

Martial arts as complementary interventions to support ADHD-related symptom control

Sztuki walki jako uzupełniające interwencje wspierające kontrolę objawów związanych z ADHD

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Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental condition that has a significant impact on daily functioning in various areas of life. While pharmacology is the primary treatment, non-pharmacological interventions such as structured physical activities, particularly martial arts, are gaining prominence. This review evaluates the effectiveness of martial arts as a supportive intervention in ADHD. In addition, through this review, we aim to suggest possible approaches for future research in this area. Current results from randomized controlled clinical trials indicate that martial arts training can positively affect ADHD-related symptoms by improving visuospatial working memory, selective attention, inhibitory control, and processing speed. The results suggest that martial arts could potentially serve as a complementary intervention for ADHD, however, at this moment the body of research supporting this thesis is insufficient. We highlight the necessity for further research to strengthen current evidence, increase knowledge of additional potential benefits, standardize protocols, and optimize training methodologies.

Keywords: ADHD, martial arts, non-pharmacological intervention, judo, tai chi, taekwondo

Streszczenie

Zespół nadpobudliwości psychoruchowej z deficytem uwagi (ADHD) jest zaburzeniem neurorozwojowym, mającym znaczący wpływ na codzienne funkcjonowanie w różnych obszarach życia. Podczas gdy farmakologia stanowi podstawę leczenia, interwencje niefarmakologiczne, takie jak ustrukturyzowane aktywności fizyczne, w szczególności sztuki walki, zyskują na znaczeniu. Niniejszy przegląd ocenia skuteczność sztuk walki jako interwencji wspierającej w ADHD. Ponadto, za pośrednictwem tego przeglądu, chcemy zaproponować możliwe podejścia do przyszłych badań w tym obszarze. Obecne wyniki randomizowanych kontrolnych badań klinicznych wskazują, że trening sztuk walki mogą pozytywnie wpływać na objawy związane z ADHD, poprawiając wizualno-przestrzenną pamięć roboczą, selektywną uwagę, kontrolę hamowania i szybkość przetwarzania. Wyniki sugerują, że sztuki walki mogłyby potencjalnie służyć jako uzupełniająca interwencja w przypadku ADHD, jednak w tej chwili liczba badań potwierdzających tę tezę jest niewystarczająca. Zwracamy uwagę, na konieczność przeprowadzenia dalszych badań w celu umocnienia aktualnych dowodów, poszerzenia wiedzy na temat dodatkowych potencjalnych korzyści, standaryzacji protokołów i optymalizacji metodologii treningowych.

Słowa kluczowe: ADHD, sztuki walki, interwencja niefarmakologiczna, judo, tai chi, taekwondo

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is widely recognized as one of the most common neurodevelopmental conditions [1]. ADHD is highly heritable, with most estimates placing its heritability between 70% and 80% [2]. A 2023 meta-analysis focused on children and adolescents reported that ADHD was diagnosed in 7.6% of children aged 3 to 12 years, and 5.6% of teenagers aged 12 to 18 [3]. A most recent 2024 meta-analysis highlights that the prevalence of ADHD across children, adolescents, and adults varies depending on the study type. Register studies reported a prevalence rate of 1.6%, survey studies 5.0%, one-stage clinical studies 4.2%, and two-stage clinical studies 4.8% [4].

ADHD is clinically classified into three presentations based on the predominant symptomatology: primarily inattentive, primarily hyperactive-impulsive, and the combined presentation [5]. Recent meta-analyses indicate that emotional dysregulation, emotional lability, and maladaptive emotional responses are significant contributors to the psychopathology of ADHD among adolescents [6] and adults [7]. Moreover, it has been observed that hyperactive-impulsive symptoms are more strongly associated with social

challenges, including peer rejection, aggressive behavior, risky driving, and accidental injuries. In contrast, inattention has been more closely linked to academic difficulties, low self-esteem, poor occupational outcomes, and diminished overall adaptive functioning. Furthermore, patterns of comorbid disorders vary depending on the symptoms presented [8]. Across many studies, ADHD has been associated with comorbid anxiety disorders, depression, bipolar disorder, autism spectrum disorder (ASD), and substance use disorder [9, 10, 11, 12, 13, 14, 15].

