Hypotheses testing and results.

Hypotheses	Results	Decision
Internal consistency: Cronbach's $\alpha > 0.7$ for GSE-6	Cronbach's $\alpha = 0.907$ [95% CI 0.892–0.920]	Accepted
No floor or ceiling effect (less than 15% of patients have extreme scores)	0.5% of cases obtained the minimum score; 6.5% of cases obtained the maximum	Accepted
GSE-6 for ADHD has a unidimensional structure	One-factor structure, eigenvalue = 4.624, RMSEA = 0.101 [90% CI 0.073–0.131], CFI = 0.994, TLI = 0.991, SRMR = 0.030	Accepted
Positive correlation between GSE-6 for ADHD and WHO-5	Spearman's $r_s = 0.578$	Accepted
Negative correlation between GSE-6 for ADHD and PHQ-4	Spearman's $r_s = -0.595$	Accepted

2.1.5. Statistical analysis

The SPSS (SPSS v. 28, IBM Corp., Armonk, NY, United States) was used for statistical analysis. Mplus version 8.8 (37) was used to conduct exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The results of the QQ-10 were evaluated using descriptive statistics, including the mean, frequency, standard deviation (*SD*), and percentage.

2.2. Study 2: Validation of the general self-efficacy-6

The construct validity, reliability, and floor or ceiling effects were investigated using predefined hypotheses (Table 1). We assessed the internal consistency for the GSE-6 for patients with ADHD using Cronbach's α and evaluated the floor or ceiling effects. We evaluated the correlation between self-efficacy, well-being, and self-reported depression using Spearman's r_s between GSE-6, the five-item well-being scale (WHO-5), and the four-item Patient Health Questionnaire (PHQ-4). Moreover, we assessed structural validity using EFA and CFA. The procedure for validating the GSE-6 for ADHD was based on an earlier validation study of the WHO-5 (38).

2.2.1. Hypothesis testing

We defined the following *a priori* hypotheses based on previous studies:

1. The internal consistency for GSE-6 is more than acceptable: We expected a Cronbach's $\alpha > 0.7$ for GSE-6 (39);
2. Floor or ceiling effect: We expected no floor or ceiling effect (less than 15% of patients have extreme scores) (40);
3. Factor structure: We expected the GSE-6 to have a one factor structure (24);

4. Correlation with well-being: We expected the GSE-6 to be positively correlated (Spearman's r_s) with the WHO-5 scale (41);
5. Correlated with mental health problems: We expected the GSE-6 to be negatively correlated (Spearman's r_s) with the PHQ-4 scale (42).

2.2.2. Participants, procedures, survey elements and measures

We recruited Norwegian-speaking adults by sending an email invitation to 525 potential participants registered in the Norwegian ADHD user-led organization. Participants were asked to send the e-mail invitation and the web link to other possible participants, and the link was also shared via social media (Vårres Regional User-led Center Mid-Norway). On the first page, participants read an online consent form, providing information about data storage policies and outlining the study purpose, survey length, and data use. By clicking "I agree," the participants confirmed that they had read the information about the validation study and that they agreed to participate. A total of 403 adults consented to participate, and data from these were used in further analyses.

Several precautions were taken to ensure anonymity and confidentiality. No identification list was created, and data collection did not include names, IP addresses, or other direct identifiers. In addition, to avoid multiple responses from the same individual, the survey settings were set to refuse responses from the same IP addresses. Data were stored as an anonymous SPSS file. The SPSS file was protected with a two-factor authentication login system.

2.2.3. Survey elements and measures

The self-rated survey took 15 min to complete using Questback software. Data were collected from January 19 to February 7, 2021.

2.2.4. Data collection and measures

Participants reported demographic data, including gender, educational level, age, marital and work status.

2.2.4.1. General self-efficacy-6 for attention/deficit-hyperactivity disorder (GSE-6 for ADHD)

The GSE-6 items for ADHD (Section 3.1 provides an overview of the items) were ranked in the same way as the GSE-10 using a four-point scale from 1 ("not at all true") to 4 ("exactly true"). The total score ranged from six to 24, where the minimum score equals the lowest level of general self-efficacy, and the higher score equals the highest level.

2.2.4.2. The five-item world health organization 5-item well-being index (WHO-5)

The WHO-5 is a reliable self-assessment tool comprising five items that evaluate different dimensions of well-being. Participants respond to statements such as "I have felt cheerful and in good spirits," "I have felt calm and relaxed," and "I have felt active and vigorous" using a scale ranging from 0 (indicating "at no time") to 5 (indicating "all the time") (38). The scale's scoring ranges from zero, representing the lowest level of perceived well-being, to 25, reflecting a higher perception of well-being. The validity of the WHO-5 has been previously confirmed through validation with a Norwegian sample (38). Its Cronbach's α is 0.868 in our study.

Well-being encompasses a spectrum of emotional aspects that can significantly impact an individual's self-efficacy beliefs. Recent studies have highlighted a notable link between self-efficacy and subjective well-being (40, 41, 43). Furthermore, it has been reported that high levels of well-being are associated with increased self-efficacy (44). When establishing the convergent validity of the self-efficacy scale, our working hypothesis was that self-efficacy would demonstrate a positive correlation with well-being.

2.2.4.3. Patient health questionnaire for depression and anxiety (PHQ-4)

PHQ-4 (45) is an ultra-brief instrument comprising four items that assess self-reported symptoms of depression and anxiety. Specifically, two of the items focus on depressive symptoms ("Over the last 2 weeks, how often have you been bothered by the following problems?": 'Feeling down, depressed, or hopeless' and 'Little interest or pleasure in doing things'), while the other two items pertain to anxiety symptoms ("Over the last 2 weeks, how often have you been bothered by the following problems?": 'Feeling nervous or anxious or on edge' and 'Not being able to stop or control worrying'). Participants provide responses on a 0–3 Likert-type scale, where zero corresponds to "not at all" and three corresponds to "nearly every day." A higher total score indicates more severe symptomatology. The PHQ-4's validation has been previously demonstrated using a Norwegian sample (45, 46). Its Cronbach's α is 0.865 in the present study.

Both self-efficacy and anxiety are rooted in an individual's beliefs regarding their health and capabilities. Research has indicated a relationship between self-efficacy and mental health issues (31, 40, 42, 47). Therefore, when establishing convergent validity, our underlying hypothesis was that self-efficacy would exhibit a negative correlation with mental health problems.

2.2.5. Statistical analysis

Data cleaning and initial statistical analysis for Study 2 were conducted using SPSS (SPSS v. 28, IBM Corp., Armonk, NY, United States). The data contained no missing values. Descriptive statistics include the mean, frequency, SD, and percentages. We also calculated floor or ceiling effects, and this was implied if more than 15% of participants obtained the highest or lowest score, respectively (48). Spearman's rho was used for correlations between GSE-6 and other measures. To assess internal consistency, we used Cronbach's alpha. A value more than 0.7 has been suggested to indicate satisfactory internal consistency (20, 49).

An exploratory factor analysis (EFA) with Oblique Geomin rotation was conducted to assess the factor structure of the GSE-6. Criteria for conducting the EFA were: a sufficiently large sample size, which includes at least 400 participants for conducting EFA (50, 51), a correlation matrix with at least some correlation coefficients at or above $r \geq 0.3$, a significant Bartlett's test of sphericity ($p < 0.05$), a Kaiser–Meyer–Olkin ≥ 0.6, and normally distributed data without outliers (52).

Given the six-items, and that it is recommended that factors have three indicators each (52), the EFA was predefined to compare a one-factor and a two-factor solution. The decision on the number of factors to extract was based on several criteria: The Kaiser criterion of eigenvalues >1.0, inspection of scree plot, parallel analysis, and a

theoretical consideration of the content of the indicators. In addition, several fit indices were applied to indicate model fit: Standardized Root Mean Square Residual; SRMR (53) values less than 0.8, Root Mean Square Error of Approximation; RMSEA (54) values below 0.05 to indicate close fit, values between 0.05 and 0.08 to indicate fair fit and values between 0.08 and 0.10 (with the upper 95% confidence interval equal to or below 0.10) to indicate poor fit. The Comparative Fit Index (CFI) should be greater than 0.90 and non-Normed Fit index (Tucker-Lewis index; TLI) greater than 0.95 (54) to indicate good fit. The CFA model was defined as a one-factor solution without correlated error terms, using the same fit indices as for the EFA. To allow for test of measurement invariance between gender, seven participants who did not report their gender as woman or man were excluded from the analysis, thus n = 396 were included in the CFA. Measurement invariance was tested in a stepwise manner. Configural invariance was supported if the number of factors and indicator-factor patterns were equal across groups. For metric invariance factor loadings were constrained equal across groups and for scalar invariance the factor loadings and thresholds were constrained equal. Nested models were compared with the Mplus DIFFTEST option (37). In addition, models were evaluated in terms of change (Δ) in fit indices, with $\Delta CFI \geq -0.01$ and $\Delta RMSEA < 0.015$ as threshold values, as recommended by Chen (55). The Weighted Least Squares Means and Variance adjusted (WLSMV) estimator was used for both EFA and CFA, due to the ordinal Likert scale of the GSE-6.

3. Results

3.1. Results for study 1

3.1.1. General self-efficacy-6 for attention-deficit/hyperactivity disorder

The following items from the GSE-10 were retained in the revised GSE-6 for adults:

Item 1: "I am confident that I could deal efficiently with unexpected events" (GSE-10 Item 4).

Item 2: "Thanks to my resourcefulness, I know how to handle unforeseen situations" (GSE-10 Item 5).

Item 3: "I can solve most problems if I invest the necessary effort" (GSE-10 Item 6).

Item 4: "I can remain calm when facing difficulties because I can rely on my coping abilities" (GSE-10 Item 7).

Item 5: "When I am confronted with a problem, I can usually find several solutions" (GSE-10 Item 8).

Item 6: "I can usually handle whatever comes my way" (GSE-10 Item 10).

3.1.2. QQ-10 results

The QQ-10 results for the GSE-6 for ADHD scale revealed that the mean was 77% (*SD* = 18.3) for the "positive value" domain, and 18% (*SD* = 13.8) for the domain "negative burden." The mean for each individual item assessing positive value was more than 2 (range 2.63 to 3.69 – raw values), that is, the participants primarily answered, "Mostly agree" and "Strongly agree" to questions from the value domain. For the negative burden domain, the mean was less than or equal to 2 (0.63 to 2.00), which means that the participants primarily chose the response options "Mostly disagree" and "Strongly disagree" when answering the burden domain questions. In the second burden domain, the only item that received a mean of 2.00 was Item 8, reflecting that the questions in the GSE-6 for ADHD were "too simple" for participants. The distribution of QQ-10 responses for the positive value domain and the negative burden domain is presented in Figure 1.

3.2. Results for study 2

The results of the hypothesis testing are presented in Table 1.

3.2.1. Sample characteristics

A total of 403 participants (287 women and 109 men) consented to participate and completed the survey. Table 2 presents the socio-demographic characteristics of the sample. There were no missing responses in the dataset. Descriptive statistics of the GSE-6 items for ADHD are presented in Table 3. The mean raw score of the scale was 16.97 (*SD* = 3.807). The distribution of total score for the GSE-6 for ADHD for the sample was normal and is provided in Figure 2. Item distribution for GSE-6 for ADHD is displayed in Figure 3. No floor or ceiling effects were present in the data. The minimum score was achieved by only two participants (0.5%), and the maximum score was achieved by 26 participants (6.5%).

3.2.2. Factor structure

The EFA supported a one-factor solution by several criteria. One factor had an eigenvalue above 1 (4.624), and inspection of the scree plot and parallel analysis also suggested one factor to be extracted, see Figure 4. The fit indices for a one-factor solution were RMSEA = 0.101 [90% CI 0.073–0.131], CFI = 0.994, TLI = 0.991, SRMR = 0.030. The fit indices were in the acceptable range except for the RMSEA.

The EFA also tested a two-factor solution, which reported item 1 and item 2 to load on factor 1 and the four remaining items to load on factor 2. This model gained following model fit indices: RMSEA = 0.035 [90% CI 0.000–0.089], CFI = 1.000, TLI = 0.999, SRMR = 0.011. However, based on the Kaiser criterion of eigenvalues to exceed 1, inspection of scree plot and parallel analysis, that only two indicators loaded on factor 1, and that the two-factor solution was not considered theoretically meaningful, we decided to retain the one-factor solution.

The one-factor solution obtained in the EFA was tested in a CFA in a sample where participants with unknown gender had been removed, to further allow for test of measurement invariance across men and women. The CFA showed acceptable fit indices: RMSEA = 0.097 [0.069–0.127], CFI = 0.995, TLI = 0.992, SRMR = 0.018.

In test of measurement invariance, the model was first fitted separate to women and men (Table 4). Fit indices indicated good model fit, except for the RMSEA for men which was above 0.10. However, as the RMSEA has been demonstrated to indicate worse fit in models with small df and low sample size (56), and because the CFI, TLI and SRMR values were in the acceptable range, we proceeded to test for measurement invariance in the complete sample. Configural invariance was achieved as the one-factor structure had adequate model fit in both samples. The metric model with factor loadings constrained equal across women and men did not show deterioration in fit indices and was retained. In the final step factor loadings and

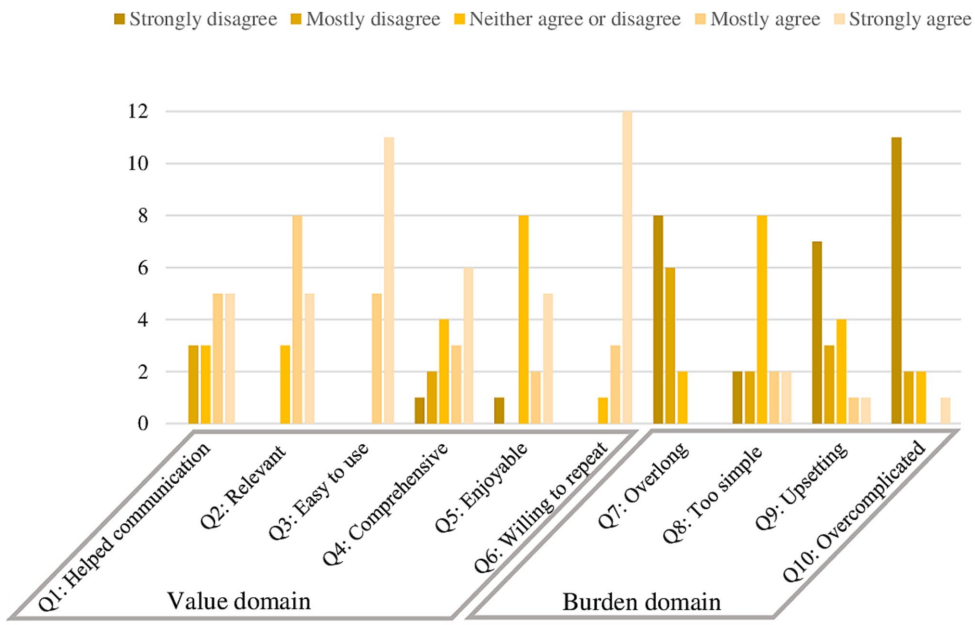

FIGURE 1
Items' distribution QQ-10.

item thresholds were constrained equal across women and men to test scalar invariance. This latter model showed a slight deterioration in the fit indices, but this change was considered marginal, and the model was retained.

3.2.3. Internal consistency

The GSE-6 for ADHD demonstrated good internal consistency among adults in a Norwegian sample (Cronbach's α coefficient equal to 0.907 [95% CI 0.892–0.920]) (57). In the inter-item correlation matrix, the corrected item-total correlation ranged from 0.668 to 0.805. Cronbach's α coefficient if an item was deleted was counted for each item and ranged from 0.881 to 0.901. More information is provided in Table 4.

3.2.4. Correlation between scales

As hypothesized, we found a moderate positive correlation of the GSE-6 and WHO-5 ($r_s = 0.578$, $p < 0.001$) and a moderate negative correlation between the GSE-6 and PHQ-4 ($r_s = -0.595$, $p < 0.001$). Correlation coefficients are presented in Table 1. The mean and *SD* of the WHO-5 and PHQ-4 are listed in Table 2.

4. Discussion

The purpose of this study was to develop and validate a condensed version of the GSE scale to assess the overall self-efficacy in adults with ADHD. We developed a six-item version of the GSE-10 by reducing it and retaining the six items deemed most relevant for adults with ADHD by an expert panel including individuals with ADHD and mental health professionals.

Face validity was assessed using QQ-10 questionnaire. The value domain received is comparable to other studies that used QQ-10 to validate measurement scales (36, 58–61). Item 3 obtained the highest mean in the value domain of the QQ-10, indicating that the testers found the new measuring tool easy to use. The burden domain also received a value comparable to other studies (35, 36, 58, 61, 62). Only 16 raters completed the QQ-10, which is a relatively small group of evaluators. However, the QQ-10 evaluation of the GSE-6 for ADHD indicates promising results, as the scale was easy-to-administer and user-friendly, revealing that the participants had a pleasant experience using the GSE-6 for ADHD.

We evaluated the reliability of the GSE-6 for ADHD, finding good quality data without missing values. The questionnaire demonstrated good internal consistency, which is in line with previous studies of the GSE-10, with Cronbach's α values ranging from 0.78 to 0.95 (22, 24, 40, 41, 63–67). Correlated item-total correlation in various studies ranged from 0.25 to 0.63 (41) and 0.36 to 0.52 (22) to 0.63 to 0.73 (67). Our scale displayed higher values of this parameter, from 0.668 to 0.805. In addition, the results did not find an increase in Cronbach's α if any of the items were removed, consistent with the results for the GSE-10 scale reported by Dahlberg et al. (65). This finding demonstrates that the reduction from 10 to six items did not deteriorate the internal consistency, and that the six retained items form a reliable scale.

Using EFA and CFA, a one-factor solution was favored based on several criteria. Most previous studies evaluating the factor structure of the GSE-10 have supported a one-factor structure (22–24, 40, 41, 63–67). The results of this study align with these previous findings, and it is promising that the brief GSE-6 for ADHD has the same factor structure as the 10-item scale. The eigenvalue corresponds to other studies of the GSE-10, which have ranged from 4.9 (68) to 6.96 (39, 40). The EFA factor loadings of the indicators in this study ranged from 0.772 to 0.936, which is equal to or somewhat higher than in previous studies (24, 41, 64). Test of measurement invariance indicated that configural, metric and scalar invariance was supported across men and women. However, as the low sample size did not allow for

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TABLE 2 Descriptive statistics and socio-demographics of respondents.

Characteristics	Frequency (*n*)	Percentage (%)
Gender		
Female	287	71.2
Male	109	27
Do not want to answer	7	1.7
Total	403	
Age		
18–24	35	8.7
25–29	42	10.4
30–34	51	12.7
35–39	60	14.9
40–44	80	19.9
45–49	57	14.1
50–54	40	9.9
55–59	21	5.2
60–64	8	2.0
Over 65	9	2.2
Total	403	
Marital status		
Not married	109	27
Married/have partner	250	62
Divorced/separated	40	9.9
Widow/widower	4	1
Total	403	
Educational level		
Primary/secondary school	159	39.5
High school/ up to 3 years of university	157	39.0
Master's degree or more	87	21.6
Total	403	
Work status		
Student	56	13.9
Paid work	220	54.6
Sick leave	62	15.4
Welfare benefits	10	2.5
Other	55	13.6
Total	403	
Descriptive statistics	Mean	SD
WHO-5 (0–25)	10.72	5.03
PHQ-4 (0–12)	5.53	3.31

splitting the data, the EFA, CFA and test of measurement invariance were conducted on the same sample. This is discouraged due to risk of overfitting or inflated model fit indices (69). Moreover, although most fit indices indicated satisfactory model fit for the CFA and test of measurement invariance, the RMSEA exceeded recommended thresholds. The results should, therefore, be considered tentative and must be replicated in studies with larger samples.

The construct validity of the GSE-6 for ADHD was assessed by investigating the correlation with other relevant measures. A negative moderate correlation between the GSE-6 for ADHD and depressive affect/anxiety measured with the PHQ-4 corresponds to previous studies. Luszczynska et al. (42) conducted a validation study of GSE-10 on 1933 participants from Poland, Germany and South Korea, and found a negative correlation of GSE-10 with negative affect. Nilsson et al. (40) also found a negative correlation between GSE-10 and depressive symptoms ($r = -0.42$). Another Norwegian study in line with our results was conducted by Leganger et al. (41). In this study, a negative correlation was also found between the GSE-10 scale and negative affect ($r = -0.21$) (41). The negative correlation between GSE-6 and PHQ-4 is also in line with those reported by Romppel et al. (31). The assessment of depression symptoms in their study was conducted using the PHQ-9 scale, where the correlation with GSE was −0.35. The study also used the Hospital Anxiety and Depression Scale (70), where the correlation was −0.35 with the anxiety domain, and − 0.45 with the depression domain. The correlation between the GSE-6 for ADHD and PHQ-4 in this study is stronger than those obtained by Romppel et al. (31). However, in this study we used the PHQ-4, which measures anxiety and depression combined; thus, the difference in correlation coefficients may be because we did not assess anxiety and depression separately.

A positive moderate correlation between general self-efficacy and well-being measured with the WHO-5 is consistent with previous studies (41, 42, 63). However, our results exhibited a stronger positive correlation of general self-efficacy and well-being compared to previous studies. This outcome can be explained both by the variety of scales used to measure well-being, and by the fact that an adult ADHD population may have unique characteristics compared to other studied populations. In general, the results support previous research that has found a positive relationship between general self-efficacy and well-being (41, 42, 63). This relationship is particularly pronounced in patients with ADHD, confirming the need to pay more attention and resources on the development of self-efficacy in this group of patients.

Romppel et al. (31) also validated a six-item version of the GSE-10 in a sample of patients at risk for heart failure. In their study, they kept GSE-10 Items 2, 3, 4, 5, 7, and 10. The decision on what items to select was different than in the present study. Romppel et al. (31) selected six items based on the highest coefficient of variation and good discrimination of participants at different levels of self-efficacy. Bonsaksen et al. (32) developed the GSE-7 (general self-efficacy scale consisting of 7 items), which uses items 4 to 10 from GSE-10. The scale was developed for the Norwegian adult population with morbid obesity, and the Rasch model was used to select the items (32). Their scale also displayed a unidimensional structure, explaining 64.5% variance. In the present study, based on the consensus reached in an expert panel of adults with ADHD and mental health professionals, we kept the GSE-10 items number 4, 5, 6, 7, 8, and 10. The two GSE-6 scales for adults with ADHD and those at risk for heart failure were constructed with different items from the GSE-10, complicating the direct comparison between these two scales. The GSE-6 for ADHD and GSE-7 differ in only one item, Item 9; however, we believe that, for patients with ADHD, a decrease in one item can play a significant role in the perception of the face validity of the scale.

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TABLE 3 Characteristics of individual items of the GSE-6 for patients with ADHD.

Item	Mean	*SD*	Factor loading	Correlated Item-total correlation	Cronbach's α if item deleted
Item 1: "I am confident that I could deal efficiently with unexpected events"	2.73	0.797	0.936	0.805	0.881
Item 2: "Thanks to my resourcefulness, I know how to handle unforeseen situations"	2.80	0.809	0.919	0.797	0.882
Item 3: "I can solve most problems if I invest the necessary effort"	3.11	0.723	0.772	0.668	0.901
Item 4: "I can remain calm when facing difficulties because I can rely on my coping abilities"	2.57	0.845	0.871	0.772	0.886
Item 5: "When I am confronted with a problem, I can usually find several solutions"	2.92	0.707	0.783	0.682	0.866
Item 6: "I can usually handle whatever comes my way"	2.84	0.716	0.846	0.739	0.891

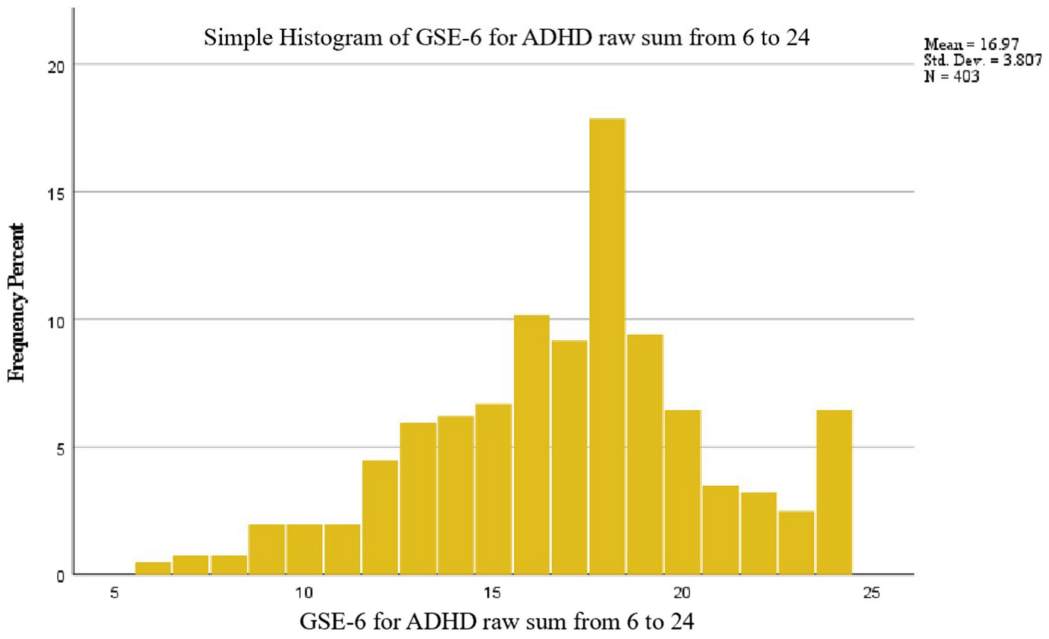

FIGURE 2
Distribution of the GSE-6 for adults with ADHD total score.

Our findings suggest that the GSE-6 is an easy-to-administer, acceptable, concise, valid, and reliable self-rated tool for measuring self-efficacy among adults with ADHD. As such, the GSE-6 is recommended for use in clinical settings as an assessment tool, aiding mental healthcare professionals, therapists and clinicians in understanding the patient's self-efficacy in an understudied ADHD adult population. Furthermore, the identified correlations between self-efficacy, well-being and mental health contribute to a more

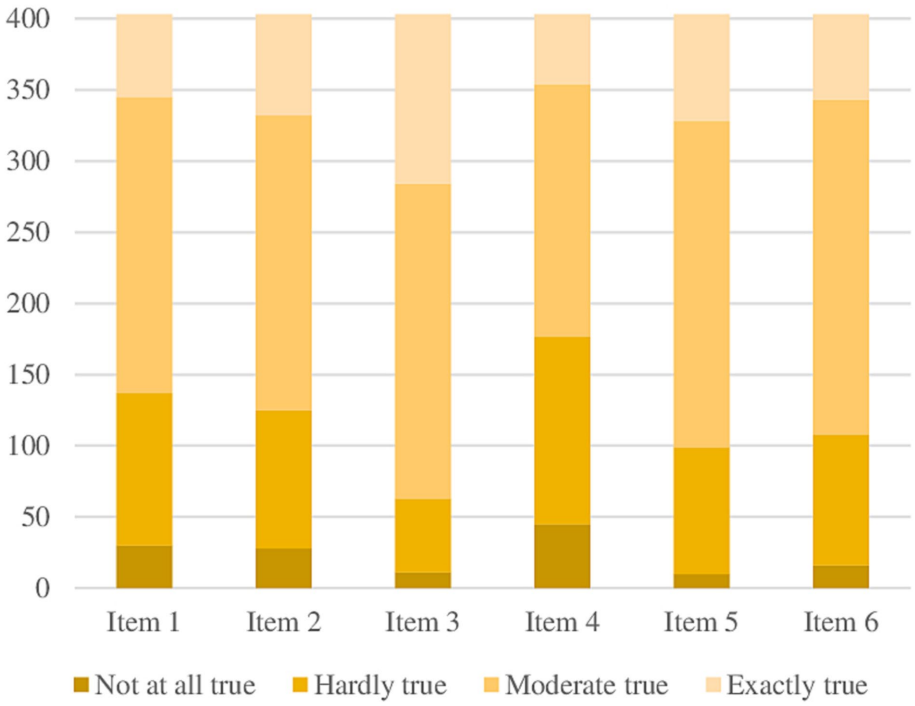

FIGURE 3
Item distribution for GSE-6 for adults with ADHD.

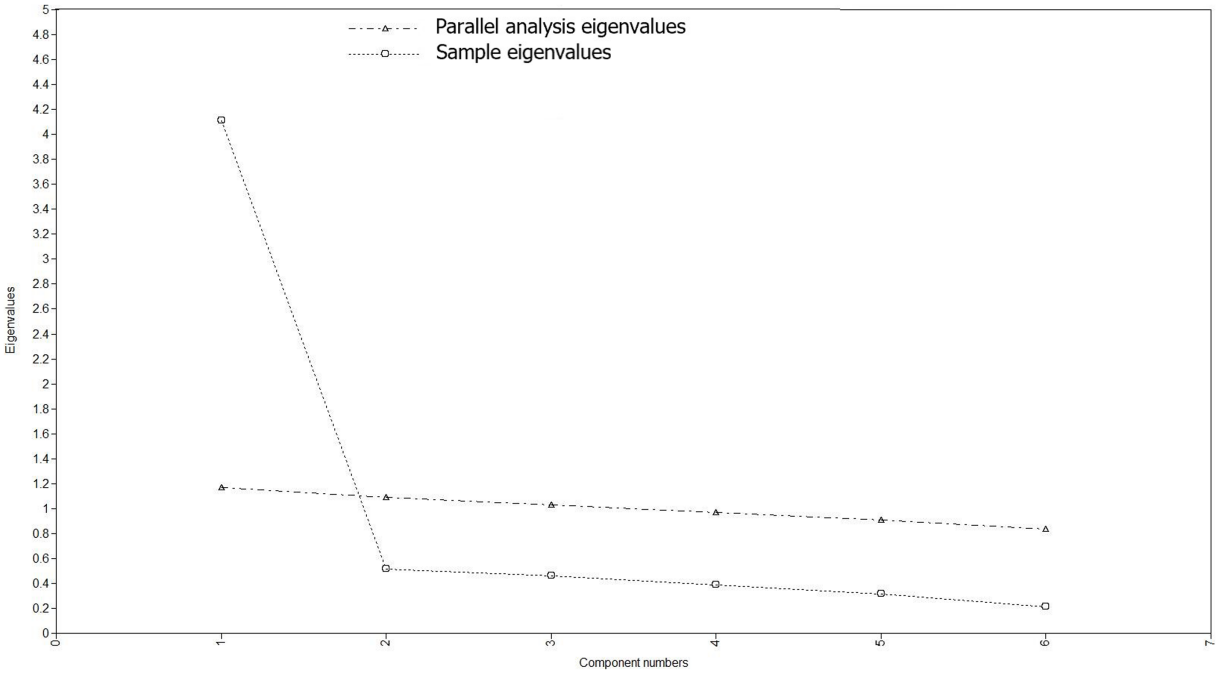

FIGURE 4
Scree plot of GSE-6 for adults with ADHD.

comprehensive understanding of the role of self-efficacy in a clinical setting. These findings can guide clinical practice and future research by contributing to the development of educational interventions and treatment approaches fostering self-efficacy and psychological well-being.

4.1. Strengths and limitations of the study

A particular strength of the current study was the participation of patient representatives in adapting the GSE-6 for ADHD. This ensures that the patient perspective related to language perception,

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TABLE 4 Test of measurement invariance (n_{women} = 287; n_{men} = 109).

Model	Test	Compared with	χ^2(df)	RMSEA	CFI	TLI	SRMR	$\Delta\chi^2$(df)	*p*	ΔCFI	ΔRMSEA	ΔSRMR
M1a	Women		25.824 (9)	0.081 [0.045, 0.118]	0.997	0.995	0.019					
M1b	Men		21.629 (9)	0.113 [0.052, 0.176]	0.993	0.989	0.025					
M2	Configural		47.485 (18)	0.091 [0.060, 0.123]	0.996	0.993	0.021					
M3	Metric	M2	39.679 (23)	0.061 [0.026, 0.092]	0.998	0.997	0.023	3.900 (5)	0.564	0.002	−0.030	−0.002
M4	Scalar	M3	64.260 (34)	0.067 [0.041, 0.092]	0.996	0.996	0.024	19.280 (11)	0.056	−0.002	0.006	0.001

accessibility of understanding and relevance of the scale items is preserved. The use of the QQ-10 to evaluate the content validity of the GSE-6 is a strength of the study, nevertheless, for a more accurate assessment of face validity, qualitative interviews should be conducted. In addition, only 16 people completed the QQ-10 questionnaire, which is a limitation. However, even though the sample might not entirely represent the ADHD-population, these participants were patient collaborators and user representatives from a wide geographical area in Mid Norway. Yet, this sample's size limitation should be considered when designing future GSE-6 validation studies. Further studies with a larger number of participants are required to assess the convenience and ease of use of the GSE-6 for ADHD.

In the second phase, participants reported to have been diagnosed with ADHD. However, the ADHD-diagnosis was not confirmed through structured clinical interviews. Therefore, further investigation on the content and construct validity of GSE-6 in a clinical sample of adults with confirmed ADHD is recommended. Due to the cross-sectional design, we could not evaluate the test–retest reliability of the GSE-6 for ADHD, which is a critical psychometric component, and future studies should use a prospective design to evaluate this. Even though we have a sufficiently large sample size for conducting EFA (50, 51), the limited sample size did not allow for the test of EFA and CFA in separate samples. Therefore, the factor structure identified in the current study should be replicated in future studies (ideally with larger samples).

5. Conclusion

This study reports the development and assessment of the validity of the GSE-6 for ADHD, which aims to measure the general self-efficacy of those with ADHD. The 6-item GSE was developed in collaboration with user representatives from the Norwegian user-led ADHD organization, and its content validity was assessed in a nonclinical adult ADHD population using the QQ-10 questionnaire, demonstrating a high positive value score and low negative burden score. The GSE-6 for ADHD demonstrated one-factor structure, and moderate correlations with measures of well-being and symptoms of depression and anxiety were found. Taken together, the results support using the GSE-6 for ADHD to measure general self-efficacy in an adult ADHD population. Future studies should evaluate the scale in clinical populations.

Data availability statement

The dataset analysed during the current study can be made available from the corresponding author on reasonable written request.

Ethics statement

The studies involving humans were approved by the Regional Committee for Medical and Health Research Ethics in Central Norway (2021/2081643). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

TS: writing – original draft. TS, AH, and HH: conceptualization. HH: data curation. TS and AH: statistical analyses. TS, HP, HH, JV, MLL-C, and AH: writing – review and editing. MLL-C: investigation. HH and MLL-C contributed to conceptualization and data collection. MLL-C and AH: supervision. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Female-specific pharmacotherapy in ADHD: premenstrual adjustment of psychostimulant dosage

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Objective: Attention-Deficit/Hyperactivity Disorder (ADHD) is a common neurodevelopmental condition which is underdiagnosed and undertreated in women. For decades, the ADHD field has called for more insight into female-specific therapy. Preliminary findings postulate that changes in sex hormones during the menstrual cycle may influence the effectiveness of psychostimulant medication. Yet, pharmacotherapeutic interventions tailored to women with ADHD remain scarce. Previously, our group showed an increase in mood symptoms in the premenstrual week in women with ADHD. Premenstrual worsening of depressive and ADHD symptoms represent a treatment challenge. In our adult ADHD clinic, we noted several women describing exacerbation of their ADHD and depressive symptoms in the premenstrual week and/or insufficient effect of their established dosage of psychostimulant. We responded to the need expressed by these women by increasing their stimulant dosage in the premenstrual week, while monitoring the response and side effects.

Methods: This community case study of nine consecutive women being treated for ADHD and co-occurring conditions (including depression and premenstrual dysphoric disorder), reports our local experience of increasing the individually prescribed psychostimulant dosage during the premenstrual period. We methodically monitored the effect of this increased dosage on ADHD symptoms, mood and somatic symptoms for the following 6–24 months.

Results: With premenstrual dose elevation, all nine women experienced improved ADHD and mood symptoms with minimal adverse events. Premenstrual inattention, irritability and energy levels improved, and now resembled the other non-premenstrual weeks more closely. All women decided to continue with the elevated premenstrual pharmacotherapy.

Discussion: Our preliminary results demonstrate potential benefits of increasing premenstrual psychostimulant dosage in women with ADHD, experiencing premenstrual worsening of ADHD and mood symptoms. The results concur with previous findings of diminished response to amphetamines in the late luteal phase. Increased dosage may help combat premenstrual worsening of cognitive and emotional symptoms in women with ADHD, with significant clinical implications. Better management of premenstrual ADHD and mood symptoms in vulnerable women can improve treatment outcome and meet an unmet need. However, implementation should be individually explored. Further investigation of luteal phase psychostimulant dose adjustment is required for safe, optimal and individualised treatment for women with ADHD.

KEYWORDS

attention deficit/hyperactivity disorder, female, women, pharmacotherapy, menstrual cycle, sex hormones, premenstrual, female specific therapy

1 Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common neurodevelopmental condition, characterised by lifetime difficulties in concentration, hyperactivity, and impulsivity (1). The cross-national prevalence of adult ADHD is 3.4% (2). ADHD often co-occurs with various conditions (3). The sex distribution in adulthood is close to 1:1, but girls and women with ADHD remain underdiagnosed and undertreated (4, 5).

For almost forty years, the literature has called for more insight into ADHD in girls and women (6–10) Even though scientific recognition of the impact of sex on the development of (mental) health conditions is increasing rapidly, therapeutic interventions tailored to women with ADHD remain scarce (11, 12). An expert consensus statement did not identify any differences in pharmacotherapeutic recommendations for ADHD between sexes, but did note that the menstrual phase might affect treatment response (7). Changing hormone levels might decrease effectiveness of stimulant medication (13). Further, the interaction between the menstrual cycle and ADHD might be an important missing link in clarifying ADHD in girls and women (14).

A recent systematic review could only include 4 articles and was unable to identify a clear relationship between hormonal changes and ADHD in the menstrual cycle, during pregnancy, and in the (peri-) menopausal period (15). Another systematic review identified several differences in prescription rates, efficacy and usage of ADHD medication between women and men, but also a lack of information on sex-specific pharmacokinetics and adverse effects of ADHD medication (16). The authors recommended differing dosage patterns to adjust for the menstrual phase, but remain unable to offer any additional specifics due to lack of existing evidence (16). This emphasises the need to investigate the influence of fluctuating reproductive hormones on the psychopharmacology of ADHD.

We, MJ, DW, and JK, are medical practitioners in an outpatient clinic that exclusively treats patients with adult ADHD (and co-occurring conditions). We noticed that many women with ADHD described a stark decrease in wellbeing in the premenstrual week (Box 1), with increased irritability, fatigue and a severe worsening of their mood. Some met the diagnostic criteria of co-occurring premenstrual dysphoric disorder (PMDD), of which the core symptoms include anxiety, irritability and depressed mood (17). Additionally, numerous women reported a worsening of their ADHD symptoms in the premenstrual week. A third, related complaint came from women who had been on stable doses of psychostimulant medication. They reported that their ADHD medication was either less effective or ineffective in the premenstrual week and shortly after commencement of menstruation. Some had independently increased their dosage, initially without adequate follow-up.

