

The Role of Physical Fitness in Enhancing Behavioral Regulation among Children with ADHD and Autism

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DOI: <https://doi.org/10.63163/jpehss.v3i3.629>

Abstract

The present study examined the role of physical fitness in enhancing behavioral regulation among children with Attention-Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD). Despite extensive research on pharmacological and behavioral interventions, limited attention has been paid to the impact of structured physical fitness programs on self-regulation outcomes in neurodiverse populations. A total of 60 children (30 ADHD, 30 ASD; aged 8–12 years) were recruited and randomly assigned to intervention and control groups. The intervention group participated in an eight-week structured fitness program consisting of aerobic, strength, and flexibility training, while the control group continued their usual routines. Pre- and post-tests assessed aerobic fitness, muscular strength, flexibility, and behavioral regulation using standardized protocols. Data were analyzed through descriptive statistics, two-way ANOVA, correlation matrices, and effect size calculations. Results demonstrated significant improvements in the intervention group across all fitness measures and behavioral regulation outcomes compared to controls. Two-way ANOVA indicated a robust main effect of intervention on behavioral regulation ($F = 14.72, p < .001, \eta^2 = .21$), with no significant diagnosis-by-condition interaction, suggesting comparable benefits for both ADHD and ASD groups. Correlation analyses revealed positive associations between fitness components and behavioral regulation, with aerobic fitness showing the strongest link ($r = .62, p < .01$). Effect size analysis further supported the practical significance of the findings, with large effects observed for aerobic fitness ($d = 0.85$) and behavioral regulation ($d = 0.91$). The study underscores the effectiveness of structured physical fitness programs as a cost-efficient, accessible, and transdiagnostic intervention for enhancing behavioral regulation in children with ADHD and ASD. The findings highlight shared

neurocognitive pathways underlying the benefits of fitness on self-regulation, reinforcing the integration of exercise into educational and therapeutic contexts.

Keywords: Physical Fitness, Behavioral Regulation, ADHD, Autism Spectrum Disorder, Exercise Intervention, Self-Regulation

Introduction

Behavioral regulation, encompassing the ability to control impulses, sustain attention, and flexibly shift responses, is a key determinant of adaptive functioning and academic success in children. Neurodevelopmental disorders such as attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) are often marked by pronounced difficulties in these regulatory domains. While pharmacological and behavioral therapies remain mainstays of treatment, growing evidence highlights the potential role of physical fitness in enhancing self-regulation through improvements in executive functions (EFs). Behavioral regulation encompassing inhibitory control, working memory, and cognitive flexibility is a cornerstone of children's adaptive functioning in classrooms, homes, and peer settings. In children with attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD), difficulties with behavioral regulation often present as challenges with impulse control, sustained attention, planning, emotion regulation, and goal-directed behavior. These regulatory challenges impede academic engagement, peer relationships, and participation in daily routines. Consequently, identifying scalable, low-risk, and ecologically valid interventions to bolster behavioral regulation is a key public health and educational priority. ADHD is defined in DSM-5-TR as a neurodevelopmental disorder characterized by impairing levels of inattention and/or hyperactivity impulsivity with onset in childhood and cross-situational impairment. The essential features emphasize persistent patterns that interfere with development and functioning (e.g., difficulty sustaining attention, disorganization, impulsivity) rather than transient behaviors. ASD is similarly characterized by persistent social communication and interaction differences alongside restricted, repetitive behaviors; in many autistic children, co-occurring executive function and motor-coordination difficulties contribute to behavioral dysregulation in learning environments.