It is reported that children with ADHD experience challenges in executive functioning, including worse performance in attention, flexibility, visuospatial abilities, working memory, processing speed, and response inhibition, compared to typically developing individuals [16]. Moreover, deficits in working memory are considered to be a particularly strong predictor of long-term outcomes, including severity of symptoms of ADHD [17, 41]. Poor performance on working memory tasks has been linked to an increased risk of grade retention, placement in special education programs, and difficulties with organizational skills, reading comprehension, and mathematics [18, 19, 41]. On the other hand, some visuospatial working memory components are associated with academic success across many different fields of study, ranging from some math abilities [20] to language acquisition [21]. Furthermore, according to the study by Bejerot et al., being diagnosed with ADHD and having poor motor skills, which is a feature commonly associated with ADHD, was strongly associated with bully victimization [22].

Another aspect of inattention and poor cognitive performance in ADHD might be connected to deficient regulation of the default mode network (DMN), which leads to excessive, spontaneous mind wandering [1]. The DMN reflects a network of interacting brain regions (i.e. medial prefrontal cortex, posterior cingulate cortex, and medial temporal regions) that show correlated neural activation that is most active in the resting state, when a typically developed person is awake but in a daydreaming or mind wandering state [1]. However, in ADHD, the DMN may contribute to increased distractibility, possibly due to difficulties in regulating attentional resources [23]. In ADHD, studies show a weakened anti-correlation between the executive control- fronto-parietal network (FPN) and the DMN, along with reduced resting-state connectivity within the DMN itself [1, 24]. Additionally, ADHD is characterized by hyperactivation, or insufficient deactivation, of the DMN during task conditions compared to resting states [1, 25, 26, 27, 28]. Research also points to abnormal interactions between the DMN and the salience network [29], which facilitates switching between the FPN and DMN [30, 31]. These findings suggest

that the DMN, along with its role in mind-wandering, may interfere with the ability of attentional networks to sustain outward-focused attention [23, 29].

Martial arts have gained global popularity for promoting physical fitness and mental discipline as a mind-body practice [32]. Recent research suggests that martial arts training offers cognitive benefits beyond its physical advantages, particularly in enhancing attention and executive functioning [32]. Moreover, martial arts training often incorporates mindfulness practices, such as meditation and deep breathing exercises. These techniques have been shown to enhance attentional control and reduce mind-wandering [32, 33]. Some recent findings suggest that martial arts-based meditation modulates negative self-referential processing associated with the DMN and may have implications for the management of negative emotions [34]. Several other studies investigated the influence of Tai Chi on DMN, reporting enhancement of DMN functional connectivity (FC) after Tai Chi sessions [35, 36, 37, 38, 39]. Furthermore, neuroimaging research has shown that children who train judo develop greater gray matter density and stronger white matter connections in critical cognitive networks, particularly the FPN and corpus callosum [40, 41, 44] which have been linked to enhanced working memory abilities [42, 43, 44].

In this paper, we aim to review the current body of research examining the efficacy of martial arts as supportive interventions for managing symptoms connected to ADHD and to identify possible future strategies for research.

2. Methods

To identify relevant studies, we conducted a systematic search using the PubMed database. The search was conducted in December 2024, and articles published from 2019 to 2024 were considered. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords related to the research topic, the following terms were used: “attention deficit disorder with hyperactivity”, “ADHD” and “martial arts”. The Boolean operator such as AND was applied to refine the search. Further, we screened the reference lists of selected articles for additional relevant studies. All identified articles were screened by title and abstract, followed by full-text reviews to assess their eligibility based on predefined criteria. The inclusion criteria were as follows: (1) studies focusing on ADHD in children, adolescents, or adults; (2) studies on martial arts; (3) randomized controlled trials (RCT) published in English. In total, we identified 15 articles, of which only 4 met the inclusion criteria. However, one study was excluded due to duplicate content, leading to the inclusion of 3 articles in this review.

