

A systematic Review of the Impact of Open and Closed Sports Interventions on Executive Function in Individuals with ADHD

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Attention Deficit Hyperactivity Disorder is one of the most common childhood psychiatric disorders, with a global prevalence estimated at 3.4%. In recent years, the impact of physical activity on the executive function (EF) of children, especially those with cognitive impairments, has garnered increasing attention from scholars, leading to a steady stream of research findings. Some scholars have conducted systematic reviews and meta-analyses of such research outcomes. While open motor skills are considered to offer advantages in enhancing EF in typical children, their impact on individuals with ADHD is not yet fully understood. This study aims to explore the impact of closed and open motor skills on the EF and its sub-functions in individuals with ADHD through a systematic review. According to the PRISMA guidelines, a search was conducted across seven databases, including PUBMED, EMBASE, Cochrane Library, for evaluation and analysis. A total of 27 articles were included, comprising 22 articles on interventions involving closed motor skills and 5 articles on interventions involving open motor skills. The results indicate that both closed and open motor skills interventions have a positive impact on the EF of individuals with ADHD. However, the improvement in the sub-function of working memory is relatively weak.

Keywords: attention deficit hyperactivity disorder, executive function, Open skill, Closed skill

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a prevalent childhood neurobehavioral disorder characterised by pervasive and impairing symptoms of inattention, hyperactivity, and impulsivity [1]. The estimated global prevalence of ADHD is 5.29%, making it one of the most common neurodevelopmental disorders in childhood [2]. ADHD is associated with a heightened risk of antisocial behavior, substance abuse, and anxiety in adulthood [3]. Individuals with ADHD not only experience persistent psychological symptoms, but also suffer physical health impacts that should not be overlooked. Epidemiological studies have shown a correlation between childhood ADHD symptoms and female obesity. Obesity can

lead to numerous chronic diseases, which can further jeopardize physical well-being [4]. Individuals with ADHD often experience academic underachievement and poor performance during adolescence due to impairments and inattention [5]. Furthermore, it is important to note that these issues are not limited to the adolescent stage, as some individuals continue to experience symptoms of hyperactivity into adulthood, which can have a significant impact on their daily lives. According to research, many adults with a history of ADHD have lower rates of enrollment and success in higher education and employment compared to the general population [6]. Treatment options for ADHD include both pharmacological and non-pharmacological interventions. Although pharmacological treatments are widely accepted and proven to be effective, their varying degrees of side effects, including severe ones such as hallucinations and other psychiatric symptoms, are a concern. Non-pharmacological interventions, such as behavioral therapy, stimulation therapy, and family therapy, among others [7], are gaining increasing attention among scholars as treatment modalities for individuals with ADHD and their prognostic effects.

Executive function (EF) is considered a prominent deficit in individuals with ADHD and is an important factor affecting their quality of life [8]. It is a critical component of cognitive function and is generally considered to have three main sub-functions: inhibition, cognitive flexibility, and working memory. Physiologically, the cerebellum influences multiple regions of the prefrontal cortex through the thalamus, with separate output pathways affecting both motor function and EF [9]. Research has indicated that physical activity has beneficial effects on cognitive function and EF, and individuals with ADHD can improve their cognitive function through exercise, thereby alleviating symptoms of hyperactivity. Furthermore, studies have shown that acute physical activity has a positive impact on EF and academic performance in individuals with ADHD [10-11]. A recent meta-analysis has demonstrated that chronic physical activity has a positive effect on ADHD, potentially providing a higher level of evidence [12]. Higher levels of physical activity are associated with better EF. School education plays a crucial role in the treatment of individuals with ADHD, as optimizing physical education programs and enriching sports activities can help students alleviate symptoms and improve their academic and behavioral performance.

