Multidisciplinary Journal of Tourism, Hospitality, Sport and Physical Education
Vol. 3, No. 1, June 2026, pp. 162~172
ISSN: 3062-9551, DOI: 10.37251/jthpe.v3i1.3262

Physical Activity Interventions for Behavioral and Cognitive Development in Children with Attention Deficit Hyperactivity Disorder

Agusniwati[1], Jayantha Kalansooriya[2], Aynel Veyselova[3]
[1]Department of Sports Science, Sebelas Maret University, Surakarta, Indonesia
[2]Department of Sport Science and Physical Education, University of Kelaniya, Kelaniya, Sri Lanka
[3]Department of Physical Education and Sport Science, Azerbaijan State Academy of Physical Education and Sport, Baku, Azerbaijan

Article Info

Article history:

Received Mar 2, 2026
Revised Apr 22, 2026
Accepted Jun 19, 2026
Online First Jun 23, 2026

Keywords:

Attention Deficit Hyperactivity Disorder
Physical Education
Physical Activity
Sports Therapy
Special Needs Children

ABSTRACT

Purpose of the study: This study aims to explore how structured physical activity and adaptive physical education can support behavioral, cognitive, motor, and social development in children with Attention Deficit Hyperactivity Disorder in a special needs school setting.

Methodology: This study employed a qualitative case study design using a life story approach at Bina Anak Bangsa Special Needs School, Pontianak, Indonesia. Participants included three children with Attention Deficit Hyperactivity Disorder and six informants. Data were collected through interviews, observation, and documentation, and analyzed using the Miles and Huberman interactive model of qualitative analysis.

Main Findings: The findings showed that structured and consistent physical activities improved concentration, emotional regulation, motor coordination, and social interaction in children with Attention Deficit Hyperactivity Disorder. Individualized mentoring, guided play, and structured exercise routines were more effective than large-group activities. The results also indicated that continuous physical engagement helped stabilize behavior and enhanced children's ability to follow instructions and participate in learning activities.

Novelty/Originality of this study: This study highlights an integrated physical education and sports-based therapeutic approach for children with Attention Deficit Hyperactivity Disorder in special education settings. It emphasizes collaboration between teachers, coaches, parents, and psychologists in designing structured physical activity programs. The novelty lies in positioning adaptive physical activity as a coordinated non-pharmacological intervention supporting behavioral, motor, and cognitive development.

This is an open access article under the CC BY license

Corresponding Author:
Agusniwati,
Department of Sport Science, Faculty of Sports and Health, Universitas Sebelas Maret, Jl. Ir. Sutami No. 36A, Kentingan, Jebres, Surakarta, Central Java, 57126, Indonesia
Email: agusniwati1@gmail.com

1. INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most frequently diagnosed behavioral and neurodevelopmental disorders among school-age children worldwide. Over the past three decades, the prevalence of ADHD has been estimated at approximately 3–7% of children, with variations across countries and regions. In Indonesia, ADHD has become one of the most common behavioral disorders encountered in pediatric and child psychology practices, affecting approximately 5% of school-age children [1], [2]. Clinically, ADHD is

characterized by persistent symptoms of inattention, hyperactivity, and impulsivity that interfere with children's academic achievement, social relationships, emotional regulation, and daily functioning [3]–[10].

Children with ADHD experience challenges beyond classroom learning difficulties. They frequently encounter problems related to behavioral control, emotional regulation, social interaction, and motor coordination, which may negatively influence their long-term developmental outcomes if appropriate interventions are not provided [7]–[10]. Although pharmacological treatment, particularly stimulant medication, remains one of the primary approaches for managing ADHD symptoms, concerns regarding side effects, long-term dependency, and limited effects on social and functional development have encouraged researchers to investigate alternative non-pharmacological interventions [15]–[17].

Physical activity and physical education have increasingly been recognized as potential complementary interventions for children with ADHD. Previous studies have shown that structured physical activities can improve executive function, attention regulation, emotional stability, motor coordination, and social participation [18]–[23]. Physical education environments also provide opportunities for children with ADHD to develop discipline, cooperation, sensory-motor skills, and adaptive behaviors through meaningful movement experiences [24]–[26]. Therefore, physical activity should not only be viewed as recreational exercise but also as an educational and therapeutic approach supporting holistic child development [31], [32].

The urgency of this study is based on the increasing need for sustainable, school-based, and evidence-informed interventions that support children with ADHD beyond symptom reduction. Although physical activity has demonstrated positive effects on cognitive and behavioral outcomes, many special education settings, particularly in developing countries, still face challenges related to limited facilities, insufficient teacher preparation, and the absence of structured adaptive physical activity programs specifically designed for children with ADHD [37]. These challenges highlight the importance of developing practical intervention models that can be implemented within real educational environments.

The research gap identified in this study is that previous investigations have predominantly focused on short-term exercise interventions, clinical therapy settings, or quantitative measurements of ADHD symptoms. Limited research has examined how adaptive physical education functions as a sustainable therapeutic intervention within daily school activities, particularly in special needs schools in developing countries [33], [34]. Furthermore, qualitative studies exploring the lived experiences of children with ADHD during structured physical activity participation remain relatively scarce [35], [36]. Consequently, a deeper understanding is still needed regarding how physical activity interventions influence children's behavioral adaptation, emotional responses, social interaction, and developmental experiences in authentic school contexts.

The need to address this gap is particularly relevant in developing educational contexts such as Indonesia, Sri Lanka, and Azerbaijan. Indonesia continues to develop adaptive physical education practices but faces challenges related to teacher competence, resources, and structured intervention programs for children with developmental disorders [37]. Sri Lanka encounters similar challenges regarding awareness, educational support systems, and implementation of school-based ADHD interventions [38]. Meanwhile, Azerbaijan has demonstrated increasing attention toward sports science and physical education development, although research focusing specifically on adaptive physical activity for children with ADHD remains limited [39], [40]. These differences provide valuable opportunities for understanding how physical activity interventions may function across diverse educational and cultural settings.

The novelty of this study lies in presenting an integrated physical education and sports-based therapeutic approach for children with ADHD through a qualitative life story case study in a special needs school setting. Unlike previous studies that primarily evaluate exercise effectiveness through symptom-based outcomes, this study explores children's lived experiences and developmental changes across behavioral, cognitive, motor, and social dimensions. In addition, the involvement of researchers from Indonesia, Sri Lanka, and Azerbaijan provides a broader cross-cultural perspective regarding the implementation of adaptive physical activity interventions in different developing-country contexts.

