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Original Article

Clinical efficacy of osmotic release oral system methylphenidate combined with electroencephalographic biofeedback and sensory integration training in children with attention deficit hyperactivity disorder

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Abstract: Objective: To evaluate the clinical efficacy of osmotic release oral system methylphenidate (OROS-MPH) combined with electroencephalographic (EEG) biofeedback and sensory integration training in children with attention deficit hyperactivity disorder (ADHD). Methods: This retrospective study included 98 children diagnosed with ADHD who were treated at Longquanyi District of Chengdu Maternity & Child Health Care Hospital between January 2023 and January 2025. Based on treatment modality, 53 patients received OROS-MPH alone (control group), while 45 received additional EEG biofeedback and sensory integration training (observation group). The intervention period was 12 weeks. Clinical outcomes were assessed using the Swanson, Nolan, and Pelham IV Scale (SNAP-IV), Conners' Parent Rating Scale (CPRS-48), and the China-Wechsler Intelligence Scale for Children (C-WISC). Physiological indices included EEG wave frequencies (θ, β, SMR), cerebral blood flow velocities, and plasma levels of adrenocorticotropic hormone (ACTH), cortisol, norepinephrine (NE), and dopamine (DA). Adverse events were recorded. Results: After intervention, the observation group showed significantly greater reductions in SNAP-IV and CPRS-48 scores, and greater increases in all C-WISC indices compared with the control group ($P < 0.05$). EEG results showed elevated β and SMR and reduced *θ* activity. Cerebral blood flow velocities improved more significantly in the observation group. Neuroendocrine markers showed decreased ACTH and elevated cortisol, NE, and DA levels in both groups, with more pronounced changes in the observation group ($P < 0.05$). No serious adverse effects were reported. Conclusion: Multimodal therapy combining OROS-MPH with EEG biofeedback and sensory integration training demonstrates superior efficacy over medication alone in improving behavioral symptoms, cognitive function, and neurophysiological parameters in children with ADHD.

Keywords: Attention deficit hyperactivity disorder, osmotic release oral system methylphenidate, electroencephalographic biofeedback, sensory integration training, multimodal intervention

Introduction

Attention deficit hyperactivity disorder (ADHD) is a childhood-onset neurodevelopmental disorder characterized by persistent inattention, hyperactivity, and impulsivity [1]. Affecting approximately 5-7% of children worldwide, ADHD has shown an increasing prevalence in recent years and is associated with significant impairments in academic performance, social functioning, and emotional regulation. ADHD may also predispose affected individuals to psychiatric comorbidities and functional impairments in adulthood [2]. Early interventions aimed at symptom relief and functional improvement are therefore of critical clinical and societal importance.

Pharmacotherapy remains the mainstay of ADHD management [3]. Osmotic release oral

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system methylphenidate (OROS-MPH), a central nervous system stimulant, exerts its therapeutic effects by inhibiting dopamine (DA) and norepinephrine (NE) reuptake, thereby enhancing catecholaminergic transmission in the prefrontal cortex to improve attention, behavioral inhibition, and executive functioning [4]. Numerous studies have demonstrated that OROS-MPH rapidly alleviates core ADHD symptoms and improves classroom behavior and academic performance, leading to its recommendation as a first-line treatment in clinical guidelines [5, 6]. Nonetheless, pharmacological treatment alone presents several limitations. Some patients exhibit suboptimal responses or experience adverse effects such as appetite suppression, insomnia, and anxiety, which may compromise adherence and quality of life [7]. More critically, medication primarily addresses overt behavioral symptoms while failing to fully resolve neurocognitive deficits such as executive dysfunction, impaired social cognition, and emotional dysregulation, all of which are closely related to long-term outcomes. Symptom rebound upon medication discontinuation also underscores the need for more comprehensive, multimodal treatment strategies [8, 9].

Electroencephalographic (EEG) biofeedback, grounded in neuroplasticity principles, is a non-pharmacological approach that provides real-time feedback of brainwave activity, enabling individuals to voluntarily regulate neural patterns to enhance sustained attention and self-regulation [10, 11]. Meanwhile, sensory integration training delivers structured multisensory stimulation via vestibular, proprioceptive, and tactile pathways, facilitating higher-order sensory integration and neurodevelopment, ultimately improving emotional control, motor coordination, and social adaptability in children with ADHD [12].