Which type of exercise better enhances executive function in ADHD patients is unclear. Some studies have shown that different types of exercise have an effect on the enhancement of cognitive function [13]. Motor skills can be categorised into open and closed based on factors such as environmental cognitive demands. OSE are performed in an unrestricted external environment and usually require adaptation to uncertain environmental factors, more cognitive demands as well as higher motor abilities. CSE have relatively stable motor requirements and are characterised by the need for precise technical and motor control. As a result, research in this direction has received more attention. Systematic evaluations and meta-analyses for the general population as well as for athletes have pointed out more support for OSE being more effective in improving cognitive function compared to CSE [14 -15]. In the ADHD population, Xu et al. conducted a systematic review for the effects of physical activity interventions on cognitive functioning in children with ADHD and showed that physical activity interventions can improve cognitive neurological abilities, motor abilities, and so on in children with ADHD [16]. However, the research on this aspect of executive function and its subfunctions and motor skill classification remains a blank area.

While the exploration in this field continues to grow, there is still a lack of in-depth analysis regarding the differential effects of different types of physical activity on the enhancement of EF in individuals with ADHD. The aim of this study is to conduct a systematic review of existing literature and, using open-skill exercises (OSE) and closed-skill exercises (CSE) as categories, explore the differential impact of motor skills on the EF and its subcomponents in individuals with ADHD, as well as the potential influencing factors, in order to objectively evaluate their differences.

2. METHODS

A. Retrieval strategy

This study was conducted as a systematic review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [17]. We first developed a search formula through discussion and searching, and then independently searched the following seven databases back-to-back: PubMed, Embase, Web of Science, APA PsycInfo (via EBSCO), Cochrane Library, China National Knowledge The search results were restricted to English and Chinese and studies from the last decade. Subject terms and free terms were identified for the search such as: (1) population: 'Attention Deficit Disorders with Hyperactivity' OR 'ADHD' (2) intervention: 'Attention Deficit Disorders with Hyperactivity' OR 'ADHD'. (2) intervention: 'Sport' OR 'Physical Activity' (3) outcome: 'Executive Functions' OR 'Inhibitory'. And use 'AND', 'OR' and 'NOT' to search.

B. Inclusion and exclusion criteria

The inclusion and exclusion criteria were established by two researchers based on the PICOS (Population, Intervention, Comparison, Outcome, Study design) principles [18]. The inclusion criteria were as follows: (a) individuals of any age, gender, race/ethnicity, diagnosed by a physician or meeting the criteria for ADHD according to the International Classification of Diseases (ICD) and national psychiatric disorder classification and diagnostic criteria; (b) acute or long-term open-skill or closed-skill motor interventions with moderate or higher intensity. Open-skill exercises (OSE) were defined as those performed in an unrestricted external environment, where the participants could not determine when to perform the motor skill, while closed-skill exercises (CSE) were conducted in a relatively stable environment, allowing participants to autonomously control the pace and use of motor skills; (c) reporting of results measured by neurocognitive tasks using EF, such as the Stroop test and N-back. The exclusion criteria were as follows: (a) comorbid conditions or intellectual disabilities in participants; (b) studies combining other interventions (e.g., exercise combined with nutrition plans and use of electronic devices to assist exercise); (c) based on observational studies; (d) inability to access the full text or lack of data.

C. Data extraction

Two researchers independently screened and extracted the data using EndNote 21 (Bld 19023). The data extraction was based on a table that included basic article information, study type, participant characteristics, intervention features, and outcome indicators. This provided clear data for subsequent comparison and analysis.

D. Quality assessment

The two researchers independently assessed the methodological quality of the included articles using the Physiotherapy Evidence Database (PEDro) scale [19], which has demonstrated good reliability. The PEDro scale consists of 11 items, with a score of 1 for each item met and 0 for each item not met. The scores for each item are summed to obtain a total score, with a maximum score of 10. Scores below 4 indicate low quality, 4-5 indicate fair quality, 6-8 indicate good quality, and 9-10 indicate excellent quality. The scale assesses the methodological quality of included studies from various aspects, including random allocation, concealed allocation, and similarity of groups at baseline.