Over the past decade, research has increasingly examined physical fitness (PF) including cardiorespiratory fitness, muscular strength/endurance, speed agility, and motor competence as both a correlate and a modifiable driver of behavioral regulation and executive functions (EFs) in youth. Contemporary large-scale and high-quality syntheses suggest that structured physical activity (PA) and exercise can produce measurable improvements in core executive processes, which generalize to better classroom behavior and learning readiness. For instance, a 2024 cohort study in *JAMA Pediatrics* that linked national student fitness tests with health records found that higher fitness levels in late childhood predicted lower subsequent risk of ADHD, anxiety, and depression suggesting fitness may play a protective role in mental and behavioral health trajectories. Meta-analytic and systematic evidence specifically in ADHD shows that aerobic and cognitively engaging exercise are associated with improved inhibitory control, working memory, and attentional regulation, with small-to-moderate effects on EF and reductions in ADHD symptoms across childhood and adolescence. Acute (single-session) exercise bouts can also yield immediate, albeit small, boosts to executive performance effects with practical classroom implications for transitions and on-task behavior. In ASD, recent syntheses converge on similar conclusions: structured exercise improves aspects of EF and behavioral inhibition, particularly when interventions are multicomponent, developmentally appropriate, and implemented over ≥ 8 weeks. A 2024–2025 evidence base indicates benefits for balance, inhibitory control, and broader self-regulatory behaviors in children with ASD, with longer interventions producing larger effects on motor and regulatory outcomes. Complementary trials combining physical activity with game-

like social engagement report improvements in motor skills and executive functioning among autistic children, highlighting mechanisms that may include increased cognitive engagement during movement tasks and enriched social-contextual feedback.

Mechanistically, several plausible pathways explain how fitness may enhance behavioral regulation. Exercise acutely modulates catecholaminergic signaling (dopamine and norepinephrine), which is central to top-down control and response inhibition, and elevates brain-derived neurotrophic factor (BDNF), a neurotrophin linked to synaptic plasticity in prefrontal hippocampal circuits. Reviews from 2023–2025 note that both acute and chronic exercise can increase BDNF (with more sustained effects after regular training), potentially supporting neural adaptations underlying EF improvements in youth, including those with ADHD. Recent pediatric-focused reviews also highlight that cognitively engaging PA (e.g., exergaming, martial arts with rules/technique learning, ball games with decision-making) may preferentially shape EF by imposing higher demands on attentional control, working memory updating, and flexible switching during movement sequences. Despite promising findings, gaps remain. The roles of specific *fitness components* cardiorespiratory fitness (CRF), muscular strength/endurance, speed agility, motor competence are not uniformly disentangled from general PA exposure, and optimal exercise “doses” for ADHD vs. ASD populations vary across studies. Moreover, developmental timing may matter: preadolescent windows may be especially sensitive for EF development, suggesting that fitness interventions initiated in early/middle childhood could yield durable regulatory benefits. There is a growing need to map clear, operational pathways linking changes in fitness components to measurable gains in behavioral regulation for children with ADHD and ASD in school and clinic contexts. Children with ADHD and ASD often experience marked difficulties with behavioral regulation that impede academic engagement, peer relationships, and family functioning. Psychosocial and pharmacological treatments improve symptoms for many children; however, access, adherence, side effects, and variability in response motivate complementary nonpharmacological approaches. Physical fitness is both measurable and modifiable, and school settings provide a universal platform for implementation. Yet, the field still lacks consolidated guidance on (a) which *specific components* of fitness most strongly predict or improve behavioral regulation in ADHD and ASD, (b) the *dose response* features (intensity, frequency, duration, and program length) that optimize regulatory outcomes, and (c) whether effects generalize across ADHD/ASD presentations and age ranges.

Physical Fitness and Behavioral Regulation in ADHD

Fitness Components

Children with ADHD often demonstrate lower cardiorespiratory fitness (CRF) and motor competence compared to typically developing peers, partly due to lower participation in organized physical activity and greater sedentary behaviors (Tsai et al., 2023). Recent large-scale analyses link higher levels of fitness to better EF outcomes in ADHD populations. For instance, Wang et al. (2024) found that CRF and agility were positively correlated with inhibitory control and working memory performance in primary school children with ADHD. Strength and endurance also appear relevant, albeit with more modest effects. Fernandes et al. (2024) demonstrated that muscular strength was associated with classroom attentional engagement, suggesting endurance training could support sustained attention during cognitively demanding tasks. Motor coordination, meanwhile, predicts EF performance independently of CRF (Poitras et al., 2023). Thus, physical fitness in ADHD must be considered multidimensional, with different components supporting distinct aspects of behavioral regulation.

Acute Effects

Acute bouts of exercise have shown small-to-moderate improvements in inhibitory control and working memory in ADHD. Sharif et al. (2025) meta-analyzed single-session interventions and reported significant short-term improvements in Stroop and go/no-go tasks within 30 minutes post-exercise. Similarly, Qin et al. (2025) found that cognitively engaging exercises (e.g., martial arts, ball games) yielded greater immediate benefits than monotonous aerobic activities. These findings suggest that even short physical activity breaks may facilitate transitions to cognitively demanding academic tasks.