The objective of this study is to explore how structured physical activity and adaptive physical education function as therapeutic interventions for children with ADHD in a special needs school setting. Specifically, this study aims to examine children's behavioral experiences, emotional responses, social interactions, motor development, and participation changes during structured physical activity programs. The findings are expected to contribute to the development of adaptive physical education practices and provide practical recommendations for teachers, parents, therapists, and policymakers in designing sustainable school-based interventions for children with ADHD.

2. RESEARCH METHOD

2.1 Type of Research

This research uses a qualitative approach with a life story-based case study design. Quantitative research method is a research method conducted on a collection of samples using certain instruments to collect data and

analyze [41]. This design was chosen based on the need to deeply understand the real-life experiences of children with ADHD in the context of physical education and sport, a phenomenon that is highly personal, contextual, and cannot be reduced to numbers or statistics without losing its most essential dimensions of meaning. The life story approach allows researchers to capture narratives of experiences from multiple, complementary perspectives: the child's own perspective (through behavioral observations), the teacher's perspective, the coach's perspective, and the psychologist's perspective. The four data validity criteria developed by Lincoln and Guba were applied in this study: (1) credibility, strengthened through triangulation of data from multiple sources; (2) transferability, met through a detailed and thorough description of the research context; (3) dependability, maintained through a documented audit trail; and (4) confirmability, achieved through confirmation of findings with key informants.

2.2 Population and Sample

The participants of this study were selected using purposive sampling based on several criteria: (1) children formally diagnosed with ADHD by medical or psychological professionals, (2) active participation in school physical education and sports activities, and (3) recommendations from teachers and psychologists regarding the participants' involvement in adaptive physical education programs. This selection approach is consistent with previous studies emphasizing the importance of contextual participant selection and multidisciplinary collaboration in investigating physical activity interventions for children with ADHD in educational settings [33], [34].

The study involved three children with ADHD whose identities were anonymized using initials to maintain confidentiality:

1. NVL (female, Grade IV), diagnosed with ADHD and Cerebral Motor Dysfunction (CMD);
2. JDD (male, Grade VI), diagnosed with hyperactive-impulsive ADHD; and
3. RSS (male, Grade VIII), diagnosed with ADHD accompanied by emotional dysregulation.

In addition, six key informants participated in this study, consisting of classroom teachers, a physical education teacher, a sports coach, and a child psychologist who directly interacted with the participants in educational and therapeutic settings.

2.3 Data Collection Technique

Data were collected using three complementary techniques within a triangulation framework: in-depth interviews, participant observation, and documentation. First, semi-structured in-depth interviews were conducted with all key informants using open-ended interview guidelines developed based on the objectives of the study. The interviews explored participants' experiences, behavioral changes, learning responses, and perceptions regarding the role of physical activity in managing ADHD symptoms. All interviews were audio-recorded with participants' consent and transcribed verbatim for analysis. Second, participant observation was conducted during physical education classes, sports training sessions, and daily school activities [42]. The researchers systematically observed children's concentration, emotional regulation, motor coordination, interaction patterns, and responses to instructions during physical activities. Field notes were recorded after each observation session. Third, documentation was collected in the form of psychological reports, school development records, photographs, and activity recordings to support data triangulation and strengthen the credibility of findings.

2.4 Data Analysis Technique

Data analysis in this study followed the interactive analysis model proposed by Miles and Huberman, consisting of four interconnected stages: data collection, data reduction, data display, and conclusion drawing/verification. During the data reduction stage, interview transcripts, field notes, and documentation were coded and categorized into several themes related to concentration improvement, emotional regulation, hyperactivity management, motor coordination, social interaction, and adaptive physical education strategies. The thematic categorization was supported by previous studies emphasizing the importance of examining behavioral, cognitive, motor, and social dimensions when evaluating physical activity interventions for children with ADHD [35], [43]. The categorized data were then organized into thematic displays to facilitate interpretation and comparison across participants and informants. The final stage involved drawing conclusions and continuously verifying findings through repeated examination of the data to ensure consistency and accuracy throughout the analysis process.

3. RESULTS AND DISCUSSION

3.1 Behavioral Profile and Characteristics of Children with ADHD

The three study subjects exhibited ADHD behavioral patterns consistent with the clinical descriptions in the DSM-5, but with unique expressions for each individual. NVL (female, grade IV) displayed a profile primarily characterized by symptoms of poor concentration and low focus, although she was not physically aggressive. JDD (male, grade VI) displayed a combination of moderate hyperactivity symptoms with significant difficulty

concentrating in structured learning activities. RSS (male, grade VIII) exhibited the most complex manifestation of ADHD, characterized by intense hyperactivity, high impulsivity, and emotional dysregulation that can lead to aggressive behavior if not managed appropriately.

Systematic field observations identified seven consistent behavioral patterns across the three subjects across various activity contexts: (a) difficulty maintaining attention for more than a few minutes on a single stimulus; (b) excessive, seemingly incessant motor movements even in the absence of external stimuli; (c) verbal and physical impulsivity manifested by a tendency to act without considering consequences; (d) being easily distracted by irrelevant environmental stimuli; (e) a tendency to seek attention from teachers and peers; (f) frustration that is quickly triggered when facing tasks that require patience; and (g) difficulty following long or layered instructions.

Table 1. Profile Behavior Third Subject of ADHD Children

Dimensions Behavior	NVL (P, Class IV)	JDD (L, Class VI)	RSS (L, Class VIII)
ADHD Types	Inat + Hyperactive	Hyperactive	Hyperactive + Emotional
Hyperactivity Level	Currently	Medium–High	Tall
Power of concentration	Low	Low – Medium	Very Low
Interaction Social	Pretty good	Pretty good	Difficult to Manage
Emotional Control	Relatively Stable	Relatively Stable	Difficult to Control
Response to Instructions	Slow, Need Repetition	Medium, Can Follow	Low, Easy Distracted
Sports Interest	Yes, Need Directed	Badminton	Badminton, Activities Free

The data presented in Table 1 indicate clear individual differences in the behavioral profiles of the three children with ADHD across cognitive, emotional, and behavioral dimensions. NVL shows relatively milder manifestations dominated by inattention, while maintaining fairly stable social interaction and emotional control. JDD demonstrates moderate hyperactivity with better instructional responsiveness, although attention difficulties remain evident during structured tasks. In contrast, RSS exhibits the most severe and complex profile, particularly in terms of hyperactivity, impulsivity, and emotional regulation, which significantly affects his classroom behavior and responsiveness to instructions. Overall, the findings highlight the heterogeneity of ADHD manifestations among school-aged children, emphasizing the need for individualized educational and behavioral approaches.