3. Results

The findings of this review are categorized into several domains, including an analysis of studies on judo, taekwondo (TKD), and Tai Chi. All relevant information is summarized in the tables below.

Table 1. Analysis of demographic and inclusion/exclusion criteria.

Study	Participants at baseline	Analyzed participants	Inclusion criteria	Exclusion criteria
Ludyga et al., 2022	63 children with ADHD 8-12 y/o • JTG n=31 • control group n=32	n=57 • JTG n=29 • (23 males, 6 females) • control group n=28 (18 males, 10 females)	• ADHD diagnosis • 8-12 y/o • right handed • corrected-to or normal vision • pharmacotherapy with D-MPH/ MPH for at least 3 months prior to the intervention	• participation once a week in martial arts 3 months prior • dosage changes MPH/ D-MPH within month prior • additional therapy • -ASD and/or structural epilepsy • injuries or diseases affecting the functionality of the right hand • chronic disease classified as contraindication for exercise
Kadri et al., 2019	40 adolescents with ADHD (36 males, 4 females) 14.35 ± 3.26 y/o • TKD group n=20 • control group n=20	no information on changes in the number of participants analyzed	• ADHD diagnosis • regular eating patterns • abstinence from strenuous exercise 48 h before testing	• consumption of dietary supplements/drugs • history of chronic illnesses, bronchospasm, allergic conditions • history of respiratory infections within month prior to • history of using medications that alter HPG axis • color blindness or visual impairments
Converse et al., 2020	21 adults with ADHD (14 females, 7 males) 18–23 y/o • Tai Chi group n=9 • active control n=5 • inactive control n=7	n=19 • Tai Chi group n=9 active • control n=4 • inactive control n=6	• ADHD diagnosis • current student in the UW-Madison McBurney Disability Resources Center	
ADHD- Attention Deficit Hyperactivity Disorder; JTG- judo training group; n- number; TKD- taekwondo; y/o- years old;				

Table 2. Analysis of applied interventions.

Study	Intervention in study group	Intervention in control group
Ludyga et al., 2022	Judo training, 60-min sessions, twice a week for 3 months alongside pharmacological treatment	wait-list control: no physical activity intervention, pharmacological treatment
Kadri et al., 2019	Taekwondo training, 50-min sessions, twice a week for 18 months	athletics, handball and gymnastics, twice a week for 18 months
Converse et al., 2020	Tai Chi training, 60-min sessions, twice a week for 7-weeks *16/21 participants used the pharmacological treatment, n/s to which group they belonged	active control: non-contact kick-boxing for cardio-aerobic fitness inactive control: no additional intervention *16/21 participants used the pharmacological treatment, n/s to which group they belonged
n/s- not specified		

Table 3. Efficacy of martial arts as supportive intervention in ADHD.

Study	Assessment	Study group compared to control group at follow-up
Ludyga et al., 2022	Change Detection task	↑ K-score (p = 0.030) ↔ Reaction time in milliseconds
	EEG	↑ CDA high load in μV (p = 0.043) ↔ CDA low load in μV
	MABC-2	↔ motor skills
Kadri et al., 2019	Ruff 2 and 7 Test	↑ Controlled search trials (p = 0.005) ↑ Automatic detection trials (p = 0.037) ↔ Total speed trials in seconds
	Stroop Color-Word Test	↑ Word Test (p = 0.028) ↔ Color Block Test, Color-Word Interference Test, Interference, Error
Converse et al., 2020	CAARS-S:L	No statistical follow- up analysis * The study focused on evaluating recruitment and retention rates to guide the planning of a larger RCT.
	FFMQ	
	SF-36	
	Postural Stability	
	Begin Cardiac Recording	
	Flanker Test	
	Change Card Sort test	
	GRE Verbal Reasoning Excerpt	
	PSQI	
ADHD self-report CAARS-S:L- Conners' Adult ADHD Rating Scales–Self-Report: Long Version; CDA- Contralateral delay activity; EEG- electroencephalography; FFMQ- The Five Facet Mindfulness Questionnaire; GRE- Graduate Record Exam; MABC-2- Movement Assessment Battery for Children-2; PSQI - Pittsburgh Sleep Quality Index; RCT- randomized controlled trial; SF-36 - Short Form Health Survey;		