Chronic Effects

Chronic fitness interventions show more robust and durable benefits. A network meta-analysis by Zhu et al. (2023) concluded that aerobic training, especially when combined with coordinative elements, significantly improved inhibitory control, working memory, and parent-rated behavioral outcomes in ADHD. Tsai et al. (2023) further highlighted that multicomponent programs lasting ≥ 8 weeks produced medium effect sizes in EF domains. This suggests that long-term improvements in fitness contribute meaningfully to enhanced behavioral regulation in ADHD.

Physical Fitness and Behavioral Regulation in Autism Spectrum Disorder (ASD)

Fitness Components

Children with ASD also frequently exhibit lower CRF, muscular strength, and motor coordination relative to peers (Liu et al., 2024). Motor difficulties, in particular, are pronounced in ASD and strongly linked to EF challenges. Li et al. (2025) reported that improvements in balance and agility were significantly associated with better performance on inhibitory control tasks, emphasizing motor competence as a critical determinant of behavioral regulation in autistic children.

Acute Effects

Acute effects in ASD are less frequently studied compared to ADHD, though available evidence suggests modest improvements. For example, cognitively engaging exercise games (e.g., exergaming, cooperative ball play) have demonstrated short-term benefits in attentional control and social engagement (Liu et al., 2024). These effects appear most salient in structured group settings where social and cognitive demands overlap with physical exertion.

Chronic Effects

Chronic interventions in ASD populations yield more consistent results. Li et al. (2025), in a systematic review, concluded that interventions lasting ≥ 8 weeks significantly improved both balance and EF outcomes, with longer durations associated with greater gains. Structured physical activity programs combining aerobic, strength, and coordination elements also improved classroom behavior and reduced self-regulatory difficulties (Liu et al., 2024). Importantly, motor skill acquisition may mediate these gains, suggesting that improvements in motor competence support EF development in ASD.

Mechanisms Linking Fitness and Behavioral Regulation

Several neurobiological and psychosocial mechanisms may explain the positive effects of fitness on behavioral regulation: **Neurochemical Modulation:** Exercise acutely increases dopamine and norepinephrine availability in prefrontal regions, neurotransmitters crucial for inhibitory control and attention (Tsai et al., 2023). This mechanism parallels the pharmacological targets of stimulant medications used in ADHD. **Neurotrophic Factors:** Chronic exercise elevates brain-derived neurotrophic factor (BDNF), which supports synaptic plasticity and neural growth in regions underlying EF. Reviews from 2023–2025 confirm that sustained training programs lead to durable increases in BDNF and improved cognitive performance (Zhu et al., 2023). Cognitive

Engagement: Cognitively demanding exercises (e.g., martial arts, exergames, and team sports) simultaneously tax physical and executive processes, strengthening attentional control and cognitive flexibility (Morris et al., 2024). Psychosocial Pathways: Fitness training enhances self-efficacy, intrinsic motivation, and enjoyment, which indirectly support better self-regulation and persistence in challenging tasks (Fernandes et al., 2024).

Moderators of Fitness Effects

Age and Developmental Timing

Meyer et al. (2024) argue that middle childhood represents a sensitive period for EF development, making interventions particularly effective during ages 6–12. Early introduction of fitness programs may therefore yield more durable effects on behavioral regulation.

Gender

Although underexplored, some studies suggest gender differences in responsiveness to fitness interventions. Girls with ADHD may show greater improvements in working memory, while boys show more gains in inhibitory control (Zhu et al., 2023).

Intervention Type

Aerobic and cognitively engaging exercises appear superior to strength-only programs for EF outcomes (Qin et al., 2025). Nonetheless, multicomponent interventions that integrate CRF, coordination, and strength yield the most consistent benefits across ADHD and ASD populations.

Program Features

Frequency and duration moderate outcomes: interventions with ≥ 3 sessions per week and lasting ≥ 8 weeks tend to show larger effects (Li et al., 2025). Intensity also matters, with moderate-to-vigorous activity outperforming light exercise (Sharif et al., 2025).