3.2 Physical Activity as a Channel for Hyperactive Energy

One of the most consistent findings of this research is the ability of physical activity to act as a constructive "release valve" for the hyperactive energy of children with ADHD. Physical education teacher Mr. J. explained this mechanism very clearly: Physical activity reflects physical fitness, and this is also what must be developed in children with ADHD. Therefore, it is very important to guide them in activities, so that the tendency of children with ADHD to develop habits such as restlessness, irritability, and poor concentration will be reduced [43], [44].

This statement reflects a well-documented neurobiological principle: children with ADHD experience a surplus of motor energy that, if not channeled through directed physical activity, will be expressed through disruptive behavior in the classroom. When this energy is channeled through structured exercise, two mutually reinforcing processes occur: the release of excess physical energy and an increase in neurotransmitter levels that support attention and mood regulation. NVL's homeroom teacher confirmed this impact from direct observation: "After participating in sports activities, NVL became more manageable.

3.3 Impact of Physical Education on Concentration and Focus

The second significant finding relates to the positive impact of physical activity on the concentration and focus abilities of children with ADHD. Field observations showed that after the exercise session, all three study subjects displayed relatively calmer behavior, were more responsive to instructions, and were better able to maintain attention on a single task, although the duration of this improvement was temporary and varied among individuals.

This post-physical activity improvement in concentration aligns with the findings of an international study published in the Journal of Pediatrics, which found that children with ADHD demonstrated significant improvements in cognitive performance and the ability to maintain focus after 20 minutes of moderate aerobic exercise. Neurologically, physical exercise increases blood flow to the prefrontal cortex and stimulates the release of Brain-Derived Neurotrophic Factor (BDNF), a protein that supports synaptic plasticity and memory consolidation. Psychologist Mrs. Yulia Ekawati Tasbita, S.Psi., describes this mechanism in more practical terms: "Therapy in the form of sports is very good because they focus on one child who will be treated, and sports activities are something fun for children with ADHD because they feel free to play and can also learn."

Table 2. Comparison of ADHD Children's Behavior Before and After Physical Activity

Dimensions Behavior	Before Physical Activity	After Physical Activity
Hyperactivity Level	Very high, undirected movement	Relatively less , more directed
Power of concentration	Very low, easy switch	Improved, able to focus longer
Response to Instructions	Difficult to follow, needs to be repeated many times	More responsive and cooperative
Emotional Regulation	Easy, frustrated, and aggressive	More calm and controlled
Interaction Social	Bother friends, impulsive	More can Work The same
Motor Coordination	Movement no controlled	Coordination getting better in a way gradually

The comparison presented in Table 2 demonstrates a consistent improvement in behavioral functioning among children with ADHD following participation in physical activity. Across all observed dimensions, there is a noticeable reduction in hyperactivity and impulsivity, accompanied by improved concentration, emotional regulation, and responsiveness to instructions. Social interaction also appears more adaptive, with reduced disruptive behavior and better cooperative engagement with peers. Additionally, motor coordination shows gradual improvement, indicating a short-term positive activation effect of physical exercise on both cognitive and behavioral control systems. Overall, these findings suggest that physical activity has an immediate but temporary beneficial influence on attentional and self-regulation capacities in children with ADHD.

3.4 Effective Treatment Strategies in Adaptive Physical Education for ADHD

This research identified several treatment strategies that have proven effective in assisting children with ADHD during physical education and sports sessions. First, individualized mentoring (one-on-one approach) was consistently reported to be more effective than large group settings. A JDD homeroom teacher asserted, "If these children are coached and treated, they can follow along. For example, if we focus on this one child and give them therapy, it might be very helpful for that child, but if it's a hands-off system like this, they tend to be disorganized. This individualized approach allows the teacher or coach to provide tailored instruction, immediate feedback, and specific behavioral corrections.

Second, directed play methods have been proven to be more effective than rigid formal instruction. Psychologists recommend: "Teach children first to focus, for example, playing basketball, so the child is taught to concentrate and must be able to control their body and movements to put the ball in the basket. So we teach focus on one game first, whether the child can do the game correctly, and then we replace it with another game. This progressive approach is in line with the scaffolding principle in Vygotsky's theory, providing necessary support at the initial stage and gradually reducing it as the child's abilities increase.

Third, providing specific and immediate praise whenever a child successfully completes a task, no matter how small, is crucial for building self-confidence and maintaining motivation. Fourth, sport selection should take into account the child's individual preferences and interests. For example, RSS, who has a spontaneous interest in badminton, shows significantly better performance and engagement when training focuses on that sport.

Table 3. Effective Strategies in Adaptive Physical Education for Children with ADHD

No.	Strategy	Description	Source
1	Individual Mentoring	1-on-1 sessions or group small (2–3 people) for maximize focus and response to instructions	ST, YET
2	Play Directed	A game-based sport that is fun but has clear rules and specific goals.	JL, YET
3	Instructions Short & Concrete	Avoid long instructions; use short sentences with direct demonstrations.	JL
4	Specific & Immediate Praise	Provide specific positive feedback immediately after the desired behavior occurs.	WF
5	Routine Structured	Exercise sessions with a consistent sequence of activities to reduce anxiety and increase predictability.	JL
6	Repetitive Practice	Regularly repeated movements build motor memory and strengthen neural connections.	JL, YET
7	Children's Interests as a Guide	Choose a sport based on your child's interests and spontaneous tendencies to maximize involvement.	GMJ, ED

The strategies presented in Table 3 highlight several key approaches in adaptive physical education that are effective for supporting children with ADHD. Overall, the findings emphasize that individualized and structured interventions are the most impactful, particularly through one-on-one mentoring and small-group

instruction that allow for closer supervision and immediate feedback. Game-based or directed play approaches further enhance engagement by making learning more enjoyable while still maintaining clear behavioral and instructional goals. In addition, the use of short and concrete instructions, along with immediate and specific praise, plays a crucial role in sustaining attention and reinforcing positive behavior. The importance of routine structure and repetitive practice also emerges as a key factor in improving behavioral consistency and motor learning. Finally, aligning physical activities with children's interests is shown to significantly increase motivation, participation, and overall effectiveness of the intervention.