3. RESULTS

A. Literature Selection Results

The final inclusion comprised 27 articles (Fig 1).

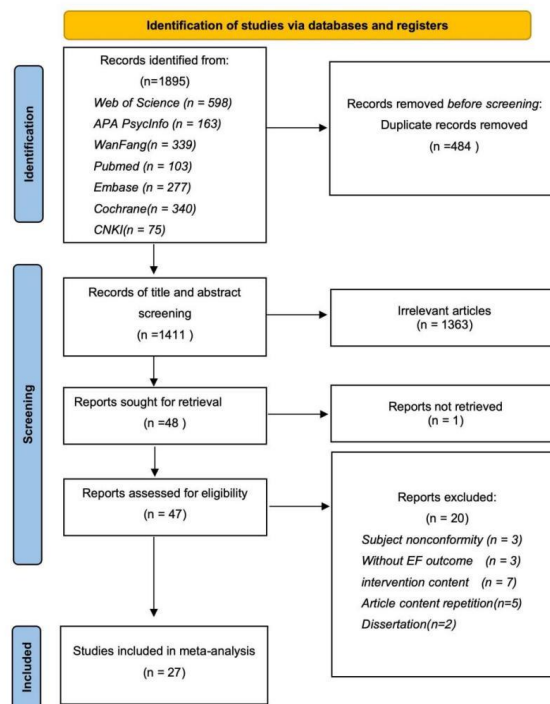


Fig 1

Table 1 Characteristics of included studies.

Study	Country or region	study design	Age Range Sex-M (%)	Sample size IG/CG	Content (skill type)	Frequency	Outcome Measures
Kadri (2019)	Tunisia	RCT	12-18; 90	20/20	Taekwondo ⁰	50-min/2s/78w	IC: SCWT*
Ludyga (2022)	CH/DE	RCT	8-12; 70	29/29	Judo ⁰	60-min/2s/12w	WM: CDPT ⁰⁰