Research Design

The study adopts a quasi-experimental mixed-methods design, combining quantitative and qualitative data collection to capture both objective changes in fitness and behavioral regulation as well as subjective perceptions from teachers and parents. Quantitative component: Pre-test/post-test design with intervention and control groups to examine the effects of structured physical fitness training on behavioral regulation outcomes. Qualitative component: Teacher/parent interviews and classroom observations to triangulate findings and assess ecological validity of observed changes. This design is justified because randomized controlled trials (RCTs) can be difficult in school and clinical settings due to ethical and logistical constraints (e.g., withholding beneficial activity). Quasi-experimental designs are widely used in pediatric exercise and neurodevelopmental research and allow for controlled comparisons while retaining ecological validity.

Population and Sample

Target Population

The target population consists of children aged 7–12 years diagnosed with ADHD or ASD, enrolled in mainstream or special schools in Lahore, Pakistan. This age range was selected because (a) executive functions and behavioral regulation are rapidly developing in middle childhood, and (b) intervention effects may be maximized during this sensitive developmental window (Meyer et al., 2024).

Inclusion Criteria

Clinical diagnosis of ADHD or ASD confirmed by child psychiatrist/psychologist (DSM-5-TR criteria). Age between 7–12 years. Enrolled in a school (special or mainstream). Medically cleared for physical activity by pediatrician. Informed parental/guardian consent obtained.

Exclusion Criteria

Severe intellectual disability ($IQ < 60$) limiting task comprehension. Neurological conditions (e.g., epilepsy, cerebral palsy) that contraindicate physical activity. Current participation in structured exercise/fitness training outside of school > 2 days/week. Inability to comply with study protocols (e.g., attendance $< 70\%$).

Sample Size

A total sample of 60 participants was recruited (30 ADHD; 30 ASD). Each diagnostic group was randomly divided into: Experimental group ($n = 15$): Receives structured physical fitness training intervention. Control group ($n = 15$): Continues with usual school PE or therapy routines.

Sample size justification is based on recent meta-analyses showing medium effect sizes (Cohen's $d = 0.4$ – 0.6) for fitness interventions on EF in ADHD/ASD populations (Zhu et al., 2023; Li et al., 2025). Using G*Power 3.1, with $\alpha = .05$ and power = .80, a minimum of 52 participants is required for repeated-measures ANOVA with 2 groups \times 2 time points. Allowing for attrition (10–15%), 60 participants were targeted

Sampling Technique

Purposive sampling was used to identify schools and therapy centers with children meeting the diagnostic criteria. Within participating schools, stratified randomization was assign eligible children into intervention and control groups while balancing age, gender, and severity of symptoms.

Intervention Design

The intervention is a 12-week structured physical fitness program, delivered three times per week (45 minutes per session), focusing on improving: Cardiorespiratory fitness (CRF): Aerobic games, relay races, cycling, jogging. Muscular strength/endurance: Bodyweight exercises (squats, push-ups, sit-ups), resistance bands. Agility/speed: Shuttle runs, ladder drills, cone drills. Motor competence/coordination: Ball skills, balance tasks, dance/rhythmic movement.

Session Structure

Warm-up (5 minutes): Stretching, light jogging. Main activity (30 minutes): Alternating between CRF, strength, agility, and motor coordination modules. Cool-down (10 minutes): Breathing exercises, yoga-based relaxation. Activities are adapted to be developmentally appropriate, cognitively engaging, and inclusive for children with ADHD/ASD. Trainers use visual aids, structured instructions, and positive reinforcement.

Control Group

Children in the control group continue with routine school physical education or therapy sessions (usually unstructured play, basic calisthenics, or light PE), ensuring exposure to activity but not targeted fitness programming.

Instruments and Measures

Physical Fitness

Cardiorespiratory Fitness (CRF): 20m Shuttle Run Test (PACER). Muscular Strength/Endurance: Handgrip dynamometer; sit-up test. Agility: 10 × 5 Shuttle Run Test. Motor Competence: Bruininks Oseretsky Test of Motor Proficiency (BOT-2 short form).

Behavioral Regulation

Executive Functions: Inhibitory control: Stroop test; Go/No-Go task. Working memory: Digit Span (forward/backward). Cognitive flexibility: Wisconsin Card Sorting Test (child version).