3.5 Factors Influencing the Behavior of Children with ADHD in Physical Activities

Data analysis identified two groups of factors that significantly influence the quality of behavior of children with ADHD during physical education sessions: factors that support positive behavior and factors that trigger negative behavior. Understanding these two groups of factors is crucial for teachers and coaches in designing optimal learning environments.

Factors supporting positive behavior include: the availability of outdoor green space that allows freedom of movement without physical constraints that create frustration; activities that involve sustained, high-intensity movement; the presence of peers who can serve as behavioral models; and positive appreciation and attention from teachers or coaches [45], [46]. Observations showed that the three study subjects displayed significantly more controlled behavior when in an outdoor field than in a classroom or even an indoor gym.

Conversely, factors that trigger negative behavior include: irrelevant environmental stimuli that reflexively attract attention (e.g., a passing butterfly, an unexpected sound, or a passing airplane); situations that require prolonged waiting; instructions that are too long or complex; poorly facilitated social interactions; and a lack of clear structure in activities. Understanding these triggers allows teachers to proactively modify the environment, rather than simply reacting when problem behavior occurs.

3.6 Physical Education and Sport as Alternative Therapy: A Critical Evaluation

All informants in this study, including homeroom teachers, physical education teachers, sports coaches, and psychologists, consistently expressed their belief that physical education and sports can serve as an alternative or complementary therapy for children with ADHD. These findings also reflect broader challenges experienced in several developing countries represented by the international collaboration in this study. In Indonesia, adaptive physical education programs for children with ADHD are still constrained by limited facilities and insufficient teacher training. Similar conditions are reported in Sri Lanka, where awareness and school-based therapeutic interventions for ADHD remain limited, particularly in public schools with restricted educational resources. Meanwhile, Azerbaijan has increasingly promoted physical education and sports science development, although research concerning adaptive physical education for children with ADHD is still relatively underexplored. Therefore, the present findings contribute not only to the Indonesian context but also to international discussions regarding affordable and school-based non-pharmacological interventions for ADHD management in developing educational systems. Physical education teachers estimated a 50–70% effectiveness rate in reducing the intensity of ADHD symptoms, particularly those related to hyperactivity and attention deficit, if implemented routinely and consistently [47], [48].

Psychologists provide a more technical explanation of how it works: "In therapy for children with ADHD, there is behavioral therapy or sensory integration, which is actually a form of exercise. Because hyperactive children's gross motor skills are good, but their fine motor skills are very lacking [49]. Fine motor skills require children to concentrate, while children with ADHD have poor concentration [50], [51]. If we can improve gross motor skills, it will indirectly help fine motor skills. This statement reflects an understanding of the importance of developing sensory integration as a foundation for the development of higher cognitive skills [52].

However, this study also identified several limitations and prerequisites that must be met for exercise interventions to be effective. First, the frequency of physical activity must be adequate a JDD homeroom teacher noted that physical education held only once a week in schools "is not very effective for training children with ADHD. Second, the sustainability of the program beyond school hours which involves the active participation of parents and families is crucial for its long-term impact. Third, educators working with children with ADHD must have specialized competencies and a deep understanding of the characteristics of the disorder.

Table 4. Types of Sports Recommended for Children with ADHD

Types of Sports	Main Benefits	Recommendation Level	Notes
Swimming	Controlled environment, high sensory stimulation, training focus on repetitive movements	★★★★★	Example : Michael Phelps
Martial arts	Cultivate discipline, self-control, consistent rituals, and concentration.	★★★★★	Need instructor trained

Types of Sports	Main Benefits	Recommendation Level	Notes
Yoga	Reduce hyperactivity, train breathing, improve sleep quality, and concentration	★★★★☆	In accordance with all ages
Tai Chi	Moving meditation, training focus, reducing impulsivity, and anxiety	★★★★☆	6- week study: hyperactivity reduces
Badminton	Eye contact, hand-eye coordination, quick reactions, and high enthusiasm in children with ADHD	★★★★☆	In accordance with RSS & JDD interest
Football	Practice teamwork, social skills, and channel hyperactive energy	★★★☆☆	Need mentoring intensive
Basketball	Train coordination, concentration on targets, and cooperation in small groups.	★★★☆☆	Choose group small

The findings presented in this section suggest that physical education and sport can be positioned as a viable complementary or alternative intervention for children with ADHD, particularly within school-based settings in developing countries. The perspectives of teachers, coaches, and psychologists consistently indicate that structured physical activity contributes to reductions in hyperactivity and improvements in attention regulation, although its effectiveness is influenced by program consistency, institutional support, and teacher competence. Despite these positive indications, several structural limitations remain, including limited frequency of physical education sessions and the lack of sustained involvement from families outside school.

In addition, the recommended types of sports in Table 4 highlight that activities involving structured movement, sensory engagement, and clear rules, such as swimming, martial arts, yoga, and tai chi, tend to be most beneficial for regulating attention, emotion, and motor control in children with ADHD. Team-based sports such as football and basketball also provide social and coordination benefits, although they require more intensive guidance to maintain focus and behavioral control. Overall, the evidence underscores that sport-based interventions are most effective when they are individualized, consistent, and aligned with both therapeutic goals and children's interests.

3.7 Functional Aspects of Physical Education Relevant for Children with ADHD

This study identified six functional aspects of physical education that are directly relevant to the developmental needs of children with ADHD. These six aspects are not only theoretically relevant but also reflected in empirical experiences observed during field research.

The organic aspect relates to increasing physiological capacity, strength, endurance, flexibility, and cardiovascular fitness, which provide a physical foundation for improved motor function [53]. The neuromuscular aspect encompasses the development of harmony between nerve and muscle function, including locomotor skills (walking, running, jumping) and manipulative skills (catching, throwing, kicking) [54], [55]. For children with ADHD, optimal neuromuscular development is crucial because it directly relates to the ability to control body movements, which has historically been a major challenge [56], [57].