In theory, pharmacotherapy offers rapid symptomatic control, establishing a neurophysiological baseline for subsequent non- pharmacological interventions [13]. In contrast, EEG biofeedback and sensory integration training target neural regulation and sensory-motor integration at a deeper level, offering potential for sustained cognitive and behavioral improvements [14]. The integration of these modalities is hypothesized to produce synergistic effects, addressing both overt symptoms and underlying neurofunctional deficits.

Despite growing interest in multimodal ADHD interventions, few studies have systematically evaluated the clinical efficacy of combining OROS-MPH with EEG biofeedback and sensory integration training. This retrospective study seeks to address this gap by comparing outcomes in children with ADHD receiving OROS-MPH monotherapy versus an integrated intervention combining medication with EEG biofeedback and sensory integration training. Treatment effects were assessed across behavioral, cognitive, and adaptive domains to inform evidence-based comprehensive care strategies for pediatric ADHD.

Materials and methods

Participants

This retrospective cohort included 98 children diagnosed with ADHD who received treatment at Longquanyi District of Chengdu Maternity & Child Health Care Hospital between January 2023 and January 2025. Based on the treatment regimen, 53 patients receiving OROS-MPH alone comprised the control group, while 45 receiving additional EEG biofeedback and sensory integration training comprised the observation group. This study was approved by the Ethics Committee of Longquanyi District of Chengdu Maternity & Child Health Care Hospital.

Inclusion criteria: (1) age between 6 and 15 years; (2) full-scale intelligence quotient (FIQ) ≥ 70; (3) no recent ADHD pharmacotherapy or at least 2-week drug washout; (4) capable of completing assessments and training; and (5) complete clinical documentation.

Exclusion criteria: (1) severe psychiatric comorbidities (e.g., schizophrenia, bipolar disorder, epilepsy); (2) major neurological or systemic diseases; (3) known allergies to methylphenidate; or (4) poor compliance or treatment discontinuation.

Sample size estimation

To evaluate the adequacy of the sample size, we referenced a previous study that utilized electroencephalographic biofeedback in combination with other therapeutic approaches for children with ADHD [15]. In that study, the mean difference in the primary outcome measure, SNAP-IV, between the treatment and conventional groups was 0.58, yielding an estimated effect size (Cohen's d) of 0.61. Based on these parameters, a post hoc power analysis was conducted using G*Power 3.1.9.7 software. The test was set as two-tailed with an effect size of d=0.61 and an alpha level of 0.05. With sample sizes of 53 in the control group and 45 in the intervention group, the calculated statistical power reached 0.83, suggesting that the sample size in this study had sufficient power to detect clinically meaningful between-group differences.

Interventions

Control group: Patients were administered OROS-MPH (Xi'an Janssen, J20150013) orally once daily in the morning, starting with one tablet and increasing to two tablets in cases of severe symptoms. Each treatment cycle lasted 6 weeks, with a total of 12 weeks across two cycles.

Observation group: In addition to the same medication protocol, participants received the following interventions: (1) EEG biofeedback (Infiniti-4000C, Nanjing Weisi): Electrodes were placed over the central scalp and earlobes. Following 3 min of relaxation, participants engaged in neurofeedback-based games designed to suppress θ waves and enhance β and SMR activity. Each sessions lasted 30 min, three times per week, for 12 weeks. (2) Sensory integration training: Activities included prone ball grasping, trampoline tasks, blindfolded object recognition, and prone board exercises to stimulate vestibular, proprioceptive, and sensory regulatory pathways. Training was delivered in two 6-week cycles.

Outcome measures

Assessments were conducted at baseline and after the 12-week intervention.

Behavioral symptoms: Caregivers completed the validated Chinese version of the Swanson, Nolan, and Pelham IV Scale (SNAP-IV), which assesses inattention, hyperactivity/impulsivity, and oppositional defiant behaviors across 26 items. Each item is rated on a 4-point Likert scale ranging from 0 to 3, with higher scores indicating greater symptom severity [16]. The Conners' Parent Rating Scale (CPRS-48) was also used to evaluate behavioral and emotional functioning. This scale consists of 48 items across six domains: conduct problems, learning difficulties, psychosomatic complaints, impulsivity-hyperactivity, anxiety, and a hyperactivity index. Items are scored from 0 (never) to 3 (often), with a mean score ≥ 1.5 considered clinically significant [17].