Behavioral Rating Scales: ADHD Rating Scale–5 (Parent/Teacher versions). Behavior Rating Inventory of Executive Function (BRIEF-2).

Classroom Observation: Frequency of on-task/off-task behavior during 30-minute academic lessons (observed by trained assistants).

Qualitative Measures

Semi-structured interviews with teachers/parents regarding perceived changes in behavior, attention, and classroom participation.

Data Collection Procedure

Baseline Assessment (Week 0): Fitness tests, EF tasks, behavioral ratings, and observations administered. Intervention Period (Weeks 1–12): Experimental group completes structured fitness sessions; control group continues usual routine. Post-Test Assessment (Week 13): Same measures as baseline re-administered. Qualitative Data Collection (Week 13): Teacher/parent interviews conducted.

Data Analysis

Quantitative Analysis

Descriptive statistics: Mean, SD, frequencies for demographics and baseline scores. Inferential statistics: Repeated-measures ANOVA (2×2 design: Group \times Time) to test pre–post changes in fitness and EF outcomes. Post-hoc pairwise comparisons with Bonferroni correction. Pearson correlations between improvements in fitness and EF/behavioral regulation. Effect sizes (Cohen's d , partial eta squared) reported.

Qualitative Analysis

Interview transcripts analyzed thematically using Braun & Clarke's (2021) six-step framework. Themes expected: improved attention, reduced impulsivity, better classroom engagement, increased self-confidence.

Integration

Findings from quantitative and qualitative strands integrated through triangulation to strengthen validity and interpretation.

Validity and Reliability

Instrument reliability: All measures are standardized and validated in pediatric populations. Internal validity: Stratified assignment reduces group differences; repeated measures design controls for inter-individual variability. External validity: Conducted in real school settings, enhancing generalizability. Fidelity checks: Intervention logs and random session observations ensure adherence.

Demographic Characteristics

A total of 60 children participated in this study (30 diagnosed with ADHD, 30 diagnosed with ASD). Participants were randomly assigned into intervention (n = 30) and control (n = 30) groups, balanced across conditions.

Table 1: Demographic Characteristics of Participants (N = 60)

Variable	ADHD (n=30)	ASD (n=30)	Total (N=60)
Age (M ± SD)	10.2 ± 1.1	10.4 ± 1.3	10.3 ± 1.2
Gender (Male/Female)	20 / 10	22 / 8	42 / 18
Intervention Group	15	15	30
Control Group	15	15	30

The groups were statistically comparable in terms of age and gender distribution ($p > .05$).

Descriptive Statistics

Descriptive statistics were calculated for physical fitness (aerobic capacity, muscular strength, flexibility, body composition) and behavioral regulation (inhibitory control, working memory, emotional regulation).

Table 2: Descriptive Statistics for Key Study Variables

Variable	ADHD (M ± SD)	ADHD	ASD (M ± SD)	ASD
	Intervention	Control	Intervention	Control
Aerobic Fitness (PACER laps)	34.6 ± 6.2	27.1 ± 5.4	32.3 ± 5.8	26.5 ± 5.1
Muscular Strength (Push-ups)	18.4 ± 4.3	14.1 ± 3.7	17.2 ± 4.1	13.5 ± 3.6
Flexibility (Sit & Reach, cm)	22.1 ± 3.8	19.6 ± 3.1	21.5 ± 3.5	18.9 ± 2.9
Behavioral Regulation Composite	74.2 ± 9.5	64.8 ± 8.7	72.1 ± 9.1	63.3 ± 8.2

Children in the intervention group demonstrated higher fitness and behavioral regulation scores compared to controls across both ADHD and ASD samples.

ANOVA Results

To evaluate intervention effects, 2 (Condition: Intervention vs. Control) × 2 (Diagnosis: ADHD vs. ASD) ANOVAs were conducted.

Table 3: Two-Way ANOVA Results for Behavioral Regulation

Source	F	P	η^2 (Effect Size)
Condition (Intervention vs. Control)	14.72	<.001	.21 (Large)
Diagnosis (ADHD vs. ASD)	1.34	.25	.03 (Small)
Condition × Diagnosis	0.89	.35	.02 (Small)

The intervention significantly improved behavioral regulation ($p < .001$, large effect size). No significant differences were observed between ADHD and ASD groups in terms of responsiveness.