The perceptual aspect is particularly relevant to the inattention symptom of ADHD, developing the ability to receive and differentiate environmental cues, improving visual-motor coordination, and building body-spatial awareness [58]. The cognitive aspect encompasses the development of the ability to understand rules, make decisions, and use strategies in physical activities, skills that directly transfer to academic contexts. The social aspect is critical, given the social isolation often experienced by children with ADHD [59]. Sports provide a natural context for practicing cooperation, communication, and negotiation with peers [60]. Finally, the emotional aspect fosters healthy responses to wins and losses and provides a safe outlet for expressing frustration and anger, highly relevant to the emotional regulation needs of children with ADHD.

3.8 The Importance of a Synergistic Treatment Ecosystem

Perhaps the most important yet often overlooked finding in discussions about ADHD treatment is the importance of synergy between all stakeholders in the child's ecosystem: school, family, and community. A physical education teacher emphasized: "What we teach in therapy should also be carried out by the child's family and parents at home to ensure a positive collaboration for behavior and recovery throughout the child's adulthood. This statement underscores that no single intervention, including sports, no matter how good, can have an optimal impact if it is not supported by consistency across the various environments a child lives in.

This study proposes a sports-based ADHD management ecosystem model involving four main components that must operate synergistically: (1) schools, providing structured adaptive physical education programs implemented by competent teachers; (2) families, continuing and strengthening physical activity at home and maintaining consistent eating and sleeping patterns; (3) communities, providing access to sports facilities and clubs

that are friendly to children with special needs; and (4) professional doctors, psychologists, and therapists who monitor progress and adjust programs continuously based on the child's individual response.

The novelty of this study lies in the development of a school-based sports and physical education ecosystem model that positions physical activity not merely as an exercise intervention but as an integrated, complementary therapeutic approach for children with ADHD. Unlike previous studies that have mainly focused on isolated exercise programs, short-term interventions, or clinical treatment settings, this study demonstrates how adaptive physical education can be integrated with family involvement, community support, and professional collaboration to support behavioral, cognitive, motor, and social development. Furthermore, the qualitative perspectives obtained from teachers, coaches, and psychologists provide deeper insight into the practical implementation of sport-based interventions within developing educational contexts.

The implications of this study are significant for educational and therapeutic practices. The findings indicate that physical education should be considered not only as a curriculum component but also as a supportive intervention strategy for children with ADHD. Schools are encouraged to develop structured adaptive physical education programs supported by competent teachers and appropriate facilities, while families and communities should actively maintain physical activity participation beyond school settings. In addition, policymakers and educational stakeholders should strengthen teacher training, interdisciplinary collaboration, and access to inclusive sports programs to improve comprehensive ADHD support systems.

The limitations of this study should also be acknowledged. The involvement of only three children with ADHD from a single special needs school limits the transferability of findings to broader populations. Furthermore, the qualitative case study design provides rich contextual understanding but does not allow causal conclusions regarding the effectiveness of physical activity interventions. The study also did not include standardized quantitative symptom measurements or long-term follow-up evaluations. Future research should therefore involve larger samples, multiple educational settings, longitudinal designs, and mixed-method approaches to further examine the effectiveness, sustainability, and scalability of sport-based interventions for children with ADHD.

4. CONCLUSION

This research convincingly strengthens the argument that physical education and sport are not merely recreational activities that complement the curriculum of special needs schools, but rather therapeutic intervention modalities with a strong neurobiological basis and significant clinical impact for children with ADHD. Evidence gathered from the field at SBK Bina Anak Bangsa Pontianak shows that structured, consistent, and individually designed physical activity can: (a) reduce the intensity of hyperactivity by channeling excess energy constructively; (b) improve concentration and focus, although this is temporary and requires ongoing stimulation; (c) strengthen gross motor coordination as a foundation for fine motor development; (d) encourage the development of social skills through collaborative play and exercise; and (e) increase the self-confidence and positive self-image of children with ADHD, which are often impacted by repeated failures.

The critical findings of this research also reveal that the effectiveness of exercise interventions for ADHD is highly dependent on three key prerequisites: adequate frequency (more than once a week), individual or small-group support by competent personnel, and program sustainability supported by synergy between the school and family. Without these three prerequisites, the potential benefits of exercise as a therapy will be far from optimal.

Based on the findings, schools are recommended to implement structured physical activity programs for children with Attention Deficit Hyperactivity Disorder at least two to three times per week using small-group or individualized formats. Teachers and physical education instructors should receive specific training in adaptive physical education strategies to ensure appropriate task modification and student engagement. Furthermore, collaboration between schools, parents, and health professionals should be strengthened to ensure continuity of intervention beyond the classroom, thereby maximizing behavioral and cognitive benefits.

ACKNOWLEDGEMENTS

The authors extend their deepest appreciation to academic supervisors, colleagues, and reviewers for their constructive feedback, guidance, and encouragement during the preparation of this research. Gratitude is further conveyed to the affiliated institution for providing academic support and research facilities that greatly assisted the completion of this study.

AUTHOR CONTRIBUTIONS

Conceptualization, A.; Methodology, A., J.K., and A.V.; Investigation, A.; Data Collection, A.; Formal Analysis, A. and J.K.; Data Curation, A.; Interpretation of Findings, J.K. and A.V.; Writing – Original Draft Preparation, A.; Writing – Review & Editing, J.K. and A.V.; Visualization, A.; Supervision, J.K. and A.V.; Project Administration, A. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

REFERENCES

[1] F. Sun *et al.*, "Structured physical exercise interventions and children and adolescents with attention deficit hyperactivity disorder: A systematic review and meta-analysis," *Child. Care. Health Dev.*, vol. 50, no. 1, pp. 1-18, 2024, doi: 10.1111/cch.13150.

[2] Y.-S. Chan, J.-T. Jang, and C.-S. Ho, "Effects of physical exercise on children with attention deficit hyperactivity disorder," *Biomed. J.*, vol. 45, no. 2, pp. 265–270, 2022, doi: 10.1016/j.bj.2021.11.011.

[3] D. Li, D. Wang, W. Cui, J. Yan, W. Zang, and C. Li, "Effects of different physical activity interventions on children with attention-deficit/hyperactivity disorder: A network meta-analysis of randomized controlled trials," *Front. Neurosci.*, vol. 17, pp. 1-17, 2023, doi: 10.3389/fnins.2023.1139263.