3.1 Efficacy of Judo in individuals with ADHD

The study by Ludyga et al., investigated the effects of a judo training program on motor skills and working memory capacity in children with ADHD. Recognizing that working memory deficits are one of the core features of ADHD, this research examined whether structured physical activity, such as judo, could enhance cognitive functioning and improve motor skills. It has been suggested that judo training, due to its requiring motor skill acquisition and visuospatial attention, may provide unique cognitive benefits compared to other exercise forms [44].

Behavioral assessments included a Change Detection task to measure visuospatial working memory and the Movement Assessment Battery for Children-2 (MABC-2) to evaluate motor skills. Electroencephalographic recordings during the Change Detection task were used to capture contralateral delay activity (CDA), which is a neural marker of working memory capacity [44].

The results indicated significant improvements ($p \leq 0.05$) in the judo group, with higher K-scores on the Change Detection task and increased CDA negativity under high working memory load conditions compared to the wait-list control group [44]. These findings suggest the enhanced maintenance of visuospatial information. However, no significant differences in motor skill development were observed between the groups [44].

3.2 Efficacy of Taekwondo in individuals with ADHD

The study by Kadri et al., investigated effects of a TKD training program on cognitive attention in adolescents with ADHD. Cognitive function was assessed before and after the intervention using two standardized tests: the Stroop Color-Word Test for measuring attentional inhibitory control and the Ruff 2 and 7 Test for measuring sustained and selective visual attention [45].

The results showed that adolescents in the TKD group demonstrated significant improvements in all cognitive measures, however, the active control group also demonstrated significant results [45]. Nevertheless, the TKD group showed significantly better outcomes ($p < 0.05$) in Controlled Search Trials (Ruff 2 and 7 test), Automatic Detection Trials (Ruff 2 and 7 test) and Word Test (Stroop test) which may indicate better improvement in selective attention, sustained attention and processing speed compared to active control group [45].

3.3 Efficacy of Tai Chi in individuals with ADHD

The study by Converse et al. explored the feasibility of using Tai Chi as a complementary therapy for ADHD in college students. The main goal of this study was to evaluate the practicality of enrolling and keeping college students with ADHD in a trial, to prepare for a larger, more definitive RCT. Therefore, no statistical follow-up analysis was conducted and only some correlations were noted [46].

Primary outcomes assessed ADHD symptoms using the Conners Adult ADHD Rating Scale, while secondary measures evaluated mindfulness using the Five Facet Mindfulness Questionnaire (FFMQ, “Acting with Awareness” subscale); sleep quality using the Pittsburgh Sleep Quality Index (PSQI); cognitive function using: Flanker Test- assessed attention and inhibitory control, Dimensional Change Card Sort Test- measured executive function, Graduate Record Exam (GRE) Verbal Reasoning- evaluated verbal reasoning ability; general health & well-being using the Short Form Health Survey (SF-36); physical measures- heart rate; and postural stability- balance assessment [46].