Cognitive function: The China-Wechsler Intelligence Scale for Children (C-WISC) was used to measure verbal intelligence quotient (VIQ), performance intelligence quotient (PIQ), and full-scale IQ (FIQ). FIQ scores were interpreted as follows: < 70 indicating impairment, 70-89 as below average, 90-109 as average, and ≥ 110 indicating above average [18].

Neurophysiological parameters: EEG recordings were obtained to measure θ, β, and sensorimotor rhythm (SMR) wave activity using standardized EEG protocols.

Cerebral hemodynamics: Cerebral blood flow velocities were measured with transcranial Doppler ultrasonography (Digi-Lite, Rimed) following a 10 min resting period, including left middle cerebral artery (MCA-L), left anterior cerebral artery (ACA-L), and left posterior cerebral artery (PCA-L).

Neuroendocrine markers: Morning fasting blood samples (5 mL) were collected, centrifuged, and analyzed. Adrenocorticotropic hormone (ACTH) was assessed using enzyme-linked immunosorbent assay (ELISA), cortisol using chemiluminescent immunoassay (CLIA), and norepinephrine (NE) and dopamine (DA) using high-performance liquid chromatography with electrochemical detection (HPLC-ECD).

Safety evaluation: Adverse events including dizziness, appetite loss, gastrointestinal discomfort, insomnia, and sore throat were closely monitored throughout the intervention period.

Statistical analysis

All statistical analyses were conducted using SPSS version 26.0. The normality of continuous variables was assessed through the Kolmogorov-Smirnov test. Variables following a normal distribution were described as mean ± standard deviation ($\bar{x}\pm s$) and compared using *t*-tests. Non-normally distributed variables were

Table 1. Comparison of baseline characteristics between the two groups

	Control group (n=53)	Observation group (n=45)	t/χ^2	P
Sex			0.116	0.733
Male	36 (67.92)	32 (71.11)		
Female	17 (32.08)	13 (28.89)		
Age	9.13±1.64	8.93±1.81	0.569	0.571
Duration of illness (months)	16.42±3.95	16.69±4.09	0.336	0.738
ADHD subtype (IA/HI/C)	24/5/24	19/4/22	-	0.954[a]
Father's education (years)	13.75±2.77	13.80±2.93	0.079	0.938
Mother's education (years)	12.46±3.02	12.37±3.23	0.081	0.936
Only child (Yes/No)	31/22	27/18	0.023	0.880

IA: Inattentive, HI: Hyperactive/Impulsive, C: Combined, ADHD: attention deficit hyperactivity disorder; a: Fisher's exact test.

expressed as median and interquartile range [M (P25, P75)] and evaluated using the Mann-Whitney U test. Categorical data were presented as frequency and proportion [n (%)] and analyzed with the chi-square (χ^2) test or Fisher's exact test, as appropriate. Graphs were generated using GraphPad Prism. A two-sided P value < 0.05 was considered statistically significant. In graphical presentations, statistical significance was indicated as follows: $^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$, $^{****}P < 0.0001$, and "ns" for no significant difference.

Results

Baseline characteristics

As shown in **Table 1**, no significant differences were observed between the two groups regarding sex, age, disease duration, ADHD subtype, or parental education levels ($P > 0.05$), indicating baseline comparability.

SNAP-IV scores

As illustrated in **Figure 1**, baseline SNA P-IV scores did not differ significantly between the two groups (P > 0.05), confirming initial comparability. Post-intervention, both groups exhibited significant reductions in SNAP-IV subscale scores ($P < 0.0001$), with the observation group demonstrating significantly greater improvements than the control group ($P < 0.01$). These findings support the enhanced efficacy of a multimodal intervention - combining OROS-MPH, EEG biofeedback, and sensory integration training - over medication alone in mitigating core ADHD symptoms.