Pan (2016)	Taiwan	RCT	6-12; 10	16/16	Table tennis ⁰	70-min/2s/12w	IC: SCWT*
Pan (2019)	Taiwan	NRS	7-12; 10	15/G1:15, G2:30 ^{TD}	Table tennis ⁰	70-min/2s/12w	IC: SCWT* CF: WCST*
Song (2022)	China	RCT	6.5-8.5; 100	8/G1:8, G2:8 ^{TD}	Football ⁰	60-min/5s/6w	IC: SCWT* CF: TMT* WM: CFT* IC: ST ⁰⁰ CF: TMT ⁰⁰ WM: L3-RMS ⁰⁰ IC: ST*
Bigelow (2021)	Canada	SGRC	10-14; 68	16	Cycling ^C	10-min/1s	CF: TMT ⁰⁰ WM: L3-RMS ⁰⁰ IC: ST*
Chang (2012)	Taiwan	RCT	8-15; 92	20/20	Treadmill ^C	30-min/1s	CF: WCST ⁰⁰
Chang (2014)	Taiwan	NRS	5-10; 85	14/13	Aquatic exercise ^C	90-min/2s/8w	IC: GNG*
Chen (2022)	China	RCT	6-10; 82	32/32	Cycling ^C	20-min/3s/12w	IC: ST* CF: OEST* WM: N-B*
Chou (2017)	Taiwan	NRS	8-12; 68	24/25	Yoga ^C	40-min/2s/8w	IC: DT*
Chuang (2015)	Taiwan	SGRC	8-12; 84	19	Treadmill ^C	30-min/1s	IC: GNG*
Durgut (2020)	Turkey	RCT	7-11; 80	15/15	Treadmill ^C	45-min/3s/8w	IC: ST* IC: FT ⁰⁰ CF: LSWMT ⁰⁰ WM: DCCST ⁰⁰ IC: ST*
Fritz (2022)	America	RCT	18-24; 0	11/16	Yoga ^C	90-min/2s/6w	CF: TMT ⁰⁰ WM: DS ⁰⁰ IC: ST* CF: TSP ⁰⁰ IC: FT* CF: WCST* IC: AX-CPT*
Gapin (2015)	America	Crossover	18-25; 60	20/20 ^{TD}	Treadmill ^C	40-min/1s	IC: FT*
Hattabi (2019)	Tunisia	RCT	9-12; 87	20/20	Swimming ^C	90-min/3s/12w	CF: AUT ⁰⁰
Hung (2016)	Taiwan	SGRC	8-12; 97	34	Treadmill ^C	30-min/1s	IC: GNG*
Jiang (2022)	China	Pre-post	6-10; 52	17	Skipping ^C	30-min/3s/8w	IC: FT*
Kouhbanani (2023)	Iran	RCT	20-50; 0	25/27	Pilates ^C	45-min/3s/24w	IC: AX-CPT*
LaCount (2022)	America	Crossover	18-25; 50	18/18 ^{TD}	Cycling ^C	16-min/1s	IC: FT*
Ludyga (2017)	Switzerland	Crossover	11-16; 61	16/18 ^{TD}	Cycling ^C	20-min/1s	IC: FT*
Ludyga (2020)	Switzerland	Crossover	11-16; 61	16/18 ^{TD}	Cycling ^C	20-min/1s	CF: AUT ⁰⁰
Mehren (2019)	Germany	Crossover	NR; 82	20/20 ^{TD}	Cycling ^C	30-min/1s	IC: GNG*
Pontifex (2013)	America	Crossover	8-10;70	20/20 ^{TD}	Treadmill ^C	20-min/1s	IC: FT*
Silva (2020)	Brazil	RCT	11-14; 70	10/10	Swimming ^C	45-min/2s/8w	CF: TT* IC: ST ⁰⁰ WM: CBT ⁰⁰ IC: ST* CF: OEST* WM: N-B*
Skalski (2021)	Poland	RCT	9-15; 81	G ¹ (30/30 ^{TD}) G ² (30/30 ^{TD})	Swimming ^C	45-min/1s/10w	IC: FT*
Wu (2023)	China	RCT	NR; 66	42/41	Cycling ^C	20-min/3s/12w	IC: FT*
Yu (2020)	Taiwan	Pre-post	8-12; 95	24	Treadmill ^C	30-min/1s	IC: FT*

Note: RCT=Randomized Control Trial, NRS=Non-Randomized Studies, SGRC= Single-Group Randomized Crossovers, M=Male, NR=No Report, TD= Typically Developing, O=OSE, C=CSE, S=Session, W=Week, IC=Inhibitory Control, CF=Cognitive Flexibility, WM=Working Memory, ST=Stroop Test, CDPT=Change Detection Paradigm Test, WCST=Wisconsin Card Sorting Test, CFT= Complex Figure test, TMT=Trail Making Test, L3-RMS= Leiter-3 Reverse Memory Subscale, GNG=Go No Go, OEST=Odd Even Size Test, N-B=N-black Test, DT=Determination Test, FT=Flanker Task, LSWMT=List Sorting Working Memory Test, DCCST=Dimensional Change Card Sort Test, DS= Digit Span Test, TSP= Task Switching Paradigm, AX-CPT= AX-Continuous Performance Test, AUT= Alternate Uses Task, TT=Trails Test, CBT= Corsi Block-Tapping Test,

*= significant statistical improvement, 00: no statistically significant change

B. Characteristics of Included Studies

Of the included studies, 5 were open motor skills interventions [21-25] and 22 were closed motor skills interventions [26-47]. A total of 1080 subjects were included in the trials. There was a slightly higher proportion of males, 55% of the total subjects, 603 in total. The number of subjects lost or withdrawn was reported in 12 of the 27 included articles, total 57 (52 for the CSE and 5 for the OSE), with a loss rate of 5% [22; 28; 30; 33; 36; 38-42; 44; 47]. (Table 1).