Our patients' reports match the existing evidence. During periods of low oestrogen, increased ADHD symptoms have been described (13, 19–21). Additionally, it has been reported that women respond less strongly to psychostimulant drugs in the luteal phase (16, 22–24). Therefore, we decided to increase the dose of the prescribed psychostimulant in the premenstrual week and evaluate the effect, hoping to improve treatment and establish a foundation for further research.

2 Methods

We report the effect of an increased dose of psychostimulant premenstrually, as part of the treatment at the outpatient specialist clinic for ADHD in adults at PsyQ, The Hague, Netherlands. This project was carried out in accordance with the Declaration of Helsinki; safety and confidentiality were foregrounded. All women gave written consent and were aware of the experimental nature of the pharmacotherapeutic adjustments.

All patients were being treated by MJ or DW, between 09–2021 and 03–2023. All had received a psychiatric assessment at our clinic, where ADHD was diagnosed or confirmed using the DIVA-5 interview (25, 26).

All women received treatment as usual, including pharmacotherapeutic and psychological interventions aimed at minimising complaints of ADHD and co-occurring conditions, in accordance with existing treatment guidelines. Despite the fact that all women had been adhering to their prescribed psychostimulant dosage for several months, they reported that their ADHD and mood symptoms worsened premenstrually. Taking this into account, a clinical decision was made in collaboration with the women to adjust the premenstrual dosage. Other possible interventions (e.g., hormonal contraceptives or antidepressants) were deemed undesirable or insufficient. Initially, the lowest readily available dose was added. If deemed necessary by patient and/or practitioner this dose was further increased monthly, until sufficient (subjective) effect was achieved, taking side effects into account. As with treatment as usual, all dosage adjustments warranted additional check-ups to evaluate the effect and possible side effects, which we describe as reported by the women. From the time the premenstrual dosage was increased, all women had regular follow-ups for six months to two years. As we described more cases, we attempted to delineate more clearly the effect women reported on their ADHD symptoms and mood complaints. We enquired more explicitly about the fluctuation of ADHD symptoms during the menstrual cycle, as well as the presence of mood symptoms in the premenstrual week. Additionally, as we started to describe the cases more systematically, we added a 5-point Likert scale to assess the effects for both ADHD and mood complaints (1: much worse, 2: moderately worse, 3: unchanged, 4: moderately improved, 5: much improved).

BOX 1 Brief definitions of key terms used

Premenstrual week	This is the week before menstruation commences. This week is also known as week 4 of the menstrual cycle. Here, we loosely use the term to signify the period in the menstrual cycle with subjective premenstrual worsening of symptoms.
Follicular phase	Approximately the first two weeks of the menstrual cycle, commencing on day 1 of menstruation and lasting until ovulation. Central in this phase is maturation of the ovarian follicles that contain oocytes (18).
Luteal phase	Approximately the last two weeks of the menstrual cycle, commencing the day after ovulation and lasting until day 1 of menstruation of the following cycle. Central in this phase is the transformation of the follicle into the corpus luteum and the preparation of the endometrium for possible implantation of a fertilised oocyte (18).
Post-ovulatory phase	The days immediately following ovulation, when some women experience mild "premenstrual-symptoms". In our study, the exact moment of ovulation is unknown. We rely solely on subjective reports of 'ovulation-like' symptoms.

3 Results

We included 9 consecutive women aged 22–48, who were receiving active treatment for their ADHD and co-occurring conditions. Seven patients were referred directly by their General Practitioners for diagnosis or treatment of ADHD symptoms, one by another mental health department and one by a psychiatrist in a neighbouring country. The women had a mean of 3.4 psychiatric co-occurring conditions (varying from 1–6), six had a diagnosis of PMDD and three were being treated with a selective serotonin reuptake inhibitor (SSRI) before the psychostimulant dose adjustment (Table 1).

The exact moment in the cycle when the increased dosage was required (commencement: 3–10 days before; until: 0–5 days after start of menstruation), the duration of using the higher dose (between 3–10 days total) and the amount with which the original dose was increased (range 30–50%), varied between cases. Follow-up ranged from 6–24 months. We summarise the reasons for increasing the premenstrual dosage and the effects thereof per patient (Tables 2, 3).

3.1 Patient 1 (24 yrs)

3.1.1 Reasons

In the premenstrual week, she described increased ADHD symptoms: less focus, more chaos and more trouble keeping up with necessary duties. She also suffered from increased irritability, low mood, more mood swings, more anxiety and decreased energy. She described herself as more "snappy," being quite reactive and crying often. Generally, she considered herself a clumsy person, which worsened premenstrually.

Physically, she described premenstrual fatigue, general malaise, mild abdominal cramps and severe premenstrual backache. Her sleep worsened with an occasional night of total insomnia.

Her dose was increased from lisdexamphetamine 30 mg to 40 mg daily (*circa* 30% increase), 3–4 days before and the first 2–3 days of her menstruation.

3.1.2 Effects

Her report was positive from the first month of increased dosage. She described her experience with the higher dose as "much more smooth," recognising less increase of her ADHD symptoms, exhaustion and irritability around her menstruation. While she would still feel defensive, she was more in control of how she reacted to emotions and could choose not to react. This resulted in fewer arguments. She was able to do necessary tasks, like cooking, and was better able to keep her routine. Her mood and irritability remained more consistent throughout the month. She could still feel down, irritable and "snappy" upon waking up, but this would fade when the medication started working. She also reported having better motor control. Physically, she felt less tired and had less bodily pain. Her sleep did not improve with the higher dose, but she was able to get through the following day with more energy.

She did not report increased side effects.

3.2 Patient 2 (24 yrs)

3.2.1 Reasons

After quitting the oral contraceptive, she noticed a dramatic increase in ADHD and depressive symptoms in the week before and the first couple of days of her menstruation. In particular, she described an increase in chaos, irritability and making more mistakes in the premenstrual week. She reported experiencing everything very intensely, being hypersensitive to small triggers and easily angered. Additionally, she was feeling more down and had decreased energy.

She did not report any physical complaints.

Her dose was increased from lisdexamphetamine 50 mg to 70 mg daily (*circa* 40% increase), in the second phase of her menstrual cycle, about 10 days before menstruation.

3.2.2 Effects

She noticed a marked improvement in her ADHD symptoms from the first month. She made fewer errors and experienced less chaos. She had better focus and concentration. The intensity of her emotional experiences and reactions was reduced, she could handle everything much better and her irritability was less. Her mood and energy level both improved. The difference between her premenstrual week and the other weeks was less marked.

3.2.3 Notes

While fasting during Ramadan, she was able to continue with the increased dosage, without experiencing increased side effects.

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TABLE 1 Demographic information, diagnoses and medication (history).

	Age*	Diagnoses (DSM 5)	Medication	(O)C#		New dosage
				Current	Past	
1	24	ADD GAD Social phobia PMDD DSPD	LDX 30 mg Melatonin 1 mg AN	IUD-	OC	LDX 40 mg
2	24	ADHD Depr-recur-remis PMDD DSPD	LDX 50 mg Melatonin 1 mg AN	No	OC	LDX 70 mg
3	26	ADHD Depr-recur-mild PMDD DSPD – RLS	LDX 70 mg Pregabalin 75 mg AN Ferr. sulphate 105mgfe 2/day	No	No	LDX 90 mg
4	48	ADHD Depr-sing-remis Panic dis. AUD-mild RLS	LDX 70 mg Seroxat 40 mg	No	OC & IUD+	LDX 100 mg
5	33	ADHD – ASD Depr-recur-remis PMDD *Ehl-Danlos – POTS*	LDX 20 mg Escitalopram 5 mg	No	OC	LDX 30 mg
6	22	ADHD – ASD Depr-recur-unspec GAD Insom – DSPD – RLS	MPH ER 72 mg Ferr. fumarate 200 mg	No	No	MPH ER 108 mg
7	30	ADHD Depr-sing-remis PMDD	DX IR 10 mg 2/day Ferr. sulphate 105mgfe 1/day	OC	OC	DX IR 15 mg 2/day
8	44	ADHD Depr-recur-moderate	DexMPH ret. 20 mg Sertraline 100 mg Atenolol 25 mg	No	No	DexMPH ret. 30 mg
9	48	ADD Sleep disorder NOS PMDD	LDX 70 mg	OC	OC	LDX 90 mg

Diagnoses: ADHD: attention-deficit/hyperactivity disorder – the combined subtype; ADD: attention-deficit/hyperactivity disorder – the inattentive subtype; AUD: alcohol use disorder; ASD: autism spectrum disorder; Depr-recur-remis/unspec: depressive disorder – recurring – in remission/unspecified; Depr-sing-remis: depressive disorder – single episode – in remission; DSPD: delayed sleep phase disorder; Ehl-Danlos: Ehlers-Danlos syndrome; GAD: generalised anxiety disorder; insom: insomnia disorder; PMDD: premenstrual dysphoric disorder; POTS: postural orthostatic tachycardia syndrome; RLS: Restless Legs Syndrome. Medication: LDX: lisdexamphetamine; MPH ER: methylphenidate extended release; DX IR: dexamphetamine immediate release; DexMPH ret: dexmethylphenidate retard; Ferr. sulphate/fumarate: ferrous sulphate/fumarate; (O) C: (oral) contraceptive; IUD+/−: intrauterine device with (+), or without (−) hormones. * At start of increased premenstrual dosage # Use of (oral) contraceptives at time of increased dosage (current) and in the past.

She did not report increased side effects.

3.3 Patient 3 (26 yrs)

3.3.1 Reasons

In the week before, and first days of her menstruation, she noticed less effect of her ADHD medication, a stark decrease in energy and an increase in depressive symptoms. In particular, she experienced decreased focus and productivity. She struggled with tasks that were boring or necessitated much work, which made it very difficult to work from home and led to task-oriented anxiety. She also reported more prevalent mood swings, feeling worthless, more sensitive, irritable and emotional.

Physically, she had fatigue and severe stinging abdominal pain in the premenstrual period, which was followed by abdominal cramps as her menstruation commenced.

Her dose was increased from lisdexamphetamine 70 mg to 90 mg daily (*circa* 30% increase), for 4–5 days before menstruation.

TABLE 2 Summary of response to dose increase.

	Age*	Regular dose	Premenstrual dose	Increase	Effect ADHD[a]		Effect mood[a]		Since[b]	Duration[c]	Y/N[d]
					1st	Following	1st	Following			
1	24	LDX 30 mg	LDX 40 mg	30%	–	**4**	–	5	11–2022	10	Y
	Summary:	Improved ADHD symptoms, mood stabilisation; and reduced irritability									
2	24	LDX 50 mg	LDX 70 mg	40%	4	**4,5**	5	4,5	02–2023	7	Y
	Summary:	Improved ADHD symptoms, emotional regulation; and reduced intensity of emotional experiences									
3	26	LDX 70 mg	LDX 90 mg	30%	–	**4**	–	4	01–2023	8	Y
	Summary:	Improved ADHD symptoms, better focus, productivity; and mood stabilisation									
4	48	LDX 70 mg	LDX 100 mg	45%	4	**5**	–	4,5	03–2023	6	Y
	Summary:	Initial difficulty implementing the higher dose, but subsequently improved concentration, emotional control, and mood									
5	33	LDX 20 mg	LDX 30 mg	50%	4	**4**	4	4,5	02–2023	7	Y
	Summary:	Better focus, increased productivity, reduced irritability; and fewer mood swings									
6	22	MPH ER 72 mg	MPH ER 108 mg	50%	–	**5**	–	4	11–2021	22	Y
	Summary:	Improved ADHD symptoms, reduced hypersensitivity, better focus, and mental clarity									
7	30	DX IR 10 mg 2/day	DX IR 15 mg 2/day	50%	–	**4**	–	4	09–2021	24	Y
	Summary:	Better self-management, improved mood; and reduced binge eating									
8	44	DexMPH ret. 20 mg	DexMPH ret. 30 mg	50%	4	**4**	5	4	03–2022	18	Y
	Summary:	Improved focus, productivity and mood; with no change in physical symptoms									
9	48	LDX 70 mg	LDX 90 mg	30%	4	**4**	4	4	03–2023	6	Y
	Summary:	Better focus, concentration; improved mood and energy levels									

Medication: LDX: lisdexamphetamine; MPH ER: methylphenidate extended release; DX IR: dexamphetamine immediate release; DexMPH ret: dexmethylphenidate retard. * At start of increased premenstrual dosage.

[a]Scored on a 5-point Likert-scale (1: very much worsened; 2: moderately worsened; 3: no change; 4: moderately improved; 5: much improved) after the first month of using the higher dose (1st), and after multiple months of using the higher dosage (Following).

[b]Date from which the women have been using the increased premenstrual dosage.

[c]How many months have women used the higher dose at time of final text revisions (09–2023).

[d]Do women wish to continue using the higher premenstrual dose: yes/no (Y/N).

3.3.2 Effects

From the first month of increased dosage, she noticed a strong improvement in the ADHD symptoms. Working from home was easier, she could focus more and for longer periods. She was motivated to start and complete tasks that she would otherwise avoid. She worked without "stressing herself out" and her productivity increased. She could regulate her emotions better. Her mood swings and irritability remained, but she could move on from them more quickly, recognising their cause. She was still "all over the place," but could distance herself from this more easily, relate it to hormonal fluctuations and let it go more quickly. With the higher dose, she completed her day with "a little bit of struggle, rather than a lot" and got through the week with more resilience. She could "take the punches better." She had more patience with herself and others. She noticed an improvement in her mood and energy level. She reported feeling more alert, less anxious and stressed. Usually, she did not take her medication during the weekends, but in the premenstrual phase she did.

3.3.3 Notes

In May 2023, after 3 months of using the increased premenstrual dosage, it was decided to commence treatment with an SSRI because her depressive symptoms remained debilitatingly present, approximately 3 weeks every month. Initially, she had strongly opposed starting an SSRI, so we agreed to try increasing her psychostimulant dosage first. With the additional SSRI her mood improved and stabilised, and her stress decreased further. She persisted with the higher premenstrual dose of lisdexamphetamine in combination with escitalopram 20 mg.

She noted a slightly stronger rebound effect and became aware of her caffeine intake, but did not report other additional side effects.

3.4 Patient 4 (48 yrs)

3.4.1 Reasons

In the premenstrual week she described increased ADHD symptoms: making more errors, being much more forgetful, and more clumsy and chaotic. She reported being emotionally labile and experiencing many mood swings. She would react to her surroundings more, engaging in conflict or feeling angry at everything. She described being confused, all over the place and experiencing "brainfog." Her irritability increased and her energy level was much lower, her mood more down. She would

TABLE 3 Summarised self-reported symptoms and symptom reduction.

Pt	Premenstrual symptoms	Symptom reduction
1	• Increased ADHD symptoms; clumsiness • Irritability • Crying • Low and labile mood • Decreased energy • Heightened anxiety	• Improved ADHD symptoms • Mood stabilisation • Reduced irritability • Less exhaustion
2	• Dramatic increase in ADHD; chaos and more mistakes • Dramatic increase in depressive symptoms • Irritability • Hypersensitivity • Decreased energy	• Marked improvement in ADHD symptoms; fewer errors and less chaos. • Improved emotional regulation • Reduced intensity of emotional experiences • Improved energy level
3	• Less effect of ADHD medication • Decreased focus and productivity • Lower mood with mood swings • Stark decrease in energy • Feeling worthless, more sensitive, irritable and emotional	• Improved ADHD symptoms; better focus, productivity • Mood stabilisation • Increased productivity • Improved energy levels • More resilience
4	• Increased ADHD symptoms; making errors, forgetful, clumsy, chaotic and 'brainfog' • Many mood swings • Irritability • Anxiety, insecurity and depressed mood	• Improved ADHD symptoms; better concentration, less clumsy, more alert • More emotional control, but internally still labile • Less agitated • Improved mood • Clear improvement in energy level
5	• Decrease in focus and concentration • Poor energy • Loss of interest and grumpiness • Unable to keep up with tasks.	• Better focus, increased productivity • More calm, with decreased anxiety • Reduced irritability • Fewer mood swings • Marked improvement in energy level
6	• Increased ADHD symptoms; 'brainfog', forgetfulness and mental chaos • Lower mood • Sensory and environmental hypersensitivity • Less energy	• Excellent improvement in ADHD symptoms; better concentration, mental clarity, less 'brainfog' • Reduced hypersensitivity • More stable mood • Less anxiety
7	• Increased ADHD symptoms; disorganisation, poor focus • Lower mood • Irritable and impatient • Lower energy	• Better self-management; better focus and concentration • Improved depression and anxiety • Fewer emotional meltdowns • Less irritability • More energy • Reduced binge eating
8	• Increased ADHD symptoms; poorer planning and making decisions • Lower mood • Anxiety • Irritability	• Improved focus, productivity, planning and organisation • Less avoidant • Better mood and emotionally much less volatile • Tiredness remained
9	• Increased ADHD symptoms; forgetfulness and 'brainfog', poor planning and sense of time • Depressed mood and emotionally volatile • Irritable and impatient	• Much better focus and concentration, less 'brainfog' and feeling more present • Improved mood; less depressed, angry and volatile • Less agitated • Better energy levels

feel much more anxious, linger in negative feelings for longer periods of time and felt more insecure.

Physically, she described fatigue, tender breasts and a distinct worsening of Restless Legs Syndrome in the premenstrual week, which negatively influenced her sleep quality.

Her dose was increased from lisdexamphetamine 70 mg to 100 mg daily (*circa* 43% increase), 10 days before menstruation.

3.4.2 Effects

She noticed an improvement in her ADHD symptoms, from the third month of the increased dosage. The first two months, she struggled to remember to increase her dose and to determine when the optimal moment was. After implementing the higher dose successfully, she described being less clumsy, bumping into things less. Her concentration was better and she felt more alert, with less

"cotton wool in her head." She understood and kept up with her schema therapy better. She reacted less emotionally, with a more delayed, or less intense response. The higher dose "took the edge off," she would feel angry, but would not start shouting immediately. She noticed a clear improvement in her energy level, which impacted her mood in a positive way. Even though she still described being agitated, this was less than it had been with her regular dosage. However, she reported that the level of emotionality had not changed.

3.4.3 Notes

Because of persisting complaints, which may be related to (peri-)menopause, she is considering additional hormone replacement therapy.

She did not report increased side effects.

3.5 Patient 5 (33 yrs)

3.5.1 Reasons

In the premenstrual week she noticed a decrease in focus and concentration and was unable to keep up with household chores, let alone work. In addition, she described a stark decrease in energy. She felt more down and experienced a loss of interest. She reported being more irritable, easily angered and would become grumpy more quickly.

Physically, she described premenstrual fatigue, migraines, headache and tender breasts.

Her dose was increased from lisdexamphetamine 20 mg to 30 mg daily (50% increase), for 3 days before her menstruation.

3.5.2 Effects

She described a big difference from the first month of the increased dosage. She reported more focus and was able to concentrate for longer. Her productivity increased and it was easier to get started on tasks, even the unpleasant ones; she "just did them." This brought a sense of calm and decreased anxiety, because she managed to stay on top of things more and keep up with household chores. She reported a marked improvement in her energy level, which influenced her mood in a positive way. In general she reported less irritability and fewer mood swings. As she was less tired, she was able to handle her physical complaints better. In addition, she noticed an effect of the higher dose on her physical complaints and experienced less headache and migraines. Conversely, she noted more eczema, dry skin and allergies, which could also be related to the season (Spring). She reported more muscle weakness and fluid retention, possibly related to her known sensitivity to hormone fluctuations and weather changes.

3.5.3 Notes

Her slow metaboliser status (decreased CYP2C19 and CYP2D6 function) was already known, therefore she required lower dosing.

The higher premenstrual dose made it easier for her to go into 'overdrive' and exhaust herself, which was a known pitfall for her and which required extra attention after increasing the dose.

She reported that she had to avoid caffeine completely and be careful not to exhaust herself, but did not note any additional side effects.

3.6 Patient 6 (22 yrs)

3.6.1 Reasons

In the premenstrual week she described increased ADHD symptoms: being more forgetful and chaotic, with "brainfog" and reduced mental clarity. She described her mood as sad, hopeless, more irritable as well as hypersensitive to triggers in her environment. Specifically, she was very frustrated with small, generally "insignificant" things which she could usually tolerate. She pulled back socially and described increased "sensory distress." Premenstrual sensory hypersensitivity resulted in difficulty with smells, textures, lights and noises. She therefore avoided very loud or bright spaces, limited her social activities, and attendance at university classes, and prepared rapid and very simple meals with few ingredients. She also had increased hypersensitivity to certain fabrics. She summarised her premenstrual state as diverting all the energy she usually used for her daily life to managing her own body and self.

Physically, she described less energy, appetite changes such as extremely hungry or no appetite, a sensation of bloating. Her bodily symptoms included aches and pains, fatigue, poor sleep schedule, resulting in delay of her sleep onset. Her sleep onset time was between 2 or 3 a.m. instead of her habitual time between 10:30 and 11:30 p.m.

Her dose was increased from methylphenidate 72 mg daily to 108 mg daily (50% increase), for 3 days premenstrually and for the 5 days of menstruation.

3.6.2 Effects

She noticed "excellent" improvement in ADHD symptoms from the first month. Premenstrually and during her menstruation, she noticed her mood being more stable with less anxiety, and fewer appetite changes. She had better sleep with earlier sleep onset. She was more productive with improved focus. Her bodily hypersensitivity was reduced. She described how the increased dosage allowed her to focus less on bodily discomfort with more mental space for concentrating on necessary tasks. She had more mental clarity and less brainfog.

She did not report increased side effects.

3.7 Patient 7 (30 yrs)

3.7.1 Reasons

In the premenstrual week she noted increased ADHD symptoms: more disorganisation, inability to complete tasks and poor focus in conversations. Her mood was lower, more irritable and impatient.

Physically she tended to have irregular eating habits and would binge in response to stress premenstrually. Her energy level was also lower.

Her dose was increased from dexamphetamine immediate release 10 mg once to twice daily to 15 mg once to twice daily (50% increase), for 7 days premenstrually.

3.7.2 Effects

She described a marked improvement in ADHD symptoms from the first month. She felt more in control at work as she could structure her day better, was more able to delegate, plan and had better self-management. She had more energy for household chores, with minimal procrastination. With better focus and concentration, she

no longer felt the drive to be continuously busy, felt more rested and peaceful. Her depressive and anxiety symptoms improved, with less irritability. She took criticism less personally. With normal life stresses, she no longer felt overwhelmed, and "emotional meltdowns" ceased. Her eating patterns became more regular and premenstrual bingeing stopped. She could fall asleep earlier.

She did not report increased side effects.

3.8 Patient 8 (45 yrs)

3.8.1 Reasons

In the premenstrual week she noted increased ADHD symptoms: difficulty planning ahead and making decisions, feeling less in control, poor focus. Premenstrually, she described her mood as lower, anxious and more irritable.

Physically she described the following mild symptoms: nausea, breast sensitivity, headache, irregular bowel habits (diarrhoea and constipation), abdominal cramps, bloated feeling.

Her dose was increased from dexmethylphenidate retard 20 mg daily to 30 mg daily (50% increase), for 7 days premenstrually.

3.8.2 Effects

She described a moderate difference in her ADHD symptoms from the first month. Her focus, productivity, ability to start with and switch tasks, planning, organisation and attention improved but were not completely optimal. She no longer needed deadlines to complete tasks and was less avoidant. Her mood and irritability improved significantly and she was emotionally much less volatile. She was less anxious and felt more in control. There was no change in her physical symptoms and she remained tired.

She did not report increased side effects.

3.9 Patient 9 (48 yrs)

3.9.1 Reasons

In the premenstrual week she noted increased ADHD symptoms: she described her mind as less clear, forgetful, "brainfog," had little perspective and poorer concentration. She had difficulty planning ahead, poorer sense of time, felt less in control, poor focus and battled to make decisions. Emotionally she was very depressed, emotionally volatile and angry with mood swings, irritability and impatience.

Physically she described premenstrual nausea, poor energy levels and constant tiredness. Everything felt like an effort.

Her dose was increased from lisdexamphetamine 70 mg to 90 mg daily (*circa* 29% increase), for 7 days premenstrually.

3.9.2 Effects

She described an improvement in ADHD symptoms from the first month with much better focus, less "brainfog," improved concentration, less distractibility and felt more present in situations. She was more energetic, productive and less avoidant of tasks. Her mood was less depressed, angry, volatile and irritable. Mood swings and agitation improved. She could begin road running again.

She did not report increased side effects.

4 Discussion

In this case study, we investigated the impact of increasing premenstrual psychostimulant dosage on nine consecutive adult women with ADHD. These participants reported premenstrual worsening of ADHD and mood symptoms. Our decision to increase psychostimulant dosage during the premenstrual week stemmed from other patients in our ADHD clinic, who independently increased their dosage without proper monitoring. Our approach involved raising the psychostimulant dosage during the premenstrual week and tracking its effects on ADHD, mood, and somatic symptoms over subsequent months, while continuing treatment as usual. To the best of our knowledge, this constitutes the only study of its kind published so far. As is common in adult ADHD (7, 27), these women were diagnosed with ADHD and several co-occurring conditions (Table 1). All had been taking stable psychostimulant treatment for several months, but expressed dissatisfaction with its efficacy during the late luteal phase, with consequential worsening of ADHD and mood symptoms. Methodically elevating the prescribed psychostimulant dosage during the premenstrual phase yielded positive results, with participants noting improvements in ADHD and mood symptoms. Additionally, they could better deal with their somatic symptoms, which improved for some.

Before the premenstrual dosage increase, the women in our study experienced the premenstrual phase as severely invalidating. They reported decreased focus, concentration, productivity, and "brain fog." They also described compromised self-control, leading to heated arguments, binge-eating, and impulsive behaviours. The aftermath of this phase included feelings of regret, shame, and a perceived lack of control over their actions. This debilitating pattern repeated itself every month and hindered women in finding and maintaining a healthy, balanced life. Unfortunately, the experiences of the patients described here appear to be quite common (13, 28, 29). They align with a growing framework exploring the interplay between hormonal fluctuations and ADHD symptoms (15). This underscores the importance of such investigations for effective treatment for women with ADHD.

Despite variations in symptomatology, age, co-occurring conditions, and type of psychostimulant, all nine women experienced and scored a positive change in premenstrual mood and ADHD symptoms with the increased dosage and wished to continue using it (Table 1). All reported improvement within the first month, except for one participant (Pt 4) who initially struggled with adherence to and timing of the increased dosage. Improvements in ADHD symptoms that were consistently noted were: better concentration, focus, productivity, and a greater ability to regulate or manage emotions. Additional side effects were minimal to absent for all women. Premenstrual mood improved for all patients, with eight reporting reduced irritability (Pts 1,2,3,5,6,7,8,9), seven describing improved energy levels (Pts 1,2,3,4,5,6,9), six experiencing decreased agitation (Pts 1,2,4,6,8,9), and four reporting less anxiety (Pts 3,5,6,7). After dose increase, six women noted fewer mood swings or less impact thereof (Pts 1,3,5,6,8,9) and four women explicitly reported feeling more in control of their emotional reactions (Pts 1,3,6,8). An additional six described being less emotionally volatile or "reactive" (Pts 2,4,6,7,8,9). In general, many described a "normalisation" of premenstrual symptoms, and less pronounced distinctions between premenstrual and non-premenstrual weeks. Notably, some women

observed improvement of premenstrual physical symptoms (Pts 1,5,6,7,9) or ability to tolerate these (Pts 3,5,6).

In healthy women, sex hormones are known to influence neurotransmitters, like dopamine (30) and serotonin (31–33). Thus, fluctuations in reproductive hormones during the menstrual cycle are thought to impact emotional states, mood disorders (34–38) and cognition (14, 39). A recent systematic review by Dubol et al. concluded that brain structure and reactivity are affected by hormonal fluctuations, which impact negative affect and cognition (40). Sacher et al. reviewed the existing neuroimaging studies and found that changes across the menstrual cycle influence the reaction to emotional stimuli and rewards. Amongst other effects, cyclical hormone fluctuations appear to interact with dopaminergic transmission (39). In healthy women, the interaction between sex hormones and neurotransmitters is also believed to influence ADHD symptoms (14, 19, 41). Low oestrogen phases correlate with increased ADHD symptoms. Young women without ADHD display heightened ADHD symptoms, particularly high trait impulsivity, during both early follicular and early luteal, or post-ovulatory phases (19). Focussing on menopausal women, Shanmugan et al. linked oestrogen to working memory, sustained attention and executive functions (41) and showed that lisdexamphetamine improved executive functioning in healthy menopausal women with executive difficulties (20). Anticipated work of Wasserstein et al. seems to solidify the relation between ADHD (symptoms) and menopause (21).

Other research findings explicitly link the effect and (ab)use of psychostimulants (particularly amphetamines) to changing levels of progesterone and oestrogens throughout the menstrual cycle (23, 24, 42, 43). In the luteal phase, women appear to respond less strongly to psychostimulant drugs (16, 22–24). In young women, fluctuating oestrogen levels may also influence the effectiveness of stimulant medications. A small study in 16 healthy women by Justice et al. showed that the effects of dextro-amphetamine (15 mg orally) were greater during the follicular phase than the luteal phase (23). During the follicular phase, subjects reported feeling more "high," "energetic and intellectually efficient" after taking dextro-amphetamine, than during the luteal phase. While oestrogen seems to aid in the effectiveness of stimulants, progesterone likely decreases it (23). These results were replicated by another small study showing that oestrogen and progesterone levels may impact on the subjective euphoric and stimulating effects of dextro-amphetamine in healthy women who are not affected by ADHD (24).

The findings in healthy women regarding hormone interaction with neurotransmitters raise questions about their relevance in women with ADHD. Low oestrogen phases might exacerbate cognitive and mood symptoms in these women. This corresponds with a case study showing worsened ADHD and mood symptoms premenstrually in a young woman with ADHD (13). Our participants' experiences align with existing evidence of increased ADHD (12–14, 19, 41), coupled with decreased response to psychostimulants during low oestrogen phases (16, 22–24). Notably, six out of nine women exhibited co-occurring PMDD, mirroring our group's previous findings of increased prevalence and severity of PMDD symptoms in a cohort of women with ADHD (28). Interestingly, the women in this cohort also described an increased prevalence of postpartum depression and peri-menopausal symptoms. These are additional periods in women's reproductive lives characterised by low oestrogen levels (28). The hypothesis emerges that in the luteal phase, when oestrogen levels fall, dopamine neurotransmission is further compromised in women with ADHD, leading to an exacerbation of their low mood and ADHD symptoms. This may explain the perceived ineffectiveness of the previously established psychostimulant dosage. Therefore, an increased psychostimulant dose may help alleviate worsening ADHD and mood symptoms in the premenstrual phase.

4.1 Clinical implications

We present a promising, relatively quick and easy intervention for the prevalent and debilitating issue of premenstrual worsening of ADHD and mood symptoms for women with ADHD. All women reported improvement with minimal increase in side effects. Healthcare professionals should initiate the conversation about this topic. Women may lack awareness of the far-reaching implications of their cyclical pattern, or feel embarrassed discussing it. Women with ADHD are particularly vulnerable: without treatment, they may lack the necessary overview and sense of timing needed to describe the impact of hormonal fluctuations on their mood and well-being (28). Failing to consider the menstrual cycle can result in sub-optimal treatment. Women may adjust dosage themselves.

The clinical implications of our findings are summarised in Box 2. Personalised dosing and timing adjustments of the psychostimulant are crucial, necessitating careful monitoring and cycle awareness. All women emphasised the increase in their energy level. However, clinicians should be cautious of women exhausting themselves and monitor, counsel and adjust treatment as necessary. Increased psychostimulant dosage should not replace SSRI treatment for depressive symptoms, nor oral contraceptives for physical complaints. If mood is insufficiently improved with increased psychostimulant dosage, addition of an SSRI can be beneficial and complement dose increase.

5 Limitations and strengths

While this study is the first (to our knowledge) to describe the beneficial effect of increased premenstrual psychostimulant dosage for women with ADHD, it does have limitations. Firstly, we present a very small number of patients in a descriptive manner and lack a control group. However, these limitations are inherent to case study design. Secondly, we adjusted our assessment of the effects of our intervention, as we proceeded with describing more cases. However, as we optimised our assessments by adding a Likert-scale, our initial results were confirmed, strengthening their internal validity. Thirdly, the women had several co-occurring conditions, which may have influenced their response to the psychostimulant dose increase, but simultaneously reflects daily practice. Finally, we acknowledge that the intervention offered here requires careful tracking of the menstrual cycle, which may be difficult for women with ADHD, and challenging for those with irregular cycles.

To strengthen our approach, we included consecutive patients, offered detailed descriptions of our nine cases and attempted to provide sufficient demographic, diagnostic and therapeutic

BOX 2 Clinical implications of increased premenstrual psychostimulant dosage

- May help control premenstrual worsening of ADHD and mood
- Consistent improvements in focus, energy, productivity and mood
- Cycle awareness is essential: *PMDD calendars or applications may help*
- Dosing and timing of increase should be individually determined
- Monitoring and adjustments should be personalised
- Appears to be valid for several types of psychostimulants
- Additional side effects are minimal or absent
- Satisfactory effectiveness: all women were motivated to continue

Please take note: Increased premenstrual dosage does not replace SSRI for depressive symptoms, or OC for somatic complaints, but may function complementarily.

background information, conform the JBI critical appraisal tool for case series (44).

5.1 Future research

It is important to replicate the findings of this case study in larger trials; ideally randomised, double-blind clinical trials, including a placebo arm, with a long(er) follow-up. A more detailed assessment of the interaction between ADHD (symptoms) and fluctuating (female) sex hormones is warranted. It would be interesting to extend the study of psychostimulant medication in postnatal and (peri-)menopausal women. Finally, we suggest examining the role of non-stimulant medications, perhaps even similar dosage adjustments, in the treatment of the ADHD/PMDD (symptom) combination. In general however, we argue that all future research concerning ADHD in women should at least take the menstrual cycle, or hormonal fluctuations in general, into consideration.

6 Conclusion

This case study demonstrates the potential benefits of increasing premenstrual psychostimulant dosage for managing premenstrual worsening of symptoms in women with ADHD. Improvements in ADHD symptoms, mood stabilisation, emotional control, and productivity were reported, with no worsening of side effects. These findings align with the concept of hormonal fluctuations impacting neurotransmitter function, affecting emotions and cognition. Furthermore, hormonal changes during the menstrual cycle may influence psychostimulant medication effectiveness. While preliminary, these results suggest that elevating premenstrual psychostimulant dosage might offer an efficient option for alleviating ADHD and premenstrual mood symptoms in women with ADHD, contributing to their overall wellbeing. Further research is needed in this important field to validate these findings and establish guidelines for personalised treatment plans based on menstrual cycle phases.

Data availability statement

The datasets presented in this article are not readily available because we are describing clinical findings and patient privacy will be protected, further inquiries can be directed to MJ, m.dejong@parnassia.nl.

Ethics statement

Ethical approval was not required for the studies involving humans because the intervention described here was offered in the context of regular clinical treatment, after careful discussion with all patients, in accordance with the ethical principles of the Parnassia Group. All patients gave written informed consent for their clinical data to be reported and published. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements because all patients had a therapeutic relationship with either MJ or DW. During the course of the therapeutic intervention and before reporting the data, written informed consent was obtained from all patients to publish clinical findings.

Author contributions

MJ: Conceptualization, Investigation, Writing – original draft. DW: Conceptualization, Investigation, Writing – original draft. EA: Writing – review & editing. AB: Writing – review & editing. JK: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Adult attention-deficit/hyperactivity symptoms and parental cognitions: a meta-analysis

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Introduction: Attention-deficit/hyperactivity disorder (ADHD) symptoms in adults interfere with parental functioning. Dysfunctional parental cognitions may play a role in this impairment. Despite the importance of parental cognitions on parents and children's outcomes, up to now, no systematic review or meta-analysis of these findings is available. To fill this gap, this meta-analysis aimed to evaluate the relationship between adult ADHD symptoms and parental cognitions.

Methods: We conducted searches in Web of Science, PubMed, and ProQuest from January 2000 to June 2023. Studies were included if they provided data on the relationship between parental ADHD symptoms and parental cognitions by means of a row correlational coefficient, or means and standard deviation were reported for each study group. A random-effects model was used. Publication bias was assessed by funnel plot and Rosenthal's fail-safe *N*. Moderator analyses were conducted by means of subgroup analysis and meta-regression analyses.

Results: Fifteen published papers were included (N = 2851), and 51 effect sizes were analysed. The weighted mean effect size was small but significant (Fisher's Z = 0.186, k = 15, 95% CI [0.120 – 0.252], z = 5.539, $p < 0.001$), indicating that ADHD symptoms in adults are associated with more negative and less positive parental cognitions. The Fail-Safe *N* analysis suggested a robust effect. Tweedie's trim and fill results suggested that five studies were missing; after five missing studies had been imputed, the mean overall effect size dropped to 0.116 (0.080 – 0.152). There was significant heterogeneity among effect sizes. The methodology of the study was found to be a significant moderator. Meta-regression analyses revealed that the lower age of the parent and the child were related to more negative parental cognitions.

Discussion: Though the analysis might be inflated by publication bias, our results suggest a significant association between ADHD symptom level and dysfunctional parental cognitions. Biased negative perceptions of the parental role, the child and co-parenting may play a central mediator role between parental ADHD and parent and child outcomes. Given the familiar nature of ADHD, targeting dysfunctional parental cognitions in parent training programs is warranted.

Systematic review registration: osf.io/pnur7.

KEYWORDS

attention/deficit hyperactivity disorder, ADHD, adult, dysfunctional cognition, parent, meta-analysis

1 Introduction

Attention-deficit/hyperactivity disorder (ADHD) (1) is one of the most prevalent chronic neuropsychiatric disorders evolving in childhood and continuing into adulthood in 4–77% of the cases (2). ADHD in adults has a worldwide prevalence of 2–3% (3, 4). About 70 to 75% of adults with ADHD are diagnosed with at least one comorbid mental disorder (5), e.g., mood and anxiety disorders (6), disruptive disorders (6), bipolar disorder (7), substance use and substance use disorders (8–10), behavioral addictions (11), insomnia (12), and personality disorders (13). In addition to the core symptoms of inattention and hyperactivity/impulsivity, emotional dysregulation (14), and executive function deficit (15, 16) are the characteristics of adult ADHD that lead to impaired functioning in multiple areas of life (17, 18) including the interpersonal domain (19–21).

Parenting is one of the important interpersonal functions ADHD symptoms in adults may interfere with (22). In their meta-analytic review, Park and Johnston (23) found that higher levels of ADHD symptoms in the parent are associated with less positive and more harsh and lax parenting behaviors. Effect sizes were small but robust across ADHD symptom clusters, parents' gender, and children's age. Furthermore, parental ADHD symptoms have been reported to be the strongest predictor of parenting stress, even after controlling for the child's ADHD symptoms and oppositionality (24). Intervention research revealed that high levels of maternal ADHD symptoms undermine the effectiveness of behavioral parent training in parents of children with ADHD (25, 26). It has been suggested that cool and hot executive dysfunctions and self-regulation deficits may account for these impairments (27).

Self-regulation and underlying executive functions are thought to be fundamental to successful adaptation to the cognitively and emotionally demanding challenges of parenting (28). Information processing during parent–child interactions, regulation of negative emotions and inhibition of automatic reactions in stressful child-rearing situations, and flexible adaptation of emotional and behavioral responses to changing developmental demands require intact working memory capacity, inhibitory control, frustration tolerance, the ability to delay gratification, cognitive flexibility, self-monitoring, planning, problem-solving and organization skills (29–31). Less effective executive functioning was shown to be related to higher levels of harsh and lower levels of warm parenting (32) and risk of physical abuse through emotional dysregulation (33). Beyond the direct association between executive function deficit and negative parenting, there is some evidence of the moderating effect of inhibitory control on the relationship between parental hyperactive/impulsive symptoms and overreactive parenting, as well as inattention and lax parenting (34).