CPRS-48 scale scores

Pre-intervention CPRS-48 scores were comparable between the two groups ($P > 0.05$). Following the 12-week intervention, scores across all six CPRS-48 domains - conduct problems, learning difficulties, psychosomatic symptoms, impulsivity-hyperactivity, anxiety, and hyperactivity index - significantly declined in both cohorts ($P < 0.05$). The observation group achieved significantly greater improvements than the control group across all dimensions ($P < 0.05$), indicating superior behavioral and symptomatic outcomes with the combined approach (**Figure 2**).

C-WISC scale scores

As shown in **Table 2**, pre-intervention C-WISC scores (VIQ, PIQ, and FIQ) were statistically equivalent between the groups. Post-intervention, both groups demonstrated significant cognitive gains ($P < 0.05$), with the observation group achieving a greater degree of improvement. Notably, the mean FIQ score in the observation group reached 104.71±10.34, significantly surpassing the control group's 98.63±12.36 ($P < 0.001$). This indicates that multimodal intervention more effectively enhances global cognitive functioning in children with ADHD.

EEG wave frequencies

As reported in **Table 3**, baseline EEG wave frequencies (β, θ, SMR) were not significantly different between groups (P < 0.05). After 12-week intervention, significant increases in β and SMR waves and reductions in θ waves