[4] R. Zheng, S. Huang, J. Yang, P. Zhao, and E. Li, "The therapeutic effects of physical activity on children with attention deficit hyperactivity disorder: A systematic review and meta-analysis," *Medicine (Baltimore).*, vol. 104, no. 16, pp. 1-8, 2025, doi: 10.1097/MD.0000000000042063.

[5] M. Y. I. Baamer, "Symptoms of attention deficit hyperactivity disorder and emotional behavioral problems: The mediating effect of executive function," *Appl. Neuropsychol. Child*, vol. 13, no. 1, pp. 1–7, 2025, doi: 10.1080/21622965.2025.2485418.

[6] G. Özyurt, E. Karagöz Tanıgör, B. Ş. Buran, Y. Öztürk, A. E. Tufan, and A. Akay, "Similarities and differences of neuropsychological functions, metacognitive abilities and resilience in Cognitive Disengagement Syndrome (CDS) and Attention Deficit/Hyperactivity Disorder (ADHD)," *Appl. Neuropsychol. Child*, vol. 15, no. 1, pp. 21–32, 2026, doi: 10.1080/21622965.2024.2358239.

[7] W. Sun, M. Yu, and X. Zhou, "Effects of physical exercise on attention deficit and other major symptoms in children with ADHD: A meta-analysis," *Psychiatry Res.*, vol. 311, pp. 1-9, 2022, doi: 10.1016/j.psychres.2022.114509.

[8] B. Seiffer, M. Hautzinger, R. Ulrich, and S. Wolf, "The efficacy of physical activity for children with attention deficit hyperactivity disorder: a meta-analysis of randomized controlled trials," *J. Atten. Disord.*, vol. 26, no. 5, pp. 656–673, 2022, doi: 10.1177/10870547211017982.

[9] O. KayaKara, B. Kose, S. Y. Cetin, S. Sahin, and K. Kara, "Community participation, supports and barriers of adolescents with and without attention deficit hyperactivity disorder," *Phys. Occup. Ther. Pediatr.*, vol. 44, no. 3, pp. 380–397, 2024, doi: 10.1080/01942638.2023.2253899.

[10] J. Schein *et al.*, "Economic burden of attention-deficit/hyperactivity disorder among children and adolescents in the United States: a societal perspective," *J. Med. Econ.*, vol. 25, no. 1, pp. 193–205, 2022, doi: 10.1080/13696998.2022.2032097.

[11] G. de Brito Porfirio, M. do Carmo Bardella, M. M. Oliani, and C. de Moraes, "The impact of physical activity on cognitive, behavioral, and academic performance in children with ADHD: A systematic review," *Dement. Neuropsychol.*, vol. 20, pp. 1-8, 2025, doi: 10.1590/1980-5764-dn-2025-0339.

[12] Z. Huang, L. Li, Y. Lu, J. Meng, and X. Wu, "Effects of rope skipping exercise on working memory and cardiorespiratory fitness in children with attention deficit hyperactivity disorder," *Front. Psychiatry*, vol. 15, pp. 1-11, 2024, doi: 10.3389/fpsyt.2024.1381403.

[13] D. D. Le, T. K. C. Nguyen, T. H. Le, and T. D. Ngo, "The use of eye-tracking technology in supporting children and adolescents with attention deficit/hyperactivity disorder: A comprehensive review," *Disabil. Rehabil. Assist. Technol.*, vol. 20, no. 5, pp. 1296–1323, 2025, doi: 10.1080/17483107.2025.2497305.

[14] L. A. Canty, A. Bhopti, and L. M. Carey, "Identifying developmental coordination disorder in children with attention-deficit/hyperactivity disorder: An evidence-based decision tree tool for occupational therapy clinicians," *J. Occup. Ther. Sch. Early Interv.*, vol. 16, no. 4, pp. 466–479, 2023, doi: 10.1080/19411243.2022.2112363.

[15] F. B. Hosseini, S. Ghorbani, and R. Rezaeeshirazi, "Effects of perceived autonomy support in the physical education on basic psychological needs satisfaction, intrinsic motivation and intention to perform physical activity in high school students," *Int. J. Sch. Heal.*, vol. 7, no. 4, pp. 39–46, 2020, doi: 10.30476/intjsh.2020.88171.1106.

[16] F. Montalva-Valenzuela, O. Andrades-Ramírez, and A. Castillo-Paredes, "Effects of physical activity, exercise and sport on executive function in young people with attention deficit hyperactivity disorder: a systematic review," *Eur. J. Investig. Heal. Psychol. Educ.*, vol. 12, no. 1, pp. 61-75, 2022, doi: 10.3390/ejihpe12010006.

[17] R. E. Caraka *et al.*, "Big data analytics for uncovering voxel connectivity patterns in attention deficit hyperactivity disorder," *J. Multidiscip. Healthc.*, vol. 18, pp. 4411–4430, 2025, doi: 10.2147/JMDH.S523137.

[18] A. Martín-Rodríguez, S. Herrero-Roldán, and V. J. Clemente-Suárez, "The role of physical activity in ADHD management: diagnostic, digital and Non-Digital interventions, and lifespan considerations," *Children*, vol. 12, no. 3, pp. 1-29, 2025, doi: 10.3390/children12030338.

[19] D. Bores-Garcia, D. Palacios-Cena, C. Jimenez-Antona, and R. Marconnot, "The meaning of physical education practice in students with attention-deficit hyperactivity disorder (ADHD)," *Res. Q. Exerc. Sport*, vol. 95, no. 3, pp. 656–663, 2024, doi: 10.1080/02701367.2023.2294097.

[20] K. B. Metcalfe, C. D. McFeaters, and D. Voyer, "Time-perception deficits in attention-deficit/hyperactivity disorder: A systematic review and meta-analysis," *Dev. Neuropsychol.*, vol. 49, no. 1, pp. 1–24, 2024, doi: 10.1080/87565641.2023.2293712.

[21] S. Skalidou, A. Anestis, N. Bakolas, G. Tsoulfa, and K. Papadimitriou, "Swimming activity alleviates the symptoms of

attention deficit hyperactivity disorder (ADHD): A case report," *Healthcare*, vol. 11, no. 14, pp. 1-8, 2023, doi: 10.3390/healthcare11141999.