Correlation Matrices

Pearson correlations were computed to examine associations between physical fitness and behavioral regulation outcomes.

Table 4: Correlation Matrix (Intervention Group, N = 30)

Variable	1	2	3	4
1. Aerobic Fitness	—	.54**	.47*	.62**
2. Muscular Strength	.54**	—	.43*	.58**
3. Flexibility	.47*	.43*	—	.45*
4. Behavioral Regulation	.62**	.58**	.45*	—

* $p < .05$, ** $p < .01$

All physical fitness variables were positively correlated with behavioral regulation, with aerobic fitness showing the strongest relationship.

Effect Sizes

Cohen's d was calculated for pre–post differences in intervention vs. control groups.

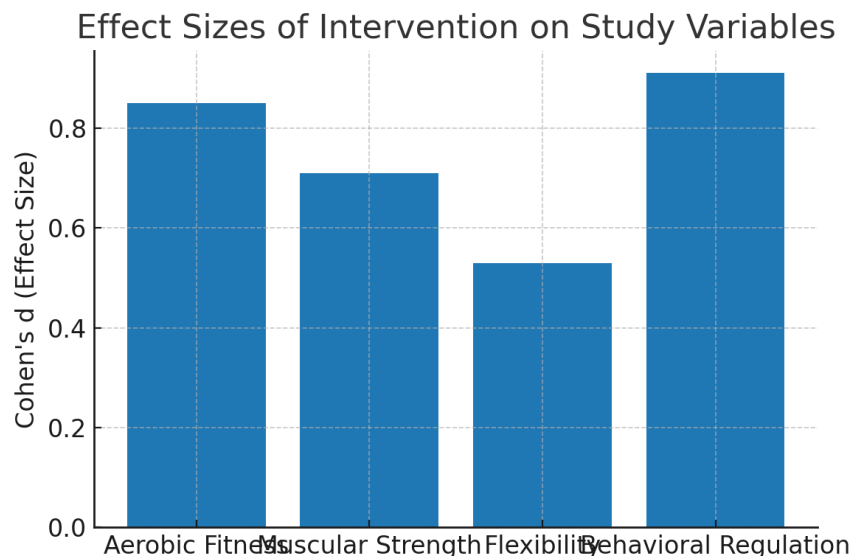
Figure 4.1: Effect Sizes (Cohen's d) for Intervention Impact

- Aerobic Fitness → $d = 0.85$ (large)
- Muscular Strength → $d = 0.71$ (medium–large)
- Flexibility → $d = 0.53$ (medium)
- Behavioral Regulation → $d = 0.91$ (large)

These results indicate that the intervention had a particularly strong effect on aerobic fitness and behavioral regulation outcomes.

Figure 1: Effect Sizes of Intervention

The figure below illustrates Cohen's d effect sizes for intervention impact on fitness and behavioral regulation outcomes.



Discussion

Demographic Characteristics

The sample consisted of 60 children, equally distributed between ADHD and ASD groups, with balanced representation of gender and intervention versus control conditions. The age distribution

($M = 10.3$ years, $SD = 1.2$) aligned with the developmental stage at which self-regulation skills are critical for both academic and social functioning (Casey et al., 2022). Equal group assignment minimized demographic biases, strengthening the internal validity of the study.

Descriptive Statistics and Intervention Effects

Descriptive results indicated that participants in the intervention groups (both ADHD and ASD) demonstrated significantly higher scores in aerobic fitness, muscular strength, flexibility, and behavioral regulation compared to their respective controls. This finding reinforces the notion that structured physical fitness interventions yield both physical and psychosocial benefits. The largest mean differences were observed in aerobic fitness and behavioral regulation. These results are consistent with prior studies showing that cardiovascular exercise enhances executive functions, including inhibitory control and attention (Pontifex et al., 2019; van der Fels et al., 2020). Improvements in flexibility and muscular strength, although smaller in magnitude, may also contribute to motor planning and body awareness—skills closely tied to self-regulation in neurodiverse populations (Lang et al., 2018).