Deficits in self-regulation and executive functions not only affect behavior but also interact with environmental challenges in forming the individual's views of the self and the world from the person's formative years (35, 36). Consequently, more negative self-concepts and lower levels of general self-efficacy (37), and self-esteem (38), especially when untreated (39), have been reported in adults diagnosed with ADHD. According to narrative reviews, the self-concept of adults with ADHD could be characterized by maladaptive beliefs about the self, i.e., failure, impaired self-control, being different from others and a sense of inadequacy (40, 41). Furthermore, some evidence refers to higher levels of more situational negative automatic thoughts in adults with ADHD compared to healthy controls (41). Besides studies on negative thinking styles, there is a growing recognition that dysfunctional cognitions in adult ADHD may also be irrationally positive or optimistic (42).

It is plausible to assume that stressful child-rearing situations may trigger these dysfunctional cognitions in parents with ADHD, resulting in a biased negative perception of the parental role and the child. Repeated failure in parenting situations resulting from core deficits in ADHD and frequent negative feedback about the person's parenting skills may also lead to increased parental stress and low parental self-efficacy which in turn may negatively affect the parent–child relationship and parenting behavior. In that way, dysfunctional parental cognitions may play a central mediator role between parental ADHD and parent and child outcomes (27). On the other hand, a positive bias by means of an overestimation of positive parenting behaviors in adults with ADHD (43) may lead to an irrationally increased parental self-efficacy.

Despite the importance of parental cognitions on parents' and children's functioning and the growing evidence of biased parental cognitions associated with adult ADHD, up to now, there is no systematic review or meta-analysis of these findings is available.

To fill this gap, this meta-analysis aimed to evaluate the relationship between adult ADHD symptoms and parental cognitions. We aimed to address this question in both dimensional and categorical approaches. More specifically, our research questions were: Are higher levels of ADHD symptoms in adults related to more negative and less positive parental cognitions? Do adults with ADHD report more negative and less positive parental cognitions than healthy or non-clinical controls? Based on the literature reviewed above, we hypothesized that higher levels of parental ADHD symptoms would be associated with more dysfunctional parental cognitions.

Further research questions were related to possible moderators: Does the relationship between adult ADHD symptoms and parental cognitions vary across the child's age groups, parent's gender, ADHD symptom clusters, and different types of cognitions: across cognitions about the self as a parent (i.e., parental self-efficacy beliefs, the perception of the parental role as rewarding or burdensome), the child (i.e., attitudes toward the child, attributions for the child's behavior), and co-parenting; by valence of the cognition (negative/positive); and, by stability of the cognition (stable/situational)?

2 Materials and methods

Methods have been developed following the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) 2020 Statement (44). The protocol of the study has been preregistered at OSF.[1]

2.1 Inclusion and exclusion criteria

2.1.1 Type of publication

Original studies published in peer-reviewed journals between January 2000 and May 2023, or dissertations/theses uploaded in repositories and available in full were considered. Only empirical studies were included, and case studies, case series, as well as studies

1 https://osf.io/pnur7/?view_only=181ede69724a4c3e8736cedac9d1ccc2

applying qualitative methodologies were excluded. We also contacted some of the authors of existing papers for possible non-published studies.

2.1.2 Population

Studies involving both clinical and non-clinical parent samples were included. We did not have any exclusion criteria regarding comorbidities, demographic or SES characteristics of the sample, or the geographic location of the study. Studies were included regardless of the past and current treatment of the participants.

2.1.3 Outcome

The primary outcome was the relationship between parental ADHD symptom level and parental cognitions by means of a standardized correlational coefficient. The definition of ADHD was based on the relevant versions of the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revision (DSM-IV-TR (45)), and fifth edition [DSM-5 (1)]. Predominantly inattentive, predominantly hyperactive/impulsive, and combined presentations were all included in the definition. Parental cognitions were defined as cognitions about parenting, the parental role, the self as a parent, the child, and co-parenting. The distinction between parental cognitions and behavior is not always clear; we included studies focusing on expectations, perceptions, attitudes, attributions, beliefs, and values, but excluded constructs that are traditionally referred to in the literature as parenting practices, parenting styles, or parenting behaviors (e.g., warmth, nurturance, overprotectiveness) even if they include a cognitive component. A distinction between parental cognitions and parenting stress defined as "aversive psychological and physiological reactions arising from attempts to adapt to the demands of parenthood" (46, page 6) was also made and studies assessing parenting stress were excluded.

Regarding the measurement of study variables, we had two criteria. First, regarding the measurement of ADHD, we included studies that assessed the actual severity of ADHD symptoms with a reliable and valid instrument (a structured clinical interview or a questionnaire) or established ADHD diagnosis in the clinical group with a reliable and valid structured or at least semi-structured clinical interview and assessed mental disorders in the comparison group by using the same procedure. Studies using a patient group with a self-reported ADHD diagnosis only, or a childhood diagnosis of ADHD without measuring current symptom severity, were excluded. Second, studies must have included a valid and reliable measure for the assessment of any type of parental cognitions defined above. Studies using self-report, partner-report, or behavioral observation were included.

In the end, for their inclusion, studies must have met one of the following criteria (1): the relationship between parental ADHD symptoms and parental cognitions was reported by means of a row correlational coefficient or (2) means and standard deviation were reported for both the ADHD diagnosed parent-group and for at least one comparison group (non-clinical or healthy controls, or a patient group with other mental disorders but not ADHD).

2.2 Search strategy

2.2.1 Data-bases

Electronic searches were performed (BK, JJ) in the following databases: Web of Science, PubMed, and ProQuest including Dissertations and Theses.

2.2.2 Keywords

Keywords for ADHD and parental cognitions were combined. The final search term is shown in Supplementary Table S1.

2.2.3 Further specifications

Only English-language papers were included. The date of publication or submission year of the dissertation/thesis must have been between January 2000 and May 2023.

2.2.4 Additional search

We conducted searches in the reference lists of previous review papers and in reference lists and citations of the papers found by the machine search.

2.3 Identification and selection of studies

Studies identified by electronic and manual searches – after removing duplicates – were evaluated by two independent researchers (KB, LF), according to their titles and abstracts. The final list was agreed upon, and discrepancies were resolved by consensus between the two researchers. The full-text version of the papers of the final list was downloaded and assessed for eligibility by two independent researchers (FL, JJ). Discrepancies were resolved by consensus between the two researchers. We linked together multiple reports from the same study, and for the same analysis, the highest quality report was considered (e.g., a published paper instead of a dissertation). From longitudinal studies, only baseline data was included.

2.4 Data extraction

The following data were extracted and inserted in an Excel sheet by two independent researchers (FL, JJ): publication details (citation, year, country); design (correlational, comparison of multiple groups); study participants, sample size, mean age of parents, % of mothers in the parent sample, mean age of children, children's age range, % of boys in the sample, sample characteristics (populational/clinical, type of comparison group, comorbid characteristics of clinical groups); method to establish parents' ADHD diagnosis and/or assessment of adult ADHD symptoms, cluster of ADHD symptoms measured (inattention, hyperactivity/impulsivity, combined); characteristics of parental cognitions assessed: valence (negative/positive), stability (stable/situational), reference (self/child/co-parenting), domain (self-efficacy/role/attitude/attribution), method (self-report/partner-report/observational), measure. Data from measures assessing positive cognitions were recoded, in that way higher scores represented lower levels of positive cognitions.

2.5 Assessment of study quality and bias

Study quality and bias assessment were conducted by two independent researchers (MM, BK) by using the modified version Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies (47). Discrepancies were resolved by consensus between the two researchers.

2.6 Statistical analyzes

The Comprehensive Meta-analysis (48) software was used for the analysis. We used random effect models which include sampling and study-level errors. All effect sizes were transformed to Pearson's correlational coefficients, which then was standardized using Fisher's transformation. The overall effect size was calculated and reported as Fisher's Z value. The heterogeneity between studies was tested with Cochran's Q test and with I^2 values (0–40%: not important; 30–60%: moderate, 50–90% substantial, 75–100%: considerable heterogeneity). Publication bias was assessed visually by funnel plot and Rosenthal's fail-safe N (49). If publication bias was detected, we adjusted for this using Duval Tweedie's method (48).

Moderator analyzes were conducted by means of subgroup analysis in case of categorical moderators: the children's age groups, the parent's gender, ADHD symptom clusters, stability of the cognition (stable/situational), by the valence of the cognition (positive/negative), across cognitions about the self as a parent (i.e., parental self-efficacy beliefs, the perception of the parental role as rewarding or burdensome), the child (i.e., attitudes toward the child, attributions for the child's behavior), and co-parenting; and the method of assessing parental cognitions (observation, self-report, partner-report). We conducted meta-regression analyzes of the moderating effect of publication year, study quality, the mean age of children and parents, the ratio of boys, and the ratio of mothers in the sample. The stability of the results and the influence of studies were tested using leave-one-study-out sensitivity analysis. Effect sizes were tested for potential outliers and standardized residuals over +/− 3.29 were excluded.

3 Results

3.1 Study selection

The flowchart of the eligible studies is represented in Figure 1. In three databases we identified 488 records. After removing duplicates, 402 records were screened by title, from which 81 papers were sought for retrieval and 27 full texts were assessed for eligibility criteria. Eleven studies did not assess parental ADHD (50–60), two studies did not report the correlational coefficients between parental cognition and ADHD symptoms (61, 62), and two studies used self-reported ADHD diagnosis (63, 64), therefore these studies were excluded. After contacting the authors we excluded an additional study (65) because its sample was highly overlapping with another study of the same research group (66). We conducted searches in citations and references of existing papers and identified seven additional records. They were all assessed for eligibility. According to the authors contacted, one study (67) used the same sample as a previously included paper (68), and there were two dissertations (69, 70) among the records for which the published versions were also identified. These three records were excluded. Taken together, 11 papers from the database search and 4 additional papers from the citation and reference search were included (Figure 1).

Fifty-one effect sizes of 15 published papers were included in the analyzes ($N = 2{,}851$). For study characteristics, see Table 1.

3.2 Study characteristics

3.2.1 Quality of studies

Most of the studies involved can be rated as studies with strong quality assessment, but there are some points where we found some weaker rates (Supplementary Table S2). In connection with the aspects of selection bias, there are 6 studies in which we cannot tell what percentage of selected individuals have agreed to participate (66, 68, 71–74). In two studies there are questions about the selection of the appropriate target population (75, 76). Questions regarding the blinding procedure show that we have one study in which they do not provide any information about the awareness of the participants (77). According to other aspects strong ratings could be given.

3.2.2 Samples

Seven studies involved community samples of parents (72, 75–80). Three studies' participants were parents of children with and without ADHD diagnosis (66, 74, 81) and five studies involved only parents of children with ADHD (68, 71, 73, 82, 83). Two studies reporting group comparisons (77, 83) grouped community samples of parents according to varying levels of ADHD symptoms. Eight studies involved only mothers, and mothers were overrepresented in almost all samples except for three studies involving mother–father dyads (66, 71, 74). Four studies involved only parents of boys, and boys were overrepresented in six further samples. According to the age of children, a single study involved first-time expectant women (77, 78), one study involved parents of 6-month-old infants (79, 80), two studies involved parents of preschool-aged children, eight studies involved parents of school-aged children, and three studies used mixed samples.

3.2.3 Measures for parental ADHD

All studies used reliable and valid rating scales for assessing current parental ADHD symptom levels. Three studies used the Current Symptom Scale of the ADHD Behavior Checklist for Adults [ABCA (84)], three measured parental ADHD symptoms with the Adult AD/HD Rating Scale [AARS (85)], three studies reported ADHD symptoms according to the Barkley Adult ADHD Rating Scale–IV [BAARS-IV (86)], and four studies used the Conners' Adult ADHD Rating Scale [CAARS (87)]. The Adult ADHD Self-Report Scale [ASRS (88)] was used in three studies. Most of the studies used the total scores of the scales, only a single study reported results for inattention and hyperactivity/impulsivity symptom scores separately. A single study used composite scores of the Adult Self Report, Attention Problems subscale (ASR) of the Achenbach System of Empirically Based Assessment [ASEBA (89)] and the Conners' Adult ADHD Rating Scale. One study used collateral informants, and another study used both self- and partner-reports, all other studies assessed ADHD symptoms using self-report.

3.2.4 Measures for parental cognitions

A variety of parental cognitions have been explored in the studies, including parental beliefs about the self as a parent (parental self-efficacy beliefs and expectations of and satisfaction with the parental role), attitudes toward the child (tolerance of misbehavior, parental critique, and empathy toward the child), and attributions of child (mis)behavior (controllability, intentionality, responsibility, perceived parental impact, locus of control). Most studies used self-report measures of parental cognition. One study gathered additional

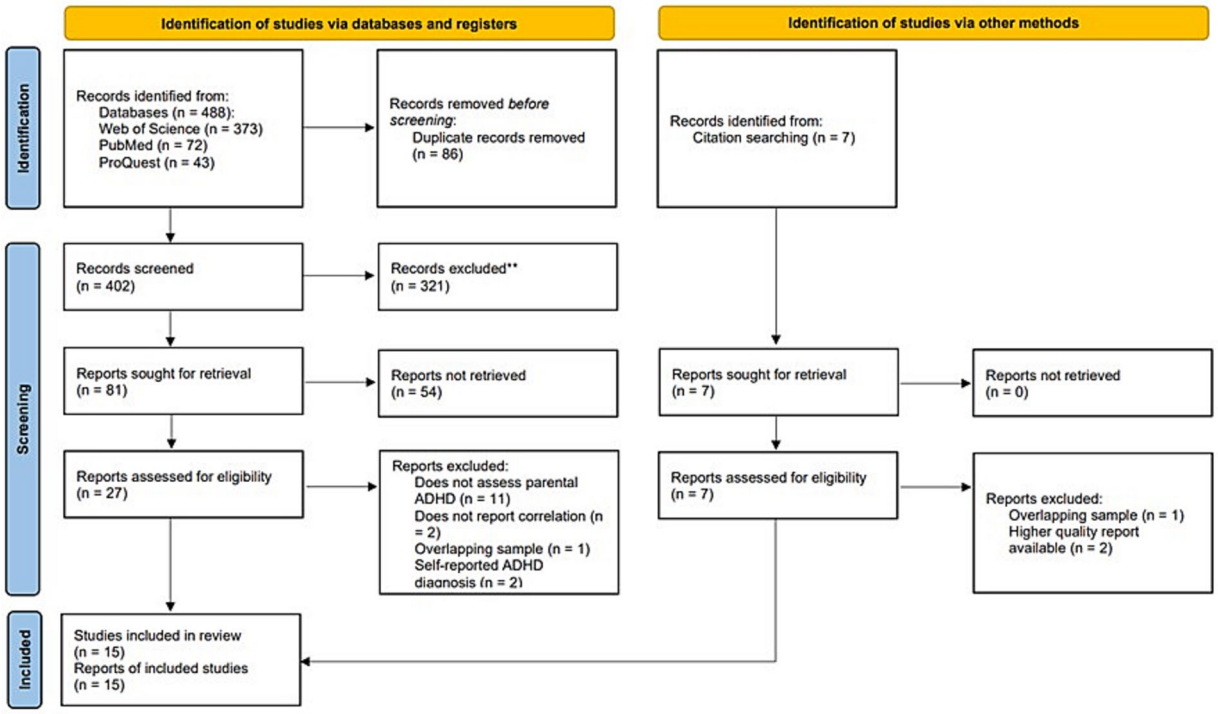

FIGURE 1
PRISMA flow-diagram (44).

information from the partner, and three studies conducted behavioral observation.

Parental self-efficacy, i.e., the degree to which parents perceive themselves as capable of performing tasks associated with the parental role (90), was the most frequently assessed construct. It was measured by the Parental Sense of Competence Scale [PSOC (91, 92)] in four studies, but the Parental Cognitions and Conduct Toward the Infant Scale [PACOTIS (93)], the Parenting Sense of Efficacy Instrument (P-SEMI (94)), and the Parental Locus of Control Scale [PLOC (95)] were also used to evaluate parental self-efficacy. The PSOC was also used to assess the degree of satisfaction derived from the parenting role. The perception of strain related to one's role as a caregiver was measured by the Caregiver Strain Questionnaire (CGSQ (96)), and the prenatal expectations regarding the infant and the future maternal role were assessed by the Prenatal Maternal Expectations Scale (PMES (97)).

Causal attributions about the child's undesirable behavior were assessed by the modified Written Analog Questionnaire [WAQ (92, 98)] and the Attribution Rating Scale [ARS (75)]. The PLOC (95) was also used to assess whether parents view their child's behavior as a direct consequence or outside the reach of their parenting efforts. A single study measured cognitive distortions related to attributions of negative child behavior and parenting by the Parental Cognitive Error Questionnaire [PCEQ (99)].

Attitudes toward the child, i.e., tolerance of misbehavior and parental empathy toward the child, were assessed by the Child Rearing Inventory (CRI (100)), and the Interpersonal Reactivity Index (IRI (101, 102)).

Two studies using behavioral observation assessed the parent's perception of the child and their relationship by the Five-Minute Speech Sample [FMSS (103)]. In one study, relational schemas about the child were assessed during the structured clinical interviews using the coding system of the Camberwell Family Interview (104).

Cognitions about the alliance in raising a child with another parent were assessed in a single study using the Parenting Alliance Measure [PAM (105)].

3.3 Main analysis

3.3.1 Mean effect size

Across 15 studies, standardized residuals fell between −2.03 and 1.19 suggesting no outliers. The weighted mean effect size was small but significant [Fisher's $Z = 0.186$, 95% CI (0.120–0.252), $z = 5.539$, $p < 0.001$], indicating that ADHD symptoms in adults are associated with more negative and less positive parental cognitions. Effect sizes ranged from −0.033 to 0.376, with all but one effect size in the expected direction and 10 of 15 effect sizes reaching statistical significance (Figure 2). Homogeneity analyzes indicated that there was a significant heterogeneity among effect sizes [$Q(14) = 35.373$, $p = 0.001$, $I^2 = 60.422$].

Sensitivity analyzes were performed to test the robustness of the effect by omitting one study at a time from the random-effect model. Mean effect sizes fell between 0.176 and 0.202 indicating a robust effect.

3.3.2 Publication bias

The Fail-Safe N analysis revealed that approximately 273 additional studies would be needed to bring the overall effect size for the association between adult ADHD symptoms and parental

TABLE 1 Study characteristics.

Study		Parents' characteristics		Children's characteristics				Measure			
First author, year (Country)	Sample size	Mean age (years)	Mothers (%)	Boys (%)	Mean age (years)	Age range (years)	ADHD diagnosis (%)	ADHD measure	ADHD symptom cluster	Cognition measure	Method
Banks et al. (2008) (Canada) (77)	80	32.3	100	–	–	3–6	–	ABCA/CSS, CAARS	C	PLOC, PSOC	SR
Fabrikant-Abzug et al. (2023) (United States) (68)	199	–	89.5	58	8.6	7–11	100	CAARS, ASEBA/ASR	C	PCEQ	SR
Johnston et al. (2018) (Canada) (66)	156 dyads	43.1	50	100	9.6	5–13	70.5	BAARS-IV	IA, H/I	CRI, IRI	SR
Lindström et al. (2022) (Sweden) (82)	549	43.3	61	70.1	10.14	3–17	100	ASRS	C	WAQ	SR
Lowry et al. (2018) (United States) (71)	79 dyads	41.1	50	71.1	8.5	6–12	100	ASRS	C	PSOC CGSQ	SR, PR
Moroney et al. (2017) (United States) (81)	205	–	87	68.0	10.2	7–12	53	ASRS	C	FMSS	O
Ninowski et al. (2007) (Canada) (78)	86	31.1	100	NA	NA	NA	NA	CAARS, ABCA/CSS	C	PMES	SR
Park et al. (2019) (Canada) (75)	79	–	100	100	–	6–12	–	BAARS-IV	C	ARS	SR
Psychogiou et al. (2007) (United Kingdom) (79)	100	–	100	100	7.9	School-aged	–	AARS	C	FMSS	O
Psychogiou et al. (2008) (United Kingdom) (72)	268	–	100	57	7.7	School-aged	–	AARS	C	IRI	SR
Richards et al. (2014) (NL) (73)	385	–	100	83.4	11.5	5–18	100	ADHD-RS-IV	C	CFI	O
Sonuga-Barke et al. (2002) (United Kingdom) (83)	83	–	100	63.4	3	NA	100	AARS	C	PSOC	SR
Watkins et al. (2009) (Canada) (80)	99	33.0	100	35.4	0.5	NA	–	CAARS	C	PACOTIS PSOC	SR
Williamson et al. (2016) (Canada) (74)	64 dyads	–	50	100	9.6	8–12	41.0	ABCA/CSS	C	PAM	SR
Williamson et al. (2019) (Canada) (76)	120	33.9	100	57.0	7.8	6–12	–	BAARS-IV	C	P-SEMI	Coll, SR

ABCA, ADHD Behavior Checklist for Adults; AARS, Adult AD/HD Rating Scale; BAARS-IV, Barkley Adult ADHD Rating Scale–IV; ASRS, Adult ADHD Self-Report Scale; CAARS, Conners' Adult ADHD Rating Scales; ASR, Adult Self Report, Attention Problems; ADHD-RS-IV, ADHD Rating Scale-IV; IA, Inattention; H/I, Hyperactivity/Impulsivity; C, Combined; PSOC, Parental Sense of Competence Scale; PMES, Prenatal Maternal Expectations Scale; ARS, Attribution Rating Scale; CGSQ, Caregiver Strain Questionnaire; CRI, Child Rearing Inventory; IRI, Interpersonal Reactivity Index; PCEQ, Parental Cognitive Error Questionnaire; WAQ, Written Analog Questionnaire; FMSS, Five-Minute Speech Sample; PAM, Parenting Alliance Measure; PLOC, Parental Locus of Control Scale; PACOTIS, Parental Cognitions and Conduct Toward the Infant Scale; P-SEMI, Parenting Sense of Efficacy Instrument; CFI, coding system of the Camberwell Family Interview; SR, self-report. PR: partner-report; Coll, Collateral Informants; O, observation; CoP, Co-parenting; NA, non-applicable.

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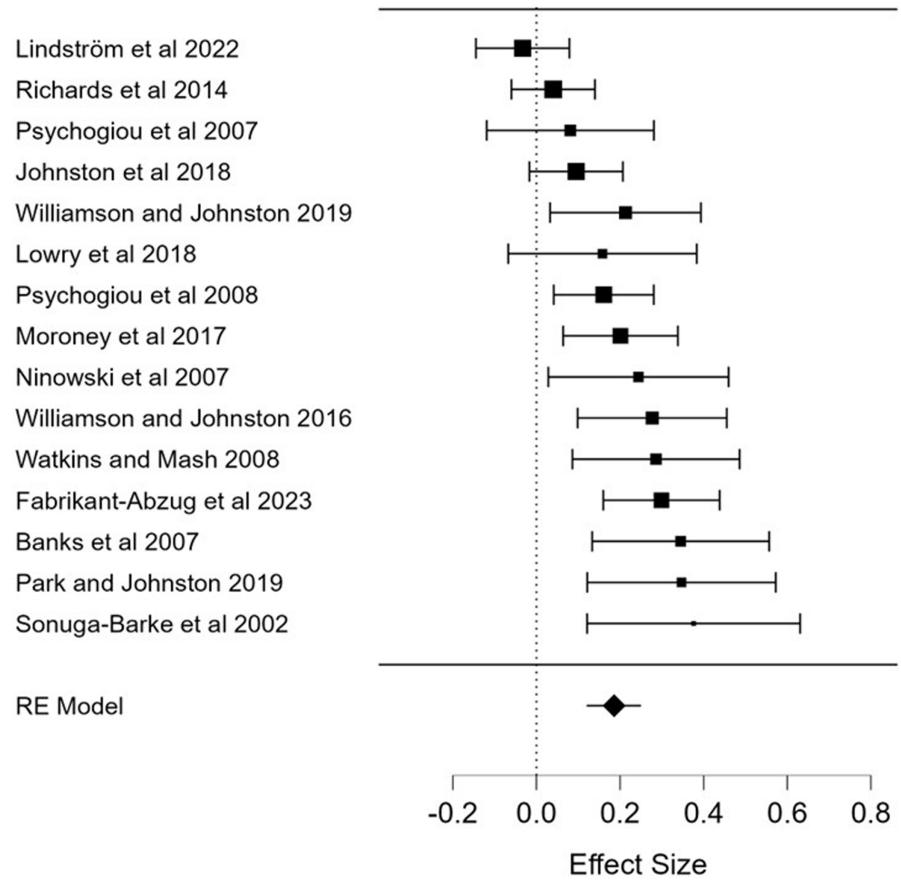

FIGURE 2
Forest plot of the associations of adult ADHD symptoms and parental cognitions. RE, random effect. Effect size: Fisher's Z.

cognitions to a non-significant level, which is larger than the tolerance level of 5 * $k + 10 = 85$, suggesting a robust effect. A funnel plot of observed and imputed studies is shown in Figure 3. Tweedie's trim and fill results suggested that five studies were missing. Using trim and fill, after five missing studies had been imputed, the mean overall effect size dropped to 0.116 [0.080–0.152]. The rank correlation coefficient, Kendall's tau was 0.43, $p = 0.023$, significant and Egger's regression method produced an intercept of 3.779, which was also significant ($p = 0.002$), supporting a conclusion that publication bias was operating. Taken together, these analyzes suggest that, while the results might be inflated by publication bias, the adjusted mean effect size continues to show that there is a significant association between ADHD symptom level and dysfunctional parental cognitions.

3.4 Subgroup analyzes

3.4.1 Children's age groups

The association between adult ADHD symptoms and parental cognitions were significant across all age groups of children. The effect size was small in a single study involving pregnant women [Fisher's $Z = 0.244$, $k = 1$, 95% CI (0.029–0.459), $z = 2.220$, $p = 0.026$], similar to another single study in mothers of six-months-old infants [Fisher's $Z = 0.286$, $k = 1$, 95% CI (0.086–0.486), $z = 2.801$, $p = 0.005$]. The weighted mean effect size of two studies that involved parents of preschool-aged children was 0.358, $k = 2$, 95% CI [0.195–0.520], $z = 4.317$, $p < 0.001$, representing a medium effect. Across eight studies in parents of school-aged children, the weighted mean effect size was small [Fisher's $Z = 0.214$, $k = 8$, 95% CI (0.157–0.272), $z = 7.275$, $p < 0.001$], with a nonsignificant heterogeneity [$Q(7) = 5.954$, $p = 0.545$, $I^2 = 0.000$]. Taken together, these results indicated that higher levels of parental ADHD symptoms were associated with dysfunctional parental cognitions across the child's age.

3.4.2 Parents' gender

Only two studies reported results separately for mothers and fathers. The weighted mean effect sizes were not significant for mothers [Fisher's $Z = 0.075$, $k = 2$, 95% CI (−0.225–0.375), $z = 0.491$, $p = 0.624$], with a significant heterogeneity [$Q(1) = 4.123$, $p = 0.042$, $I^2 = 75.747$], and was small for fathers [Fisher's $Z = 0.269$, $k = 2$, 95% CI (0.135–0.403), $z = 3.940$, $p < 0.001$], with a nonsignificant heterogeneity [$Q(1) = 0.138$, $p = 0.711$, $I^2 = 0.000$].

3.4.3 Attention-deficit/hyperactivity disorder symptom clusters

Only a single study reported results separately for attention-deficit and hyperactivity/impulsivity symptoms. The mean effect sizes were not significant for both separate symptom clusters [Fisher's $Z = 0.089$, $k = 2$, 95% CI (−0.023–0.201), $z = 1.561$, $p = 0.119$ and Fisher's $Z = 0.101$, $k = 2$, 95% CI (−0.011–0.213), $z = 1.774$, $p = 0.076$, respectively]. The

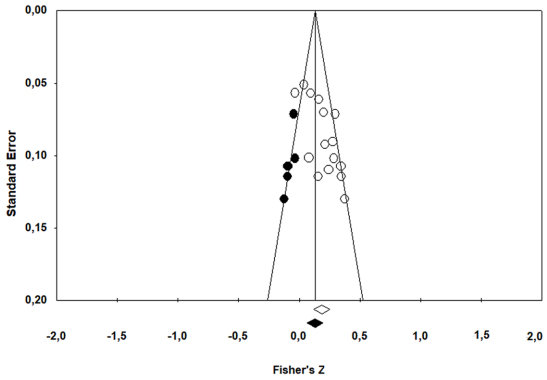

FIGURE 3
Funnel plot after trim and fill.

weighted mean effect size for studies using composite scores of the two ADHD symptom clusters was small, but significant [Fisher's $Z = 0.197$, $k = 14$, 95% CI (0.125–0.268), $z = 5.367$, $p < 0.001$]. The heterogeneity was significant [$Q(13) = 34.169$, $p = 0.001$, $I^2 = 61.954$].

3.4.4 Stable versus situational cognitions

Nine studies assessed stable cognitions, the weighted mean effect size was small [Fisher's $Z = 0.233$, $k = 9$, 95% CI (0.169–0.297), $z = 7.146$, $p < 0.001$], with a nonsignificant heterogeneity [$Q(8) = 5.739$, $p = 0.676$, $I^2 = 0.000$], and six studies focused on more situational cognitions, the weighted mean effect size was small [Fisher's $Z = 0.134$, $k = 6$, 95% CI (0.030–0.238), $z = 2.530$, $p = 0.011$], but the heterogeneity was significant [$Q(5) = 20.143$, $p = 0.001$, $I^2 = 75.177$].

3.4.5 Negative versus positive cognitions

Eight studies assessed negative parental cognitions. For these outcomes, the mean effect size was 0.145 [$k = 8$, 95% CI (0.048–0.241), $z = 2.937$, $p = 0.003$], and the heterogeneity was significant [$Q(7) = 21.470$, $p = 0.003$, $I^2 = 67.396$]. Ten studies assessed positive parental cognitions, the mean effect size was 0.269 [$k = 10$, 95% CI (0.179–0.359), $z = 5.876$, $p < 0.001$], the heterogeneity was also significant [$Q(9) = 22.037$, $p = 0.009$, $I^2 = 59.160$].

3.4.6 Self-referent cognitions

Across six studies, the association between self-referent cognitions and parental ADHD symptoms was significant, indicating that higher levels of the symptoms are related to more negative cognitions about the self. The weighted mean effect size was small/medium [Fisher's $Z = 0.287$, $k = 6$, 95% CI (0.201–0.373), $z = 6.551$, $p < 0.001$], the heterogeneity was not significant [$Q(5) = 2.520$, $p = 0.773$, $I^2 = 0.000$]. More specifically, the weighted mean effect size for the relationships between parental sense of competence and adult ADHD symptoms was 0.331 [$k = 6$, 95% CI (0.220–0.442), $z = 5.848$, $p < 0.001$] indicating a medium effect. The heterogeneity of the effect was not significant [$Q(5) = 8.264$, $p = 0.142$, $I^2 = 39.500$].

3.4.7 Cognitions about the child

Across nine studies, the weighted mean effect size for the association for parental ADHD symptoms and cognitions about the child was 0.125 [95% CI (0.054–0.197), $k = 9$, $z = 3.445$, $p = 0.001$, $Q(8) = 17.148$, $p = 0.029$, $I^2 = 53.346$], representing a small effect. When analyzing different types of child-referent cognitions separately, results revealed, that, across six studies, the weighted mean effect size indicated that higher levels of ADHD symptoms in the parent are associated with more negative parental attitudes toward the child [Fisher's $Z = 0.120$, 95% CI (0.061–0.179), $k = 6$, $z = 3.980$, $p < 0.001$], with a nonsignificant heterogeneity [$Q(5) = 5.824$, $p = 0.324$, $I^2 = 14.149$]. The weighted mean effect size was small, however. Across three studies, parental attributions about the child's behavior were not significantly related to parental ADHD symptoms [Fisher's $Z = 0.158$, $k = 3$, 95% CI (−0.084–0.399), $z = 1.280$, $p = 0.200$], with a significant heterogeneity among the effect sizes [$Q(2) = 10.590$, $p = 0.005$, $I^2 = 81.114$].

3.4.8 Cognitions about co-parenting

Only a single study reported the relationships between adult ADHD symptoms and cognitions about co-parenting, effect size was small but significant [Fisher's $Z = 0.277$, 95% CI (0.100–0.455), $z = 3.061$, $p = 0.002$], indicating that parents with higher levels of ADHD symptoms have a more negative perception of their collaboration in raising a child with another parent.

3.4.9 The method of assessing parental cognitions

Across three observational studies, the weighted mean effect size for the association of adult ADHD symptoms and parental cognitions was nonsignificant [Fisher's $Z = 0.102$, $k = 3$, 95% CI (−0.003–0.207), $z = 1.908$, $p = 0.056$], with a nonsignificant heterogeneity [$Q(2) = 3.428$, $p = 0.180$, $I^2 = 41.660$]. Twelve studies used self-report measures for assessing parental cognitions, the weighted mean effect size was 0.218 [$k = 12$, 95% CI (0.140–0.297), $z = 5.429$, $p < 0.001$], with a significant heterogeneity [$Q(11) = 28.859$, $p = 0.002$, $I^2 = 61.883$], representing a small but significant effect. Only a single study used a partner report, the effect was non-significant [Fisher's $Z = 0.065$, 95% CI (−0.159–0.290), $z = 0.570$, $p = 0.569$].

3.5 Meta-regression analyzes

Meta-regression analyzes revealed that publication year ($b = -0.006$, $SE = 0.005$, $z = -1.06$, $p = 0.290$), quality rating ($b = 0.004$, $SE = 0.022$, $z = 0.17$, $p = 0.867$), the ratio of boys ($b = -0.001$, $SE = 0.002$, $z = -0.78$, $p = 0.434$), and ADHD diagnoses in children ($b = -0.001$, $SE = 0.001$, $z = -1.54$, $p = 0.125$), and the ratio of mothers in the sample ($b = 0.004$, $SE = 0.002$, $z = 1.54$, $p = 0.124$) did not have a significant effect, while the effects of parents' mean age ($b = -0.017$, $SE = 0.008$, $z = -2.18$, $p = 0.029$) and the mean age of children ($b = -0.021$, $SE = 0.009$, $z = -2.39$, $p = 0.017$) were significant. The lower mean age of the parent and the child were related to more negative parental cognitions.

4 Discussion

4.1 Parental ADHD symptoms and dysfunctional cognitions

Parental beliefs and expectations about the parental role, the parents' attitudes toward the child and their causal attributions about the child's behavior play a potentially important role in shaping

developmental trajectories (106). A growing body of research reported that ADHD symptoms in adults are associated with dysfunctional cognitions in general (37–39, 42, 107–110), and more specifically, in the parenting domain (66, 68, 71–75, 80–83). However, our meta-analysis was the first that aimed to assess the relationships between parental ADHD symptoms and parental cognitions.

We were able to include 15 studies of overall strong quality. As hypothesized, the analysis revealed a significant association between parental ADHD symptoms and dysfunctional parental cognitions; parents with higher levels of ADHD symptoms reported less positive and more negative parental cognitions. The weighted mean effect size was small, however. Though the analysis suggested that a publication bias may inflate the results, the effect was robust and remained significant after five missing studies had been imputed.

It is important to note that, though previous research found overly optimistic dysfunctional automatic thoughts about efficacy and performance in adult ADHD, leading to procrastination and avoidance (42), our meta-analysis did not provide any evidence for positively biased parental cognition. On the contrary, ADHD symptoms were related to less positive cognitions about the self as a parent.

The results suggest that stressful child-rearing situations may trigger dysfunctional cognitions in parents with ADHD, resulting in a biased negative perception of the parental role, the child and co-parenting. Repeated failure in parenting situations resulting from emotional dysregulation and executive function deficits related to ADHD (14–16) and frequent negative feedback about the person's parenting skills may also lead to increased parental stress and negative cognitions, which in turn may negatively affect the parent–child relationship and parenting behavior (106). In that way, dysfunctional parental cognitions may play a central mediator role in the relationship between parental ADHD symptoms and parent and child outcomes.

ADHD in adults is often accompanied by other mental disorders (5). In this meta-analysis, we could not statistically control for comorbid symptoms, but the results of individual studies suggest that comorbid conditions do not fully explain the relationship between parental ADHD symptoms and dysfunctional parental cognitions. For example, Ninowski et al. (78) found that, after controlling for comorbid symptoms, ADHD symptoms still predicted less positive expectations about the infant and the future parental role in a sample of first-time expectant women. The results suggest that the relationship between parental ADHD and dysfunctional cognitions is not exclusively mediated by comorbid symptoms.

Not only do parental characteristics affect parental cognitions, but they also may be driven by the child's characteristics. Previous meta-analyzes indicated that genetically influenced behaviors in the child affect and shape parental behavior (111), and, more specifically, externalizing symptoms in the child elicit changes in parents' psychological stress and parenting practices (112). A recent study found that ADHD polygenic scores in the child significantly predicted lower levels of parental involvement and monitoring and higher levels of inconsistent discipline through the child's ADHD symptoms after controlling for parental ADHD symptoms (113). It is plausible to assume that this evocative effect also exists in relation to parental cognitions. We could not control our analyzes for the child's ADHD symptoms. However, Psychogiou and et al. (72) reported a significant negative association between parental empathy toward the child and the child's ADHD symptoms, even when parental ADHD symptoms were included in the model, suggesting that child-driven effects might also operate on parental cognitions. Therefore, both the child's and the parent's characteristics should be incorporated into explanatory models of parental cognitions.

Because of the heterogeneity of the effects, we conducted several subgroup analyzes and meta-regressions to uncover factors affecting the relationship between parental ADHD symptoms and parental cognitions. The effect was small but significant across all age groups of children, for both stable and situational cognitions, for negative and positive cognitions, and for cognitions about the self, the child, and co-parenting. Across six studies assessing parental sense of competence, the weighted mean effect size reached the medium level. According to previous research, low general self-efficacy may be a central maladaptive belief in adults with ADHD (39). On the other hand, general self-efficacy was shown to be the strongest predictor of parental self-efficacy (114). In that way, lower levels of perceived parental competence may be related to more general beliefs about the person's ability to meet responsibilities in different roles in life. Parental self-efficacy beliefs were shown to be related to several positive parent and child outcomes (115, 116) and served as mediators of treatment effects on parenting (117). Therefore, addressing dysfunctional cognitions about the parenting role and the person's abilities to raise a child may be crucial in parent interventions when working with parents with ADHD symptoms.

Meta-regression analyzes indicated that the lower age of the parent and the child were related to more negative parental cognitions. Previous research revealed mixed evidence on age-related changes in parental cognitions. The older age of the parent was shown to be related to higher satisfaction with the parental role (118) but not to higher levels of parental self-efficacy (119). However, ADHD symptoms were shown to decline with age (120) in both the parent and the child, which may explain the decrease in the strengths of the association between parental ADHD symptoms and dysfunctional cognitions in our analysis.