Findings in the study by Converse et al. indicated a high retention rate of 90%, suggesting that college students are open to non-traditional interventions, however, scheduling conflicts resulted in low adherence in the Tai Chi group [46]. Interestingly, at baseline, those participants who reported higher symptom levels on Conners Adult ADHD Rating Scale, DSM IV inattention scale, reported significantly lower levels of the “Acting with awareness” subscale of the FFMQ ($p < 0.001$ uncorrected, $p < 0.05$ corrected for multiple comparisons) [46].

4. Discussion

Studies analyzed suggest that martial arts might have a positive impact on cognitive functioning in individuals with ADHD [44, 45, 46]. Studies by Kadri et al. and Ludyga et al. concluded that TKD and judo may enhance cognitive performance by improving selective attention, sustained attention, processing speed [45] and visuospatial working memory [44] in individuals with ADHD. These findings suggest that martial arts could serve as a valuable complement to pharmacological treatment by targeting cognitive deficits, which supports the integration of structured exercise programs like judo and TKD into ADHD treatment plans. While these results are promising, the limited number of well-designed RCTs does not allow drawing definitive conclusions. In the study by Converse et al., the baseline correlations linked lower mindfulness to greater inattention, supporting the idea that Tai Chi, as a mindful technique, may help in alleviating ADHD symp-

toms [46]. Moreover, the study suggests possible assessment tools that could be applied to evaluate the efficacy of martial arts as an additional intervention in ADHD [46]. Furthermore, we agree with the conclusions drawn by the authors of the study by Ludyga et al. that the effect of judo on motor skills should be reevaluated using a different scale than the MABC-2 battery. Since this set of tasks evaluates fine and gross motor skills, it might not adequately capture skill refinements more specific to judo [44]. Future research on the utility of martial arts in ADHD should also investigate their effects on FC, as previous research reported their influence on FC in other conditions [35, 36, 37, 38] and in healthy individuals [39, 40, 41, 44]. Lastly, future RCTs should also study other popular and widely available martial arts such as jiu-jitsu, karate, examine if any type of martial art is most effective and investigate whether the type of presentation of ADHD symptoms affects the outcomes.

5. Conclusions

The findings of this review suggest that martial arts training may be a promising complementary approach to managing ADHD symptoms. Improvements in selective attention, sustained attention, processing speed and visuospatial working memory observed in participants highlight the potential benefits of structured physical activity in ADHD treatment. The emphasis on discipline, repetitive practice, and self-awareness in martial arts aligns well with strategies aimed at enhancing cognitive control in individuals with ADHD. Yet, the strength of evidence is still insufficient, due to the lack of more well-designed RCTs. More rigorous research, with larger sample sizes, is necessary to establish clear guidelines on the frequency, duration, and type of martial arts training best suited for managing ADHD symptoms. Future studies should explore the long-term effects of martial arts practice, its integration with other therapeutic interventions, and its influence on the core ADHD traits (inattentiveness, hyperactivity, impulsivity, emotional lability) and FC. Moreover, it would be valuable to evaluate how different martial arts impact mindfulness, postural stability, sleep quality, verbal reasoning, physical health and executive function in individuals with ADHD. While martial arts may offer benefits, their role should be considered as part of a broader, individualized ADHD treatment plan rather than a standalone solution.

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List of abbreviations:

ADHD (Attention Deficit Hyperactivity Disorder); **ADHD self-report CAARS-S:L** (Conners' Adult ADHD Rating Scales–Self-Report: Long Version); **ASD** (Autism Spectrum Disorder); **CDA** (contralateral delay activity); **DMN** (Default Mode Network); **EEG** (electroencephalography); **FC** (functional connectivity); **FFMQ** (The Five Facet Mindfulness Questionnaire); **FPN** (fronto-parietal network); **GRE** (Graduate Record Exam); **JTG** (judo training group); **MABC-2** (Movement Assessment Battery for Children-2); **n** (number); **n/s** (not specified); **PSQI** (Pittsburgh Sleep Quality Index); **RCT** (randomized controlled trials); **SF-36** (Short Form Health Survey); **TKD** (taekwondo); **y/o** (years old).

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