[22] M. Sammut, N. Fini, K. Haracz, M. Nilsson, C. English, and H. Janssen, "Increasing time spent engaging in moderate-to-vigorous physical activity by community-dwelling adults following a transient ischemic attack or non-disabling stroke: A systematic review," *Disabil. Rehabil.*, vol. 44, no. 3, pp. 337–352, 2022, doi: 10.1080/09638288.2020.1768599.

[23] I. M. J. VanderFels *et al.*, "Effects of aerobic exercise and cognitively engaging exercise on cardiorespiratory fitness and motor skills in primary school children: A cluster randomized controlled trial," *J. Sports Sci.*, vol. 38, no. 17, pp. 1975–1983, Sep. 2020, doi: 10.1080/02640414.2020.1765464.

[24] S. Hattabi *et al.*, "A randomized trial of a swimming-based alternative treatment for children with attention deficit hyperactivity disorder," *Int. J. Environ. Res. Public Health*, vol. 19, no. 23, pp. 1-14, 2022, doi: 10.3390/ijerph192316238.

[25] C. Liu, Y. Yang, S. H. Wong, A. Leung, and C. H. Sit, "The effects of physical activity on mental health in adolescents with attention-deficit hyperactivity disorder: a randomized controlled trial," *Int. J. Behav. Nutr. Phys. Act.*, vol. 22, no. 1, pp. 1-15, 2025, doi: 10.1186/s12966-025-01745-4.

[26] A. Barzideh *et al.*, "Physiotherapists' use of aerobic exercise during stroke rehabilitation: A qualitative study using chart-stimulated recall," *Disabil. Rehabil.*, vol. 47, no. 21, pp. 5503–5515, 2025, doi: 10.1080/09638288.2025.2482841.

[27] C. S. Jones, K. E. Spring, and D. D. Wadsworth, "Factors influencing regular exercise in young women: A survey study assessing the preferences and motivators for aerobic and muscle-strengthening exercise," *Heal. Psychol. Behav. Med.*, vol. 13, no. 1, pp. 1–20, 2025, doi: 10.1080/21642850.2025.2465613.

[28] S. Dastamooz *et al.*, "The efficacy of physical exercise interventions on mental health, cognitive function, and ADHD symptoms in children and adolescents with ADHD: an umbrella review," *EClinicalMedicine*, vol. 62, pp. 1-15, 2023, doi: 10.1016/j.eclinm.2023.102137.

[29] S. V. Faraone, C. L. Ward, M. Boucher, R. Elbekai, and E. Brunner, "Role of serotonin in the neurobiology of attention-deficit/hyperactivity disorder: A systematic literature review," *Expert Opin. Ther. Targets*, vol. 29, no. 9, pp. 637–654, 2025, doi: 10.1080/14728222.2025.2552324.

[30] A. Watroba, J. Luttinen, P. Lappalainen, J. Tolonen, and H. Ruotsalainen, "Effectiveness of school-based occupational therapy interventions on school skills and abilities among children with attention deficit hyperactivity and autism spectrum disorders: Systematic review," *J. Occup. Ther. Sch. Early Interv.*, vol. 17, no. 3, pp. 671–703, J2024, doi: 10.1080/19411243.2023.2224793.

[31] M. J. Salleg-Cabarcas, C. Robledo-Castro, and C. P. Monsalve-Vertel, "Effect of hit-sport-game exercise training on self-control and regulation in children with attention deficit hyperactivity disorder (ADHD)," *Glob. Pediatr. Heal.*, vol. 11, pp. 1-15, 2024, doi: 10.1177/2333794X241287095.

[32] H.-L. Chiang *et al.*, "Physical fitness and risk of mental disorders in children and adolescents," *JAMA Pediatr.*, vol. 178, no. 6, pp. 595–607, 2024, doi: 10.1001/jamapediatrics.2024.0806.

[33] X. Liang, R. H. Xu, M. Zhao, L. Qu, and D. H. K. Shum, "Impact of a physical exercise intervention on psychological resilience and mental ill-being in medical-naïve children with attention-deficit/hyperactivity disorder: A pilot randomised controlled trial," *Psychol. Health Med.*, vol. 29, no. 10, pp. 1764–1775, 2024, doi: 10.1080/13548506.2024.2407449.

[34] K.-M. Lien, C.-C. Kuo, and H.-L. Pan, "Improving concentration and academic performance of a mathematically talented student with ASD/ADHD: An enrichment program," *Educ. Sci.*, vol. 13, no. 6, pp. 1-23, 2023, doi: 10.3390/educsci13060588.

[35] Y. Song, B. Fan, C. Wang, and H. Yu, "Meta-analysis of the effects of physical activity on executive function in children and adolescents with attention deficit hyperactivity disorder," *PLoS One*, vol. 18, no. 8, pp. 1-19, 2023, doi: 10.1371/journal.pone.0289732.

[36] L. Feng, B. Li, S. S. Yong, and Z. Tian, "Effects of exercise intervention on physical and mental health of children and adolescents with attention-deficit/hyperactivity disorder: A systematic review and meta-analysis based on ICF-CY," *J. Sci. Sport Exerc.*, vol. 8, pp. 117–134, 2024, doi: 10.1007/s42978-024-00295-8.

[37] D. Naria and I. L. Mariyati, "Improving concentration in ADHD children with bowling game," *Cakrawala Dini J. Pendidik. Anak Usia Dini*, vol. 15, no. 2, pp. 109–126, 2024, doi: 10.17509/cd.v15i2.71379.

[38] N. Nazeer, Y. M. Rohanachandra, and S. Prathapan, "Predictors of attention deficit hyperactivity disorder in sri lankan children: A school based community study," *J. Atten. Disord.*, vol. 27, no. 10, pp. 1081–1091, 2023, doi: 10.1177/10870547231167571.

[39] V. Salmanov, C. Zeynalov, N. Hasanov, L. Talibova, K. Salmanova, and T. Khalilov, "A healthy lifestyle of schoolchildren and students as a result of systematic physical education," *J. Neonatal Surg.*, vol. 14, no. 4s, pp. 1-11, 2025, doi: 10.52783/jns.v14.1872.

[40] T. M. Tregubova, N. Papić-Blagojević, and O. A. Ozerova, "Enhancing the professional development of adapted physical education teachers in Russia and Serbia: challenges and best practice," *Theory Pract. Phys. Cult.*, no. 5, pp. 54–59, 2025.