The methodology of the studies was found to be an important moderator. Across 12 studies using self-report measures for assessing parental cognitions, the weighted mean effect size was small but significant. However, the association between parental ADHD symptoms and dysfunctional cognitions were non-significant across three observational studies and in a single study using partner report. This is in line with the results of a meta-analysis on the relationship between adult ADHD symptoms and parenting behavior (23), in that Park and Johnston found a larger effect in studies using self-report for both ADHD symptoms and parenting behavior than in studies using other methodologies. Though self-report is undoubtedly the most valid source of information about the individual's beliefs, attitudes and attributions, self-report measures are susceptible to measurement error, especially social desirability biases. Self-report on ADHD symptoms may also be biased by executive function deficits and comorbid conditions such as depressive symptoms. On the other hand, behavioral observation may be prone to reactivity bias. Our results draw attention to the need for multi-method, multi-informant research in parental psychopathology, dysfunctional cognitions, and parental functioning.

4.2 Limitations and call for further research

Several factors might impact our results, limit the generalizability of the findings, and call for further research.

4.2.1 Biased samples

The studies involved in the meta-analyzes used community samples or parents of children with ADHD, but none of them used adult ADHD samples. The limited range of ADHD symptoms displayed in the parents in these samples might contribute to the overall small effect sizes found in the analyzes. Further research is warranted on parents with a clinical diagnosis of ADHD.

Mothers were overrepresented in most of the samples. In previous studies, gender differences have been reported in symptom presentation, prevalence, comorbid profile, and social perception of ADHD symptoms (121, 122). Women may be more likely to show symptoms of inattention rather than hyperactivity/impulsivity, which may lead to delayed referral and diagnosis (122, 123). Furthermore, mothers and fathers may differ in their perception and parenting of a child with ADHD (124). These gender differences might impact the results of our analyzes; future research should focus on other caregivers as well.

Furthermore, boys were overrepresented in most samples. However, gender differences were reported in symptom presentation (125), etiology (126), referral (127), and, more importantly to our topic, in parental perception of ADHD (128); in that way, it is plausible to assume that child's gender may impact parental cognitions.

4.2.2 Studies from high-income countries

We included only English language publications, which is a clear limitation of the study. Perhaps related to this, two-thirds of the studies involved in the meta-analysis were conducted in North America, and one-third of them in North and Western Europe, in that way all of them came from high-income countries. Though the prevalence of ADHD is similar across countries with different levels of income, according to a recent narrative review (129), access to treatment, especially to psychological interventions, is overall limited in low and medium-income countries, which might have an impact on parents' perception of the symptoms of and knowledge about ADHD and effective parenting. Cultural differences have also been reported in the structure of ADHD symptoms (130), and therefore, more research is needed in different cultural contexts.

4.2.3 Constructs and measurement issues

Another limitation of the meta-analysis was that the concepts in the field of parental cognitions are sometimes overlapping and not well-defined (106); it was difficult to draw a conclusion across studies using varying constructs and measures of parental attitudes, attributions, and beliefs. On the other hand, the distinction between parental cognition and behavior was not always clear in previous theories and research. Though we excluded such constructs from the analysis that are traditionally referred to in the literature as parenting practices, parenting styles, or parenting behaviors, we are aware of the fact that these concepts also include a cognitive component. Furthermore, the categorization of parental cognitions as stable or situational is somewhat arbitrary (106), they are more likely two endpoints of the single continuum than distinct categories, and therefore these characteristics could be better treated dimensionally. Similarly, because parenting involves an interaction between the parent and the child, it was sometimes debatable whether the reference of the cognition was the parent, the child, or the interaction *per se*.

4.2.4 The low number of independent contrasts

Because of the low number of independent contrasts in most moderators, we decided to report preliminary descriptive results of subgroup analyzes, i.e., the average effects in the different categories without statistically contrasting them. With more cumulating evidence these issues should be revisited.

Only one study included pregnant women (78), and a single study used a sample of mothers of infants (79). Even in this early period, maternal ADHD symptoms were associated with more negative expectations about the parental role and lower parental self-efficacy. These results suggest that parent characteristics could influence parental cognitions beyond child-driven effects. On the other hand, they draw attention to the importance of early prevention programs in mothers living with ADHD. More research is needed in this field.

Only a single study reported the relationships between parental cognitions and symptoms of inattention and hyperactivity/impulsivity separately, and all other studies used the total score of the rating scales as a general measure of ADHD symptoms. However, previous research found different associations of attention deficit and hyperactivity/impulsivity factors with comorbid conditions, cognitive variables, and different domains of functional impairment (131). Therefore, further research should explore the impact of different symptom domains on parental cognitions.

The interpersonal problems associated with adult ADHD are not limited to the parent–child relationship but can also affect cooperation between parents (74). Although a recent meta-analysis found that coparenting was associated with child mental well-being (132), only one study has examined the relationship between parental ADHD and coparenting. Further studies are needed in this area.

4.2.5 Cross-sectional data

We analyzed cross-sectional data which did not allow us to test cause-effect relationships. Longitudinal studies are needed to uncover the possible bidirectional nature of parental ADHD symptom-level and dysfunctional cognitions.

5 Conclusion

Despite these limitations, the present study contributed to the research on parental cognitions by giving insight into the strength of the association between parental ADHD symptoms and parental cognitions. Though the analysis might be impacted by publication bias, our results suggest a significant association of small effect size between ADHD symptom levels and dysfunctional parental cognitions. Dysfunctional parental cognitions may play a central mediator role between parental ADHD and parent and child outcomes. Considering the high heritability of ADHD (133), and the huge amount of evidence on its familiar risk factors (134, 135), targeting parental cognitions in parent training programs is warranted.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: OSF https://osf.io/pnur7/?view_only=181ede69724a4c3e8736cedac9d1ccc2.

Author contributions

MM: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. BK: Conceptualization, Formal analysis, Methodology, Writing – review & editing. JJ: Data curation, Formal analysis, Investigation, Writing – review & editing. FL: Data curation, Formal analysis, Investigation, Writing – review & editing. RK: Formal analysis, Methodology, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2023.1321078/full#supplementary-material

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Efficacy and safety of transcranial direct current stimulation over the left dorsolateral prefrontal cortex in children and adolescents with attention-deficit/hyperactivity disorder: a randomized, triple-blinded, sham-controlled, crossover trial

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Introduction: Although pharmacological treatment for Attention-Deficit/Hyperactivity Disorder (ADHD) has demonstrated efficacy, several individuals persist in experiencing social and academic impairment. Additionally, the occurrence of significant side effects may render the use of psychotropic medications untenable. However, Transcranial Direct Current Stimulation (tDCS), a non-invasive brain stimulation technique, shows promising results in treating ADHD.

Objectives: To investigate the efficacy and safety of tDCS on the performance of children and adolescents with ADHD in neuropsychological tests involving visual attention, visual and verbal working memory, and inhibitory control.

Methodology: This study was a triple-blind, randomized, sham-controlled, crossover clinical trial. The intervention consisted of a daily session of tDCS (2 mA) or sham targeting the left dorsolateral prefrontal cortex (L-DLPFC), for 30 min, on five consecutive days. The primary outcome was change in the Visual Attention Test, Fourth Edition (TAVIS-4) before and after each intervention. Subjects were also evaluated pre and post-tDCS using the Digit Span subtest of the Wechsler Intelligence Scale for Children, Fifth Edition

(WISC-V), the Developmental Neuropsychological Assessment, Second Edition (NEPSY-II) Inhibiting Response (IR) subtest, and the Corsi Block-Tapping Task.

Results: Fifteen individuals were included, and no statistically significant difference was observed when comparing the results of the TAVIS-4, the IR of NEPSY-II, and the intragroup Digit Span subtest of WISC-V undertaken before and after the procedure. Adverse events were mainly self-limiting and transient. The participants did not perceive any benefit from tDCS when measured on the Patient Global Impression of Improvement (PGI-I) Scale.

Conclusion: This study did not meet its primary endpoint and found no performance enhancement in any investigated neuropsychological outcomes relating to the intervention group.

KEYWORDS

tDCS, ADHD, non-invasive brain stimulation, dorsolateral prefrontal cortex, executive functions, neuromodulation, randomized controlled trial

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that manifests in early childhood and combines inattention, disorganization, and/or hyperactivity-impulsivity. Symptoms appear in at least two different environments, compromising cognitive abilities, such as motivation and executive functions (1).

Given that ADHD has negative repercussions for the daily life of children and adolescents in their social and learning environment and, when left untreated, can lead to disciplinary issues, substance abuse and also is correlated with depression and anxiety, treatment is recommended. The first option usually involves pharmacological treatment with psychotropic stimulants, whether or not with behavioral therapy (2–5). Among the stimulant drugs approved for use by the US Food and Drug Administration are methylphenidate and amphetamines, which work by increasing the amount of dopamine and epinephrine released in the prefrontal cortex (6). However, some of these medications can adversely affect children and adolescents, which can result in problematic therapeutic adherence and the consistency in usage intolerable to the individual (7, 8).

Transcranial Direct Current Stimulation (tDCS) is currently tested for the treatment of several neuropsychiatric disorders (9–13) and is considered safe for use in the pediatric population (14, 15). Evidence shows that tDCS applied to the dorsolateral prefrontal cortex can improve inhibitory control, impulsivity, and decision-making (16).

However, in the adult population, studies using tDCS to treat ADHD have shown contrasting results, with some suggesting improved performance in tests involving attention, memory, and inhibitory control (17, 18). In contrast, others report no difference concerning the sham group (19, 20). Nonetheless, trend-level improvements regarding inhibition and processing speed (though not attention) were found in a recent meta-analysis (21).

In 2014, Bandeira et al. (22) carried out an open-label trial with nine children and adolescents who received anodic tDCS with a current intensity of 2 mA for 30 min over five consecutive days to promote activation of the left dorsolateral prefrontal cortex (L-DLPFC). Increased performance was observed in the Visual Attention Test, 3rd Edition (TAVIS-3) as well as the Inhibiting Response subtest of the Developmental Neuropsychological Assessment, Second Edition (NEPSY-II) (22). These results could have been influenced by tDCS treatment, and the change in performance suggests a greater processing speed and better ability to detect stimuli and switch between activities.

Effects of tDCS in children and adolescents with ADHD were also shown in previous randomized clinical trials (RCT), such as modulation of memory consolidation (23), executive and inhibitory control, cognitive flexibility (24), and reduction in clinical symptoms of inattention and impulsivity (25).

Based on the previous data in the pediatric population, this study aims to reproduce the Bandeira et al. (22) study findings while widening the research scope and ensuring the technique's safety.

Methodology

Study design

This was a triple-blind, randomized, sham-controlled, crossover clinical trial. The study was conducted at the Attention Deficit Hyperactivity Disorder Outpatient Clinic of Professor Edgard Santos University Hospital, Federal University of Bahia in Salvador, Brazil. The protocol for this clinical trial has been published (26), and the trial was registered in the Brazilian Registry of Clinical Trials (ReBEC), which is affiliated with the World Health Organization (WHO).[1]

The study participants were randomly assigned to two groups: the sham group, which did not receive effective stimulation, and the active group, where tDCS was performed. The allocation process was conducted by an individual not involved with the clinical trial using

1 http://www.ensaiosclinicos.gov.br/rg/RBR-7h5qzf/

the randomization tool on randomization.com. The resulting allocation list was secured in a sealed envelope and kept by one of the investigators until the first day of stimulation, when the same individual opened it. Only the investigators responsible for performing tDCS had access to the envelopes to ensure that allocation concealment was maintained. After 1 month, the tDCS and sham-tDCS groups were reversed.

Intervention

The anode was positioned on the left dorsolateral prefrontal cortex (F3 according to the 10–20 system for EEG), and the cathode in the supraorbital region was on the opposite side. The device used was Striat (Ibramed, Amparo-SP, Brazil), approved by the Brazilian National Health Agency (ANVISA). During the stimulation period, the participants engaged in recreational activities involving memory and attention through memory games, such as "Super Lince" and "Genius." A trained individual performed five sessions (one per day) in the presence of a qualified physician to avoid possible intercurrence. We delivered tDCS treatment for five consecutive days since the same protocol was performed in previous clinical trials (18, 22, 25, 27).

The tDCS procedure involved the application of a direct current of low amplitude (2 mA) for 30 min using two electrodes (5 cm × 7 cm) soaked in saline solution. The current intensity of 1 mA was initially applied for 1 min before it was increased to 2 mA. At 29 min, the device returned to 1 mA at the last minute. Importantly, current strength, duration, and electrode array size had been previously found to be well tolerated (28). To ensure blinding in the sham group, the devices were covered during the sessions, and no participants or their parents had contact with them. To ensure that participants in the sham group were unaware of the sensation of current flow during the procedure, the device was switched on at 1 mA for the first minute, then turned off for 28 min, and reconnected again in the last minute at 1 mA. The families, research subjects, evaluators, and statistician were blind to the allocation groups. To ensure that family members remained blinded, they were asked not to be present in the room during the tDCS sessions. More details about the trial blinding procedures were previously published elsewhere (26). After a month of washout, the groups were switched. Children and adolescents who initially received tDCS moved to the sham-tDCS group and vice versa.

Participants

The inclusion criteria was comprised of individuals aged 6 to 16 with a diagnosis of ADHD according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) and confirmed by experienced child neurologists. Furthermore, the child neurologists conducted interviews with the parents of the participants to validate the presence of ADHD symptoms. Additional criteria included right-handedness, literacy, attending school, residency in Salvador-Brazil or within its metropolitan region, not undergoing pharmacological treatment during the intervention week, and EEG without epileptogenic activity. Consent of those responsible for participating in the study was also required before enrollment since all subjects were underage. We excluded individuals with sensory deficits or other neuropsychiatric comorbidities.

Outcome measures

After selecting the sample according to the aforementioned criteria and child neurology evaluation, children diagnosed with ADHD participated in a neuropsychological assessment to gauge their intellectual level and ability regarding attention, working memory, and inhibitory control. During the screening visit, the investigators assessed the participants and parents with the following instruments:

1. Wechsler Intelligence Scale for Children-WISC-V (29): to estimate IQ, we used the vocabulary subtest, which measures semantic knowledge, and the matrix ratio subtest, which evaluates nonverbal logical reasoning ability.
2. Swanson, Nolan, and Pelham Rating Scale, Fourth Edition (SNAP-IV) (30): The children's guardians answered this questionnaire, which assessed the diagnostic criteria for ADHD based on DSM-IV.
3. Child Behavior Checklist—CBCL (31, 32): this questionnaire evaluates social competence and behavioral issues in individuals aged 4–18, relying on information from their caregivers or guardians.

After enrolling in the study, the subjects were evaluated before and after the first cycle of tDCS or sham and before and after the second cycle of tDCS or sham. Moreover, neuropsychological tests were used for measuring executive function outcomes:

1. Visual Attention Test, Fourth Edition (TAVIS-4) (33): this assessment is designed for children aged 6–17. The child must press and hold a button on a joystick whenever a target appears on the screen. There are two versions of the test: one for ages 7–11 (target stimulus duration of 6 min) and another for ages 12–17 (target stimulus duration of 10 min). Each task provides scores for various parameters, including reaction time, commission errors, omission errors, and the number of successful hits. "Commission Errors" refer to instances when the child responds when they should not. "Error by omission" represents the lack of response to a target stimulus. The average reaction time, measured in milliseconds, indicates how long it takes for the child to press the button once the stimulus appears on the screen. Task 1 assesses selective attention, where the child needs to press the button when the target stimulus appears. Task 2 involves alternating attention, requiring the child to switch between two types of responses to identify identical geometric shapes of the same color. Task 3 evaluates concentration (sustained attention) through an uninterrupted performance test.
2. Digit Span subtest, as a component of WISC-V (29): measures attention and working memory through auditory tasks involving forward (auditory attention) and backward (working memory) digit recall. The examiner verbally presents a sequence of numbers, and the child's task is to repeat the numbers in the same order as they were spoken (forward) and then repeat the numbers in reverse order (backward).
3. Corsi Block-Tapping Task (34): aims to evaluate visual working memory. The subject is asked to repeat sequences of touches on various cubes. When reproducing the sequences in the forward order, the test assesses visual attention. On the other hand,

reproducing the sequences in the backward order examines the visuospatial sketch of working memory.

4. Inhibiting Response subtest (IR) from NEPSY-II (35, 36): this assessment evaluates the capacity to restrain the desire to engage in a pleasant task, stop an automatic behavior, or switch between stopping and automatic behavior. The examinee is presented with a series of stimuli, such as shapes or arrows, and is required to name the shape or direction or provide an alternative response, depending on the color of the stimulus. Errors may occur when an incorrect answer is given, skipped, or not corrected. Any unanswered items due to time constraints are also considered incorrect errors. Additionally, self-corrected errors are noted when an incorrect answer is subsequently corrected by the examinee. The total number of errors is calculated by summing up uncorrected errors and self-corrected errors for each condition, such as naming (involving the selection of information), inhibition (evaluating the ability to inhibit an automatic response), and switching (assessing the ability to switch attention).

Further details concerning the tests used and their applications can be found in the previously published protocol (26). The primary outcome was the difference in the total TAVIS-4 score between baseline and immediately after the fifth tDCS/sham-tDCS session.

The secondary outcome involved differences between pre-and post-tDCS/sham-tDCS in the Digit span subtest of WISC-V, Corsi Block-Tapping Task, and IR of NEPSY-II.

Sample size calculation

The sample size was calculated based on data from both our previous pilot study (22) and relevant literature (37). While the pilot study provided preliminary estimates, its limited sample size and larger standard deviation (3.58 pre-tDCS and 2.9 post-tDCS) prompted the inclusion of data from the literature, which offered a more precise estimate of the standard deviation. This standard deviation was used for both groups, as the individuals in the sham group were identical to those in the active group. This choice ensured a more validated approach, as the literature-based standard deviation carries greater weight and reliability. The variable "errors by omission" of the TAVIS-4 was considered the primary outcome. The calculation initially resulted in 11 subjects, with a significance level of 5%, power of 80%, a mean difference between paired groups of 1.2, and a standard deviation of 1.24. Assuming a dropout rate of 25%, the final sample size calculated was 14.

Statistical analysis

The primary efficacy measure was the change from baseline to treatment day 5 in the TAVIS-4 scores in the tDCS and sham-tDCS groups. Secondary analysis was performed on the change from baseline for the Digit span test, IR, and Corsi Block-Tapping Task. We used random intercepts linear mixed-effects models to analyze continuous outcomes, which can adequately account for associations induced by repeated measurements within participants and automatically handle missing values. Independent models included treatment (2 levels, tDCS and sham-tDCS), time (pre and post-treatment), treatment by time interaction, and participants as random effects. F-statistics assessed the main treatment effects using Satterthwaite's approximation for degrees of freedom. We estimate the effect size between groups using Cohen's d and defined cutoff values for small, medium, and large effect sizes as 0.2, 0.5, and 0.8, respectively (38). Significance levels were set at 0.05 and were two-sided. All analyses were conducted using R programming software version 4.2.3, and the ImerTest package was used for linear mixed models (39).

Ethics approval and consent to participate

This study was approved by the local Institutional Review Board (Medical School of Bahia, Federal University of Bahia, Number: 74002515.9.0000.5577) and followed the ethical principles of the Declaration of Helsinki, 2013. All the parents or guardians of the study participants agreed with the methodology used and signed an informed consent form before participant enrollment.

Results

We assessed 18 children and adolescents for eligibility and randomized 16 into active and sham groups (8 per group). One participant discontinued interventions after finishing five sessions of sham-tDCS, missing the treatment week of active tDCS due to a respiratory infection. Fifteen participants were included in the final analysis (Figure 1). The sociodemographic characteristics of the participants and their guardians can be found in Table 1. Most of the individuals were male (66.67%), black (73%), Latino (100%), had not repeated academic stages (80%), and were born at full term (93.33%). The children were aged from 6 to 15 (Mean: 11 ± 3.1 years), and their IQ ranged from 73 to 105 (Mean: 90.3 ± 10.4). Regarding the level of education, the parent with the best academic level was considered, with two-thirds (66.7%) of them having completed a higher education degree. Regarding the clinical and psychometric profile of the subjects, the mean score on SNAP-IV for attention-related symptoms, hyperactivity/impulsivity, and oppositional defiant disorder were 17.9, 12.6, and 8.6, respectively. According to the cut-off point, attention deficit, hyperactivity/impulsivity, and oppositional defiant disorder were detected in 93.33, 46.7, and 20% of the cases, respectively, having been assessed using SNAP-IV. Detailed baseline psychometric characteristics of individual participants' data are described in Table 2, including intelligence, executive function, and inhibitory response domains.

Primary outcome

No statistically significant results were found for tDCS treatment. Moreover, when compared to TAVIS-4 between tDCS and sham-tDCS groups, the interaction treatment and time was also not statistically significant regarding reaction time, errors by omission, and commission errors. Mean changes from baseline, confidence intervals, and correspondent effect sizes (Cohen's d) between tDCS and sham-tDCS groups can be found in Table 3 and Figure 2.

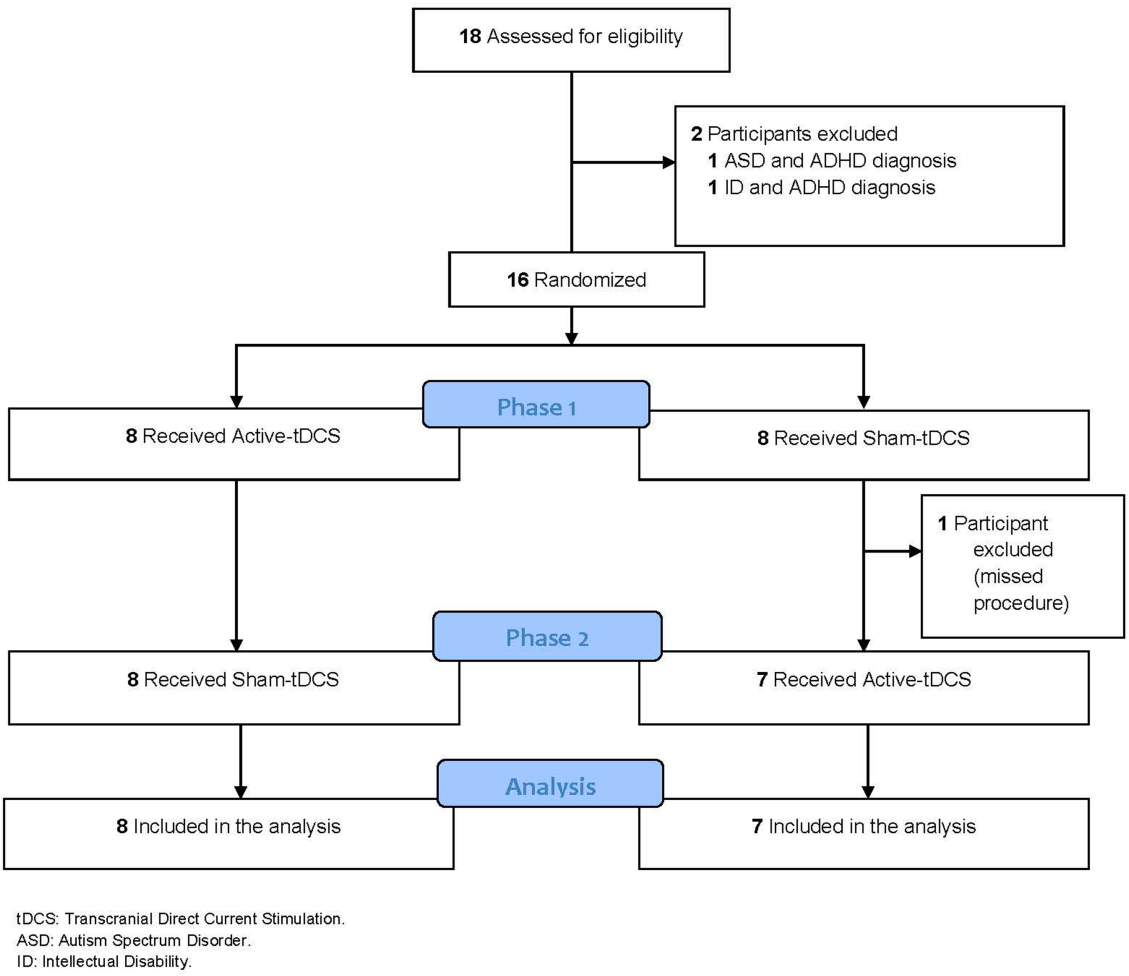

FIGURE 1
Consort flow diagram.

Although we found medium effect sizes in some tasks, confidence intervals were wide and encompassed negative values.

Secondary outcome

Outcomes were ascertained by the use of the Digit Span subtest (forward and backward orders), IR (inhibitory control and cognitive flexibility), and Corsi Block-Tapping Task. There was no statistically significant difference regarding therapeutic response between tDCS and sham-tDCS groups (Tables 4–6).

Table 7 presents the parents' subjective perception of therapeutic response after tDCS and sham-tDCS, reporting improvement (mild, moderate, or marked), no change, or worsening (mild) respectively in 2, 8, and 2 of the tDCS group and 5, 8 and 1 of the sham-tDCS group. No significant difference was observed in the perception of improvement between the two groups.

Blinding integrity

Regarding the parents' perception of the allocation group, it could be seen that, of 26 responses obtained, 16 (61.5%) were in agreement regarding the allocation of the tDCS (9) and sham (7) groups. Of those who disagreed (38.5%), three manifested this after tDCS and seven after sham. Concerning the children's perception, there were 18 (60%) concordant responses: 10 after tDCS and eight after sham, and 12 (40%) discordant responses: 5 after tDCS and seven after sham (Table 8). The data suggest a low level of agreement, indicating preserved blinding.

TABLE 1 Sociodemographic characteristics of children and adolescents with Attention-Deficit/Hyperactivity Disorder ($n = 15$).

Subject	Sex	Age	Race/Ethnicity	Repeated academic years	Parent/guardian's level of education
1	M	13	Black/Latino	0	HEC
2	M	9	White/Latino	0	HEC
3	M	10	Black/Latino	0	HEC
4	F	13	White/Latino	0	HEC
5	M	8	White/Latino	0	HEC
6	M	11	Black/Latino	1	HEI
7	F	6	Black/Latino	0	HEC
8	M	8	Black/Latino	0	SC
9	F	15	Black/Latino	3	MC
10	F	7	Black/Latino	0	MC
11	M	11	Black/Latino	0	HEC
12	F	14	Black/Latino	0	HEC
13	M	15	Black/Latino	1	SC
14	M	15	White/Latino	0	HEC
15	M	13	Black/Latino	0	HEC
Mean		11.2 (3.0)			

F, Female; M, Male; EI, Elementary Incomplete; SC, Secondary Complete; HEI, Higher Education incomplete; HEC, Higher Education Complete.

Adverse events

Adverse events were mostly self-limiting and characterized as mild to moderate. Pruritus was identified in 9 (60%) children from the tDCS group and 3 (20%) from the sham-tDCS group. Tingling and burning of greater intensity were reported by 4 (26.7%) and 3 (20%) children, respectively, from the tDCS and sham-tDCS groups (Table 9).

Discussion

Research on brain stimulation has occurred less frequently in the pediatric population than in adults (40), and using cortical neuromodulation techniques in treating neurodevelopmental disorders is a comparatively recent development. However, ADHD remains one of the most studied mental disorders, with a majority of clinical trials involving the anodic stimulation of L-DLPFC (41).

Evidence indicates that variations relating to the stage of the menstrual cycle in which stimulation is performed may be a determining factor for cortical activation, which would then modify tDCS response at an individual level (42). In our study, specific control was not performed according to the menstrual cycle phase during the intervention, which could have affected the results. However, this control would only have been necessary for two of the five females in the study who had menarche.

In a crossover study by Breitling et al. (43), a single 20-min session of 1 mA of anodic tDCS and 1 mA of cathodic tDCS or sham-tDCS was performed, with intervals of at least 1 week between each intervention. The study population consisted of 21 male adolescents diagnosed with ADHD compared to 21 male adolescents who served as healthy controls. Female subjects were not included due to the possibility that menstruation and hormonal factors could affect cortical activation. Although the trial did not include female subjects, the results showed no statistically significant effects in the intervention group.

Westwood et al. conducted a double-blind, randomized, sham-controlled trial testing tDCS in 50 male children and adolescents with ADHD. The active group received anodic stimulation (current of 1 mA, administered for 20 min), associated with cognitive training, over the right inferior frontal cortex. Aligned with our results, this trial also failed to meet its primary endpoint (44). Moreover, in an analysis of a subpopulation of this sample with 23 boys, no significant difference was found in QEEG spectral power during rest and Go/No-Go Task performance. The authors also pointed out the lack of statistically significant findings regarding clinical and cognitive measures in their study (45). These negative findings in the gender-controlled studies previously mentioned suggest that the presence of female participants in our study might not have influenced the observed lack of tDCS effect.

Along with our negative results, many other RCTs have failed to show the superiority of tDCS compared with sham. Schertz et al., performed a randomized, double-blind, sham-controlled pilot study on 25 children, combining cognitive training with the use of anodic tDCS on L-DLPFC three times a week (20 min per session) at an interval of 4 weeks. This study found no difference between the tDCS and sham groups in any of the measures used to assess subjects pre-intervention. This was the case after six sessions, 12 sessions, and 1 month after completing the sessions (46).

Salehinejad et al. performed a sham-controlled trial of tDCS evaluating the executive functions of 22 children with ADHD. The stimulation time in the active group was 15 min, with a current intensity of 1.5 mA. Bilateral anodal left and right DLPFC tDCS did not enhance performance regarding inhibitory control, working memory, and cognitive flexibility (47).

Klomjai et al. performed a pilot randomized sham-controlled crossover study of cathodic tDCS on 11 individuals with ADHD on neurophysiological and behavioral outcomes. The active group received current stimulation of 1.5 mA for 20 min over the L-DLPFC for five

TABLE 2 Psychometric baseline characteristics of children and adolescents with Attention-Deficit/Hyperactivity Disorder ($n = 15$).

Subject	IQ	SNAP-IV: Attention-Deficit	SNAP-IV: hyperactivity	SNAP-IV: ODD	SNAP-IV total	TAVIS-IV: reaction time	TAVIS-IV: errors by omission	TAVIS-IV: actions errors	Digit Span[a]	Inhibition response test[b]	Corsi Block-Tapping Task[c]
1	79	23	8	8	39	2.28	15	11	10	3	7
2	99	18	16	6	40	2.01	12	21	11	6	7
3	100	10	22	16	48	1.92	0	7	11	0	10
4	90	14	3	4	48	1.49	18	18	9	5	9
5	92	19	18	18	55	2.17	19	58	3	27	8
6	84	16	11	7	34	1.94	0	10	6	4	8
7	95	21	23	6	50	2.35	7	4	6	48	4
8	80	20	18	8	46	1.37	12	35	6	4	4
9	73	18	8	12	38	1.59	13	21	8	9	8
10	105	21	24	11	56	2.56	1	111	7	32	3
11	104	20	14	9	43	1.32	19	16	11	0	5
12	97	19	9	15	43	1.61	15	15	6	3	9
13	78	17	8	7	32	1.96	16	53	11	3	8
14	98	15	5	1	21	1.75	9	17	11	3	9
15	81	17	2	1	30	2.19	19	10	15	5	6
Mean (SD)	90.3 (10.3)	17.8 (3.2)	12.6 (7.2)	8.6 (5.0)	41.5 (9.6)	1.90 (0.37)	11.6 (6.8)	27.1 (28.0)	8.7 (3.0)	10.1 (14.0)	7 (2.1)

SNAP-IV, Swanson, Nolan and Pelham-IV; TAVIS-IV, Visual Attention Test-IV.

[a]Scores on the direct order of Digit Span test, subtest of the Wechsler Intelligence Scale for Children (WISC-IV).

[b]Scores on the Inhibition Response test, subtest of the Neuropsychological Assessment Battery Second Edition (NEPSY II).

[c]Scores on the direct order of the Corsi Block-Tapping Task.

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TABLE 3 Visual Attention Test (TAVIS-4): estimate of mean change on TAVIS-4 scores after procedures and effect sizes comparing tDCS and sham-tDCS groups in children and adolescents with Attention-Deficit/Hyperactivity Disorder.

Parameters	tDCS ($N = 15$)[a]	Sham-tDCS ($N = 15$)[a]	Analysis			Cohen's d
			F	df	*P*-value[b]	
Reaction time						
Task 1						
Baseline	0.49 (0.13)	0.53 (0.12)				
Change after procedure	0.03 (−0.01 to 0.06)	0.004 (−0.03 to 0.04)	0.97	1, 28	0.33	0.36 (−0.36 to 1.08)
Task 2						
Baseline	0.66 (0.15)	0.63 (0.19)				
Change after procedure	−0.060 (−0.123 to 0.003)	0.005 (−0.053 to 0.069)	2.24	1, 14	0.15	−0.55 (−1.27 to 0.19)
Task 3						
Baseline	0.747 (0.21)	0.698 (0.30)				
Change after procedure	−0.037 (−0.194 to 0.102)	0.155 (−0.034 to 0.366)	2.35	1, 28	0.13	−0.56 (−1.29 to 0.17)
Errors by omission						
Task 1						
Baseline	7.07 (5.12)	8.00 (6.05)				
Change after procedure	0.20 (−1.66 to 2.06)	−1.47 (−3.33 to 0.398)	1.67	1, 28	0.20	0.47 (−0.26 to 1.19)
Task 2						
Baseline	3.80 (3.00)	3.13 (2.53)				
Change after procedure	−0.20 (−1.76 to 1.36)	0.13 (−1.43 to 1.70)	0.09	1, 28	0.75	−0.11 (−0.83 to 0.60)
Task 3						
Baseline	0.80 (1.32)	3.00 (6.13)				
Change after procedure	−0.40 (−3.05 to 2.25)	0.60 (−2.05 to 3.25)	0.35	1, 14	0.55	−0.20 (−0.92 to 0.52)
Commission errors						
Task 1						
Baseline	11.20 (8.31)	8.73 (5.14)				
Change after procedure	−2.20 (−4.77 to 0.37)	−0.73 (−3.31 to 1.84)	0.82	1, 14	0.38	−0.30 (−1.02 to 0.42)
Task 2						
Baseline	5.53 (6.57)	5.07 (7.37)				
Change after procedure	−3.00 (−6.09 to 0.09)	−1.60 (−4.69 to 1.49)	0.44	1, 14	0.51	−0.24 (−0.96 to 0.48)
Task 3						
Baseline	10.40 (24.98)	5.20 (8.11)				
Change after procedure	−2.53 (−16.20 to 11.10)	4.80 (−8.87 to 18.50)	0.92	1, 14	0.35	−0.29 (−1.00 to 0.44)

tDCS, Transcranial Direct Current Stimulation. There was no statistically significant difference between baseline values presented. For Cohen's d, negative values favors tDCS, whereas positive values favors sham-tDCS.

[a]For baseline values, mean and Standard Deviation. For changes after procedures, mean and 95% Confidence Intervals.

[b]*P*-values obtained from time by group interaction in Linear mixed effects models.

consecutive days, 1 month apart. After five active sessions, the study also did not show improvements in attention, only in inhibitory control (27).

Aligned with these previous trials, our study also did not show significant differences for children undergoing tDCS compared to sham-tDCS, contrasting with the positive results of other studies on children and adolescents (16, 22, 24, 25). Due to these studies' high heterogeneity, it is challenging to define what contributed to the differences in outcomes in the previously published RCT. Possible explanations could be related to the stimulation protocols or the outcomes assessment methods, which can justify the differences between the studies and impair their interpretation, being a confounding factor (21).

Other aspects that may have influenced the results are the tDCS parameters and the simultaneous performance of tasks that require more attention to encourage engagement during the procedure. There still needs to be a consensus in the literature on the influence of simultaneous activities on cortical activation. According to previously published data, performing cognitive tasks to stimulate attention during the application of tDCS is less favorable to the consolidation of neuroplasticity (48). On the other hand, there is data regarding the potential positive use of concomitant tasks during stimulation, such as a previous study testing tDCS for aphasic subjects with simultaneous language training (49).

The current intensity in our trial was 2 mA, higher than 1-1.5 mA used in other studies with children and adolescents (16, 24, 25, 50), which may have influenced the negative results. The behavior of an electrical current in the developing brain can be unpredictable, and the few studies that compared different intensities were carried out using computer models. Although based on estimates regarding anatomical

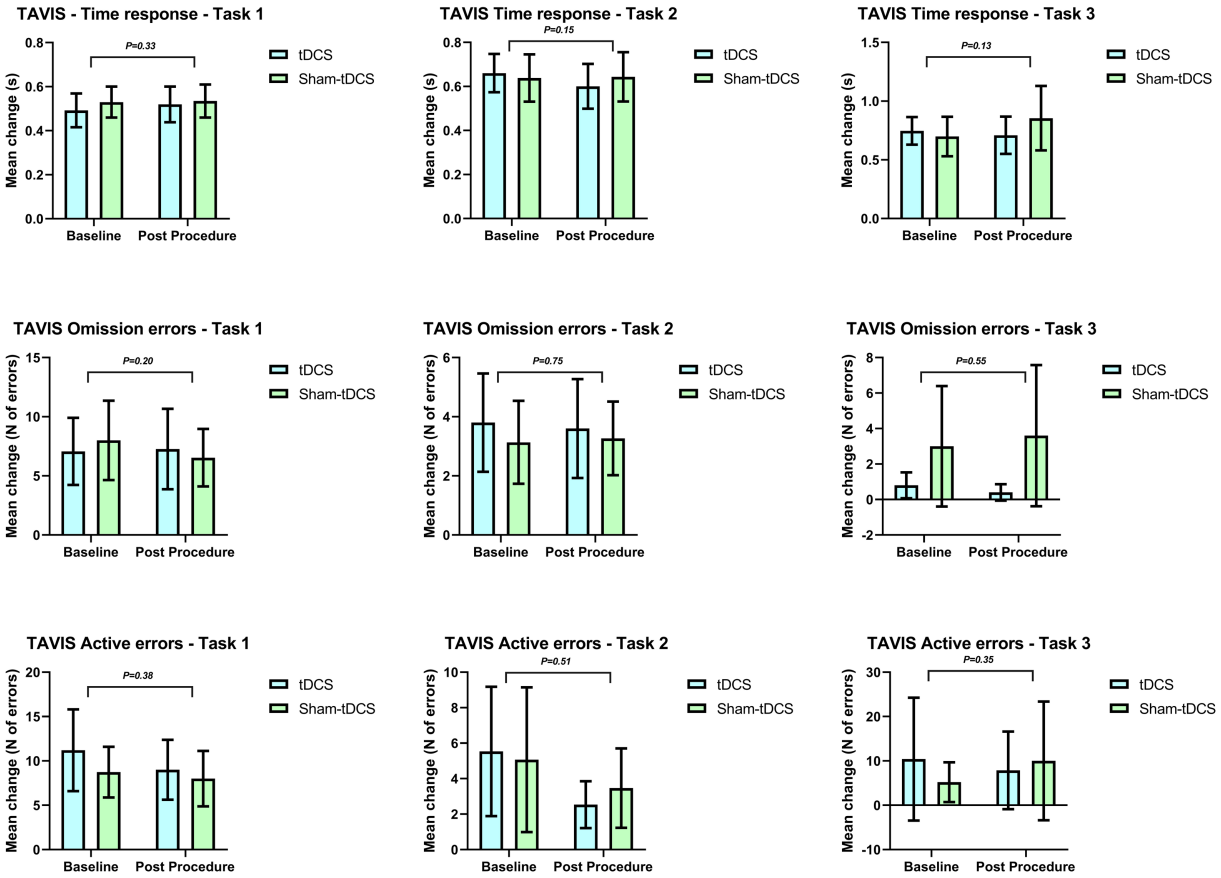

FIGURE 2
Mean change on TAVIS-4 comparing tDCS and sham-tDCS groups in children and adolescents with Attention-Deficit/Hyperactivity Disorder.