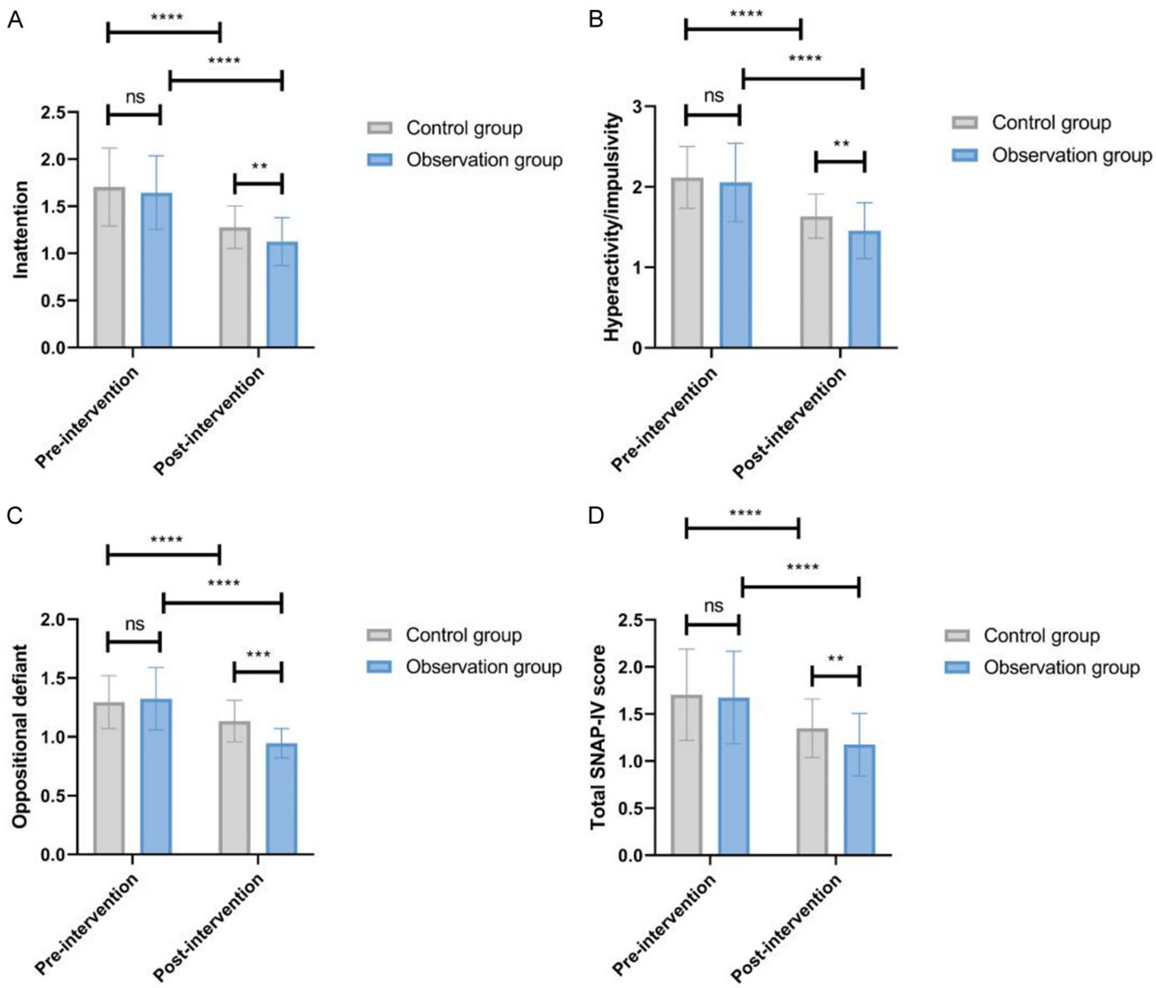

Figure 1. Comparison of SNAP-IV scores between the two groups before and after intervention. A. Inattention; B. Hyperactivity/impulsivity; C. Oppositional defiant; D. Total SNAP-IV score. SNAP-IV: Swanson, Nolan, and Pelham IV Scale. $^{**}P < 0.01$, $^{***}P < 0.001$, $^{****}P < 0.0001$, ns, no significant difference.

were observed in both groups ($P < 0.05$), with more pronounced improvements in the observation group ($P < 0.001$). The observation group showed a β wave of 7.01±0.69 Hz (vs. 6.43±0.82 Hz), θ wave reduction to 20.49±2.40 Hz (vs. 23.68±2.13 Hz), and an SMR wave increase to 10.67±1.16 Hz (vs. 8.55±0.96 Hz). These EEG shifts suggest enhanced attentional regulation and neurobehavioral stabilization facilitated by the combined intervention.

Cerebral blood flow velocity

As shown in **Table 4**, no baseline differences were observed in cerebral blood flow velocities between groups. After treatment, significant improvements were noted in all three arteries (MCA-L, ACA-L, PCA-L) for both groups, with greater enhancements in the observation group ($P < 0.05$). These changes may reflect improved anterior circulation and enhanced neural perfusion, contributing to better cognitive and attentional performance.

Neuroendocrine biomarkers

As presented in **Table 5**, baseline plasma levels of ACTH, cortisol, NE, and DA were comparable between groups ($P > 0.05$). Post-treatment, ACTH levels declined, while cortisol, NE, and DA levels increased significantly in both groups ($P < 0.001$), with more pronounced changes observed in the observation group.

Safety

No significant adverse events were reported in either group during the course of treatment.