C. Methodological quality of included studies

The 27 studies included in this analysis were interventional studies, and their methodological quality was evaluated using the PEDro scale. The results showed an average score of 5.6, with a range of 4-7. The quality assessment revealed an average score of 6.2 for open-skill motor intervention studies and 5.5 for closed-skill motor intervention studies (Table 2).

Table 2 Physiotherapy Evidence Database (PEDro) scale

Study	1	2	3	4	5	6	7	8	9	10	11	Total
Kadri (2019)	√	√		√				√	√	√	√	6
Ludyga (2022)	√	√	√	√			√	√	√	√	√	8
Pan (2016)	√	√		√				√	√	√	√	6
Pan (2019)	√			√				√	√	√	√	5
Song (2022)	√	√		√				√	√	√	√	6
Bigelow (2021)	√	√		√				√	√	√	√	6
Chang (2012)	√	√						√	√	√	√	5
Chang (2014)	√							√	√	√	√	4
Chen (2022)	√	√	√	√				√	√	√	√	7
Chou (2017)	√			√				√	√	√	√	5
Chuang (2015)	√	√		√				√	√	√	√	6
Durgut (2020)	√	√	√	√			√	√	√	√	√	8
Fritz (2022)	√	√	√	√					√	√	√	6
Gapin (2015)	√	√		√				√	√	√	√	6
Hattabi (2019)	√	√	√	√				√	√	√	√	7

Hung (2016)	√		√		√	√	√	√	5
Jiang (2022)	√		√		√	√	√	√	5
Kouhbanani (2023)	√	√	√		√	√	√	√	6
LaCount (2022)	√	√	√		√	√	√	√	6
Ludyga (2017)	√	√	√		√	√	√	√	6
Ludyga (2020)	√	√	√	√	√	√	√	√	7
Mehren (2019)	√		√		√	√	√	√	5
Pontifex (2013)	√	√	√		√	√	√	√	6
Silva (2020)	√	√	√			√	√	√	5
Skalski(2021)	√	√	√		√	√	√	√	6
Wu (2023)	√	√	√		√	√	√	√	6
Yu (2020)	√		√			√	√	√	4

D. Study findings

Intervention program

The included interventions were conducted in various settings, with 13 studies taking place in laboratory environments, 11 in community settings, 2 in schools, and 1 in a home setting. In the open-skill motor intervention studies, the interventions were predominantly conducted in community or school settings. Open-skill motor interventions are generally less common in laboratory settings due to the need for larger spaces and facilities, as well as personnel. However, such interventions are more conducive to the integration of ADHD patients into social and educational environments and are more beneficial for improving social and other functional aspects. For instance, Kadri et al. conducted a study on the impact of taekwondo on the EF of adolescents, with the intervention lasting up to one and a half years. The study demonstrated a large effect size ($ES = 2.16$; $P < 0.001$) and no dropouts, indicating strong compliance [21]. Open-skill motor interventions may enhance the natural reward mechanisms of participants, potentially improving compliance [48]. About CSE, Jiang et al. conducted a 24-week study in a home setting, with participants engaging in moderate-intensity jump rope exercises three times a week for 30 minutes each session, showing significant improvement in inhibitory function. This type of intervention is more practical, simpler to implement, and yielded significant improvements.

Additionally, a study by Bigelow et al. had the shortest intervention duration, and its results showed no significant differences. A 10-minute moderate-intensity exercise was not sufficient to improve EF in ADHD patients. However, it is worth noting that in the study by LaCount et al., when the duration was extended to 16 minutes, significant improvements were observed, possibly related to the nature of the intervention. Their study examined the impact of 16 minutes of high-intensity interval training (HIIT) on the EF of adults with ADHD [39].