TABLE 4 Digit Span: estimate of mean change on Digit Span scores after procedures and effect sizes comparing tDCS and sham-tDCS groups in children and adolescents with Attention-Deficit/Hyperactivity Disorder.

Parameters	tDCS ($N = 15$)[a]	Sham-tDCS ($N = 15$)[a]	Analysis			Cohen's d
			F	df	*P*-value[b]	
Forward order						
Baseline	8.73 (3.08)	8.33 (2.52)				
Change after procedure	−0.33 (−1.12 to 0.45)	−0.80 (−1.59 to 0.01)	0.74	1, 28	0.39	0.33 (−0.42 to 1.07)
Inverse order						
Baseline	6.73 (1.90)	6.47 (1.72)				
Change after procedure	−0.60 (−1.55 to 0.36)	0.2 (−0.76 to 1.16)	1.46	1, 28	0.23	−0.46 (−1.20 to 0.30)

tDCS, Transcranial Direct Current Stimulation. There was no statistically significant difference between baseline values presented. For Cohen's d, negative values favors tDCS, whereas positive values favors sham-tDCS.
[a]For baseline values, mean and Standard Deviation. For changes after procedures, mean and 95% Confidence Intervals.
[b]*P*-values obtained from time by group interaction in Linear mixed effects models.

parameters (scalp thickness, subarachnoid space, and skull), these models may not effectively represent what happens in the brain under natural conditions (51).

The allocation order (tDCS or sham) does not seem to have influenced the results. Moreover, the baseline characteristics were similar between subjects since it was a crossover study. Also, despite being a crossover study, there was minimal dropout (only one participant after sham-tDCS).

Adverse events during tDCS were mainly mild and self-limiting, as previously reported (28). The most frequent were pruritus and tingling, in the tDCS and sham-tDCS groups, in accordance with previous studies (25, 50), In addition, there were also reports of a burning sensation and local erythema (mainly in the tDCS group).

Our study assessed responses using the Patient Global Impression of Improvement (PGI-I) Scale. There was no difference in the subjective perception of parents regarding the therapeutic response in

TABLE 5 Inhibiting Response (IR) subtest: estimate of mean change on IR subtest scores after procedures and effect sizes comparing tDCS and sham-tDCS groups in children and adolescents with Attention-Deficit/Hyperactivity Disorder.

Parameters	tDCS ($N = 15$)[a]	Sham-tDCS ($N = 15$)[a]	Analysis			Cohen's d
			F	df	*P*-value[b]	
Inhibitory control						
Errors						
Baseline	10.13 (14.5)	7.67 (15.7)				
Change after procedure	−0.06 (−5.08 to 4.95)	4.73 (−0.28 to 9.75)	1.91	1, 28	0.17	−0.52 (−1.27 to 0.23)
Reaction time						
Baseline	70.8 (27.9)	74.8 (33.7)				
Change after procedure	−7.45 (−23.60 to 8.66)	1.71 (−14.40 to 17.81)	0.67	1, 28	0.41	−0.31 (−1.05 to 0.44)
Cognitive flexibility						
Errors						
Baseline	14.7 (57.9)	12.1 (X)				
Change after procedure	−1.66 (−7.05 to 3.72)	0.86 (−4.52 to 6.25)	0.46	1, 28	0.50	−0.26 (−1.00 to 0.49)
Reaction time						
Baseline	105.3 (57.9)	102.3 (43.8)				
Change after procedure	−7.7 (−31.2 to 15.6)	−14.8 (−38.2 to 8.6)	0.18	1, 28	0.66	0.16 (−0.58, 0.91)

tDCS, Transcranial Direct Current Stimulation. There was no statistically significant difference between baseline values presented. For Cohen's d, negative values favors tDCS, whereas positive values favors sham-tDCS.
[a]For baseline values, mean and Standard Deviation. For changes after procedures, mean and 95% Confidence Intervals.
[b]P-values obtained from time by group interaction in Linear mixed effects models.

TABLE 6 Corsi Block-Tapping Task: estimate of mean change on Corsi Block-Tapping Task scores after procedures and effect sizes comparing tDCS and sham-tDCS groups in children and adolescents with Attention-Deficit/Hyperactivity Disorder.

Parameters	tDCS ($N = 15$)[a]	Sham-tDCS ($N = 15$)[a]	Analysis			Cohen's d
			F	df	*P*-value[b]	
Forward order						
Baseline	7.00 (2.13)	7.73 (2.21)				
Change	0.26 (−0.56 to 1.09)	−0.86 (−1.69 to 0.03)	3.92	1, 28	0.05	0.75 (−0.02 to 1.51)
Inverse order						
Baseline	6.73 (2.31)	6.73 (2.65)				
Change after procedure	−0.46 (−1.55 to 0.62)	0.20 (−0.88 to 1.29)	0.79	1, 28	0.38	−0.34 (−1.08 to 0.41)

tDCS, Transcranial Direct Current Stimulation. There was no statistically significant difference between baseline values presented. For Cohen's d, negative values favors tDCS, whereas positive values favors sham-tDCS.
[a]For baseline values, mean and Standard Deviation. For changes after procedures, mean and 95% Confidence Intervals.
[b]*P*-values obtained from time by group interaction in Linear mixed effects models.

TABLE 7 Perception of therapeutic response after tDCS and sham-tDCS.

Characteristic	tDCS	Sham	*P*
Impression scale of improvement	$n = 12$	$n = 14$	
No difference	2 (16.7%)	5 (35.7%)	0.524
Better	8 (66.6%)	8 (57.2%)	
Worse	2 (16.7%)	1 (7.1%)	
Fisher's exact test			

TABLE 8 Parents' and subjects' perception of allocation group after five sessions of tDCS and sham-tDCS.

	tDCS		Sham-tDCS		Kappa
Parents	tDCS (12)	Sham (12)	tDCS (14)	Sham (14)	0.24
	9	3	7	7	
Subjects	ETCC (15)	Sham (15)	ETCC (15)	Sham (15)	0.20
	10	5	7	8	

TABLE 9 Adverse events attributed to tDCS and sham-tDCS in children and adolescents with Attention-Deficit/Hyperactivity Disorder.

Adverse Event	tDCS ($n = 15$)		Sham-tDCS ($n = 15$)	
	Mild/moderate	Severe	Mild/moderate	Severe
Headache	5	0	5	0
Itching	4	9	11	3
Tingling	7	4	11	1
Burning	9	3	9	0
Scalp pain	4	0	1	0
Local erythema	13	0	1	0
Irritability	2	0	1	0
Sleepiness	2	1	2	0

the two groups, which reinforces the null effect of tDCS for the parameters used. Furthermore, there was disagreement between the perception of parents and subjects about the allocation group, which shows the preservation of study blinding and the tolerability of tDCS when compared to sham.

Our study has several limitations. First, our small sample size may not have been sufficient to show differences between the groups. However, the sample size calculation was based on differences identified in the literature and our pilot study (22), with a power of 80% and an alpha error of 5%. Secondly, our sample size did not allow for a more robust statistical analysis, controlling for confounding factors. However, some factors minimize this limitation, including our crossover design, which allowed the intervention and control groups to be homogeneous, once they were composed by the same participants. Additionally, we conducted an exploratory subgroup sensitivity analysis with our data based on sex, age, and severity of symptoms; however, no significant differences were observed.

Still, regarding our limitations, we did not select a population with the same ADHD subtype. People diagnosed with ADHD can experience inattention, hyperactivity, or both, linked to a heterogeneous cluster of symptoms and possibly differing regarding functional brain abnormalities. Different stimulation protocols might be needed for each subtype, yet few clinical trials address this issue. The clinical heterogeneity of mental disorders is a challenge in psychiatry research. For instance, a recent study has explored new subgroups of symptom clusters within Major Depressive Disorder, uncovering specific biomarkers (52). However, in ADHD, the current body of data remains insufficient to warrant a study focusing on different subtypes.

Conclusion

In contrast to previous studies with the same focus, we found no measurable difference in comparison to the sham group in the neuropsychological parameters of visual attention, visual and verbal working memory, and inhibitory control in any of the investigated outcomes involving the application of tDCS for the treatment of pediatric ADHD. In the subjective opinion of the participants, there were no perceptible benefits of tDCS in relation to sham, according to the Patient Global Impression of Improvement (PGI-I) Scale.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board (Medical School of Bahia, Federal University of Bahia). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

RSQG and IDB: conceptualization, data curation, investigation, methodology, project administration, validation, visualization, writing – original draft, writing – review & editing. BLB: investigation, project administration, visualization, writing – original draft. TW, COCA, and TLB: Investigation. CFC: methodology, writing – review & editing. ID-B and DL-S: writing – original draft, writing – review & editing. AT: formal analysis, visualization, writing – review & editing. PHL: formal analysis. RL: conceptualization, methodology, resources, supervision. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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A comparison of visual attention to pictures in the Autism Diagnostic Observation Schedule in children and adolescents with ADHD and/or autism

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Background: Attention-Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD) are neurodevelopmental conditions which frequently co-occur. The Autism Diagnostic Observation Schedule (ADOS) is commonly used to aid with diagnostic assessment of ASD but was not originally designed for use in those with comorbid ADHD. Visual attention to social stimuli has been often studied in ASD using eye-tracking, to obtain quantitative indices of how attention is deployed to different parts of a social image/scene. As the ADOS includes tasks that rely on attending to and processing images of social scenes, these measures of visual attention could provide useful additional objective measurement alongside ADOS scores to enhance the characterisation of autistic symptoms in those with ADHD.

Methods: Children with ASD, comorbid ASD and ADHD, ADHD and Neurotypical (NT) controls were recruited (n=84). Visual attention was measured using eye-tracking during free viewing of social scenes selected from the ADOS. The full ADOS was then administered. Stimulant medication was temporarily withdrawn during this assessment. Research diagnoses were based on the Development and Wellbeing Assessment (DAWBA), ADOS, Social Communication Questionnaire (SCQ, a measure of ASD severity) and Conners' Rating Scales (CRS-3, a measure of ADHD severity) following clinical consensus.

Results: Using factorial ANOVAs to model ADHD, Autism and their interaction, we found that fixation duration to faces was reduced in those with ASD (ASD and ASD+ADHD) compared to those without ASD (ADHD and NT). Reduced visual attention to faces in the whole sample was associated with Autism symptom severity (SCQ subscale scores) but not ADHD symptom severity (CRS-3 scores).

Discussion: Our findings provide preliminary evidence in support of implementing visual attention measurement during assessment of ASD in the context of comorbidity with ADHD. For example, if a child with ADHD was found to reduce attention to faces in ADOS pictures this may suggest additive difficulties on the autism spectrum. Replication across a larger sample would be informative. This work has future potential in the clinic to help with complex cases, including those with co-occurring ADHD and ASD.

KEYWORDS

Attention Deficit Hyperactivity Disorder, autism, autistic spectrum disorder, Autism Diagnostic Observation Schedule, eye-tracking, comorbidity, diagnosis

1 Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a common heterogeneous neuro-developmental condition characterised by developmentally inappropriate levels of hyperactivity, impulsivity and inattention (1). Autism Spectrum Disorder (ASD) encompasses impairing reciprocal social communication difficulties in addition to restrictive repetitive behaviours (1). Although ICD-10 and DSM-IV stipulated that children referred for ADHD diagnostic assessment should not meet the criteria for ASD; DSM-5 now allows for the dual diagnosis of both ADHD and ASD (1–3).

Current diagnostic methods are generally based on assessing for individual diagnoses separately even though cooccurrence is common (4, 5). The consequence is that children with ADHD who have significant social-emotional difficulties (including ASD), which cause impairment, are often missed at the outset (6). This can lead to extensive morbidity for the individual and poor socio-economic outcomes for society as it has been shown that children with ADHD who show increased emotional dysregulation and social dysfunction, have a poorer prognosis (7–9).

Previously, socio-emotional difficulties in ADHD have been assumed to be a consequence of core ADHD symptoms such as inattention, poor listening skills, difficulties waiting their turn and social impulsivity (10). However, the fact that social-emotional problems persist in many individuals treated with stimulant medication that are so effective at improving core ADHD symptoms (11–13), suggests that other mechanisms could be leading to socio-emotional difficulties in ADHD. The comorbidity between ADHD and ASD could be one possible explanation for the socio-emotional difficulties in ADHD. There is, however, still uncertainty whether all socio-emotional difficulties are due to an independent ASD diagnosis, diagnostically subthreshold ASD symptoms, or a severe and broader ADHD phenotype; therefore, it is important to understand this more fully.

In research and clinical practice, the Autism Diagnostic Observation Schedule (ADOS) is used in the assessment of ASD and includes tasks designed to identify emotion recognition and to test for processing and comprehension of social information. The ADOS was designed to be used in community populations to distinguish ASD from typically developing children. It's validity to assess ASD in those with ADHD is unclear (14). For example, in some children with both diagnoses of ADHD and ASD, scores on the ADOS can be within the range of those with an ADHD diagnosis alone (15). In those with ADHD without a diagnosis of ASD, scores on the ADOS can be raised above the threshold for ASD across the lifespan (10, 16, 17). Furthermore, in verbal adolescents, the specificity of the ADOS has been shown to be low for ASD versus those without ASD (including ADHD) (18). Overall, these studies suggest that ASD diagnoses maybe misdiagnosed or missed in those with ADHD. Additionally, although the ADOS is an observer-based tool by a trained clinician, it can still be prone to subjective bias by the administrator.

Given the high rates of comorbidity between ADHD and ASD, and the evidence of socio-emotional difficulties in ADHD, it is important to objectively clarify the use of the ADOS in children and adolescents with ADHD. In particular, as children with ADHD may have independent difficulties in socio-emotional functioning due to their ADHD symptoms, the ADOS scores could be artificially raised leading to a false positive diagnosis of ASD on this instrument (15). Alternatively, the ADOS may be well-placed to detect co-occurring ASD symptoms in those with ADHD, supporting a dual diagnosis when appropriate, and providing valuable information for treatment. Further research is needed to investigate whether the ADOS is sensitive to ASD features in children who have both ADHD and autism, and whether performance is also influenced by core symptoms of ADHD.

Visual attention, often assessed using eye-tracking to obtain quantitative indices of how attention is deployed to social stimuli, has been extensively reviewed in the ASD literature. The most consistent finding is that children with ASD process social information differently than those without ASD; for example when assessing visual attention using eye tracking, the time spent to focus on the social areas/components of certain scenes (such as the eyes and face) was found to be reduced in ASD compared to neurotypical controls (19–23). Furthermore, visual attention has

been found to be more altered in ASD when the scene is more complex (24) and, orienting to faces in social scenes has been shown to be slower in ASD compared to neurotypical controls (25) and those with ADHD (26). Visual attention to social stimuli in children with ADHD has been found to be slightly reduced or similar to neurotypical children; these findings may be explained depending on the emotion depicted in the scene for example, Serrano et al. (2018) found that children with ADHD had highest effect sizes for reduced visual attention to angry/scared faces however effect sizes for reduced visual attention to happy/neutral faces were modest compared to neurotypical children (27).

1.1 Aims & hypotheses

The main aim of this study is to compare visual attention to ADOS pictures amongst children and adolescents with ADHD, ASD, ADHD+ASD, and Neurotypicals. As the ADOS includes tasks that rely on attending to and processing social scenes, eye-tracking can provide quantitative and objective measures of visual attention to the scenes, alongside ADOS scores.

To quantify visual attention to ADOS pictures, eye tracking measures commonly used in the ASD literature described above were derived. Viewing time, otherwise known as fixation duration or Dwell Time (DT), is a measure of how long an area of interest (e.g., a face) is looked at when an individual is presented with a social scene. DT taps into attention duration. The number of times an area in the social scene is looked at is measured by the Fixation Count (FC), and how long it takes to look at an area of interest (orienting) is measured by the First Fixation Time (FFT). Measures of visual attention to Interest Areas, including social areas (faces) and non-social areas (vehicles/buildings), were compared between the groups, in the present study.

Based on the literature presented above, it was hypothesised that children with ASD would have reduced viewing time/interest (DT), exploration (FC) and slower orienting (FFT) to the social areas (faces) than the non-social areas of the pictures, compared to neurotypical children and children with ADHD. It was also hypothesised that this profile of atypical visual attention would be more pronounced for the pictures with highest content density.

It was hypothesised that, in neurotypical controls, visual attention to social areas (faces) would be greater than non-social areas (vehicles/buildings). The predicted profile would include increased DT (indexing viewing time/interest), increased FC (indexing exploration) and, quicker FFT (indexing faster orienting) to social areas (faces) compared with non-social areas in the pictures.

We predicted that the ADHD group would show less impaired attention to social parts of the ADOS pictures (happy and neural emotional content) compared to the ASD group and would be more like the neurotypical controls. It was postulated that the ADHD group may still favour social over non-social areas if their visual attention is impacted by a general impairment in attention rather than socio-emotional difficulties per se. This would manifest in slightly reduced DT and FC, and slower FFT to non-social parts of the image compared to neurotypical controls. In those with both co-occurring ASD and ADHD, we did not specify one-tailed predictions due to the relative lack of prior literature on eye-tracking in this population. However, we reasoned that if atypical attention to the ADOS images is driven by the presence of ASD symptoms, they would show a profile more like the ASD group, reflected in reduced DT, FC and longer FFT to the social areas specifically when compared with non-social areas. Conversely, if atypical attention was primary due to ADHD symptoms, the comorbid group may show a profile of predominantly reduced DT, FC and longer FFT to non-social areas. To test our hypotheses, we modelled ADHD and ASD as between-subjects factors and tested the main effects of each on DT, FC and FFT, and the interaction with the type of interest area (social, non-social). We also tested the interaction between ADHD and ASD factors, to determine whether the comorbid group showed a unique pattern when compared with either the ADHD or ASD groups.

2 Methods

2.1 Participants

Participants were recruited as part of a larger study called the Study of Attention and Arousal in Neurodevelopmental Disorders —SAAND, funded by The Baily Thomas Charitable Fund and The Waterloo Foundation (grant number 980-365) within the Division of Psychiatry and Applied Psychology at the University of Nottingham. Ethical approval for the study was given by the East Midlands Research Ethics Committee (REC) (17/EM/0193), IRAS project number 220158. A large proportion of the children recruited to the SAAND study also took part in this eye tracking study. Detailed methods and results from the SAAND study are reported elsewhere (24, 28, 29).

2.1.1 Clinical groups

Children and adolescents aged 7–15 years with a clinical diagnosis of ADHD, ASD or ASD+ADHD were recruited from Child and Adolescent Mental Health Services (CAMHS) and community paediatric clinics in Nottinghamshire. Some children were also recruited from local ASD and ADHD charities. Children from ASD and ADHD support groups were also informed of the study by the support group convenor. Although many children had prior diagnoses of ASD or ADHD, some children (awaiting assessment) who were deemed high risk by CAMHS of a neurodevelopmental disorder were recruited as long as they met study inclusion criteria for the SAAND study (24, 28, 29). After referral to the research study, a full research diagnostic assessment was undertaken on each clinical case using the measures described in section 2.2 below. This was to ensure correct assignment to one of 3 clinical groups: ADHD, Autism, comorbid ADHD and autism.

The initial clinical diagnoses were confirmed or overturned by PK (an experienced clinical rater) after the Development and Wellbeing Assessment (DAWBA) transcripts (30) and screening questionnaires were completed. Further details of how DAWBA diagnoses were operationalised are given below. Where diagnostic decisions were complex, clinical consensus with at least two child

and adolescent psychiatrists (PK and CH) took place. This included discussing all the information available and assigning the final diagnoses based on the overall consensus. This methodology has been employed previously by PK and CH (31, 32).

Children with comorbid diagnosis of epilepsy or learning disability (IQ<70), and children with visual problems (such as colour blindness) and hearing problems, were excluded. Children with comorbid mental health conditions including anxiety disorders, mood disorders and conduct disorders were included in recognition of the prevalence of these comorbidities with ADHD and autism. Children with comorbid specific learning disorders, e.g., dyslexia or developmental coordination disorder, were also included.

This process resulted in 16 children assigned to the ADHD group, 18 assigned to the Autism group, and 28 to the comorbid group.

Patients recruited to the study and taking stimulant medication were asked not to take this medication on the day of the study. Patients taking ADHD non-stimulant medication such as atomoxetine were excluded due to its longer duration of action and those taking dexamphetamine were also excluded due to its low rate of prescribing. Children on medication for sleep such as melatonin or taking Selective Serotonin Reuptake Inhibitors (SSRIs) were also included. Children taking antipsychotics such as risperidone were excluded as this could potentially affect our measures of interest and not be easily withdrawn.

2.1.2 Neurotypical control group

Letters detailing the study were sent to families of children in primary and secondary schools in the Nottinghamshire region. From an initial sample who volunteered to take part, a group of controls matched pairwise for age (± 6 months) to individuals in one of the clinical groups were selected. Eligibility for the neurotypical control group was determined by asking parents to complete the Conners parent rating scale and Social Communication Questionnaire. Those with significant ADHD or ASD symptoms on the Conners (T score > 65) or SCQ (total score > 15) were excluded from the study.

2.2 Measures

To establish assignment to one of the groups, a combination of questionnaires, interview and observational measures were used. Children were screened for ASD using the SCQ-lifetime version (33), a 40-item, parent-rated questionnaire which provides an overall index of risk of autism spectrum condition. The scale also provides scores relevant to 3 sub-scales: social reciprocal interaction, communication, and repetitive stereotyped behaviours. A score of 15 on the SCQ is a recognised, evidence-based cut-off for differentiating those at risk of ASD from neurotypical children (34).

Parents and teachers also completed the Conners' Rating Scales (CR-3) (35). To be included in the ADHD group or comorbid ADHD+ASD group, the T-scores on the Conners' Rating Scales had to be more than 1.5 standard deviations above the mean on the attention scale (this equates to T-scores of more than 65). Parents completed the Strength and Difficulties Questionnaire (SDQ) (36). The SDQ is a 25-item questionnaire with a 3-point scale (not true, somewhat true and certainly true) to measure emotional and behavioural difficulties in children. Five domains are measured (conduct, emotions, hyperactivity, peer problems and prosocial behaviour), each using 5 questions. Participants required a parent reported hyperactivity score of more than 5 to be included in the ADHD group or comorbid ADHD+ASD group.

In the clinical groups, all scales were rated when the child was off medication and the parent was asked to rate what their child was like when they were off medication in the last six months; however, the SCQ also required parents to comment on their child's behaviour when they were aged 4–5 years old.

The Development and Wellbeing Assessment (DAWBA) is a structured interview, which can be administered by interviewers to informants or completed directly online by parents, teachers or adolescents (11–17 years old) to generate DSM-IV and ICD-10 diagnoses. In this study, the DAWBA was administered online to parents. The DAWBA measures emotional, behavioural and hyperactive disorders and also has a developmental section covering ASD (30). Children's parents completed the Social Aptitudes Scale (SAS) as part of the Development and Wellbeing Assessment (DAWBA) (30). The SAS is a 10-item scale and is a broad measure of complex interactive social skills. Parents are asked to compare their child's behaviour across a range of situations to their peers. Scores can range from 0 to 40 and low scores have been shown to be associated with ASD in community samples (37). It should be noted that higher rates of difficulties on the SAS than the SCQ have been found in those with ADHD without a comorbid diagnosis of ASD in a clinical sample (38). A score of 12 or less on the SAS indicates difficulties in social functioning and necessitates that all items of the development Section (ASD diagnostic Section) of the DAWBA are completed.

All clinical participants were invited to attend an Autism Diagnostic Observation Schedule 2nd Edition (ADOS-2) (39) as part of the research diagnostic assessment. ADOS-2 assessments were carried out by PK and IA, who have research reliability accreditation. Module 3 or 4 of the ADOS was used depending on chronological age and verbal fluency of the participant. The assessment takes 45 minutes to complete, and the child is observed carrying out 14 tasks (e.g. description of a picture). The assessment provides scores in the domains of communication, reciprocal and social interaction, and stereotyped behaviours and restricted interests. Based on cut-off scores, an ADOS classification of autism or autism spectrum is generated, which is used to help reach a research diagnosis in the clinical consensus. Within the reciprocal social interaction domain, the ADOS also has scores related to emotion recognition. For the purposes of this study, the 'Comments on Others' Emotions/Empathy' subscore was used in further analysis. This subscore reflects the participants' spontaneous emotion recognition, understanding and response to feelings of others throughout a series of tasks. It was predicted that this particular subscore would be closely related to visual attention to faces within the ADOS pictures. It is scored from 0 to 2 with higher scores reflecting less spontaneous emotion recognition. Further details of how this ADOS emotion recognition subscore is

generated in the ADOS scoring procedure, are presented in the Supplementary Materials.

To screen for learning disability, all children completed an abbreviated intelligence test, Wechsler Abbreviated Scale of Intelligence (WASI) (40), which is an abbreviated measure of IQ and takes around 20 minutes to complete. Two sections (vocabulary and block design) enable performance, verbal and full-scale IQ to be generated. Any participants with a full-scale IQ of less than 70 were excluded from the study.

2.3 Eye tracking procedure and task stimuli

To measure visual attention to social scenes, participants viewed stimuli from the ADOS Description of a Picture Task while their eye gaze was measured on the EyeLink 1000 Plus eye tracker (SR Research Ltd. 2017) at a sampling rate was 500Hz (sampling every 2ms). Participants' rested their chin on a chin-rest to reduce head movement and maximise comfort during the procedure. Stimuli were presented on a screen (48cm wide x 27cm height), 60cm from the participant. A 9-point calibration was completed prior to the task. The laboratory eye tracking room had no natural light allowing the lighting in the room to be kept constant during the eye tracking procedure. Laboratory room luminance was measured using a photometer to ensure luminance consistency (between 70–90 lux) for each testing session. ADOS pictures were resized to 16cm wide x 10cm height. A central fixation cross was presented for 100ms interspersed by the ADOS pictures which were presented in a random order for 20 seconds each. Participants were verbally instructed to look at the stimuli however they liked.

Stimuli consisted of the three pictures selected from the ADOS 'Description of a Picture' task. These pictures depict scenes of a Holiday, of Hollywood and of people eating a Meal (39). The pictures from the ADOS are colourful, content dense with many faces and other objects such as vehicles or planes that can take the participant's interest. The faces were classified as social interest areas while the vehicles and buildings were classified as non-social interest areas. The majority of the faces in the pictures range from neutral to positive valence emotions. The 3 pictures range slightly in content density with the highest number of faces in the Holiday picture, the least number of faces in the Meal picture and the Hollywood picture having a number midway, between the other two pictures. The crowding of the components and the contrast of colours was also deemed to be in a similar descending order for the 3 pictures (with the Holiday picture having the most components and brightest colours and the Meal the least). The valence and content density of the pictures was defined in this way for analysis.

For the ADOS pictures, two types of interest areas were created a priori, faces (social areas) and non-social areas. Faces needed to be in full view to be selected as a social interest area (for example the back of the head or faces obscured by a large hat or glasses were not selected). Non-social areas included any vehicle or building in the pictures and were selected as they were deemed as the most non-social 'mechanical' areas of the pictures. Although food and trees could be classed as non-social, these were not included as they are more organic in nature and could be visualised for other reasons for example food due to hunger in the participant. As the ADOS pictures are copyrighted these cannot be displayed in the manuscript however the reader is referred to the ADOS-2 manual for further detail (39).

The eye tracking tasks to the ADOS pictures was completed before the full ADOS assessment which was administered in full separately. The eye tracking tasks, including the calibration took approximately 5 minutes for participants to complete. Raw eye tracking data was processed using the EyeLink 1000 Plus accompanying software EyeLink Data Viewer. This software allows for interest areas such as faces to be isolated from the rest of the image and visual attention to be measured within the specified interest area. In addition to Dwell Time which is an indication of viewing time to the specified interest area, this software provides automated extraction of a wide range of additional eye tracking measures defined within the specified interest area.

Total stimulus length was analysed which corresponds to 20 seconds for the ADOS images. A minimum fixation duration of 100ms was set to allow for shorter fixations while scanning complex pictures as opposed to faces only (41). Blink artefacts were removed by defining these as any periods of data where pupil size was equal to 0mm.

Trials were removed if eye movement data was not continuously recorded for at least 25% of the trial time. Trial adequacy was verified using a two-step approach; firstly, the data was visually assessed in Data Viewer and secondly, a percentage acquisition was computed by Data Viewer for cross checking. Participants with more than 50% invalid trial data were removed from the analysis, as has previously been documented in the literature with similar trial numbers in ASD and disruptive disorders (42). Of the initial 87 eligible children recruited, two control children and one child in the ASD+ADHD group did not have adequate eye movement data using the described procedure so 84 children were included in the final eye movement data analysis.

As the stimuli vary based on colour, emotions and density, it can be conceived that using one single visual attention measure may fail to disentangle what might be driving viewing patterns to these stimuli. A range of eye tracking measures are likely to be required to distinguish complex neurodevelopmental disorders and, attentional patterns and priorities to people in scenes have been analysed by multiple eye tracking measures in ASD previously (25). Eye tracking measures from social scene perception literature in ASD were included for extraction in this study as described below. In addition to Dwell Time (DT) which is an indication of viewing time to the specified interest area, two additional eye tracking measures were chosen for the main analysis. These included the First Fixation Time (FFT) and the Fixation Count (FC). The FFT to an interest area is indicative of orientation to an interest area, for example time to orient to a face. This was important to test as faces are not preselected in everyday life and those with ASD have been shown to have slower orientation to faces (25, 26). The FC which is a measure of the number of fixations within an interest area was also extracted. The FC allows for the estimation of the exploration and processing of a face.

TABLE 1 Demographic and clinical characteristics of the sample (n=84).

	Group				Group effect		Group differences (post-hoc)
	ADHD (n=16)	ASD (n=18)	ASD +ADHD (n=28)	Controls (n=22)	*F*	p	
Mean age in years (SD)	10.17 (2.06)	11.01 (2.11)	10.82 (1.56)	10.80 (2.40)	0.55	>0.05	n/s
Gender % male (n male)	68.8% (11)	61.1% (11)	75.0% (21)	59.1% (13)	0.56	>0.05	n/a
Mean FSIQ (SD)	111.44 (10.37)	103.53 (15.41)	103.04 (19.47)	119.00 (9.83)	5.66	<0.01	Controls > ASD/ASD+ADHD [b]
Conners' IA T score (SD)	83.50 (10.97)	77.44 (12.47)	84.04 (7.62)	52.05 (8.81)	52.38	<0.001	Controls < ADHD/ASD/ASD +ADHD [a]
Conners' HI T Score (SD)	85.69 (7.17)	75.71 (12.57)	84.70 (8.92)	53.23 (10.26)	50.74	<0.001	Controls < ADHD/ASD/ASD +ADHD [a] ASD < ADHD/ASD+ADHD [c]
Conners' OD T Score (SD)	81.75 (10.55)	77.12 (15.08)	83.48 (11.04)	52.95 (10.27)	32.31	<0.001	Controls < ADHD/ASD/ASD +ADHD [a]
SAS (SD)	11.38 (6.75)	7.33 (5.64)	7.42 (5.53)	24.28 (4.87)	37.70	<0.001	Controls > ADHD/ASD/ASD +ADHD [a]
Total SCQ (SD)	16.19 (7.22)	19.31 (6.12)	21.41 (6.48)	4.45 (4.75)	34.11	<0.001	Controls < ADHD/ASD/ASD +ADHD [a] ADHD < ASD+ADHD [c]
ADOS Total score * (SD)	5.00 (3.35)	14.00 (4.86)	14.08 (5.18)	n/a	21.76	<0.001	ADHD < ASD/ASD+ADHD [a]
ADOS emotion recognition subscore* (SD)	0.37 (0.50)	0.75 (0.68)	0.67 (0.62)	n/a	1.73	>0.05	n/s
Oppositional and Conduct Disorders	50.0% (8)	52.9% (9)	53.6% (15)	0	–	n/a	–
Emotional Disorders†	37.5% (6)	64.7% (11)	53.6% (15)	0	–	n/a	–

FSIQ, Full Scale Intelligence Quotient (WASI); Conners' Parent Rating Scale: IA (Inattentive), HI (Hyperactive-Impulsive), OD (Oppositional) T scores (≥65 suggests difficulties in these areas). SAS, Social Aptitudes Scale (≤ 12 is suggestive of ASD); SCQ, Social Communication Questionnaire (≥15 suggestive of ASD); Rating scale scores shown are parent rated. ADOS, Autism Diagnostic Observation Schedule total score (Autism spectrum cut-off score ≥7). *ADOS total and emotion recognition scores not available for typically developing controls (n=22). †Emotional Disorders include: general anxiety disorder, mild depressive episode, obsessive compulsive disorder or specific phobia (note: participants could have more than one disorder). [a]$p<0.001$; [b]$p<0.01$; [c]$p<0.05$.

The pre-selected eye tracking measures described above were extracted using the interest area report function in EyeLink. For the ADOS pictures, the sum of all the variables was calculated, except the FFT which was the minimum value.

2.4 Statistical analysis

Group differences for the demographic and clinical scores were calculated using univariate ANOVAs and followed up using *post hoc* tests adjusted for multiple comparisons. If Levene's test of difference between group variances was significant, the Games-Howell *post hoc* test was used; otherwise, Tukey's test was used.

A series of ANOVAs were performed to test the main effects of, and interactions between, two between-subject factors ASD (yes, no) and ADHD (yes, no) on eye-tracking variables (DT, FC and FFT). ASD factor (yes) includes children from the ASD group and ASD+ADHD group. ASD (no) includes children from the ADHD group and control group. ADHD factor (yes) includes children from the ADHD and ASD+ADHD group and ADHD (no) includes children from the ASD and control groups.

Within-subjects factors Interest Area, comprising two levels (Social, Non-social), and Picture, comprising 3 levels (Meal, Hollywood, Holiday), were entered. The Picture factor was manipulated in this way to reflect increasing image content density (defined by the number of faces, the crowding of the components and the contrast of colours in the ADOS pictures) as it was hypothesised that visual attention allocation would differ based on content density. Significant interactions were followed up by simple effects analysis (pairwise comparisons). As DT percentage gave a similar pattern of results to DT, only results for DT are reported for brevity.

The two factor design tests the main effect of ASD and ADHD factors on variables of interest in addition to an interaction between ASD and ADHD factors (43, 44). In particular, an interaction between ASD and ADHD factors could suggest a model compatible

with the comorbid group belonging to a third separate nosology to either of the pure groups as described by Rutter and Taylor (2002) (45). Alternatively, a main effect of ASD and/or ADHD factors, with a lack of interaction between ASD and ADHD factors could suggest an 'additive model' of comorbidity, especially if a double dissociation exists (43). This additive model would be in keeping with the comorbid group sharing a profile with both the pure groups and potentially shared risk factors within the comorbid group.

Pearson's correlation analyses were conducted to analyse associations between symptom severity subscales (SCQ and CRS-3) including the ADOS emotion recognition subscore and the eye tracking variables that were found to be predictors of ASD or ADHD factors in the factorial ANOVAs described above.

To examine the possible effects of covariates, hierarchical linear regression was used to test if FSIQ or oppositional symptoms (Conners' parent rating scale oppositional subscale T scores) had significant contributions to the dependent variable over and above ADHD and ASD factors. Hierarchical linear regression models were applied to the dependent visual attention variable being tested (e.g., DT to ADOS pictures). This analysis was performed only on dependent variables that were found to be significant in the main analyses described above. Further details of the model design and the results of the analysis are presented in the Supplementary Materials.

3 Results

As shown in Table 1, groups were well matched for age and there was a male predominance in all groups. Groups differed in mean Full Scale IQ (F (3, 79)=5.66, p<0.01, ηp^2 = 0.18) with significantly lower scores in the ASD group (p<0.01) and ASD +ADHD group (p<0.01) compared to the control group.

As expected, groups differed significantly on the Conners' DSM-5 subscale T-scores with significantly higher T-scores in all three clinical groups compared to control group (p<0.001). The groups differed significantly on SCQ (F (3, 77)=34.11, p<0.001, ηp^2 = 0.57) with significantly higher scores in all the clinical groups (p<0.001) compared to the control group. SCQ scores were also significantly higher in the ASD+ADHD group (p<0.05) compared to the ADHD group (Table 1). The clinical groups differed significantly on total ADOS scores (F (2, 53)=21.76, p<0.001, ηp^2 = 0.45) with significantly higher scores in the ASD group (p<0.001) and the ASD+ADHD group (p<0.001) compared to the ADHD group. The clinical groups did not differ significantly on the ADOS emotion recognition sub-score (F (2, 53)=1.73, p>0.05, ηp^2 = 0.06) (Table 1).

Considering first the main effect of Autism on the eye-tracking variables, DT was significantly reduced in those with ASD (1911.10ms, SD=111.02) compared to those without (2245.92ms, SD=117.81; F (1, 78)=4.28, p<0.05, ηp^2 = 0.05). FFT was significantly increased in those with ASD (4952.67ms, SD=399.71) compared to those without ASD (3641.71ms, SD=424.18; F (1, 78)=5.06, p<0.05, ηp^2 = 0.06). There was a trend for reduced FC in those with ASD (6.70, SD=0.04) compared to those without ASD however, this did not reach significance (7.71, SD=0.43; F (1, 78)=3.00, p=0.09, ηp^2 = 0.04). There was no significant main effect of ADHD on any of the eye-tracking variables or a significant ASD*ADHD interaction (Table 2).

There was a significant interaction between Autism and Interest Area on DT (F (1, 78)=4.16, p<0.05, ηp^2 = 0.05). The interaction between Interest Area and ASD factor on DT was followed up by simple effects analysis which showed a significantly reduced DT to faces in those with ASD (2204.53ms, SD=210.22) than without ASD (2920.27ms, SD=223.09; F (1, 78)=5.45, p<0.05, ηp^2 = 0.07), as shown in Figure 1. There was no significant difference in DT to non-social areas in those with ASD compared to those without ASD. There was significantly increased DT to faces versus non-social areas within ASD (p<0.05) although, this finding was more robust in those without ASD (p<0.001), explaining the 2-way interaction between ASD and Interest Area. Overall, these findings suggest that DT to faces is specifically reduced in those with ASD compared to those without ASD (Figure 1).

There was a trend for an interaction between Autism and Interest Area on FC (F (1, 78)=3.17, p=0.08, ηp^2 = 0.04) and FFT (F (1, 78)=2.42, p=0.12, ηp^2 = 0.03) but these did not reach significance. There was no interaction between ADHD factor by Interest Area or by Picture or by ASD factor. Significant multivariate effects of Interest Area, Picture and Picture by Interest Area on all the eye tracking variables that were independent of the fixed factors (ASD factor and ADHD factor) are tabulated in the Supplementary Material. Raw eye tracking data in the groups (ASD, ADHD, ADHD +ASD and control groups) are also tabulated in the Supplementary Material.

TABLE 2 Summary of main effects of fixed factors (ADHD, ASD, ASD*ADHD) on eye tracking measures in ADOS pictures.