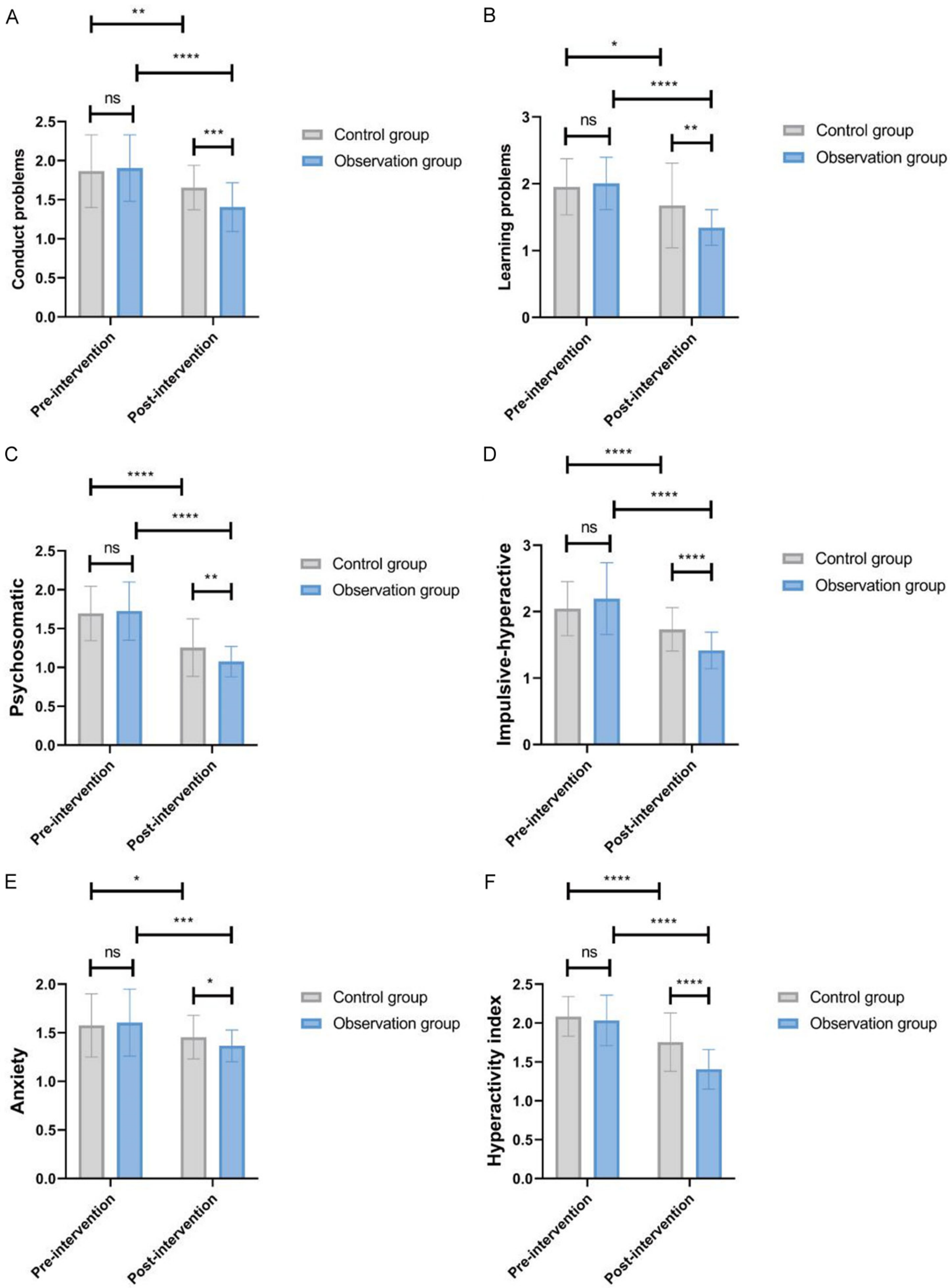

Figure 2. Comparison of CPRS-48 scale scores between the two groups before and after intervention. A. Conduct problems; B. Learning problems; C. Psychosomatic; D. Impulsive-hyperactive; E. Anxiety; F. Hyperactivity index. CPRS: Conners' Parent Rating Scale. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, ****$P < 0.0001$, ns, no significant difference.

Table 2. Comparison of C-WISC scores between the two groups before and after intervention

	Control group (n=53)	Observation group (n=45)	*t*	*P*
VIQ				
Pre-intervention	92.68±12.26	93.36±10.94	0.286	0.776
Post-intervention	98.45±13.28[b]	105.78±10.07[b]	3.033	0.003
PIQ				
Pre-intervention	94.09±13.55	93.09±13.64	0.365	0.716
Post-intervention	98.81±11.50[b]	103.64±10.62[b]	2.147	0.034
FIQ				
Pre-intervention	93.39±12.88	93.22±12.29	0.091	0.928
Post-intervention	98.63±12.36[b]	104.71±10.34[b]	3.694	< 0.001

C-WISC: the China-Wechsler intelligence scale for children, VIQ: verbal intelligence quotient, PIQ: performance intelligence quotient, FIQ: full-scale intelligence quotient; b: compared with pre-intervention, $P < 0.05$.

Table 3. Comparison of EEG wave frequencies (Hz) between the two groups before and after intervention

	Control group (n=53)	Observation group (n=45)	*t*	*P*
β				
Pre-intervention	5.63±0.76	5.84±0.63	1.543	0.126
Post-intervention	6.43±0.82[b]	7.01±0.69[b]	3.726	< 0.001
θ				
Pre-intervention	26.28±3.35	26.41±3.04	0.185	0.854
Post-intervention	23.68±2.13[b]	20.49±2.40[b]	6.956	< 0.001
SMR				
Pre-intervention	6.94±0.81	7.08±0.89	0.877	0.383
Post-intervention	8.55±0.96[b]	10.67±1.16[b]	9.900	< 0.001

EEG: Electroencephalographic, SMR: sensorimotor rhythm; b: compared with pre-intervention, $P < 0.05$.