Inhibitory control

The article reviewed 22 studies on inhibitory function, which accounted for 81% of the total. Of the four studies that investigated the enhancing effect of OSE intervention on inhibitory function, all showed significant improvement. Notably, Pan et al. conducted a 12-week table tennis intervention study on the impact of inhibitory function in children with ADHD, using a

crossover design. The follow-up results for the first group after 12 weeks showed continued improvement, albeit lower than the post-assessment, but still significant compared to the pre-assessment [23]. Eighteen studies examined the intervention effects of CSE, with 14 studies supporting significant improvement. The improvement was evident in various aspects. Chou et al.'s study indicates a significant improvement in the accuracy of the Determination test for ADHD adolescents after an 8-week yoga intervention. This reflects the participants' ability to effectively inhibit distracting information when faced with interference stimuli. Chuang et al.'s study showed a significant improvement in reaction time in the Go/No Go test after a single 30-minute acute treadmill intervention. This reflects the participants' ability to make correct decisions quickly when needing to inhibit responses [30; 31]. However, four studies did not find any improvement effect, two of which involved adult participants. Fritz et al. conducted a 6-week yoga intervention for ADHD patients aged 18-24, while Mehren et al. conducted a 30-minute acute intervention for ADHD patients with an average age of 31.4 ± 9.6 . Although the results showed some regulatory effects on EF, they did not reach statistical significance [33; 42]. However, LaCount et al.'s study showed a significant effect of high-intensity interval training (HIIT) on the enhancement of inhibitory function. This may be due to the high-intensity intermittent aerobic load, which leads to increased arousal levels in ADHD patients, resulting in significant improvement in inhibitory function after a single acute intervention [49].

Cognitive flexibility

Research on cognitive flexibility comprises 12 studies, accounting for 44% of the total. Both studies indicate that OSE has a significant enhancing effect on cognitive flexibility. In Pan's study, the control group, which only participated in school physical education classes, also showed some improvement. Physical education in schools is an important treatment for individuals with ADHD and requires greater attention. Six studies on CSE found no improvement in cognitive flexibility, of which five were acute interventions and one was a yoga exercise intervention for adult subjects. Four studies indicated a significant enhancing effect of chronic interventions, with durations ranging from 8 to 24 weeks. Kouhbanani et al. investigated the impact of a 24-week Pilates intervention on cognitive flexibility in adults with ADHD. The results showed a significant improvement. However, the follow-up assessment six months after the intervention revealed that the effect had decreased to the level of the pre-assessment.

Working memory

There were eight studies on working memory (29%). Ludyga et al. investigated the effect of a 24-week, 60-minute, twice-weekly judo intervention on working memory in children with ADHD and showed an increase in the number of items that could be retained in visuospatial working memory, but there was no significant difference. Increased CDA negativity under high load at the neurocognitive level is a positive sign and can be significantly improved by extending the intervention period [22]. Song et al. investigated the effects of a 6-week, 5 x weekly soccer intervention on working memory in children with ADHD with both a short but frequent intervention period and a single 60-minute intervention period, and showed that the immediate structure and detail scores of the experimental group increased significantly ($P < 0.05$), but the delayed structure and detail scores did not change significantly ($P > 0.05$).

[25]. OSE interventions typically involve high cognitive load and require continuous reception of feedback from the environment and the body, as well as prompt responses. They have a relatively weak impact on working memory. Two studies of CSE interventions have supported the efficacy of CSE interventions in improving working memory in ADHD patients. The research protocols of Chen et al. and Wu et al. are similar. Both studies lasted for at least 12 weeks, with interventions occurring three times a week and each session lasting 20 minutes. Four CSE studies suggest that it does not enhance working memory subfunctions. Two of the studies were chronic interventions, and the other two were acute interventions. Fritz et al. conducted a 6-week study with a frequency of two sessions per week, involving adult ADHD patients [33]. Skalski et al. conducted a 10-week study with an intervention frequency of only once a week, resulting in minimal impact on EF [45].