		Main effect (fixed factors)†		
Stimulus	Measure	ADHD	ASD	ASD* ADHD
ADOS Pictures	DT	n/s	↓	n/s
	FC	n/s	n/s	n/s
	FFT	n/s	↑ (slower)	n/s

†2X2 factorial approach: ADHD (ADHD and ASD+ADHD) versus no ADHD (ASD and controls); ASD (ASD and ASD+ADHD) versus no ASD (ADHD and controls); ASD*ADHD [interaction of fixed factors; comorbid group differs from pure group(s)]. DT, Dwell Time; FC, Fixation Count; FFT, First Fixation Time- ↑(slower)=increased time to fixate and slower to orientate. ADOS, Autism Diagnostic Observation Schedule; Direction of findings are significant (p<0.05); n/s (non-significant; p>0.05).

3.1 Correlations with clinical symptoms

DT to faces in all the pictures correlated negatively with the communication (r=–0.32; p<0.01) and repetitive stereotyped behaviour sub-scores (r=–0.27; p<0.05) on the SCQ but the correlation with the social reciprocal interaction sub-score was not significant (r=–0.09; p>0.05). DT to faces did not significantly correlate with the ADOS emotion recognition subscore or Conners' IA or HI T-score (p>0.05).

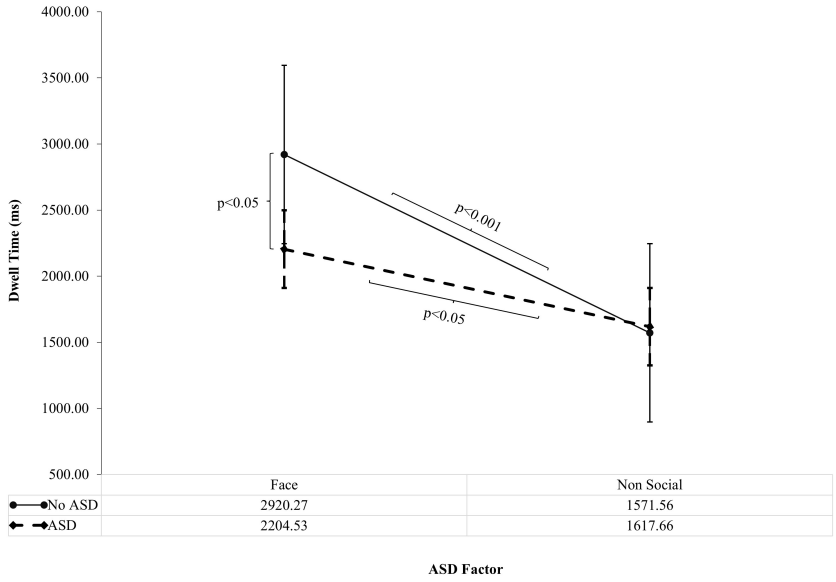

FIGURE 1
ASD Factor on Dwell Time to Faces versus Non-social areas of ADOS Pictures (Standard Error Bars=95% CI). The interaction between Autism and Interest Area on Dwell Time (F (1, 78)=4.16, p<0.05, ηp^2 = 0.05) was followed up by simple effects analysis. Significance bars denote significant findings from simple effects analysis. ASD = ASD group and ASD +ADHD group; No ASD = ADHD group and Control group.

3.2 Hierarchical regression

For ADOS emotion recognition subscore and eye tracking variables analysed in the pictures, neither IQ nor oppositional symptoms explained a significant amount of the variance over and above ASD or ADHD factors. Hierarchical linear regression model results tables for each dependent variable are presented in the Supplementary Material.

4 Discussion

In the present study, we assessed visual attention to ADOS pictures amongst children and adolescents with ADHD, ASD, ADHD+ASD, and Neurotypicals. We found slower orientation to ADOS pictures, indexed by FFT (First Fixation Time), and reduced viewing time, indexed by DT (Dwell Time), in those with ASD (ASD and ASD+ADHD) compared to those without ASD (controls and ADHD). We did not find a significant main effect of ADHD on visual attention or a significant ASD*ADHD interaction. As summarised in Table 2, these findings suggest that those with ASD (ASD and ASD+ADHD) have reduced visual attention to ADOS pictures compared to those without ASD (ADHD and Neurotypical controls).

As shown in Figure 1, There was a significant interaction of ASD factor by Interest Area (Faces versus Non-social areas). When this was followed up by simple effects analysis, DT to faces was reduced in those with ASD (ASD and ASD+ADHD) compared to those without ASD (ADHD and Neurotypical controls). Furthermore, DT to faces in pictures was associated with symptom severity on the SCQ (ASD) but not the Conners' IA or HI subscales (ADHD). These findings are suggestive of an association of atypical visual social attention with ASD but not ADHD symptom levels and, confirm the factorial analysis findings that ASD is driving the influence of reduced visual attention to faces in ADOS pictures.

Findings of slower orientation, indexed by FFT and reduced viewing time, indexed by DT to faces (social interest areas) in ADOS pictures in children with ASD (ASD and ASD+ADHD) is in line with the eye tracking literature on social scene perception in ASD (25, 26, 46). EEG studies have also found atypical ERP responses to faces in those with ASD (ASD and ASD+ADHD), supporting face processing deficits in ASD at the neural level (44, 47). Our findings from ADOS pictures suggest that the ASD +ADHD group genuinely have visual social-emotional attention like ASD rather than a 'phenocopy' or a severe form of ADHD as, we found a significant main effect of ASD but did not find a significant main effect of ADHD or a significant ASD*ADHD interaction.

Spontaneous emotion recognition was measured using the ADOS emotion recognition subscore. Children with ADHD had increased scores on the ADOS emotion recognition subscore which were not significantly different from those with ASD or ASD +ADHD. Although ADOS was not completed in typically developing children, if we consider that an ADOS emotion recognition score of 0 would be the expected score in typically developing children, then those with ADHD have raised scores. Thus, all clinical groups showed raised scores on the ADOS emotion recognition subscore. As predicted, the ASD group had the highest scores, suggestive of more difficulties with spontaneous emotion recognition (although this was not statistically significant amongst the clinical groups; Table 1).

Children with ADHD without comorbid ASD showed normal visual attention to ADOS pictures, which were predominantly of

positive emotional valence. Our findings are in keeping with Serrano et al. (2018) who found highest effect sizes for reduced visual attention to angry (d=-0.73) and scared faces (d=-0.50) in social scenes in children with ADHD (27). Pishyareh et al. (2015), however, found reduced fixation latencies to pleasant versus unpleasant pictures, in children with ADHD, which differs from our findings albeit with different fixation latencies and methodology as they presented pictures stimuli side by side and did not capture attention to faces (48). Additionally, differences between studies could also be explained by the inclusion of children with oppositional symptoms in our study. Indeed, this association between social communication difficulties and conduct problems including oppositional behaviours in children with ADHD has been found in larger samples previously (8, 49, 50). Furthermore, Santosh et al. (2004) also found an association with ADHD, social communication difficulties and conduct problems with relational difficulties with peers on parental report (49). We did not find an association with visual attention and Conduct problems in this study, however as we did not include pictures of negative valence this could explain the difference in findings.

We did not find an association with visual attention and IQ in this study. This could be because of the free viewing task of shorter duration in this study, requiring minimal cognitive effort compared to longer emotion recognition tasks (27).

In this study, a dissociation was found with reduced viewing time to faces in those with ASD (ASD and ASD+ADHD) but not ADHD (without ASD); suggesting reduced interest to faces is a specific finding in those with ASD.Furthermore, viewing time to faces, indexed by Dwell Time (DT) was significantly negatively correlated with communication and repetitive stereotyped behaviour severity on the SCQ. This would suggest that reduced viewing time to faces in ADOS pictures is associated with poorer communication and more restrictive and repetitive behaviours in our study. DT to faces was not significantly associated with the social reciprocal interaction sub-score on the SCQ and as discussed previously, children with ADHD have difficulties with social interaction. Our findings therefore support communication and repetitive stereotyped behaviour SCQ subscale interpretation when assessing for ASD in ADHD.

It could be postulated that aspects of visual social attention that are thought to be more classical ASD deficits seem to be preserved in ADHD. For example, preserved visual social-emotional attention to faces in ADOS pictures compared to those with ASD. It could be postulated that the ADOS pictures were rewarding and motivating to look at as they were colourful with no explicit task requiring sustained attention. As motivation and reward have been shown to be as effective as stimulant medication for those with ADHD (51), preserved visual social attention to ADOS pictures without expense to other areas of visual attention could be quite likely. Furthermore, our findings could suggest that social impairments and atypical visual social-emotional attention in ADHD may not be pervasive but rather context dependent and potentially influenced by intensity of stimulation, arousal, emotional valence, and reward (52).

4.1 Limitations, strengths and future directions

Due to study time limitations, participants in this sample were subject to a small number of trials (n=3). However, this allowed for more bottom-up processing and increased saliency with less habituation. The sample size (n=84) is not big enough to look at subsamples (e.g., girls). Our findings are therefore potentially less generalisable to the whole neurodevelopmental population.

We looked at positive valence images in this study; however, comparing this with negative valence pictures could also be helpful. Future avenues, such as incorporating the pupil as a measure of arousal and measures of peer relations or emotional liability, could help to uncover further insights into atypical visual social attention in ASD and ADHD.

Despite the small sample size, the participants were well categorised and all children with ADHD were either stimulant naive or taken off stimulant medication minimising confound due to medication. Further studies would benefit from taking this multisite approach so that analysis of subsamples such as within the comorbid group and in girls is more feasible.

The DAWBA was used as opposed to more lengthy semi-structured interviews such as the ADI-R to aid the categorisation of ASD. The SCQ, however, relates closely to the ADI-R and the use of the SCQ in combination with the DAWBA has been used by the assessors (PK and CH) in a large longitudinal study previously (31, 32).

Due to study time limitations, the ADOS was not completed for the typically developing group, meaning that comparisons for ADOS scores including the emotion recognition subscore could only be made amongst the clinical groups. As an ADOS score of 0 is denoted as typically developing, this can be substituted, allowing for a 'pseudo' comparison amongst the groups, but it is acknowledged that this was not explicitly tested and therefore was not carried out in the analysis.

In terms of study design, it is also important to consider the limitations of eye tracking. Firstly, there are technical issues with eye tracking. Head movements, eye blinking and participant fatigue can lead to artefact data which requires data cleansing. Eye tracking measures are sensitive to luminance, image properties such as contrast and spatial properties. Although luminance was measured and kept constant, it was not possible to control for some of the other stated factors as images were not manipulated. There are potential confounding factors when studying visual attention using eye tracking, for example lighting and cognitive loading of the task. Visual attention in the context of this study explored overt attention in relation to active vision (53). This design does not take covert attention into consideration thereby potentially missing the effects of early visual attentional processes that neural EEG techniques would detect.

A 2x2 factorial approach to examine the effects of ADHD and ASD as fixed factors on visual social-emotional attention variables was used as it is commonly used in studies of comorbidity (43, 44, 54). The 2x2 factorial approach has the ability to differentiate the

effect of ADHD, ASD and of comorbidity through an interaction of fixed factors allowing for the research questions to be tested. Furthermore, it improves the power of the sample by the combination of 2 groups into one factor, essentially doubling the power of a more traditional group effect. Interpretation and comparison of findings (e.g. pure group versus controls) can be more difficult in the 2x2 factorial approach compared to the group approach. This was less of a problem for this study, as the main question was regarding ADHD versus ASD and comorbidity, however raw eye tracking data in the groups is provided in the Supplementary Materials.

Hierarchical linear regression was used to test for added variance of IQ and oppositional symptoms over and above ADHD and ASD on the significant eye tracking variables as clinical groups differed on IQ and oppositional symptoms have been shown to be important in social problems in ADHD (49). Although, it could have been argued that analysis of covariates (ANCOVA) could have been used, the use of ANCOVA has been shown to be a poor way of covarying for IQ in psychiatric and developmental disorders especially if IQ is tightly bound to the clinical profile of the disorder as is the case for both ASD and ADHD (55). Miller and Chapman (2001) proposed that having a control group with a lower IQ would be the best way to examine the effects of IQ. Unfortunately, this was not possible in our studies due to recruitment difficulties and time limitations, but future study designs will benefit from controls with lower IQ (55). It would also be important to consider comparison of groups with other psychiatric disorders as studies have shown that visual attention can be affected in conduct and emotional disorders at the diagnostic level (56, 57).

4.2 Clinical Practice Implications

The ADOS was originally designed as a research tool in the assessment of ASD and has become commonly adopted in clinical practice as a tool to standardise observed autistic behaviours as part of the diagnostic process (58, 59). As the clinical phenotype of ASD has broadened, there has been suggestion that the ADOS may not be sensitive enough to pick up all of these cases and can also be prone to assessor subjectivity (14). Furthermore, the ADOS was not originally designed to be used in clinically complex cases with high levels of comorbidity. Although the ADOS is an observer-based tool by a trained clinician, it can still be prone to subjective bias by the administrator. Our findings however seemed to validate the use of the ADOS; when children viewed ADOS pictures, visual attention to faces was reduced in those with ASD compared to those without. These findings are in line with findings in the literature using complex and dynamic scenes (19). Those with ADHD (without ASD) did not show these atypicalities to ADOS pictures; in particular, they did not show slower orienting to ADOS pictures or reduced viewing time to faces.

We found that atypical visual attention to ADOS pictures is an indicator of ASD symptoms. Measuring atypical visual social attention could be a helpful adjunct to ADOS examination when assessing for neurodevelopmental conditions with social cognitive deficits. Furthermore, visual social attention measurement may have a role in those cases that are missed by standard clinical assessments or in cases where there is controversy, or a second opinion is being sought.

Findings suggest that atypical visual social attention to ADOS images could be a potential utility for differentiating the groups. Prediction of diagnoses from significant atypical visual social-emotional attention measures could be tested in future studies on a larger scale.

It is interesting to note that there were more children in the ASD+ADHD group than the ADHD group in this study. As these samples are from the clinic population, this is in keeping with comorbidity being common in child psychiatry (60). As we found that those with ASD+ADHD had atypical visual attention to ADOS pictures, associated with ASD symptom severity, our findings support the early assessment of comorbid ASD in ADHD. Unfortunately, this is often not the case in clinical practice (61, 62). Prompt assessment of comorbidity would allow for timely treatment approaches for additional socio-emotional difficulties in children with ASD+ADHD, with the potential to improve long term outcome.

5 Conclusions

In conclusion, we found that visual attention to faces was reduced in those with ASD (ASD and ASD+ADHD) compared to those without ASD (ADHD and NT). Reduced visual attention to faces in the whole sample was associated with Autism symptom severity (SCQ subscale scores) but not ADHD symptom severity (CRS-3 scores). Our findings provide preliminary evidence in support of implementing visual attention measurement during assessment of ASD in the context of comorbidity with ADHD. For example, if a child with ADHD was found to reduce attention to faces in ADOS pictures this may suggest additive difficulties on the autism spectrum. Replication across a larger sample would be informative. This work has future potential in the clinic to help with complex cases, including those with co-occurring ADHD and ASD.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving humans were approved by East Midlands Research Ethics Committee (REC) (17/EM/0193), IRAS project number 220158. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

PK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Writing – original draft, Writing – review & editing. IA: Data curation, Project administration, Software, Writing – review & editing. AB: Data curation, Writing – review & editing. DR: Funding acquisition, Writing – review & editing. CH: Conceptualization, Resources, Supervision, Writing – review & editing, Funding acquisition. MG: Conceptualization, Formal analysis, Funding acquisition, Resources, Supervision, Writing – review & editing, Investigation, Methodology, Validation.

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Conflict of interest

AB receives an honorarium as Joint Editor of JCPP Advances.

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Supplementary material

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The impacts associated with having ADHD: an umbrella review

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Introduction: Attention Deficit Hyperactivity Disorder (ADHD) affects up to 5% of the population and is characterised by symptoms of impulsivity, hyperactivity and inattention. These symptoms are significantly impairing and carry additional risks for children and adults with ADHD, including negative mental health (e.g. depression), physical health (e.g. obesity) and societal outcomes (e.g. imprisonment, divorce). Very few studies have attempted to synthesise these risks in one publication due to the breadth of evidence published on the adverse outcomes of ADHD.

Methods: An umbrella review was performed to identify reviews (systematic, meta-analysis and narrative) that investigate the risks arising from having ADHD. We conducted a narrative synthesis of the findings and conducted a quality review of the included publications.

Results: Upon searching five databases, 16,675 records were identified. Of these, 125 reviews met the criteria for inclusion. A narrative synthesis of these findings highlighted three key domains of risks associated with ADHD: mental health, physical health, social and lifestyle. Most reviews were of good and moderate quality.

Discussion: This review highlights the many risks associated with having ADHD, beyond its three key symptom domains and the impact of the condition on daily functioning.

Registration: International Prospective Register of Systematic Reviews (PROSPERO CRD42023404073).

KEYWORDS

ADHD, umbrella review, long-term outcomes, risks, impact

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1 Introduction

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder affecting around 5% of children, with symptoms often continuing into adulthood (1). The three key symptoms of ADHD include hyperactivity, impulsivity and inattention, which are developmentally atypical and functionally impairing across at least two settings such as home life and school/work (2). ADHD is associated with differences in cognitive function including impairments in attention, problem-solving, vigilance, inhibitory control, language processing, memory and flexibility (3–6). Other functions such as sensory processing (7), motor skills (8), social skills (9, 10) and emotion regulation (11) can also be affected. These impairments have significant impacts on multiple aspects of life and carry many associated risks. Additionally, ADHD has been linked to comorbid disorders such as sleep disorders (12), learning and mood disorders (13), and other mental health (14) and neurodevelopmental disorders (15). ADHD is recognised as a lifelong condition that has a profound impact on daily functioning and quality of life (16).

The symptoms and impairments associated with ADHD can impact individuals throughout their lifetime and place them at increased risk of poor outcomes. Risks can be defined in many ways but in the context of this review, risks encompass any outcomes that adversely affect the individual and their peers/family, but are not part of the core ADHD symptomatology.

In children and young adults (CYA), many studies have highlighted the health risks associated with ADHD. In a recent cohort study of young people (16–25), Langley and colleagues (17) showed that ADHD was associated with increased risks of anxiety/depression, self-harm, alcohol and drug use and emergency department service use.

ADHD also impacts CYA's education outcomes. ADHD is associated with increased use of school-based services, increased rates of detention and expulsion, and lower rates of high school graduation and postsecondary education (18). Children with ADHD fare worse than non-ADHD peers on a wide range of additional educational outcomes including: academic attainment, unauthorised absence, exclusion and age of leaving (19). ADHD has also been linked with difficult and antisocial behaviour. There is evidence of relationships between ADHD and delinquent behaviour, adolescent arrest and convictions (20, 21) and these effects are mediated by ADHD symptom severity (22). The prevalence of ADHD in teenage offenders in prison is above the population prevalence, ranging between 4% and 72% (23, 24).

Many health-related risks have also been associated with ADHD in CYA with for example, conditions such as obesity (26), binge eating (27) and Type 1 diabetes (28). ADHD is also associated with higher risks of self-harm (29), early tobacco, alcohol and marijuana use (30, 31) as well as early risky sexual behaviours (32). For example, adolescents with ADHD are at much higher risk of teen pregnancy (33). Although fewer studies have examined later-life impacts, new evidence is showing an increased risk of developing neurodegenerative disease (34). As well as evidence of comorbidities with mental health disorders such as depression and anxiety (35, 36), ADHD has been consistently linked with poorer multiple mental health outcomes (37, 38) in CYA. These risks have significant impacts on day-to-day life but also on CYA's experiences and quality of life. Compared with non-ADHD children, children with ADHD have reported reduced quality of life, lower happiness, and elevated levels of bullying from siblings (39). Similarly, a recent review (40) demonstrated a consistent positive association between bullying, ADHD in youth and depressive symptoms.

These risks not only affected CYA but also the wider family. Harpin (41) highlights the many impacts that ADHD difficulties have on families and siblings, including the amount of time spent with parents, family activities, more fights with siblings and parents and general family dynamics. Parents report reduced quality and hours of sleep, poorer mental well-being and lower quality of life (42). Additionally, parents of CYA with ADHD report higher levels of stress due to the difficulties experienced by their children and the impact these have on the family (43, 44). Peasgood and colleagues (39) found that siblings of children with ADHD also reported lower quality of life.

While many risks are associated with ADHD in childhood, adult ADHD has also been associated with many adverse health outcomes, including smoking and substance abuse, poor sleep, physical injury, obesity, hypertension and diabetes. Nigg (45) also reported that ADHD was associated with an increased risk of cardiovascular disease including cardiac arrest, stroke and vascular disease.

Many links with psychological health have also been made. ADHD has been linked with worse mental health outcomes such as depression (46) or anxiety (47) and often lower self-esteem (48) and quality of life (49). A recent review found that the most frequent psychiatric disorders comorbid with ADHD were substance use disorders, mood disorders, anxiety disorders and personality disorders (50). Unfortunately, these mental health risks can lead to more extreme outcomes such as suicide. Garaz and Balazs's (51) systematic review of longitudinal studies showed a positive association between the presence of ADHD diagnosis in childhood and suicidal thoughts and/or attempts in adulthood. Septier and colleagues (52) also demonstrated a significant association between ADHD and suicidal attempts, suicidal ideations, suicide plans and completed suicide. Additionally, ADHD has been significantly associated with early mortality and reduced life expectancy (53).

As well as health risks, many other functional impairments have been established. These include driving risks, accidents, impairments (54, 55), lower academic achievements, lower full-time employment and household income (56) increased social impairments (57) or higher risks of divorce (58). ADHD is also associated with higher rates of gambling (59), and a five-fold increased rate of imprisonment compared to the general population (60). Reinhardt and Reinhardt (61) reviewed the risks associated with ADHD and observed several situations in which ADHD was the most relevant psychiatric diagnosis in relation to urgency (a specific aspect of impulsivity) including higher rates of accidents, suicide, exposure to violence or sexual abuse.

The impacts of having ADHD have been widely researched and documented but to date, only a few reviews have attempted to summarise these in a comprehensive synthesis, all with their own limitations (62–65).

Shaw and colleagues (65) reviewed the long-term outcomes of having ADHD and found that these outcomes affected key domains

related to: addictive behaviour, academic difficulties, antisocial behaviour, social function, occupation, self-esteem, driving and obesity. They demonstrated that adults with ADHD experienced poorer outcomes in all these domains with the most often studied outcomes being substance abuse, academic difficulties and antisocial behaviour. However, this review focussed primarily on the effect of treatment on these outcomes.

Ginsberg and colleagues (64) evaluated the impacts of underdiagnosis and undertreatment of ADHD through their review. They demonstrated that ADHD had effects on multiple outcomes including educational and vocational underachievement, social interactions, antisocial behaviour, substance abuse, imprisonment, driving, and physical and psychiatric comorbidities (such as eating disorders, anxiety, phobia, depression, sleep disorders). While this review usefully measured a wide range of outcomes, its main focus was on underdiagnosis and undertreatment and the search strategy was limited to one database, limiting the reliability of the findings.

Di Lorenzo and colleagues (63) looked at prospective studies of the long-term outcomes of children and adolescents with ADHD. They found that ADHD was associated with five key constructs, namely: substance abuse, antisocial behaviour, criminal activities, anxiety and depression. However, this review limited the scope of the findings by only including studies with a 5-year (or less) outcome timeframe, meaning that longer-term risks may have been missed.

Cherkasova and colleagues (62) also looked at prospective studies from childhood to adulthood on the long-term outcomes of ADHD in adulthood. These outcomes included: impairments in education and occupation (lower educational attainment and lower occupational status), mental health comorbidities and suicide attempts, and physical health (increased mortality, smoking, obesity, poor sleep), substance abuse, driving and antisocial behaviour. However, the inclusion criteria for this review limited the outcomes to only seven included studies.

The breadth of publication on this topic is significant and it would be extremely difficult to gather all publications on the topic, which is why the reviews above impose strict limitations on their search criteria. However, this might have led to missing key constructs around this important topic. The present review proposes a novel approach to synthesise the impact of having ADHD by conducting a review of reviews. Only reviews of outcomes associated with ADHD were included. This allowed the synthesise of outcomes to be manageable but also to include outcomes that have been evidenced over time through multiple publications, strengthening the validity of these impacts. Additionally, while all previous reviews have focussed on adult outcomes, this review will establish the impacts for both children and adults.

This review aims to synthesise the adverse impacts that ADHD has on children and adults, with regard to physical and mental health, and social and lifestyle functioning.

2 Methods

This review was written in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRISMA-P) guidelines (66). A protocol for this review is registered with the International Prospective Register of Systematic Reviews (PROSPERO; CRD42023404073).

2.1 Inclusion criteria

2.1.1 Type of studies

Eligibility criteria included: published reviews of any design (including, but not limited to narrative reviews, systematic reviews (with and without meta-analysis) or scoping reviews). exploring the impacts, long-term outcomes or risks associated with ADHD. Only studies published in peer-reviewed publications were considered.

2.1.2 Type of population

Eligible reviews included individuals (adults and children) who meet the criteria for or have received a diagnosis of ADHD, as defined by the review authors, this criterion was based on a variety of methods including meeting DSM or ICD criteria, self-report, or achieving a specified cut-off on a validated measure. If reviews included multiple groups such as ADHD and autistic individuals, ADHD findings were extracted and reported separately if possible.

2.1.3 Type of phenomenon of interest

This review examined the impacts of having ADHD. Within the context of this study, impacts were defined as any direct consequence of the condition on daily life, encompassing consequences for the individuals, their environment (such as job, schools, friendships), their families and any others impacted. The precise ways in which impact is defined and measured differ between studies. We therefore aimed to capture broader concepts such as risks, effects, outcomes or consequences that transcend different impacts of having ADHD.

2.1.4 Context

Included papers were conducted in any setting and took an international perspective. The period of the review was not restricted, covering all publications from inception up to July 2023.

2.2 Exclusion criteria

Unpublished and grey literature was excluded, as were publications that were not peer-reviewed. Reviews were also excluded if they did not specify the status of the neurodevelopmental disorder examined and did not mention the term "ADHD". Reviews linking impacts to other neurodevelopmental disorders with common (such as autism, dyspraxia etc.) were excluded. Studies that are not reviews were excluded as well as studies not published in English. Reviews on the prevalence, assessment, interventions, management, treatment and treatment outcomes of ADHD were excluded. Reviews on biological features such as brain correlates, genetics, biological mechanisms, cognitive tests, and executive and motor functions were also excluded. Reviews that did not report a direct link between diagnostic status and risks were excluded. Finally, reviews that

reported more than one direct link were excluded as it was not possible to separate the direct impacts and reviews on risk factors for ADHD.

2.3 Search strategy

Five databases (PsycINFO, Embase, Scopus, Medline, ERIC) were searched. Following this search and removal of duplicates, a preliminary analysis was conducted of the subject headings (MeSH) and text words (in the title, abstract, and author keywords) related to ADHD and risks. PROSPERO was checked for ongoing or already published systematic reviews on the subject. A full search strategy for Medline (MEDLINE In-Process & Non-Indexed Citations and OVID MEDLINE 1946 to present-Ovid) is detailed in Supplementary Material as an example. The MEDLINE search strategies were adapted for the other databases according to their individual structures. The search was performed in July 2023, date limits were not imposed. While hand-searching was not a strong component of our planned search strategy, the reference lists of all papers that meet the inclusion criteria were hand-searched to check for any additional reviews.

2.4 Study selection

Following the search, all identified citations were uploaded into reference manager software (Zotero). Two of the review authors (BF and GM) independently screened the titles and abstracts for assessment against the search inclusion criteria. Full reports were obtained for all titles that appear to meet the inclusion criteria. The same two review authors screened and assessed the full-text reports in detail against the inclusion criteria. Studies that did not meet the inclusion criteria were excluded and a record of reasons for excluding trials is provided. The study selection process is presented below (Figure 1).

2.5 Data extraction and outcomes

2.5.1 Data extraction

Two reviewers independently extracted qualitative and quantitative data from the included studies.

2.5.2 Outcomes

The main outcome is the synthesis of impacts and risks associated with having ADHD. Multiple types of factors reported in the selected reviews were evaluated such as societal factors (divorce, imprisonment etc.) and health factors (suicide, drug abuse, etc.). These factors were grouped into themes within the synthesis phase.

2.6 Data synthesis

Qualitative and quantitative findings were aggregated into a narrative synthesis. The aggregation/configuration of all themes generates a set of statements that represent the final aggregation

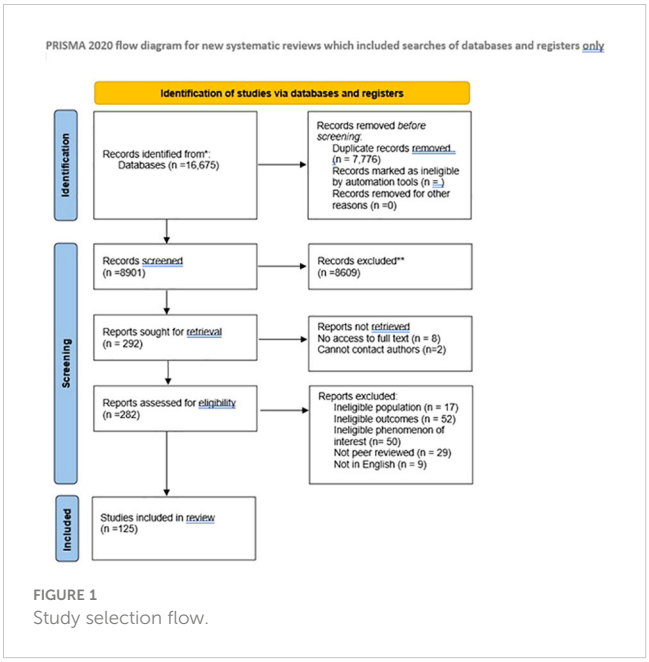

FIGURE 1
Study selection flow.

(or the development of a theoretical framework, a set of recommendations, or conclusions). Two reviewers (CLH and BF) conducted the syntheses in sequential order; one reviewer developed the synthesis and the second checked the findings. Any disagreement was discussed and/or mediated by a third reviewer.

2.7 Assessment of methodological quality

Following mixed methods review guidelines (67), two review authors (HW and BF) independently critically appraised all selected reviews for methodological quality. 104 of the reviews were systematic reviews (with or without meta-analysis) and were assessed using a standardised quality appraisal tool by the Joanna Briggs Institute Tool for Systematic Reviews (68). The remaining 21 literature or narrative reviews were scored on the Scale for the Assessment of Narrative Review Articles (SANRA, 69) as it was not appropriate to score these on the systematic review checklist. Any disagreement between reviewers was resolved through discussion and/or a third reviewer. The quality rating of each study did not affect the inclusion of the review; all reviews that met the inclusion criteria were submitted to the data extraction and synthesis process.

3 Results

3.1 Study selection

The study selection process is shown in the flow chart above (Figure 1). Reasons for excluding reviews after full-text assessment are provided in Supplementary Data Sheet 1. In total, 125 reviews published between 1991 and 2023 met the inclusion criteria. The reviews included systematic reviews, meta-analyses, narrative reviews, rapid reviews, and scoping reviews. Characteristics of each review and their review themes are given in Supplementary Table 1

(Supplementary Material 1). A range of countries were represented within the reviews, encompassing a worldwide representation.

3.2 Data methodological quality

Results of study quality are reported in Supplementary Table 1. Following Kmet, Lee and Cook's guidelines (70), an original quality score from 0 to 1 was calculated for each review. Scores were then classified into poor (0–0.44), moderate (0.45–0.69) and good (0.70–1.00). The same boundaries were used for the scores from the SANRA scale for the non-systematic reviews for consistency in the table. The studies reviewed using SANRA are marked in Supplementary Table 1. Study quality was assessed and agreement between reviewers was 88% overall. The studies showed some variation in their quality. Of the 125 studies, 53 (42%) scored 'good', 60 (48%) scored 'moderate' and 12 (10%) scored 'poor'.

3.3 Data extraction and summary of results

3.3.1 Mental health (42 reviews)

Forty-two reviews highlighted the important association between mental health and ADHD (see Table 1). These risks covered a range of topics including addiction, suicide and self-harm, mood, personality, and other disorders.

3.3.1.1 Addiction

A total of 16 reviews explored various forms of addiction.

Two meta-analyses looked at internet addiction and ADHD in children, young people and adults (71, 72). The findings demonstrated that ADHD was associated with internet addiction (71) and had a positive correlation with more severe symptoms of ADHD (72). One meta-analysis looked at gambling and individuals with problem gambling were 4.18 times more likely to have ADHD than controls. Individuals with ADHD were 2.85 times more likely to experience problem gambling (gambling that disrupts, damages or interferes with daily life) than individuals without ADHD (59).

Eight reviews looked at substance or alcohol disorders/misuse (73–80). All reviews showed a positive association between ADHD and substance misuse (drugs and alcohol). Overall, the findings indicated a prevalence of approximately one-quarter of people with ADHD having substance misuse and similar rates of ADHD in patients with substance misuse (77–79). A review conducted by (76) found ADHD was an independent risk factor for developing substance disorder during childhood and adolescence and found that children with ADHD had twice the risk of developing nicotine, alcohol or substance misuse compared to children without ADHD. Willens (80) also found that ADHD increased the risk of cigarette smoking and that ADHD was associated with greater substance misuse severity and chronicity.

A meta-analysis of 13 studies conducted by Charach (73) showed that children with ADHD are at risk of developing substance and alcohol use disorders. However, the odds ratio (1.35) was lower for alcohol disorder than for nicotine (OR=2.36) or drug use (OR=3.48). The authors state this may be due to the influence of one or two studies within a relatively small pool of papers. Interestingly, Lee (74) found childhood ADHD predicted substance misuse, but not alcohol. Luderer (75) found ADHD was highly prevalent in patients with alcohol use disorder, with 43% of individuals with ADHD developing alcohol-related disorders and approximately 20% of individuals with alcohol disorder having ADHD. Of note, Van Emmerik (79) found that cocaine dependence was associated with lower ADHD prevalence than alcohol dependence. However, their review also highlighted the importance of the choice of measurement scale.

Four reviews looked at gaming (81–84). Three systematic reviews reflected young people (81, 82, 84) and one (83) did not report age, all found an association between ADHD and gambling. Weinstein (83) found a relationship between computer game addiction and ADHD, which they proposed shared a common mechanism of reward and sensitization mediated by dopamine. Gonzalez-Bueso (82) found a high correlation between gaming disorders and ADHD. Dullur (81) found the strongest correlations were with the ADHD inattentive subscale, however, they also noted poor quality studies, predominantly using survey waves or group-wise comparisons. Salerno's (84) review showed that ADHD symptoms may be a risk factor for problematic gambling, particularly for males. However, although some studies supported a bidirectional correlational relationship between gaming and ADHD symptoms, one of the studies included in the review showed (83) that whereas ADHD predicted more time gaming, gaming behaviour did not predict greater ADHD symptoms.

Finally, one review explored an association between ADHD and various forms of addiction (85) and found an association between ADHD and gambling, sex and internet addiction. The overall prevalence of comorbid ADHD in individuals with addictions ranged from 5.8-88.3% and the prevalence of addiction in individuals with ADHD ranged from 5.9-71.8%.

3.3.1.2 Suicide and self-harm

Eight papers looked at ADHD suicide and self-harm (29, 51, 52, 86–90). All reviews showed a positive association. A meta-analysis conducted by Septier (52) demonstrated a significant association between ADHD and various markers of suicidal behaviour including, suicidal attempts (OR; 2.37, 95% CI = 1.64–3.43; I^2 = 98.21), suicidal ideations (OR; 3.53, 2.94–4.25; I^2 = 73.73), and completed suicide (OR; 6.69, 3.24–17.39; I^2 = 87.53). A review conducted by James (86) showed the overall suicide rate in ADHD was 0.63-0.78%. The authors suggest that the increase may be particularly prominent in males and as a result of worsening of co-morbid conditions. Giupponi (87) also highlighted that it is unclear if the increase in suicidal behaviour reflects a direct link or is due to the worsening of co-morbid conditions. Balazs and Kereszteny (88) found that co-morbid disorders mediated the role between ADHD and suicide while Impey and Heun (89) found that co-morbidities of delinquency and substance misuse had a large influence on the association.

3.3.1.3 Mood and personality disorders

Seven reviews looked at mood disorders (91–97), and an additional review conducted by Biederman (98) also covered

TABLE 1 Summary of mental health reviews.

Mental health			
Mental health area	Number of reviews	Association	No association
Addiction	16 reviews*: 2 internet addiction 1 gambling 8 substance/ alcohol 4 gaming 1 mixed	2 reviews showed an association with internet addiction. 1 shows a positive association with gambling 8 reviews showed a positive association between ADHD and various forms of substance/alcohol addiction (including substance misuse, alcohol and cigarettes) 4 reviews showed a positive association between ADHD and gaming issues. 1 mixed showed a positive association with behavioural addiction (including gaming, sex and internet addiction)	1 of the 8 reviews on substance/ alcohol found no association between ADHD and alcohol misuse
Suicide and self-harm	8 reviews	8 reviews showed a positive association between ADHD and suicide or self-harming behaviours. 4 reviews specifically highlight the mediating link of co-morbidities in this relationship	
Mood and personality disorders	8 reviews 1 OCD 7 bipolar and mood disorders	8 reviews showed a positive association with mood disorders but with the caution that the relationship was less evident in longitudinal research. Two reviews showed a positive association in adults with anxiety. The review on OCD showed a link in children but not adults	
Other disorders	7 reviews 4 eating disorders 3 psychotic disorders	6 reviews explored other topics including eating disorders and psychotic disorders. Overall, the reviews indicated a positive relationship between ADHD and these disorders including schizophrenia and anxiety	
Self-esteem	1 review	The review showed a positive association among adults	

*Biederman's paper covered multiple topics, hence the number of reviews in each topic is more than the sum of the total papers.

mood disorders amongst other topics. Overall, the studies found a positive association between the two disorders, however, there is a need to conduct further longitudinal research.

Schiweck (94) showed an association between ADHD and mood disorders, demonstrating that up to 1/13 individuals with ADHD have bipolar disorder and up to 1 in 6 bipolar patients have ADHD. Sandstrom (97) found ADHD was three times more common in people with mood disorders compared to those without and 1.7 times more common in bipolar compared to mood disorders. Brancati (91) found a greater risk of bi-polar occurrence in ADHD compared to healthy controls (risk ratio: 8.97, 95%-CI: 4.26-18.87) while Zdanowicz and Myslinski (96) cautioned that despite evidence of potential dual diagnosis between ADHD and bi-polar, there is a need to consider them as two separate diagnoses.

Faraone (92) conducted a meta-analysis of family genetic studies and found a significantly higher prevalence of ADHD amongst relatives of bipolar probands (relative risk, RR; RR=2.6; 95% CI=2.1–3.2) and the same pattern emerged for bipolar amongst relatives of ADHD probands, indicating a potential genetic relationship between the two.

Meinzer (93) showed that 22 out of 29 papers revealed a positive relationship between ADHD and depression, however, there was large variability in the association. The link was most evident in cross-sectional studies, but for longitudinal studies, there was weaker/no reliable evidence. Skirrow (95) also indicated a relationship between the two, including a familial link found in genetic studies, however, they also highlighted the lack of consistent evidence from longitudinal studies and the need to conduct further research.

Additionally, one review (99) explored the association between ADHD and OCD. Overall, the paper found an increased risk of OCD with ADHD in children, but with large variability (0-60%). This relationship was not observed in adults, although the authors noted a lack of research in adult populations hampering the ability to draw definitive conclusions. Another looked specifically at the link between ADHD in childhood and later adult Borderline Personality Disorder (100). The review found an association between the two and suggested the need for further research to explore whether ADHD is a specific risk factor for some sub-groups of BPD (e.g. predominately impulsive or predominately affective). Furthermore, the Biederman review (98) also explored the link between BPD and ADHD as well as anxiety and BPD and found a positive association.