Table 4. Comparison of cerebral blood flow velocity (cm/s) between the two groups before and after intervention

	Control group (n=53)	Observation group (n=45)	*t*	*P*
MCA-L				
Pre-intervention	58.33±4.47	59.21±3.92	1.027	0.307
Post-intervention	60.04±3.53[b]	62.87±3.20[b]	4.147	< 0.001
ACA-L				
Pre-intervention	47.28±3.04	47.54±4.12	0.345	0.731
Post-intervention	48.62±3.19[b]	49.98±3.46[b]	2.041	0.044
PCA-L				
Pre-intervention	36.38±4.19	36.14±3.23	0.300	0.765
Post-intervention	38.30±2.16[b]	39.48±3.10[b]	2.193	0.031

MCA-L: left middle cerebral artery, ACA-L: left anterior cerebral artery, PCA-L: left posterior cerebral artery; b: compared with pre-intervention, $P < 0.05$.

Discussion

Effective ADHD management requires not only the suppression of observable symptoms but also the targeting of underlying neurocognitive dysfunctions [19]. While pharmacological agents such as OROS-MPH have demonstrated efficacy in alleviating core symptoms such as inattention and hyperactivity-impulsivity, their impact on executive function, emotional regulation, and adaptive behavior remain limited [20]. This study, therefore, sought to evaluate a multimodal intervention strategy combining pharmacotherapy with EEG neurofeedback and sensory integration training, aiming to assess its clinical value in promoting multidimensional improvements in children with ADHD.

The behavioral manifestations of ADHD are closely associated with prefrontal cortical dysfunction, dysregulation of neurotransmitter systems, and impairments in executive function. These neurobiological abnormalities contribute to deficits in sustained attention, behavioral inhibition, and academic performance [21]. EEG biofeedback has been shown to enhance self-regulatory capacity by modulating the balance between fast and slow brainwave activity, thereby improving attention stability and executive control [22]. At the same time, sensory integration training engages multiple sensory pathways, including vestibular, proprioceptive, and tactile modalities, which promotes neural integration and supports improvements in sensorimotor coordination and emo-

Table 5. Comparison of neuroendocrine biomarker levels between the two groups before and after intervention

	Control group (n=53)	Observation group (n=45)	*Z*	*P*
ACTH/(pg/mL)				
Pre-intervention	35.82 (32.56, 38.62)	36.16 (30.98, 40.99)	0.253	0.800
Post-intervention	27.06 (23.52, 31.19)[b]	21.65 (16.63, 26.39)[b]	3.686	< 0.001
Cortisol/(nmol/L)				
Pre-intervention	213.86 (190.54, 243.61)	193.83 (181.57, 238.49)	1.244	0.213
Post-intervention	317.86 (290.93, 332.11)[b]	378.67 (344.39, 391.63)[b]	6.380	< 0.001
NE/(pg/mL)				
Pre-intervention	113.06 (101.23, 131.16)	118.06 (108.61, 129.88)	0.749	0.454
Post-intervention	173.63 (166.63, 181.88)[b]	204.72 (197.11, 217.87)[b]	7.258	< 0.001
DA/(pg/mL)				
Pre-intervention	19.62 (15.58, 22.85)	18.36 (14.59, 25.07)	0.741	0.458
Post-intervention	23.44 (12.99, 31.57)[b]	32.82 (22.12, 36.79)[b]	2.438	0.015

ACTH: adrenocorticotropic hormone, NE: norepinephrine, DA: dopamine; b: compared with pre-intervention, $P < 0.05$.

tional regulation during cognitively demanding tasks [15]. In the present study, the combination of EEG biofeedback and sensory integration training, when added to OROS-MPH therapy, significantly improved both core ADHD symptoms and cognitive function. No serious adverse events were observed in the observation group, suggesting that this multimodal approach is safe and well-tolerated, making it a suitable option for children who require long-term management. Furthermore, given that children with ADHD often present with delayed verbal processing and deficits in visuospatial function, they may benefit additionally from the enhanced information integration and cognitive flexibility supported by multisensory training [23, 24]. The capacity of biofeedback to improve neural efficiency and strengthen executive processes provides further support for its clinical utility [25].