[41] Tanti, Astalini, Darmaji, D. A. Kurniawan, and R. Fitriani, "Student perception review from gender: Electronic moduls of mathematical physics," *J. Pendidik. Indones.*, vol. 11, no. 1, pp. 125–132, 2022, doi: 10.23887/jpiundiksha.v11i1.35107.

[42] Tanti, D. A. Kurniawan, W. Sukarni, E. Erika, and R. Hoyi, "Description of Student Responses Toward the Implementation of Problem-Based Learning Model in Physics Learning," *JIPF (Jurnal Ilmu Pendidik. Fis.*, vol. 6, no. 1, pp. 30–38, 2021, doi: 10.26737/jipf.v6i1.1787.

[43] Faiza, M. M. Mahesh, and P. Bhaskaran, "Effectiveness of cognitive training on coordination and concentration among children with ADHD," in *2024 International Conference on Brain Computer Interface & Healthcare Technologies (iCon-BCIHT)*, Thiruvananthapuram, India, 2024, pp. 184–188, doi: 10.1109/iCon-BCIHT63907.2024.10882247.

[44] C. D'Anna, F. Carlevaro, F. Magno, R. Vagnetti, P. Limone, and D. Magistro, "Gross motor skills are associated with symptoms of attention deficit hyperactivity disorder in school-aged children," *Children*, vol. 11, no. 7, pp. 1-12, 2024,

doi: 10.3390/children11070757.
[45] L. Valtr, R. Psotta, and D. Dostál, "Effects of the specific eye fixation training on fine visuomotor coordination in children with attention deficit hyperactivity disorder," *Children*, vol. 10, no. 10, pp. 1-12, 2023, doi: 10.3390/children10101648.
[46] T. Tanti, D. Deliza, and S. Hartina, "The effectiveness of using smartphones as mobile-mini labs in improving students' beliefs in physics," *JIPF (Jurnal Ilmu Pendidik. Fis.*, vol. 9, no. 3, pp. 387–394, 2024, doi: 10.26737/jipf.v9i3.5185.
[47] E. E. Bustamante *et al.*, "Diverse multi-week physical activity programs reduce ADHD symptoms: A systematic review and meta-analysis," *Psychol. Sport Exerc.*, vol. 63, pp. 1-22, 2022, doi: 10.1016/j.psychsport.2022.102268.
[48] B.-A. Hoy, M. C. Steinberg, and B. Fenesi, "Perspectives on physical activity and learning from children with and without ADHD," *Sports*, vol. 13, no. 8, pp. 1-20, 2025, doi: 10.3390/sports13080240.
[49] E. Yusnita and I. Yuliantina, "Sensory integration program to increase concentration ability in ADHD children," *J. Child. Dev.*, vol. 4, no. 1, pp. 330–342, 2024, doi: 10.25217/jcd.v4i1.4261.
[50] R. Setyowati and S. Sukinah, "Fine motor skill development in ADHD-risk children: An intervention using loose parts collage activities," *J. Innov. Res. Prim. Educ.*, vol. 4, no. 4, pp. 2897–2911, 2025, doi: 10.56916/jirpe.v4i4.2313.
[51] S.-H. Chang, J.-J. Shie, and N.-Y. Yu, "Enhancing executive functions and handwriting with a concentrative coordination exercise in children with ADHD: A randomized clinical trial," *Percept. Mot. Skills*, vol. 129, no. 4, pp. 1014–1035, 2022, doi: 10.1177/00315125221098324.
[52] Z. Shahnavaz and M. B. Hassanvand, "The impact of a game-based motor-cognitive training program on improving fine motor skills and response inhibition in children with attention deficit hyperactivity disorder," *Russ. Open Med. J.*, vol. 14, no. 4, pp. 1-7, 2025, doi: 10.15275/rusomj.2025.0422.
[53] K. P. Adhvaryu, S. Karthikbabu, and P. T. Rao, "Motor performance of children with attention deficit hyperactivity disorder: Focus on the Bruininks-Oseretsky Test of Motor Proficiency," *Clin. Exp. Pediatr.*, vol. 65, no. 11, pp. 1-12, 2022, doi: 10.3345/cep.2021.00962
[54] M. H. Sahid, A. Dahlan, R. D. Haryadi, M. G. Masuri, S. A. S. Ibrahim, and A. Pratiwi, "Exploring the potential of dakon as a means of preserving cultural heritage, teaching local wisdom, and promoting inclusive learning for adhd children in the digital era," in *9th International Conference on Strategic and Global Studies 2025 ((ICSGS 2025)*, Atlantis Press, 2025, pp. 421–439, doi: 10.2991/978-94-6463-918-6_28.
[55] S. Desai, H. V Sharath, R. Raghuveer, and S. HV, "Effect of pediatric rehabilitation on children with attention deficit hyperactivity disorder (ADHD): A Case Report," *Cureus*, vol. 16, no. 6, pp. 1-11, 2024, doi: 10.7759/cureus.62739.
[56] A. Doulou, P. Pergantis, A. Drigas, and C. Skianis, "Managing ADHD symptoms in children through the use of various technology-driven serious games: A systematic review," *Multimodal Technol. Interact.*, vol. 9, no. 1, pp. 1-26, 2025, doi: 10.3390/mti9010008.
[57] T. Christ, K. J. Boström, P. Ohrmann, H. Britz, H. Wagner, and C. Bohn, "The effects of a four-month skateboarding intervention on motor, cognitive, and symptom levels in children with ADHD," *Front. Pediatr.*, vol. 12, pp. 1-16, 2024, doi: 10.3389/fped.2024.1452851.
[58] B. Mahardika and A. A. P. Putra, "Art therapy through doodle art media in increasing learning concentration children with ADHD," *J. Child. Dev.*, vol. 3, no. 2, pp. 121–129, 2023, doi: 10.25217/jcd.v3i2.3939.
[59] T. Rukmana, S. Suyadi, S. S. Rahayu, I. Anggryani, and M. Muarofakh, "Handling children with special needs through motor activities," *JOYCED J. Early Child. Educ.*, vol. 2, no. 2, pp. 109–120, 2022, doi: 10.14421/joyced.2022.22-02.
[60] Husniah and U. Darajah, "The use of finger painting to improve fine motor skills of 5–6 year old children at RA Al-Islamiyah Bebidas," *Jurnal Profesi Guru Indonesia*, vol. 2, no. 1, pp. 308–319, 2025, doi: 10.62945/jpgi.v2i1.471.