3.3.1.4 Other disorders

Four reviews (including one meta-analysis) showed a positive association between ADHD and eating disorders in children and young people (27, 101–103). Nazar (102) found a three-fold increase in ADHD in young people with eating disorders and a two-fold increase in eating disorders in young people with ADHD. However, Nickel (103) found a large variation in the relationship, ranging from no relationship to 21.8% of females with ADHD having ED.

Three reviews (50, 104, 105) (including one meta-analysis) explored the link between ADHD and psychotic disorders, demonstrating a positive association between Schizophrenia and ADHD. Norredine (105) found an increased risk of personality disorders for participants with childhood ADHD with a pooled relative effect of 4.74 (95% CI 4.11-5.46). Choi (50) found in schizophrenia patients, the prevalence of ADHD in childhood ranged from 17-57% and 10-47% in adults.

3.3.1.5 Self-esteem

Although not a mental health disorder, our search revealed one review that looked at ADHD and self-esteem (106). The review was based on the findings from only 13 articles, some of which were of low methodological quality, due to weak design or sample size concerns. However, overall, the review concluded that ADHD was associated with lower self-esteem in adults, which could be partially mitigated by psychotherapeutic interventions.

3.3.2 Physical health (51 reviews)

Fifty-one reviews investigated the risks associated with ADHD and physical health (see Table 2). These risks encompass, sleep, oral health, weight, accidents and injuries, and other diseases and impairments. A review of 126 studies investigating the relationship between ADHD and somatic diseases demonstrated that Obesity, sleep disorders, and asthma were well-documented comorbidities with adult ADHD (107). Tentative evidence was found for an association between adult ADHD and migraine and celiac disease and in a large health registry study, cardiovascular disease was not associated with adult ADHD (107).

3.3.2.1 Sleep

The relationship between sleep and ADHD was explored in 13 different reviews, reporting the findings of over 323 studies (25, 84, 108–119).

Many reviews investigated the link between ADHD and sleep in children. Cortese and colleagues (109), demonstrated in an early review that the number of movements in sleep, and the apnea index were significantly higher in children with ADHD than in controls but no significant differences in sleep-onset difficulties and bedtime resistance between children with ADHD and controls were found after controlling for comorbidity and medication status. In a subsequent review, the same author (110) found that children with ADHD are significantly more impaired in most of the parentally reported sleep items (concerning problematic behaviours around bedtime and in the early morning) as well as in some measures indicating fragmented sleep, poor sleep efficiency, and excessive daytime sleepiness. Additionally, children with ADHD are more likely to experience sleep-disordered breathing (25) and periodic limb movement in sleep (118). Sleep disturbance was also significantly higher in children aged 7-12 with ADHD (117) and in adolescents (116). While both studies highlighted the limited number of methodologically sound studies on this topic, Bondopadhyay and colleagues (108) reviewed over 148 studies and demonstrated that sleep disturbances in ADHD are common and that they may worsen behavioural outcomes.

Reviews focusing on adults only have also demonstrated similar findings. Adults with ADHD are more likely to experience sleep onset latency and poorer sleep efficiency (111, 115), greater number of awakenings during sleep, and a general lower self-perceived sleep quality compared with healthy controls (115). Sleep disorders in adults with ADHD have also been shown to have a bidirectional relationship, with poor sleep exacerbating ADHD symptoms and vice-versa (84).

Finally, a few studies have looked at sleep and ADHD over the lifespan. Kim and colleagues (113) revealed that the prevalence of ADHD symptoms in narcolepsy was 33% (95% CI, 28.0–38.3). This prevalence was higher in adults (36.2%) compared to children and adolescents (25.0%). Short sleep duration has also been shown to be associated with ADHD symptomology, especially hyperactivity, with a subgroup meta-analysis demonstrating a significant correlation in studies where sleeping time was six hours or less (114). Additionally, ADHD has been reported for up to 95% of

TABLE 2 Summary of physical health related reviews.

Physical health			
Health area	Number of reviews	Association	No association
Sleep	13 reviews	All reviews showed a significant relationship between sleep difficulties and ADHD.	However, 5 reviews reported caution in generalising findings due to lack of studies, methodological issues and continuity
Oral Health	6 reviews	Six reviews showed a link between poor oral health and habits and children with ADHD.	
Weight	9 reviews	All reviews have shown an association between obesity/ overweight and ADHD	The relationship between ADHD and obesity is well established, however, in children, the findings are mixed with 3 studies relaying contractive/ weaker results.
Accidents and injuries	8 reviews	Eight reviews showed an increased risk of accidents, injuries and mortality across the life span with significant differences between children and adults	
Other Diseases and impairments	15 reviews	One review showed an association with celiac disease in children Two reviews showed a link with asthma One with some vision impairments Two with restless leg syndrome One on chronic pain One on vision One on type 2 diabetes One on the allergic diseases One on neurodegenerative diseases One on cardiovascular diseases	One review showed no association with celiac disease

individuals suffering from obstructive sleep apnea (OSA), demonstrating another bidirectional relationship with OSA potentially contributing to ADHD symptomatology in a subset of patients diagnosed with ADHD (119).

3.3.2.2 Oral health

Six reviews explored the relationship between ADHD and oral health in children (120–125). A meta-analysis of 26 reviews (120) found a significantly higher number of decayed surfaces, higher plaque scores and higher dental trauma risks. Drumond and colleagues (121, 122) also demonstrated a higher chance of dental trauma and that children and adolescents with ADHD had higher gingival inflammations. Despite weaker evidence, Manoharan (124) demonstrated that dental caries were also more common in children with ADHD. Finally, children with ADHD are also more likely to have tooth grinding and clenching (123). This finding was confirmed by Souto-Souza (125) in a meta-analysis of 27 studies that demonstrated a much higher level of sleep and awake tooth grinding and/or clenching in children with ADHD.

3.3.2.3 Weight

Nine reviews explored the relationship between weight and ADHD (126–134), primarily focussing on overweight and obesity and representing over 260 studies.

Multiple reviews by Cortese and colleagues (126–129) demonstrated that obese patients referred to obesity clinics may present with a higher than expected prevalence of ADHD, that individuals with ADHD are heavier than expected (126, 127) and have a higher than average body mass index (127). The pooled prevalence of obesity was increased by about 70% in adults with ADHD (28.2%, 95% CI=22.8–34.4) compared with those without ADHD (16.4%, 95% CI=13.4–19.9), and by about 40% in children with ADHD (10.3%, 95% CI=7.9–13.3) compared with those without ADHD (7.4%, 95% CI=5.4–10.1) (128). Although findings are mixed across individual studies, meta-analytic evidence shows a significant association between ADHD and obesity, regardless of possible confounding factors such as psychiatric comorbidities (129). These findings confirmed that individuals with ADHD are heavier than expected and that the prevalence of ADHD in obese patients may be higher than expected (130), especially in adults (131).

Li and colleagues (132) demonstrated a small overall association between ADHD and obesity in children, but this effect is moderate in adults. This difference between children and adults was also highlighted by another review which found no reliable association between ADHD and body mass index in children at any age or time point (133). In this national survey, ADHD was associated with obesity only in adolescent girls and adults but not in children or boys. However, the most recent review, highlighted different findings showing that children with ADHD had a significant risk for co-occurring overweight and obesity [OR 1.56; 95% confidence intervals (CI) 1.32–1.85], especially in particular groups such as boys (OR 1.45; 95% CI 1.10–1.90), people in Asia (OR 3.25; 95% CI 1.70–6.21) and Europe (OR 1.85; 95% CI 1.61–2.12), and patients not using medication (OR 1.54; 95% CI 1.22–1.94) (134).

3.3.2.4 Accidents and injuries

The link between accidents, injuries and ADHD was observed in eight reviews (135–142).

Reviews focussing on children established many different risks. A significantly higher risk of poisoning has been shown in children and adolescents with ADHD compared with their non-ADHD peers, with an estimated relative risk of 3.14 (95% CI=2.23 to 4.42) (135). Children and adolescents with ADHD are also at an increased risk of unintentional injuries (141) and two times more likely to have bone fractures (142). With regards to brain injuries, severe traumatic brain injuries in children appear to be associated with an increased risk for attention-deficit/hyperactivity disorder compared with non-injured and other injured controls, however no association between ADHD and concussions and mild or moderate traumatic brain injury was identified (138).

While many risks are observed in childhood, many also occur across the lifespan. As opposed to Asarnow's findings (33), strong evidence for an association between ADHD and mild traumatic brain injury (mTBI) has been demonstrated across the lifespan (136). However, most studies fail to report which came first and therefore the sequencing of ADHD and mTBI must be made with caution (136). A meta-analysis of 35 studies demonstrated that individuals with ADHD were two times more likely to be injured than control (137). The risk of accidents and injuries differs across age groups, peaking in adolescents and young adults with a cluster around ages 12–25 years (139).

Finally, ADHD has been linked to mortality. While we know that poisoning is an important cause of mortality amongst all children, those with ADHD have a higher risk of poisoning and are therefore more at risk of dying through poisoning (135). All-cause mortality was also found to be higher in individuals with ADHD than for the general population, most specifically through deaths from unnatural causes were higher than expected (10 studies; RR, 2.81; 95% CI, 1.73-4.55; I2, 92%; low confidence) (140).

3.3.2.5 Diseases and Impairments

Finally, fifteen reviews reported links between ADHD and multiple diseases and impairments (34, 107, 143–157).

Children-focussed reviews highlighted many significant risks in early years. Children with ADHD are more at risk of having lower urinary tract symptoms (LUTS- urinary frequency, pressure, urgency, and overactive bladder syndrome) with the severity of ADHD positively associated with the severity of LUTS (151). A systematic review investigating allergic diseases showed that children with ADHD had elevated rates of asthma compared to children without ADHD but no association with food allergy and weak links with allergic rhinitis, atopic dermatitis, and allergic conjunctivitis (153). Additionally, an association between chronic pain and ADHD in children has been shown (144). While a review of celiac disease in children showed that children with ADHD were more likely to have celiac disease (149), another review on celiac disease in the lifespan showed no conclusive link with ADHD (147).

Across the lifespan, many risks are associated with diseases and impairments. A review looking at ADHD and vision (143) found

evidence of an association between ADHD and reduced colour discrimination, astigmatism, hyperopia and hypermetropia, and strabismus (but not myopia), however, did not detect a higher prevalence of ADHD in patients diagnosed with problems of vision. Although still limited, evidence from clinical and population studies demonstrates an association between restless leg syndrome (RLS) and ADHD or ADHD symptoms across the lifespan (146, 152). In the ADHD group, RLS symptoms ranged from 11 to 42.9% in children and 20–33.0% in adults (152). Individuals with ADHD also experience a two-fold increased risk of developing type two diabetes compared to those without ADHD (Cohen's d = 0.46, CLES = 62.68%) (148). A positive association between ADHD and migraine has also been reported (155) as well as with celiac disease (147). In ageing populations, a history of ADHD may increase the risk for the development of neurodegenerative diseases, in particular Lewy body diseases (LBD), by up to five-fold (34). Finally, an increased risk of cardiovascular diseases was associated with ADHD across all ages (157).

3.3.3 Social and lifestyle (32 reviews)

Daily life, social life and lifestyle are also strongly affected by having ADHD and was explored in 31 reviews (see Table 3). These impacts included risks linked with offending and criminality, education and employment, quality of life, relationships and social interactions and risk-taking behaviour.

3.3.3.1 Offending, criminality and violence

Nine reviews looked at the link between ADHD and criminality (21, 60, 160–166). The findings showed a positive association between ADHD and offending (96, 99).

Having ADHD was associated with an earlier onset and an increased risk of re-offending (21, 165). Mohr (163) presented risk ratios of childhood ADHD and adolescent and adulthood arrests (RR: 2.2, 95% CI: 1.3–3.5), convictions (RR: 3.3, 95% CI: 2.1–5.2) and incarcerations (RR: 2.9, 95% CI: 1.9–4.3). One review found 45% of youths incarcerated screened positive for ADHD (165). A further review (166) using diagnostic interview data, indicated the estimated prevalence of ADHD in prison was 25.5% and there were no significant differences for gender and age. Similar findings were reported by Baggio (60) who found that the adult ADHD prevalence rate for incarnated individuals was 26.2% (95% confidence interval: 22.7–29.6), with retrospective assessments of ADHD in childhood being associated with an increased prevalence estimate (41.1, 95% confidence interval: 34.9–47.2).

Buitelaar (161) specifically explored intimate partner or domestic violence and found positive associations between childhood and/or adult ADHD and adult domestic violence/ Intimate Partner Violence. However, they note some studies did not control for comorbid Conduct Disorder (CD) or Antisocial Personality Disorder (ASPD) which may have impacted the findings. Similarly, Arrondo's (160) meta-analysis showed a higher risk of ADHD individuals being involved in interpersonal violence as perpetrators (six studies, OR 2.5, 95% CI 1.51–4.15) or victims (OR 1.78, 95% CI 1.06–3.0). Additionally, individuals with ADHD were at increased risk of being perpetrators (three studies, OR 2.73, 95% CI 1.35–5.51) or victims of sexual violence (OR 1.84, 95% CI 1.51–2.24).

TABLE 3 Summary of social and lifestyle reviews.

Social and lifestyle			
Topic area	Number of reviews	Association	No association
Offending and criminality	9 reviews	All showed a positive association between ADHD and offending and criminal behaviour. One also showed a positive association between ADHD and being a victim of crime.	
Employment and education	5 reviews	All reviews showed poor educational and employment outcomes such as fewer attainment, prematurely leaving schools, more frequent changes	
Quality of life	5 reviews	All reviews showed poorer QoL in adults and children	
Relationship and social interactions	5 reviews	All reviews showed poorer social relationships including, peer functioning social skills, social dysfunction, peer interaction and intimate relationships.	
Risk-taking	6* reviews	All 6 reviews showed a positive relationship between ADHD and risk-taking – including pregnancy, driving offences and general risk-taking	2 of the 6 reviews noted no increased risk for vehicle crashes despite the overall risk of increased driving offences
Others	2 reviews	Association between gender dysphoria and ADHD, but limited data of poor quality One review showed an association with problematic internet use	

Six reviews were included in this topic, however, two reviews were the same paper published twice under different titles (158, 159).

3.3.3.2 Employment and education

Five reviews established the links between ADHD, employment and education (167–171). Poor education outcomes have been consistently reported in the literature. Academic risks have been demonstrated in various ways such as fewer attainment of a Bachelor's degree compared to controls (170), poor education performance and prematurely leaving school both at the high school and college level (167), grade repetition, need for special education, lower scores on achievement tests (168), higher risks of school drop-out (171). An extensive review of 176 studies (169)

found that achievement test outcomes (79%) and academic performance outcomes (75%) were worse in individuals with untreated ADHD compared with non-ADHD controls, also when IQ difference was controlled. Improvement in both outcome groups was associated with treatment, more often for achievement test scores (79%) than academic performance (42%), also when IQ was controlled (100% and 57%, respectively).

ADHD diagnosis affected the nature of the individual's employment. Individuals with ADHD are more likely to struggle with work performance and demonstrate difficulty maintaining job stability and attaining high-status jobs, subsequently face more financial hardships and have a greater reliance on public aid than those without ADHD (167). Adults with ADHD are less likely to be in employment, especially full-time, and change work more frequently than controls (171). Christiansen and colleagues (170) highlighted that adults with childhood-diagnosed ADHD, generally experience employment of lower quality compared with peers, in relation to income, education and occupational attainment. Additionally, adults with persisting symptoms had significantly more problems at work and for those with ADHD symptoms lessened in adulthood, the negative impact of earlier ADHD symptoms can still be seen on occupational outcomes.

3.3.3.3 Quality of life

ADHD has been found to impair the quality of life in adults (172) and children (173). ADHD has a comparable overall impact on QoL compared to other mental health conditions and severe physical disorders, with increased symptom levels and impairment predicting poorer QoL (173). While robust negative effects on QoL are reported by the parents of children with ADHD across a range of psycho-social, achievement and self-evaluation domains, children with ADHD rate their own QoL less negatively than their parents and do not always see themselves as functioning less well than healthy controls (173, 174). Children's health-related QoL was also significantly poorer (174) with a moderate impact on physical health-related QoL but a large impact on psychosocial domains (175, 176). Children with attention deficit hyperactivity disorder had more problems in all psychosocial domains and family activities, including mental health, self-esteem, parental impact, and emotional/behavioural (176).

3.3.3.4 Relationships and social interactions

ADHD is also linked with relationship and social difficulties spanning a wide range of impacts (177–181).

Children with ADHD have significantly more impairment in peer functioning and social skills than non-ADHD peers (178). Social dysfunction and peer interaction problems are especially salient in girls with ADHD, who demonstrate increased difficulties in domains of friendship, peer interaction, social skills and functioning, and peer victimization (179). Social functioning difficulties also impact children's interactions with teachers. Students with ADHD indicate feeling less close to their teacher while teachers experience less emotional closeness, less cooperation and more conflicts with their students with ADHD compared to other students (181).

Additionally, ADHD strongly impacts intimate relationships in adults. Adults with ADHD are more likely to divorce and report less satisfaction and more trouble navigating romantic relationships, and are more likely to have less intimacy and fear of intimacy (180). ADHD is also associated with intimate partner violence (IPV), anger, hostile conflict, and low conflict resolution (180). In terms of sexual relationships, Soldati and colleagues (177) demonstrated that individuals with ADHD report less sexual satisfaction, more sexual desire, more masturbation frequency, more sexual dysfunctions, poorer sexual health and difficulty in romantic relationships. Finally, difficulties with parenting are also often observed in adults with ADHD (180, 182).

3.3.3.5 Risk-taking

Five papers explored risk-taking behaviour, three related to driving (55, 158, 183), one pregnancy (182) and one general risk-taking (184).

The three reviews on ADHD and driving all revealed an overall increased risk of accidents in people with ADHD. Jerome (158) found a relative risk ratio of 1.54, however, a meta-analysis conducted by Vaa (55) found a lower risk of 1.29 (1.12; 1.49) when correcting for publication bias, and 1.23 (1.04; 1.46) when adjusting for exposure. Vaa (55) also found that whereas ADHD drivers have more speeding violations, they do not have more drunk or reckless driving citations than drivers without ADHD. Similarly, Jerome (159) also noted that the relationship between ADHD and driving incidents was more evident in violations and citations rather than vehicle crashes. Deshmukh (183) found ADHD led to more traffic citations, accidents and licence suspension and postulated that this may be a result of road rage exacerbated by ADHD characteristics.

The review that explored the relationship between ADHD and pregnancy found that ADHD was associated with an increased risk of teenage pregnancy (182). Maternal ADHD was also associated with pregnancy complications (including eclampsia, infection, and caesarean section). The review found no increased risk of malformations because of ADHD treatment during pregnancy. In fact, there was some evidence that stimulant treatment during pregnancy was associated with a lower risk for pregnancy and birth complications (e.g. miscarriage, and placental dysfunctions).

Finally, one meta-analysis looked at overall risk-taking by reviewing data from behavioural task studies, self-reports and virtual reality studies (184). The review found children and adults with ADHD show moderately greater risk-taking than those without ADHD. Sub-optimal decision-making was the only moderator, which was not impacted by age, gender, sub-type or co-morbid disruptive behaviour disorder.

3.3.3.6 Other domains

Two reviews did not fit any of the criteria above. Thrower et al. (185) conducted a review exploring the relationship between Gender Dysphoria and ADHD. Their review found four papers (two in adult populations and two in child populations) and indicated a higher prevalence of ADHD in people with gender dysphoria. However, no studies explored gender dysphoria in

ADHD specifically and papers were of low quality (e.g. retrospective clinical case review). Finally, Werling (186) revealed that youth with ADHD spend more time on digital media and have more severe symptoms of problematic internet.

4 Discussion

This umbrella review was conducted to establish the relationships between ADHD and a range of potentially adverse outcomes in the domains of physical and mental health, and social and lifestyle functioning. It aimed to identify systematic associations based on previous reviews and meta-analyses to provide a comprehensive picture of outcomes related to ADHD. The findings revealed that the outcomes most commonly and consistently associated with ADHD were addiction, other mental health disorders, sleep disorders, overweight/obesity, accidents/injuries, offending and criminality, lower educational attainment/occupational functioning, reduced quality of life, relationship difficulties, and risky behaviours such as driving accidents/convictions and unplanned pregnancy. These findings have implications for improved identification efforts and developing effective interventions and support for those living with ADHD to help mitigate the impact of adverse outcomes on their health and wellbeing. We now explore the main findings in greater depth and their relevance to the management of ADHD and to policy development to improve support for people with ADHD.

4.1 Mental health

Mental health outcomes including addiction, self-harm and suicidality, psychiatric and personality disorders, and poor self-esteem were strongly and consistently associated with ADHD across most reviews included in this synthesis. The reviews we rated as being of 'good' quality often included over 50 studies within their analysis, demonstrating the strength of evidence in this area. In the area of addiction, there was consistent evidence that ADHD is associated with addictions to recreational drugs, alcohol and nicotine. For example, the review of Charach et al. (73) reported a significant association between childhood ADHD and alcohol use in adulthood and nicotine in adolescence, although the evidence of an association with drug use was less clear. This review included 49 studies and used appropriate methods of data extraction, synthesis and analysis, providing one of the strongest pieces of evidence in support of an association between ADHD diagnosis in childhood and substance use disorders later in development. Newer areas of research which included fewer reviews showed evidence of associations between ADHD and internet, gaming and gambling addictions, suggesting a relationship between ADHD and addiction which transcends a range of types of addiction. Further research is needed to disentangle the links between ADHD and addiction. For instance, impulsivity, particularly a preference for novelty and sensation-seeking, are core features of ADHD and are also strongly implicated in addictive behaviours (187, 188) making it difficult to clarify which issue comes first in the developmental trajectory. Treatment with methylphenidate is associated with a reduced risk of substance misuse (189) suggesting that reducing ADHD symptoms leads to better outcomes in this area. Arguably, ADHD medications could also reduce addictive behaviours via primary effects on dopamine and norepinephrine (190). Further research is therefore needed to disentangle the complex interactions between ADHD and addiction. Nonetheless, the findings of this review highlight the importance of strategies to mitigate the risk of addictive behaviours in ADHD.

Other aspects of mental health that were associated with ADHD include increased suicidal behaviours and mood disorders, particularly bipolar disorder, in addition to personality disorder. The findings were highly consistent with 8/8 reviews showing a positive association between ADHD and risk of suicide/self-harm, and 8/8 reviews showing increased risk of mental health disorders. Of these, several reviews were rated as poor or moderate quality, undermining the weight of evidence in this area. However, the reviews rated as good quality indicate that these associations are worthy of consideration when developing healthcare strategies for ADHD. In particular, Septier (52) reviewed a large number of studies (59) and used reliable methods for selection and synthesis across studies. They report a significant association between ADHD and suicidal attempts, ideations, plans and completed suicide, highlighting that the ADHD population should potentially be considered as an at-risk group for mental health professionals carrying out risk assessments around self-harm or suicidal intent. Similarly, the review of Allely et al. (29) showed increased rates of self-harm in ADHD.

These findings suggest some commonality in the pathophysiology of these conditions, and this is supported by previous research. One area of potential overlap is emotional dysregulation which is common to ADHD and to mood and personality disorders. Similarly, impulsivity is a core feature of ADHD and may also play a role in completed suicide and self-harm (191). Poor mental health is an important and consistent adverse outcome of ADHD, but it is not always easy to differentiate between ADHD and the clinical profile of these other diagnostic categories. Further research is therefore needed to establish whether these outcomes are latent comorbidities which only emerge at specific life stages, or whether ADHD is a precursor to and risk factor for these adverse outcomes which has implications for treatment and support. For instance, effective treatment of ADHD symptoms may be the best approach to reduce the risk of the onset of an additional mental health disorder, but additional or alternative treatment may be required if this is arising as a comorbidity instead. Furthermore, the poor self-esteem consistently reported in the reviews may be linked closely to mood disorders given that it is often associated with depression.

In summary, adverse mental health outcomes are clearly associated with ADHD and these may require specific intervention to mitigate their onset and improve prognosis. Tailored support is needed for effective treatment of mental health difficulties among people with ADHD as some existing interventions may not be effective given their symptoms and interacting challenges.

4.2 Physical health

Physical health outcomes including sleep, oral health, weight, accidents and injuries, and disease, were also strongly and consistently associated with ADHD across most reviews included in this synthesis. Unlike with mental health, there was a less oblivious relationship between the number of included studies and the overall quality of the review.

Thirteen reviews contributed to our conclusions on sleep, covering over 300 studies. An early review (108) which was rated as poor on our quality assessment suggested significant differences in movement in sleep and sleep apnea, but no differences in sleep-onset or bedtime resistance between ADHD children and controls. However subsequent reviews (109) highlighted parental reports of challenges around bedtime and in the early morning. The limited number of methodologically sound studies in this area was highlighted, which is disappointing as there are objective measures of sleep that can be collected via actigraphy, unlike in mental health where outcomes are nearly always restricted to self or parental report. Greater levels of period limb movement have also been shown to be more prominent in children with ADHD compared to controls (117) although it is not clear how periodic limb movement was differentiated from fidgeting by raters in those studies. Similar results were found for Adults with ADHD, but the bi-directional relationship between poor sleep and ADHD symptoms was much clearer in adult studies. This underlines both the impact of Sleep on ADHD symptom expression, but also how it may create a vicious cycle that maintains both poor sleep and high symptom expression for adults, exacerbating impairments. A high-quality review (113) that explored sleep and ADHD over the lifespan, showed a clear association between lower sleep levels and higher ADHD symptoms. It is tantalising to speculate how improved sleep could reduce Adult ADHD symptom expression (e.g. inattention) and reduce impairment and more support for sleep problems in children and adults with ADHD could provide a credible indirect route for ADHD symptom and impairment reduction.

Six reviews focussed on oral health all were rated good in our quality assessment. Reviews showed that children with ADHD were at a greater risk of dental problems including higher levels of tooth decay and tooth cavities, higher plaque scores and higher dental trauma risks. The mechanisms that might underscore differences in oral hygiene are unclear, but being impatient and impulsive may lead to less time spent brushing, inattention may lead to more frequent skipping of teeth brushing, and the link between ADHD and obesity may also suggest that children with ADHD eat more sugary foods. Previously discussed sleep difficulties in children with ADHD may also play a role in oral hygiene. Bedtime resistance and difficulties establishing and maintaining daily routines may encourage parents to also skip tooth brushing when they finally manage to get their child into bed, and poor sleep quality may explain the higher occurrence of tooth grinding in children with ADHD.

Nine reviews explored the relationship between weight and ADHD although studies were of variable quality. Results consistently demonstrated a significant association between ADHD and obesity, measured in different ways including overall weight and BMI, findings which parents and clinicians may find surprising, given the stereotype of an ADHD child as being full of energy and never sitting still. This association appears to be universal, with Li and colleagues (131) showing especially high levels of obesity in children with ADHD in Europe and Asia. This association between ADHD and obesity can also be mediated by poverty: poverty is often linked with parental ADHD and thus to poorer nutrition. A greater understanding of how to combat obesity in children with ADHD is required, including the potential moderating role of stimulant medication, as well as a greater understanding of how inattention and impulsivity may influence eating patterns.

Eight reviews explored accidents, injuries and ADHD, all of moderate quality. Reviews consistently demonstrated the link between ADHD and a higher risk of accidents, including poisoning, non-intentional injury and bone fractures. The risk of greater accidents was present in both children and adults with ADHD, with a greater risk of traumatic brain injury in adults that was not present in childhood. This risk for adults is most likely associated with the much higher level of car and motorbike accidents experienced by adults with ADHD. Finally, while not always accidental, the link between ADHD and unnatural death is much higher than expected.

Thirteen reviews highlighted the link between ADHD and disease and impairment, studies were all moderate to good in terms of quality. ADHD was associated with a range of diseases or impairing experiences, including asthma, migraine, chronic pain, and sight problems. Evidence for the link between ADHD and celiac disease was inconclusive with different reviews finding evidence for and against an association. While disparate in nature, these findings do highlight the additional burden and impairments for individuals with ADHD over and above the direct burden of the disorder.

4.3 Lifestyle and social factors

There was consistent and strong evidence of associations between ADHD and criminal behaviour, poor educational attainment, and poor relationships, as well as increased levels of risk-taking behaviours including unplanned and teenage pregnancy, and driving-related incidents and offences. These associations were significant for all the reviews included in this umbrella review. Quality of life was also found to be significantly adversely impacted by ADHD in all the reviews included here.

Regarding criminal behaviours, offending and incarceration, there was clear evidence of an association. Mohr-Jensen et al. (163) conducted a large systematic meta-analysis of data gathered from registries held in 6 countries yielding a sample size of over 15,000 children and adolescents who were followed up into adulthood. They reported significantly elevated rates of convictions and imprisonment in ADHD and showed that offending behaviours had an earlier age of onset in ADHD compared with neurotypical peers. They also defined the types of criminal activity to have an impulsive component, indicating a link to one of the diagnostic features of ADHD, which is also linked to emotional dysregulation poor inhibitory control, and alcohol/

substance misuse. Similarly, another small but high-quality review (159) reported a significant association between ADHD and intimate partner violence, with some studies identifying alcohol use and comorbid conditions including conduct disorder (CD) and antisocial personality disorder (ASPD) as mediators. It is important to note that one of the reviews (160) found that ADHD is also associated with an increased risk of being a victim of intimate partner and sexual violence. This suggests that the relationships between ADHD and domestic or intimate partner violence are complex and multifactorial, with some of the association explained by additional factors. Some studies included in these reviews suggest that impulsivity may be a core underpinning construct explaining increased criminal activity and violence, and this would also explain the transdiagnostic associations with CD, ASPD, and alcohol use highlighted by Buitelaar et al. (161), which need further exploration. Overall, the evidence of significantly increased prevalence of ADHD in prison settings confirms that this is a notable area of poor outcomes in ADHD and should therefore be a focus of further research and policy development to reduce the likelihood of offending in those with an ADHD diagnosis, particularly when there is comorbidity with CD, ASPD and alcohol use disorder.

Poor educational attainment and occupational outcomes are also significantly associated with ADHD, particularly when ADHD is untreated, and these associations remain significant when variation in intellectual ability is accounted for. Our analysis found worse outcomes from all 5 reviews in this domain which synthesised data from over 200 studies. The outcomes synthesised include leaving school early, achieving lower academic qualifications, unemployment and frequent job changes, and lower pay compared with peers. Christiansen et al. (170) also noted that those with more severe symptoms persisting into adulthood fared worse in employment. The evidence in this domain indicates that poorer academic outcomes are likely to lead to poor employment experiences, highlighting an urgent need to cater for children with ADHD in the classroom to scaffold their learning more effectively, engage them in academic activities more fully, and support them into further studies/employment post-education. Under the Equality Act in the UK (192), ADHD is classified as a disability for which employers must make reasonable adjustments. There is compelling evidence describing the challenges of ADHD symptoms in the workplace (5) but very little research into effective workplace interventions that can support ADHD in the workplace (193). Further research is urgently needed to investigate how best to support children with ADHD in schools, and adults with ADHD in the workplace/higher education institutions. This is particularly important given the increase in adults presenting to services requesting a diagnostic assessment; the ultimate outcome of such an assessment must include recommendations for educators and employers.

Five reviews were included which explored associations between ADHD and relationship difficulties. Between them, these reviews included over 100 studies in this area, designed to assess a range of indicators of social functioning, peer relationships and intimate relationships. All reported evidence of poorer functioning in individuals with ADHD. This manifests as difficulties forming and maintaining peer and intimate relationships, poorer social skills, and differences in social cognition, which may be partially mediated by CD in children (178). Previous research has shown an overlap between ADHD and CD in explaining social cognitive differences in children with ADHD (194). Furthermore, ADHD and autism spectrum disorders frequently co-occur and there is evidence of shared genetic and phenotypic aetiology (195, 196), including difficulties in core social processing skills such as following eye gaze (197, 198). Despite this, none of the reviews included here mentioned autism as a possible mediating factor in explaining relationship difficulties in ADHD, highlighting an area for further research.

Of six reviews focusing on risk-taking behaviours in ADHD, 4 focussed on driving and showed evidence of significantly increased rates of a range of driving outcomes, including accidents, collisions, road rage, and driving citations and offences. The methods of these systematic reviews were judged to be poor quality, largely due to a lack of detail in the methods around core aspects of the search strategy such as the number of databases searched, lack of reliability checks for screening and data extraction, and no quality rating of the included papers. Two of the reviews also overlapped considerably in their included papers and findings. Notably, Vaa (55) highlighted a potential role for CD and ODD in explaining the link between ADHD and driving-related outcomes, suggesting that previous research had overlooked these mediators, and they should be taken into consideration in future research. Another review in this domain focussed on ADHD and pregnancy (182) and reported significant associations between childhood ADHD and CD symptoms and unplanned and teenage pregnancies, with lower academic achievement and substance misuse associated with risky sexual behaviours in girls with ADHD. The authors highlight the lack of research investigating boys with ADHD and predictors of unplanned parenthood at an early age. This area needs further research given the potential impacts on other life outcomes for the individual and the costs to health and social care from unplanned and teenage pregnancies.

Research investigating ADHD has tended to focus on symptom ratings as the primary outcome. Recently, there has been an increased emphasis on other outcomes that may ultimately have greater relevance to those living with ADHD, including quality of life (199). All five reviews included in this umbrella review demonstrated a significant association between ADHD and reduced quality of life, particularly in the areas of school and psychosocial functioning and family and social relationships, with less clear findings related to physical functioning. This may be partly a consequence of the measures used in this field of research which have often been designed for populations with physical rather than mental health difficulties. The reviews also found that parent-rated QoL tended to be lower than children's ratings where both were gathered. This is a common feature of ADHD, that children (particularly those younger than 12-15 years) may be less able to reflect on or describe their own difficulties and challenges, or they may perceive certain aspects of ADHD symptoms (e.g. impulsiveness) positively, and this has led to a reliance on proxy reports (teachers, parents, school observations) for evaluating children with ADHD. Another interpretation advanced by Danckaerts et al. (173) is that parent ratings of their children's QoL reflect their burden as parents, and that further work is needed to understand in more depth children's perspectives on their QoL.

4.4 Strengths and limitations

This is the first umbrella review to explore the main impacts associated with having ADHD, including, physical, mental and lifestyle aspects. This review enables findings of reviews relevant to the review question to be compared and contrasted. As such, this review provides a valuable resource for clinicians and academics where these impacts are presented together and demonstrate the wide implications of ADHD. With over 1,000 studies included, this review has the unique advantage of incorporating years of research into one publication. The strengths of this review include the broad focus of the review and the thorough approach to selecting reviews for inclusion. The focus was deliberately broad in order to provide a comprehensive analysis of outcomes associated with ADHD in the core domains that have often been reported as negatively impacted by this condition, including mental health, physical health and lifestyle/social factors. This review enabled us to identify a variability of risks and impacts which can then guide future research studies to explore in greater depth the mechanisms of negative outcomes in ADHD and guide policy development to enhance a range of outcomes for those affected by ADHD.

Despite the strength of this approach, it is important to note that the findings of this review are inevitably limited by the quality of the included reviews and their underpinning studies. Many reviews were rated as poor or moderate, largely because the conduct or reporting of the methodology was unsatisfactory. The quality rating enabled us to determine a high variability in the quality of reviews, however, it is important to bear in mind that these are a reflection of the review methodologies rather than the individual studies and therefore limit our abilities to gauge the quality of each included studies. Our findings are thus constrained by the quantity, quality and comprehensiveness of the available information in the primary reviews. There was large heterogeneity in methodologies and statistical techniques across the reviews, as such, it was not possible to conduct a meta-analysis or directly compare findings between publications. The topics covered by this review are also limited due to the nature of umbrella reviews. While it would be impossible to look at every study investigating this important topic, a review of reviews was the most pragmatic and feasible approach to get a broad understanding. However, topics that have not been synthesised through a review will not have been captured and therefore important factors might be missing. This review was limited to papers published in the English language, resulting in nine studies being excluded. While it is not uncommon to restrict reviews to the English language, these papers might have added important nuances to this review. Finally, while most sub-themes included multiple reviews, a couple only included one. Self-esteem and gender dysphoria were only explored by one review, limiting the evidence for this topic.

4.4 Recommendations

Our findings highlight the importance of clinicians taking a holistic approach to the assessment and management of ADHD, being mindful of common co-occurring conditions and impacts on lifestyle. Many people and professionals are impacted by these findings, including healthcare practitioners, social, forensic, education and industries. In relation to mental health conditions, our review highlights the need for clinicians to be mindful in assessing for co-occurring difficulties in addiction, suicide, eating disorders, mood and personality disorders. Our review also indicates that clinicians should be aware of physical conditions such as sleep, oral hygiene, injury and obesity in relation to individuals with ADHD. Future research could explore the development of psychoeducation packages for families and adults to support these areas. These findings could also support the development of future tailored prevention or treatment interventions aimed specifically at ADHD populations, such as tailored exercise or diet management programmes to reduce obesity. Future research could also explore the under-represented areas of gender dysphoria and self-esteem.

5 Conclusion

In conclusion, this comprehensive review sheds light on the multifaceted impacts of ADHD, extending beyond its core symptoms and impairments. The findings reveal a spectrum of health and lifestyle risks associated with ADHD, encompassing mental health vulnerabilities such as addiction, suicide, eating disorders, mood, and personality disorders. Moreover, the review underscores the significance of recognising key physical health risks, notably obesity, sleep issues, oral hygiene, injuries, and somatic diseases.

Crucially, the review unveils the broader implications on lifestyle, encompassing areas such as offending behaviour, criminality, violence, employment, education, quality of life, relationships, and risk-taking. This holistic perspective emphasises the interconnectedness of ADHD with various aspects of an individual's life and societal dynamics.

This research is the first to systematically illuminate the extensive ramifications of ADHD. The identified impacts underscore the necessity of adopting a holistic approach in the realms of recognition, treatment, research, and support for individuals with ADHD. As we move forward, it is imperative to integrate this comprehensive understanding into the discourse surrounding ADHD, fostering a more nuanced and effective approach to address the diverse challenges posed by this neurodevelopmental disorder. By doing so, we can enhance the well-being of individuals affected by ADHD and contribute to the development of more targeted interventions that consider the intricate interplay between the disorder and various aspects of life.

Author contributions

BF: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. GN: Data curation, Methodology, Software, Writing – review & editing. HW: Investigation, Project administration, Resources, Validation, Writing – review & editing. KS: Conceptualization, Supervision, Writing – review & editing. DD: Conceptualization, Investigation, Methodology, Supervision, Visualization, Writing – review & editing. MG: Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing. SC: Conceptualization, Investigation, Supervision, Writing – review &

editing. CH: Formal Analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing.

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The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1343314/full#supplementary-material

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Experience of CBT in adults with ADHD: a mixed methods study

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Introduction: The National Institute for Health and Care Excellence (NICE) recommends Cognitive-Behavioural therapy (CBT) as the psychotherapeutic treatment of choice for adults with Attention Deficit Hyperactivity Disorder (ADHD) in the UK. However, the literature often refers to adapted CBT programs tailored for ADHD and provides limited insight into how adults with ADHD experience and perceive this form of treatment in routine clinical practice.

Methods: This mixed-methods study aims to explore ADHD individuals' experience and perception of CBT delivered in routine clinical practice, to gain a better understanding of this treatment's helpfulness and perceived effectiveness.