Alterations in EEG frequency serve as a critical physiological indicator of central nervous system function [26]. β activity is closely associated with alertness, attentional focus, and cognitive engagement, with increases reflecting elevated neural activation. In contrast, θ activity is commonly observed during relaxed or drowsy states and is widely regarded as a neurophysiological marker of attention deficits and slowed cognitive processing [27]. SMR is implicated in motor control and behavioral inhibition, with higher levels linked to reductions in impulsivity and behavioral dysregulation [28]. EEG biofeedback enables real-time modulation of brainwave activity, allowing children to consciously regulate neural responses, thereby improving both cognitive processing and behavioral control [29]. Notably, Zuberer et al. reported that these self-regulatory capacities can persist and even consolidate after the completion of the training period [30]. Supporting this, Enriquez et al. reported that upregulation of β and SMR bands significantly enhanced executive function and reduced hyperactive and impulsive behaviors, while reductions in θ activity signified a shift toward a more efficient brain state [31]. Consistent with these findings, this study observed marked increases in β and SMR activity and a significant decrease in θ activity in the observation group, indicating clear gains in attentional control and impulse regulation.

Resting-state cerebral blood flow abnormalities, particularly hypoperfusion in the frontal and parietal cortices, are frequently reported in children with ADHD. Specifically, decreased flow velocities in the MCA-L and ACA-L have been observed compared with typically developing peers [32, 33]. These arteries supply key regions such as the anterior frontal cortex, anterior cingulate cortex, and attentional networks essential for executive functioning. Reduced flow velocity in these vessels is commonly interpreted as a marker of diminished regional neural activity [34]. In the present study, the combined intervention significantly increased ACA-L and MCA-L flow velocities, suggesting enhanced activation of associated neural circuits and improved attentional regulation and self-monitoring. Furthermore, the observed increase in PCA-L flow velocity may reflect heightened neural excitability and arousal levels [35]. Enhanced cerebral perfusion supports the metabolic demands of functionally active brain regions, laying a stronger physiological foundation for cognitive and behavioral improvements. Overall, these findings suggest that the intervention may facilitate cognitive recovery by optimizing anterior circulation and neurovascular support in children with ADHD.

Neuroendocrine dysregulation is another core pathophysiological feature of ADHD, particularly involving the hypothalamic-pituitary-adrenal (HPA) axis and the catecholaminergic system. Dysfunction in these pathways has been linked to deficits in emotional regulation and impulse control [36, 37]. Empirical studies have shown that children with ADHD often exhibit aberrant regulation of ACTH and CORT, indicating a blunted or dysregulated stress response [10]. Additionally, reduced DA and NE levels have been implicated in prefrontal cortical dysfunction, contributing to impairments in attention and executive function [38]. EEG biofeedback can enhance prefrontal connectivity, improving self-regulatory capacities and attenuating excessive cortical inhibition [39]. Complementarily, sensory integration training provides multimodal sensory stimulation that activates the thalamus and brainstem arousal systems, promoting the release of catecholaminergic neurotransmitters such as NE and DA [40]. While plasma neurotransmitter concentrations may not directly reflect central neurotransmission, their directional changes can serve as meaningful peripheral indicators of neuroregulatory adaptation [41]. In this study, post-treatment assessments showed that the observation group exhibited decreased ACTH, increased CORT, and significant elevations in NE and DA levels, suggesting that the combined intervention may restore neuroendocrine homeostasis through a multi-target synergistic mechanism.

While this study presents compelling preliminary evidence supporting an integrated therapeutic approach for ADHD, several limitations warrant attention. These include its single-center retrospective design, limited sample size, relatively short intervention duration, and absence of neuroimaging verification. Future investigations should employ multi-center, prospective designs, incorporate neuroimaging tools such as fMRI, and extend follow-up periods to elucidate the neural remodeling processes underlying therapeutic benefits and to further guide the development of precision-based interventions for ADHD.

Disclosure of conflict of interest

None.

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