The studies above have demonstrated that both OSE and CSE have a positive impact on inhibitory function. The OSE study showed that a longer intervention period resulted in a more significant enhancement and higher compliance. On the other hand, CSE is advantageous due to its short duration and ease of operation, making it more feasible for incorporating into daily life. Both the OSE and CSE studies found significant differences in cognitive flexibility only with chronic intervention. The study found a significant enhancement in adult subjects. However, the results for the working memory subfunction were contradictory. The OSE study only found a boost in immediate memory, while the CSE study suggested that a 12-week intervention cycle, with a frequency of two interventions per week and an intervention duration of 20 minutes, significantly improved working memory in children and adolescents with ADHD.

4. DISCUSSION

This study analysed the impact of various interventions for motor skill OSE and CSE on executive functioning in patients with ADHD. A total of 27 articles were reviewed, and the results indicated that OSE and CSE interventions had a positive effect on ADHD patients of different ages and sub-functions.

Exercise may improve the EF of patients through several potential mechanisms. It has been found that exercise is effective in improving the function of the autonomic nervous system, which in turn affects heart rate variability (HRV). The HRV of patients with ADHD mainly shows low variability, which may be related to difficulties in emotion regulation and excessive stress responses [50]. However, some studies suggest that exercise can improve the brains of ADHD patients, as shown by brain imaging techniques such as electroencephalography after exercise interventions. ADHD patients have certain deficiencies in brain development compared to normal individuals, particularly in the neurotransmitter system, prefrontal cortex, and cerebral connectivity [51]. Research has shown that aerobic exercise can improve the response of the right prefrontal cortex in patients with ADHD [52]. Jiang et al.'s study found significant differences in the subjects' medial superior frontal gyrus, left superior frontal gyrus, left middle frontal gyrus, and right anterior cerebellar lobe after exercise [37]. Research has studied the effects of OSE and CSE on executive functioning in typically developing children. The effect of OSE on EF appears to be more pronounced, which may be attributed to the greater cognitive load and need for external information required in performing OSE

interventions [53]. However, ADHD may require longer interventions to adapt due to lower cognitive and motor function. The mechanisms still require further study and clarification.

Research has demonstrated that individuals with ADHD often experience significant deficits in their motor abilities when compared to typically developing children. In fact, the majority of individuals with ADHD exhibit motor difficulties that are consistent with developmental coordination disorder [51]. As a result, they may face challenges when participating in physical activities and physical education class. However, Pan et al. found in their study that a Physical education class improved executive functioning in both ADHD patients and a control group of typically developing children [24]. Therefore, with appropriate support and measures, school sports can be a beneficial opportunity for people with ADHD to participate in sports activities, which can enhance EF and improve ADHD symptoms. Pontifex et al. found that exercise improved executive functioning and academic performance in ADHD patients [43]. Further research that takes into account patients' daily lives and education may be needed to develop effective exercise programmes for the treatment of ADHD.

Despite some evidence of effectiveness, there are still limitations to our study that should be interpreted with caution. The number of original studies is not yet sufficient, and there is a lack of comparisons of intervention effects for OSE and CSE, as well as a lack of original studies directly comparing interventions in ADHD populations. Regarding the enhancement of EF, the studies we included showed improvement only in inhibitory function with acute intervention, and not in the other two subfunctions. Studies have not demonstrated the dose required to significantly improve cognitive flexibility and working memory, indicating the need for further research. There were fewer studies on working memory across the EF subfunctions. Only three studies supported a significant enhancement of working memory in ADHD patients with exercise. Further original research may be needed to support this idea. Future studies should explore the potential therapeutic effects and real-life possibilities of different physical activities for ADHD patients. Direct comparisons are needed in motor skill classification. Further research is required for intervention programmes, including those related to frequency, period, duration, and other relevant factors.

5. CONCLUSION

The results indicate that both closed and open motor skills interventions have a positive impact on the EF of individuals with ADHD. However, the improvement in the sub-function of working memory is relatively weak.

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