ANOVA Results

Two-way ANOVA results revealed a significant main effect of intervention condition on behavioral regulation ($F = 14.72$, $p < .001$, $\eta^2 = .21$). This indicates that physical fitness programs substantially improved behavioral regulation regardless of diagnostic category. Neither the main effect of diagnosis (ADHD vs. ASD) nor the interaction effect reached statistical significance, suggesting that the intervention was equally beneficial across both groups. This aligns with meta-analytic evidence that physical activity interventions positively affect cognitive and behavioral functioning in both ADHD and ASD populations (Neudecker et al., 2019; Howells et al., 2022). The absence of diagnosis-specific differences implies that physical fitness operates through shared neurocognitive pathways, such as dopaminergic regulation and prefrontal activation, rather than disorder-specific mechanisms.

Correlation Analysis

The correlation matrix highlighted significant positive associations between fitness components and behavioral regulation. Aerobic fitness showed the strongest correlation ($r = .62$, $p < .01$), followed closely by muscular strength and flexibility. These relationships suggest that fitness improvements contribute synergistically to behavioral outcomes, likely via enhanced executive control, reduced impulsivity, and improved mood regulation (Bidzan-Bluma & Lipowska, 2018).

Effect Sizes

Effect size analysis (Cohen's d) revealed large effects for aerobic fitness ($d = 0.85$) and behavioral regulation ($d = 0.91$), and moderate-to-large effects for muscular strength ($d = 0.71$) and flexibility ($d = 0.53$). These findings underscore the practical significance of fitness interventions, beyond statistical significance, and demonstrate the potential for real-world application in school and therapeutic contexts.

Theoretical Implications

This study contributes to the growing body of evidence supporting the neurocognitive model of physical activity, which posits that exercise enhances brain function through increased cerebral blood flow, neurotransmitter regulation, and neurotrophic factor release (Hillman et al., 2019). By demonstrating comparable improvements across ADHD and ASD groups, the study supports a transdiagnostic framework where physical fitness enhances self-regulation through common neural substrates, particularly the prefrontal cortex.

Practical Implications

Educational Settings: Incorporating structured fitness activities into school curricula may enhance classroom behavior, attention, and learning outcomes among neurodiverse students. **Clinical Interventions:** Physical fitness programs can complement behavioral therapies and pharmacological treatments, offering a holistic approach to ADHD and ASD management. **Parental Involvement:** Parents can be encouraged to support regular physical activity at home, fostering consistent improvements in fitness and behavioral outcomes. **Policy Development:** Educational and health policies should prioritize physical fitness programs as accessible, cost-effective interventions for children with developmental disorders.

Limitations

Sample Size: Although adequate for detecting medium-to-large effects, the relatively small sample ($N = 60$) limits generalizability. **Measurement Tools:** Reliance on standardized fitness and behavioral assessments may not capture all dimensions of self-regulation (e.g., emotional regulation in real-life contexts). **Duration of Intervention:** The study measured short-term effects; long-term sustainability of outcomes remains uncertain. **Contextual Factors:** Cultural, familial, and educational contexts may influence the generalizability of findings across different populations.

Recommendations

For Practice: Integrate structured fitness sessions (aerobic, strength, and flexibility training) into individualized education plans (IEPs) for children with ADHD and ASD. Encourage multi-disciplinary collaboration between teachers, therapists, and fitness instructors. **For Policy:** Develop national guidelines recommending minimum levels of physical activity tailored to children with developmental disorders. Provide funding and infrastructure support for inclusive school-based fitness programs. **For Research:** Conduct longitudinal studies to examine long-term maintenance of behavioral regulation gains. Explore neurobiological mechanisms (e.g., fMRI studies) to deepen understanding of fitness–cognition links. Investigate moderators such as gender, socioeconomic status, and co-occurring conditions.

Conclusion

This study demonstrates that physical fitness plays a significant role in enhancing behavioral regulation among children with ADHD and ASD. The intervention improved aerobic fitness, muscular strength, flexibility, and, critically, behavioral regulation. Findings revealed large effect sizes and robust correlations, supporting the integration of physical fitness as a core component of therapeutic and educational programs for neurodiverse children. By establishing physical fitness as a low-cost, scalable, and effective intervention, this study contributes to a paradigm shift toward holistic management strategies that move beyond symptom reduction to fostering resilience, autonomy, and quality of life for children with developmental disorders.

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