Results: A survey (n=46) and semi-structured in-depth interviews (n=10) were conducted to explore the experience of CBT and its perceived effectiveness in managing ADHD. The interviews were analysed using thematic analysis and the survey was synthesised using descriptive narratives. The thematic analysis highlighted three key themes: difficulties with the CBT framework, difficulties with CBT therapists, and consequences of CBT. The survey highlighted similar findings. Participants described the CBT framework as, generic, rigid, and too short, and described the CBT therapist as unspecialised, unempathetic, and not sufficiently adapting CBT to ADHD-related difficulties.

Discussions: Overall, participants found non-adapted, generic CBT in the UK to be unhelpful, overwhelming, and at times harmful to their mental well-being. Therefore, it is necessary for clinical bodies in the UK, while following the indicated NICE guidelines, to be mindful of adapting CBT delivery of CBT, to be most effective for people with ADHD and to mitigate potential harm.

KEYWORDS

attention-deficit hyperactivity disorder (ADHD), cognitive-behavioural therapy (CBT), adapted CBT, psychotherapy, interviews

1 Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental condition characterised by symptoms of persistent inattention and/or hyperactivity-impulsivity, that causes clinical impairment in academic and social functioning (1) affecting approximately 5% of children (2) and 2.5% of adults (3). While this suggests that ADHD attenuates over time, the prevalence of symptomatic adults is estimated to be 6.7% (3).

ADHD is centrally a disorder of impaired executive functions (EFs) creating a devastating effect on self-regulation (4), inhibition, planning and working memory (5). These impairments impact many different aspects of life such as education, employment and mental well-being (6) Barkley (7) argued that inhibition is the central EF impairment in ADHD, that hinders the utilisation of other functions. Moreover, a body of research reports significant deficits in the EFs of shifting and working memory for ADHD adults (8–10). Furthermore, Bailey & Jones (11) argued that the EF processes of inhibition, updating, and shifting are closely linked to emotional regulation. Henceforth, ADHD is also described as a disorder of emotional dysregulation (12). In a systematic review by Soler-Gutiérrez et al. (13), adults with ADHD demonstrated the consistent use of non-adaptive emotion regulation strategies when compared to controls. Bodalski et al. (14), also reported emotion regulation deficits in adults with ADHD including the use of avoidance strategies. Adults with ADHD demonstrate increased use of experiential and cognitive-behavioural avoidance strategies which mediates the relationship between ADHD, deficits in emotion regulation, and internalising disorder outcomes (14).

The National Institute for Health and Care Excellence (15) considers pharmacological treatment as the first-line treatment for adults with persisting ADHD symptoms. However, Ramsay (16) attests that individuals with ADHD who experience symptom improvement from medications still experience difficulties in academic and social functioning, due to ADHD's high comorbidity with other psychological disorders, such as anxiety, depression, and substance abuse. For this reason, the NICE guideline (2018) recommends a structured psychological intervention in the form of cognitive-behavioural therapy (CBT) for individuals with ADHD as the first psychotherapeutic treatment of choice.

CBT is an umbrella term for a range of related therapies, including for instance cognitive therapy, behavioural therapy, and metacognitive therapy (17). These therapies share a strong commitment to developing clinical interventions grounded in empirical evidence, with CBT described as the most researched form of psychological therapy (18). The therapies encapsulated by the term CBT aim to reduce client's experience of distress by helping the person to explore patterns in their behaviour, thinking processes and thought content, (19). Probably the most commonly practised form of non-adapted CBT in the UK, derives from a mixture of behavioural therapy principles and Beck's cognitive therapy, to employ an active goal-oriented problem-solving approach (20). CBT is highly structured, present-oriented, and time-limited, usually lasting from 5–20 sessions (21). Typically, a CBT therapist may seek to address an individual's cognitive distortions by challenging maladaptive core beliefs, dysfunctional assumptions, and negative automatic thoughts using techniques including Guided discovery, Socratic questioning, positive data logs, and thought records (21). Additionally, CBT therapists may employ behavioural techniques such as activity scheduling, where tasks are reduced to a controllable list, or behavioural experiments to try responding differently to identified situations or stimuli. The CBT therapeutic relationship is based on genuineness, rapport and empathy between the patient and the therapist (21).

In England, CBT is predominantly provided through the National Health Service (NHS) Increasing Access to Psychological Therapies Programme (IAPT), recently rebranded as NHS Talking Therapies for Anxiety and Depression (NHSTTAD). This programme was developed in 2008 in an attempt to radically increase the availability of CBT in primary care, in response to a range of NICE guidelines increasingly recommending CBT and other psychological therapies as the first-line interventions for anxiety and depression (21, 22). This programme commissions a range of primary care psychological therapies services across England, with one-to-one CBT the most frequently provided therapy (23). Therapists are trained in accordance with a competency-based curriculum (24), which does not include specific content on adapting CBT for ADHD. This potentially leads to therapists having high variability in their knowledge, skills and ability to support ADHD patients. Access to NHSTTAD services is often by self-referral, with no separate formal diagnostic assessment of presenting problems required as a precursor to treatment. While the NHSTTAD programme is mainly designed for individuals with mild to moderate depression and anxiety, therapists working in NHSTTAD services often find they are working with complex cases, for which they may have insufficient training and knowledge (22) including ADHD. According to Ramsay (4, 25), individuals with ADHD often seek treatment for comorbid depression and/or anxiety, therefore they may be highly likely to receive CBT treatment through the NHSTTAD service. Whilst statistics of the number of people accessing NHSTTAD who have an existing ADHD diagnosis, or who experience ADHD-related difficulties are not recorded, more than thirty-three thousand people seeking help from NHSTTAD services during the year 2021–22, were assessed as experiencing problems with memory, and concentration, learning and understanding (26).

Previous evidence from empirical studies reported that adults with ADHD found adapted CBT helpful for their symptoms (27, 28). Virta and colleagues (27) reported a pilot RCT of short-term outpatient adapted CBT to adults with ADHD (n=10), delivered over 10 weekly appointments. Participants in this study reported significantly reduced symptoms as a result of engaging in adapted CBT. Two patients (20%) dropped out of adapted CBT. Solanto and Scheres (28) reported a cohort study of adapted CBT for college students (n=18) delivered in a group format, over 12 weekly sessions. Clinician's ratings and participants' self-report data evidenced a reduction in ADHD symptoms and student's perceived self-efficacy in managing ADHD. One participant dropped out of group adapted CBT. These studies suggest that adapted CBT is acceptable to ADHD patients.

Numerous studies have also highlighted the efficacy of adapted CBT in reducing symptoms of ADHD and EF (27–31) as well as mental well-being and general functioning (32, 33). A randomised controlled trial by Safren et al. (34) highlighted the efficacy of an ADHD-adapted CBT treatment in providing significantly better outcomes for participants over an active control treatment based on relaxation and educational support. Additionally, studies comparing CBT to treatment as usual control groups, have shown the treatment's efficacy compared with medication-only groups (35, 36). A meta-analysis by Knouse et al. (37) reported that studies with active control groups indicated significantly smaller effect sizes for CBT treatment, than studies without active controls. The differences in these results could be due to variations in the CBT interventions applied in each study, which varied by treatment type, format, length, and the medication status of the participants, which can arguably moderate the effect of treatment (37). Finally, Solanto and Scheres reported the effectiveness of a CBT program in reducing inattention and EF in college student with ADHD.

Additionally, there are a number of studies which have shown the efficacy and acceptability of adapted Dialectical Behaviour Therapy (DBT) for ADHD patients (38–43). DBT (44) is an empirically validated approach for working with distress tolerance and coping behaviours. Early DBT papers focused on reducing self-harm and suicide attempts in individuals diagnosed with personality disorder (45), whereas more recent work has applied modified DBT to diagnostically heterogenous groups (46). DBT is often considered part of the 'third wave' of CBT, given its focus on emotional and behavioural regulation (47). As applied to ADHD treatment, adapted DBT includes acceptance, mindfulness, functional behavioural analysis, psychoeducation and distress tolerance techniques (42, 43). Many of the studies of adapted DBT for ADHD, have utilised group level interventions (38–43). The reliance on group interventions is at odds with the dominant model of one-to-one CBT used within NHSTTAD services. Furthermore, within the English context, DBT is a psychological therapy approach rarely delivered within primary care in England, given low numbers of DBT trained therapists and supervisors. The English NHS has plans to rapidly expand the availability of DBT by commissioning additional training (48), but there are still few DBT trained practitioners working with primary care populations.

Moreover, it is important to note that the majority of studies reporting on the efficacy and acceptability of CBT, have delivered ADHD adapted DBT or adapted CBT, rather than generic CBT, which is essential for treatment efficacy but the title and often content of these studies do not always reflect this important nuance. Ramsay (4) suggested the adaptation of CBT to accommodate for the executive and emotional dysfunctions experienced by adults with ADHD, using environmental engineering and EF training. This entails changing work, home, and personal settings by implementing systems to lessen dysfunction as well as delivering organisation and time management skills, (4). As adults with ADHD often have a history of negative experiences related to their EF deficits, which may foster negative cognitions about themselves or their abilities and maladaptive emotional strategies, these must be addressed in CBT to motivate change and encourage appropriate coping (4, 19).

Knouse & Ramsay (49) argued that non-adapted CBT could be harmful to adults with ADHD, as negative experiences of therapy can occur in relation to the experience of therapy in interaction with ADHD symptoms and individuals' sense of self. While the benefits can outweigh the negative experiences, therapists must be aware of the possibility of certain negative experiences which might occur during all stages of a CBT treatment course, and any such experiences of therapy must be managed appropriately to reduce harm and barriers to treatment.

CBT therefore appears an efficacious treatment for people with ADHD, yet one that could cause side effects, or iatrogenic harm, if not delivered in a way that is responsive to the needs of people with ADHD. However, the existing literature provides limited indepth, qualitative insight as to how adults with ADHD experience and perceive CBT treatment. In response to this gap in the literature, the present mixed-methods study aims to record and collate the CBT experiences (adapted or non adapted) of adults with ADHD, to capture and analyse the perceived impact of this form of therapy and its value for ADHD individuals. A mixed-method approach lends itself well in capturing user experiences and understanding social phenomena better (50). This study aims to explore the following research question, 'How do individuals with ADHD experience CBT therapy in the UK?'

2 Methods

2.1 Design

An explanatory sequential mixed methods design (51) was employed, consisting of an online survey, followed by in-depth, semi-structured interviews with a sub-sample of survey respondents. The survey data was collected over 3 months (June-August) in 2023. Interviews were conducted and recorded over one month in August 2023. The survey and interviews took place online and followed data protection procedures and best practices for record-keeping, and storage of personal data, in accordance with the BPS Code of Human Research Ethics (52). The study received ethical approval from the University of Nottingham School of Psychology (ethics reference number: FMHS 81–0922).

2.2 Material

The survey and interview questions were developed by the authors (who include CBT practitioners and researchers). The surveys took on average 15 minutes and included 28 questions in the form of multiple choice, 10-point Likert-scale, and free text box questions (Supplementary Material 1). A demographic questionnaire gathered demographic data from the samples. On average, the interviews lasted for 30 minutes and encompassed 23 questions exploring the participants' experience of CBT and its effectiveness in addressing their ADHD difficulties (Supplementary Material 2).

2.3 Participants

Participants were recruited from across different regions of the UK, using a database of adults with a diagnosis of ADHD, collated at the University of Nottingham's ADHD research lab. The database had been created from previous research studies with individuals who have an ADHD diagnosis who previously indicated a willingness to participate in future research studies. Additionally, participants were also recruited from, 'The ADHD Collective', an online community of adults with ADHD based in the UK.

Inclusion criteria were that participants were aged 18 years old or greater, had an existing diagnosis of ADHD before receiving CBT, and the course of CBT was delivered within the UK by any provider (NHS, private or others).

Participants who reported receiving CBT within a mixed, integrative or eclectic psychotherapeutic approach, such as those mixing CBT concepts with other concepts drawn from other psychotherapy approaches (e.g. psychodynamic or humanistic approaches), were excluded from the study.

2.4 Procedure

Details of the studies were sent to mailing lists by the research team. Participants in the survey were entered in a £10 Amazon voucher prize draw. Additionally, interview participants were provided with a £20 Amazon voucher code after the completion of the interview.

Participants in both the survey and interviews who wished to participate signed an online consent form. Participants who responded to the semi-structured interview invitation were interviewed over Microsoft Teams at a time of their convenience.

2.5 Analysis

The interviews were analysed using an inductive approach to thematic analysis (53), which employed an essentialist perspective in extracting codes. The thematic analysis consisted of a six-stage process (53). The analytic process began by transcribing each interview verbatim shortly after being conducted. Following this process, the lead investigator first familiarized herself with the interview data and made notes in a diary of preliminary thoughts on the content of the interviews. From this, initial codes were identified in a coding manual that was then collated and combined to be classified into broader themes using constant comparative analysis, both within and between transcripts. Finally, as the analysis evolved, these broader themes were reviewed and refined to generate the final themes proposed. An ongoing analysis allowed for a clear definition of the final themes. Semantic themes were developed using participants' descriptions of their own experiences. Themes were then reviewed by a second researcher (BF) to ensure that they mapped to the original transcripts. Interrater reliability of themes was tested on a small proportion (2/10, 20% of interviews) of the transcripts. The results were validated collectively as a team, and any discrepancies were discussed and reconciled. The survey responses were reported descriptively and were used to triangulate the responses from the interviews.

3 Results

Ten participants took part in the interviews (70% female) and 46 in the surveys (71% female). Tables 1, 2 (Interview) and 2 (survey) describe the demographics of each group.

3.1 Semi-structured interviews

The codes from the thematic analysis captured three main themes: The complex structure of the CBT framework, the intricacy of the therapist relationship, Consequences of CBT.

3.1.1 The complex structure of the CBT Framework

Participants reported that the overall framework of CBT was unhelpful due to several factors. Firstly, the generic nature of CBT sessions was usually not adapted to individuals with ADHD, making therapy ineffective and experienced as highly frustrating. Secondly, the CBT sessions followed a rigid structure that was not personalised to the participants' needs. Thirdly, the timeframe of the therapy was experienced as too short to be of benefit to the ADHD participants.

Participants reported that the CBT they received was essentially incompatible with their experience of ADHD, as it did not take into consideration the inherent EF and emotional dysregulation difficulties they experienced. Working memory deficits were not accommodated in sessions, leading to a cycle of unnecessary pressure and ineffective treatment. Moreover, participants

TABLE 1 Interview participants demographic characteristics.

	Interview participants (n=10) range (mean)
Age (years)	21–59 (43.4)
Gender (total)	
Female	7
Male	3
Number of CBT course	1–3 (1.5)
Number of CBT sessions	4–30 (13.1)
Years since CBT course	0–10 (2.8)
Years since ADHD diagnosis	01–13 (6.05)
Institution offering CBT (total)	
NHS	4
Independent provider	6

Data is range, mean unless otherwise stated. CBT, cognitive behavioural therapy. NHS, national health service.

TABLE 2 Survey participants demographic characteristics.

	Survey participants (n=46) range (mean)
Age (years)	20–60 (39.9)
Gender (total)	
Female	33
male	13
Number of CBT course	1–8 (1.5)
Years since ADHD diagnosis	0.5–38 (5.2)
Number of CBT sessions (total)	
Less than 6	17
6–8	11
9–12	6
More than 12	9
Unsure	3
Did you complete the CBT course (total)	
Yes	25
no	21
Institution offering CBT (total)	
NHS	23
Independent provider	18
Unsure	5

Data is range, mean unless otherwise stated. CBT, cognitive behavioural therapy. NHS, national health service.

described that the content of therapy did not account for ADHD symptoms of inconsistency, distractibility, and inattention. As a result, ADHD participants reported feeling overwhelmed and frustrated by the approach, which they found unhelpful in managing their ADHD difficulties.

"I think there's core things about CBT that are just seen on the face of it to me to be incompatible with ADHD. So, there is an element of having, decent working metacognition, working memory and things like that […] I might discuss a technique with my therapist, but I would not remember to remember that technique. It just wasn't going to happen." (P5).

Only one participant reported receiving adapted CBT, with a therapist who also had ADHD. This participant reported that their CBT sessions allowed for self-acceptance of their EF difficulties, which moderated their approach to facing ADHD-related difficulties. For instance, they were able to moderate their time and chunk activities to avoid resistance and boredom. Overall, through the adapted CBT course, they were able to adopt cognitive strategies in their daily life, easing their day-to-day activities.

In contrast, however, most participants reported that the goals set in generic CBT were unspecific and unhelpful in managing ADHD symptoms. They explained that there was often no obvious relation between the CBT process and the management of their ADHD difficulties. They reported that ADHD topics such as understanding ADHD, time management, organization, and emotion regulation were often not discussed.

> *"In the sense of actually managing ADHD symptoms […]like time management, procrastination, achieving goal, it wasn't really helpful for that kind of stuff, which is initially what I was hoping for" (P3).*

Furthermore, participants commented on the learning aids or physical resources offered in sessions. Some participants reported an absence of any learning aids or physical resources to summarize sessions, which caused an unhelpful dependence on memory, that led to forgetfulness. Conversely, other participants reported that they received an overwhelming amount of generic CBT resources which required high levels of literacy and concentration to comprehend, and which were not adequately adapted to ADHD individuals.

> *"I got sent a whole load of files and stuff to read and it was just volumes and volumes and volumes and stuff […] Reading stuff is something I don't do very well, and just the thought of doing all of that just overwhelmed me. I kept losing them as well" (P6).*

Participants reported that they needed CBT to offer an acceptance and management of their ADHD condition, rather than a fixing of their condition. Some participants reported that the sessions were too focused on symptom reduction, which did not allow for an appreciation of their strengths. This focus on just part of the person's experience was sometimes experienced as unfair, with elements of their identity as a person with ADHD being ignored, or repressed, akin to being 'dampened down'.

Conversely, the one participant who received adapted CBT reported that this course explained the behavioural irregularities as well as the strengths of having ADHD, fostering their acceptance of the condition.

> *"What I liked about it was that I understood how my mind worked […] So it was really kind of understanding what the strengths I think of ADHD were. I just felt that I'm more accepting of myself and I'm more aware of myself and I'm more aware of my kind of behaviours if that makes sense" (P4).*

Participants also reported that the CBT objectives were not focused on the client's needs but followed an unhelpful systematic approach. Participants who had undergone multiple courses of CBT reported that sessions felt like a pre-written script. Moreover, other participants reported that the CBT approach did not view the participant as an individual requiring personalised treatment.

> *"I felt the therapist had got their own set of exercises both times that they wanted to do from their own training, and I felt that I*

needed a much more bespoke approach" (P9).

However, one participant expressed that their adapted CBT course was personalised in relation to their current situational difficulties, rather than being a generic application of CBT strategies. They reported sessions not being highly structured or systematic, but rather following an organic and client-centered approach, where the direction and flow of the therapy coincided with their feelings and needs.

Participants also reported that the generic CBT courses were too short to be helpful for their ADHD. They described that the number of offered sessions was inappropriate for individuals with ADHD who require more time to process information.

"It'd have to be extended because not only are you meeting someone new … you still got to bring the courage to open up to that person and then the sessions end, don't last long enough, and then the overall course doesn't last long enough. And I feel like something that takes that much would need to have more time for it" (P7).

3.1.2 The intricacy of the therapist relationship and its impact on therapy

Participants reported multiple difficulties with their therapists affecting the overall experience. Firstly, almost all therapists were reported to be unspecialised in working with ADHD symptoms and seemed to have little knowledge about the condition, demotivating participants. Secondly, many therapists were experienced as unempathetic, affecting the participants' healing and learning. Thirdly, many participants described their therapists' approach as non-accommodative and inflexible.

Therapists appeared to lack a genuine understanding of ADHD, which affected participants' treatment and motivation to continue with therapy. Some participants commented that they believe therapists with extensive ADHD experience should be delivering the CBT to ADHD individuals, for it to be maximally effective. Several participants reported that they had to explain multiple times to their therapists that the techniques they were assigned would not work with their ADHD, creating a lack of being understood and their experiences invalidated. Additionally, participants reported that their therapists seemed to assume their mental health difficulties could be treated in the same way as neurotypicals, disregarding that the myriad difficulties participants experienced were intricately linked to ADHD.

"I couldn't see the link with ADHD and she didn't see it either. […] She knew nothing [about ADHD], and she told me that straight away. So, I think it impacted every single aspect of the therapy because she would just look on the surface of the problem and never be able to understand the deeper-rooted issues and difficulties" (P8).

In contrast, tailored CBT facilitated participants understanding of the relationship between anxiety experiences and ADHD, and this was further aided by therapist's disclosure of personal experience and knowledge of difficulties inherent in the condition.

"I felt very comfortable with her. I felt I could be very open and felt that she understood me, which was really important. I don't know what it would be like to have that experience with a therapist who didn't have ADHD … but I think unless you really know somatically how it feels that might be difficult to really know what someone else is experiencing" (P4).

Participants reported that their therapist was unempathetic during treatment. They often felt judged and dismissed, which worsened their emotional state and affected the healing process.

"I always felt like quite dictated, like talking at me when I feel like, no one can be healed or learn about themselves or anything if they feel like they're being judged or talked down to" (P7).

Several participants felt that their therapist was not accommodating of their difficulties, nor their explicit feedback, resulting in feeling dismissed and demotivating their activation participation in CBT.

"I was sharing things that I thought were relevant, associated with ADHD and she didn't really embrace it. She acknowledged it and she read it and said it was interesting, but she then didn't necessarily adapt for it. So, I felt like it was listened to but not understood and acted upon. At the end I sort of gave up sharing my thoughts, trying to prepare for it" (P6).

Some participants reported situations where the therapist was extremely rigid and inflexible with the timing of sessions. For instance, one participant reported that their therapist asked them to leave the room very abruptly because their time had ended, whilst they were severely distressed from recalling a traumatic event. Another participant reported that their therapist cancelled the appointment due to a five-minute bus delay.

"The therapist changed the time and he kept scheduling times that I couldn't make, So, in the end, he wasn't able to accommodate the time that I had available for the sessions, he ended up just discharging me" (P3).

3.1.3 Consequences of unadapted CBT

The majority of participants reported little gain from or feeling worse off after the course of CBT.

Participants reported feeling worse off due to lowered self-esteem, increased sense of failure, frustration with self, increased

emotional dysregulation and hopelessness with the future. One participant reported that their inability to perform the required techniques frustrated them greatly and lowered their self-esteem. Similarly, another commented that CBT made them feel responsible for their inability to benefit from the sessions, leading to a sense of failure. Other participants felt the CBT sessions left their emotional dysregulation even worse, not knowing how else they could move forward or be helped.

> *"I kept forgetting to practice, so by the time I come to the next session, they would have asked me how it went with the practice and I wouldn't have practised, I wouldn't have had time or I would've forgotten. And then it felt that if I didn't do that, we couldn't move forward. […] So it felt like I was being punished and I couldn't do the therapy properly because I couldn't do those exercises" (P8).*

Some participants also felt at times that CBT sessions were a complete waste of time for them and that the lack of available alternative treatments for managing ADHD, led them feeling hopeless for the future.

> *"It was just such a waste of time for everyone, and it's a shame, […] it made me feel worse going there, and that's not what you hope when you do therapy, you expect to feel better afterwards. But I felt worse and it's just not very nice" (P8).*

Conversely, Participant Four described their adapted CBT experience as,

> *"… very transformational … because it really helped me to understand my mind and how to kind of work, I guess with my mind more. That made me feel happier about being me rather than trying to fit into what I believe the world sort of expected of me" (P4).*

3.2 Survey

All participants completed 11 Likert-scale questions on their experience of CBT from a scale of 1 to 10, where 1 indicated 'strongly disagree' and 10 indicated 'strongly agree'. The results of the Likert-scale questions are presented in Table 3.

Additionally, 41 participants responded to the remaining short-answer questions. When asked, 'What were you hoping to get out of your CBT sessions?' participants responded that they wanted to receive help in managing their ADHD symptoms and executive functioning and to feel better about themselves. Moreover, most participants commented that they needed help understanding their thought processes and managing their emotional regulation, anxiety, self-esteem, organization, and low motivation. In addition, many participants expressed their need for actionable tools and effective coping strategies. When asked whether the CBT sessions met these expectations, participants responded that they did not. Participants commented that they felt blamed, not understood by their therapist, and constantly needed to explain themselves. For instance, one participant replied,

TABLE 3 Experience of CBT questionnaire.

Question	Mean (SD)	Mode
My CBT therapist was knowledgeable on ADHD	4.6 (3.2)	1
My difficulties were understood and treated in the context of my ADHD	3.7 (2.9)	1
CBT was adapted to accommodate my ADHD	3.6 (2.9)	1
I was made to feel that my ADHD symptoms were my fault	4.3 (2.8)	1
My therapist took the time to understand my ADHD	3.7 (2.9)	1
Overall, my experience of CBT was positive	4.2 (2.8)	3
Overall, my experience of CBT was negative	6.1 (2.4)	8
Information about CBT and my treatment was clear and easy to understand	5.5 (2.7)	5
Information about CBT and my treatment was provided in an accessible format for me	5.3 (2.8)	5
My therapist validated my difficulties because of ADHD	4.3 (2.6)	1
I found CBT really helpful	3.8 (2.8)	1

> *"No. ADHD wasn't understood, and I constantly felt I had to explain why some the things being asked of me were a challenge"(P124).*

When asked about the challenges of accessing CBT, most participants argued that the sessions were too time-consuming. In addition, some participants noted that the waiting time to access CBT was too long and did not allow the patient to choose their own therapist. When asked what accommodations were made to support the participants' access and engagement with CBT, most participants noted that no accommodations were made. Only a few participants commented that they were alerted prior to their appointments and that they were given extra time. When asked what the participants had liked or disliked, found helpful or unhelpful about CBT, many participants responded that it was unhelpful because it was manualised, repetitive, and did not address the underlying causes of symptoms. Moreover, some participants commented that they found the homework, tools, and therapists unhelpful, increasing their frustration. For example, one participant wrote,

> *"I struggled with speaking to someone who didn't understand ADHD and didn't seem to want to make any effort to. Some of the tasks required more forward planning or future thinking than I'm able to engage with. I came away feeling I'd need a much more intense level of interaction and support than I could*

> *afford or was on offer"(P106).*

When asked what the CBT course included, most participants responded that the course included working on unhelpful thinking styles, managing multiple tasks, organisation and planning, and managing distractibility. Moreover, when asked whether they had anything else to add about their experiences with CBT, some participants responded that they did not find it suitable and would not recommend this form of therapy to individuals with ADHD. For instance, one participant said,

> *"Overall, it made me feel more inadequate as I felt I couldn't do the stuff I was supposed to. You can't change how you think when your brain is wired differently. ADHD isn't a thinking or positivity problem, and CBT seemed to assume it was"(P121).*

4 Discussion

The present study aimed to explore how individuals with ADHD experienced CBT in the UK. In this study, individuals with ADHD experienced several difficulties with CBT, that was not adapted to ADHD, which could have a negative impact on their overall wellbeing. These difficulties encompassed nonalignment of an unadapted CBT framework with specific aspects of ADHD, alongside a perceived unspecialised, unempathetic and non-accommodative CBT therapist, collectively resulting in suboptimal therapeutic experiences.

Participants expressed frustrations with the generic CBT framework due to its inconsideration of the EF and emotional dysregulation impairments experienced by individuals with ADHD. Participants described being forgetful, distracted, inconsistent, and inattentive, which pertained to impairments in their EF processes of updating, shifting, and inhibition, supporting previous research highlighting these difficulties in ADHD adults (8–10). Moreover, the participants' emphasis on emotional regulation difficulties further supports previous research describing ADHD as a disorder of emotional dysregulation (14, 54). Sadly, the generic, non-adapted CBT framework was not experienced as helpful, causing a counterproductive effect where participants felt overwhelmed, frustrated, and hopeless.

Research shows that when CBT is adapted specifically for ADHD symptoms, it can provide concrete strategies for managing the core symptoms of inattention, hyperactivity and impulsivity, and the associated personal interpersonal, social and occupational concomitants of the condition (55). Additionally, adapted DBT group interventions have demonstrated high effectiveness and acceptability, in helping people manage ADHD related symptoms (38–43). Group delivery of therapy is not commonplace within NHSTTAD services for patients with higher levels of distress or complexity, with one to one CBT being the primary treatment option. Moreover, as previously highlighted, there are few DBT trained therapists and supervisors currently working in primary care within England, giving rise to current plans to increase numbers of DBT trained therapists (48). The implication is that at this present time, adapted DBT maybe unlikely to be delivered in primary care with fidelity to the empirical studies.

Hayes and Hoffman (47), make the point that 'third wave' and traditional CBT approaches are often blended in reality, and this may be reflected in the range of empirically validated key adaptations to CBT for ADHD, which include helping the person to develop and review strategies to improve attentional focus, impulse control, planning and problem-solving, cognitive restructuring in the context of ADHD, managing emotional arousal in conflict and ensuing emotional or behavioural responses (e.g. managing anger and anxiety) and pro-social skills, e.g. empathy skills including perspective taking, recognition of the thoughts and feeling of others, critical reasoning, evaluating options and negotiation skills (28, 34, 56).

This is consistent with a body of research showing the efficacy of CBT in reducing ADHD symptoms and improving EF (29, 31, 34, 56). Moreover, in a recent meta-analysis by Young et al. (19), CBT was shown to be an effective psychotherapeutic treatment for reducing ADHD symptoms.

Potential inconsistency in results across included studies is affected by stark differences in the implementation and delivery of CBT. Ramsay (4) described the impeding effect of ADHD symptoms on standard CBT and the need for an adapted approach to CBT to accommodate the EF and emotional dysregulation difficulties in participants with ADHD. Additionally, previous studies reported CBT content targeted to address ADHD symptoms, in countries outside the UK (19, 31, 34, 56, 57). The English NHSTTAD system is unique as it is a single point of access for CBT for all resident adults seeking support with mental health, following a prescribed competency-based approach to CBT for a limited range of presenting problems (58). Therefore, CBT in NHSTTAD is not necessarily easily tailored to or adapted for specific conditions outside of its core focus on anxiety and depression. CBT programs in other countries and published studies have often been adapted for ADHD and therefore do not represent the same form of care.

The difference in outcome between adapted and generic CBT is demonstrated in the striking disparity between Participant Four's account and those of the other participants. They received a form of CBT specifically adapted for individuals with ADHD, by a therapist who was reported as having specialist expertise in working with clients with ADHD and who also had lived experience of ADHD. This experience of CBT was found extremely helpful and meaningfully tailored to their experiences by explaining their cognitive processes and behavioural responses in the context of their ADHD diagnosis. Psychoeducation of ADHD and an adapted approach allowed for an understanding of the client's strengths and promoted self-acceptance and moderation of their ADHD-related difficulties. This mirrors previous studies which have highlighted the benefits of psychoeducation in cognitive interventions (43). Conversely, most participants, reported that there was no obvious accounting for ADHD symptoms within their CBT sessions.

Therapists appeared to lack cursory knowledge of ADHD and did not seem to understand ADHD as a root cause behind symptoms experienced, and therefore could not appropriately adapt CBT or provide relevant techniques to help clients accept and moderate ADHD-related difficulties. Similar experiences of CBT delivered in routine practice in NHSTTAD services, as not being adequately tailored to the needs of clients are reported in the literature. Omylinska-Thurston et al. (59) reported similar findings in a group of participants with severe mental health disorders, where generic CBT was not experienced as adequately addressing underlying core issues, and was delivered inflexibly, leading to CBT being perceived as a waste of time and financial resources. The pressure on NHSTTAD therapists is significant, including considerations such as measurement against key performance indicators relating to client and service recovery rates, 'throughput' of clients, limited session numbers, high caseloads, and a range of client problems that are less likely to respond to time-limited CBT, such as experiences of poverty, social exclusion, or systematic oppression and social injustice (22). Against such a demanding context, several studies report significant levels of stress and psychological disturbance among the NHSTTAD workforce (60–62). It is possible, that against this context of background stress, therapists may be struggling to provide personalised formulation and therapy adapted to the presenting needs of their clients.

Indeed, in this study, most participants reported not receiving behavioural components of CBT for ADHD, meaning that they were not given graded task assignments, activity scheduling, or other behavioural tools to help manage procrastination and anxiety. The exclusion of valid behavioural elements of CBT has been previously noted by Binnie (22), who argued that CBT delivered in NHSTTAD often tended to focus on cognitive interventions, neglecting valid behavioural components.

Participants argued that the structure of therapy was not client-centred but followed a rigid and systematic approach which neglected their feelings, needs, and self-expression. Decades of research highlight the importance of a therapeutic relationship in which the therapist is experienced as empathic and attuned to the needs of the client, (e.g. 63), however, this crucial element of therapy was not experienced by several participants in the present study. Omylinska-Thurston et al. (59) reported that when participants felt their therapists were unempathetic and adhered to a rigid CBT protocol, instead of attending to the participant's individual needs, therapy was unhelpful. Binnie (22) supported this by arguing that the delivery of CBT in NHSTTAD services may omit collaborative empiricism and guided discovery where the therapist works compassionately with the client, and instead overly focuses on manualised treatment for a restrictive range of presenting problems.

In contrast, Participant Four's, specialised therapist idiosyncratically formulated the participant's current situational difficulties and meaningfully personalised the treatment plan to the participant's feelings and needs. This was experienced as crucial and helpful by the participant, who was able to learn from and manage undesirable situations, supporting Omylinska-Thurston et al. (59) who argued that an adjusted client-centred (i.e. idiosyncratically formulated) CBT process can improve the therapeutic relationship and outcome of therapy.

Overall, most participants reported feeling discontent or disappointed with therapy, which led to an increased sense of failure, increased emotional dysregulation, low self-esteem and a sense of self-blame. The ineffectiveness of therapy increased their feelings of hopelessness and disappointment in themselves. According to Ramsay (4), individuals with ADHD are more inclined to have pessimistic thoughts and expectations of failure due to their past unsuccessful experiences, which runs the risk of being amplified by therapy not adjusted to consider the person's experiences of ADHD.

The survey results further supported the insights gleaned from the conducted interviews. Similar to the interviews, participants responded that they found the non-adapted form of CBT unhelpful and challenging, further deploring their self-esteem and increasing their frustration. Moreover, the therapists' lack of knowledge of ADHD was apparent from most survey responses, demonstrating a need for additional training for therapists, on working with people who have ADHD.

4.1 Limitations

While the present study addresses an important research gap on the experience of generic, non-adapted CBT in adults with ADHD, there are limitations to the study. A convenience sample was used to recruit participants. The sample was predominantly female, which may not be an adequate representation of the predominantly male ADHD population, limiting the generalisability of the results. Moreover, convenience sampling may attract participants with charged emotional experiences, who may deliver a more negatively, or positively exaggerated account than that of the rest of the ADHD population. Additionally, the impact of the different ADHD presentations (inattentive, hyperactive-impulsive, and combined) on participants' experiences of CBT was not analysed, which may have left an interesting variable unexplored. Finally, it is important to acknowledge that the findings refer to a vast range of non-adapted CBT treatment episodes experienced across the UK and therefore refers to a heterogeneous form of therapy. While we could discern between private, adapted CBT programs and NHS delivered generic programs, we cannot generalise the findings broadly as we lack details on these specific programs. Finally, we did not explore the different types of CBT that might have been received. The study aimed to look into how adults with ADHD experienced CBT, adopting a broad definition of what CBT is, as we did not want to be too prescriptive, believing that individuals might not always know the exact type of CBT they have received. This variance in the nature of CBT delivered, and understanding of what type of CBT is received may reflect naturalistic practice in the NHS, however through this omission, we might have missed important information about different nuances.

4.2 Future considerations

4.2.1 Implications for practice

This study highlights that routine delivery of CBT in the UK, may not be adapted appropriately for many adults with ADHD, negatively impacting their experiences. To combat this counterproductive effect of therapy, CBT therapists treating ADHD adults must receive additional training on adapting CBT to work with the array of symptoms and common experiences of people with ADHD, to more appropriately adapt CBT techniques and resources (4). Through this adaptive framework, necessary considerations regarding the EF and emotional dysregulation difficulties of ADHD individuals should be considered, transforming the nature of standard CBT to being more explicitly aligned with the experiences of people with ADHD.

4.2.2 Implications for research

The present study illustrates the potential negative impact of CBT on adults with ADHD revealing the need for more research in this topic area. Further investigation on the difference between adapted versus non-adapted CBT would further the important nuance in how beneficial CBT may be as a first line of psychotherapy treatment. Additionally, future research should consider the effect of different ADHD presentations on the effectiveness of CBT treatments, since research suggests improvement for clients with the predominantly inattentive ADHD sub-type (64). Moreover, specific post-qualification training on adapting CBT to work with ADHD symptoms appears indicated, and the authors are developing such training packages in association with people with lived experience of ADHD.

5 Conclusion

In conclusion, the present study portrays how adults with ADHD experienced CBT in the UK, with most ADHD participants reporting negative experiences when CBT programs were not adapted. This evidence prompts future research and clinical practice to address the issues highlighted in this study for a deeper understanding of how best to accommodate adults with ADHD in therapy. Moreover, this prompts therapists and service providers in the UK to consider the current implementation of CBT to ensure CBT can be appropriately adapted and delivered by therapists with relevant training, who understand the difficulties of ADHD, to ensure that treatment is helpful, efficient and meaningful to adults with ADHD, and to mitigate against the possibility of iatrogenic harm.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Nottingham School of Psychology ethics committee (ethics reference number: FMHS 81-0922. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SW: Formal analysis, Investigation, Writing – original draft, Writing – review & editing. MH: Conceptualization, Methodology, Supervision, Writing – review & editing. JR: Conceptualization, Methodology, Supervision, Writing – review & editing. CH: Conceptualization, Investigation, Supervision, Writing – review & editing. BF: Conceptualization, Investigation, Methodology, Project administration, Supervision, Writing – review & editing.

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Conflict of interest

BF reports personal fees and nonfinancial support from Takeda and Medice.

All remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1341624/full#supplementary-material

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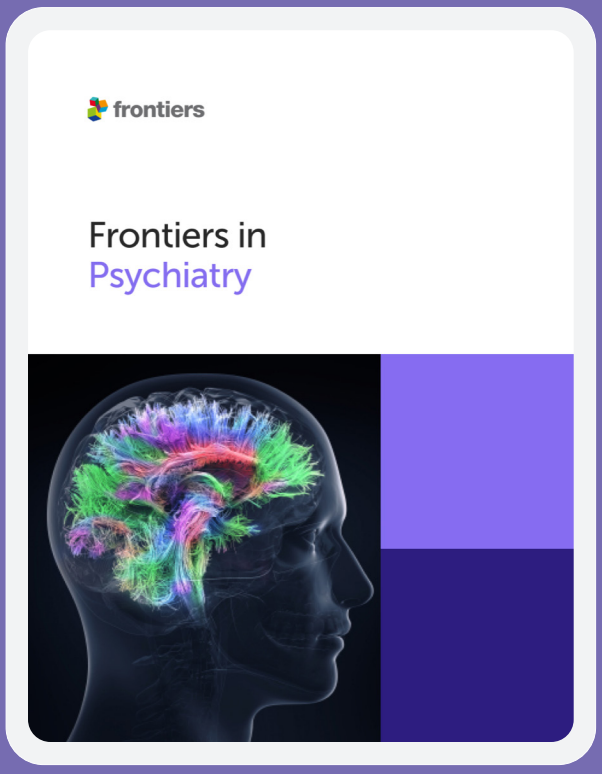

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