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

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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.

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1. INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most frequently diagnosed behavioral and neurodevelopmental disorders in school-age children worldwide. In the past three decades, the global prevalence of ADHD has been estimated at 3–7% of the school-age population, with significant geographic variation across countries and regions. In Indonesia, the prevalence of ADHD has shown a steady increase, reaching approximately

5% of the school-age population, or 1 in every 20 children, making it the most common behavioral disorder encountered in pediatric and child psychology clinical practice in the country [1], [2].

Clinically, ADHD is characterized by three core interrelated symptoms: attention deficit (inattentiveness), hyperactivity, and impulsivity disproportionate to the child's developmental stage [3]-[6]. Children with ADHD face more than just academic challenges in school; they also face serious social barriers, difficulty managing emotions, and a higher risk of various long-term behavioral problems if they do not receive appropriate and consistent intervention [7]-[10]. It is important to emphasize that children with ADHD are not naughty or lazy; they are individuals with a significant neurological disorder that requires comprehensive, multidisciplinary treatment [11]-[14].

For decades, pharmacological treatment, particularly psychostimulant medication, has been widely used as the primary intervention for children with ADHD. Although medication has shown effectiveness in reducing ADHD symptoms, concerns regarding side effects, long-term dependency, emotional impact, and limited improvement in social behavior have encouraged researchers and educators to explore alternative non-pharmacological interventions [15]-[17]. In recent years, physical activity and physical education have gained increasing attention as potential therapeutic approaches that may improve cognitive functioning, emotional control, motor coordination, and social development among children with ADHD [18]-[20].

Previous studies have demonstrated that regular physical activity contributes positively to executive functioning, concentration, impulse control, and emotional stability [21]-[23]. Aerobic exercise and structured movement activities are believed to stimulate neurotransmitters such as dopamine, serotonin, and norepinephrine, which play important roles in attention regulation and behavioral control [24]-[27]. In addition, physical education provides opportunities for children with ADHD to engage in movement-based learning, cooperative interaction, discipline development, and sensory-motor training within an inclusive educational environment [24]-[26]. These findings indicate that physical activity may serve not only as recreational activity but also as a therapeutic intervention that supports holistic child development [31], [32].

Despite the growing body of international literature, most previous studies have primarily focused on short-term exercise interventions or clinical therapy settings. Limited research has explored how adaptive physical education can function as a sustainable therapeutic intervention within daily school activities, particularly in special needs schools in developing countries [33], [34]. Furthermore, qualitative studies examining the lived experiences of children with ADHD during physical activity interventions remain relatively scarce [35], [36]. This gap highlights the need for more contextual and in-depth research regarding the implementation of physical activity and physical education as therapeutic strategies in educational settings.

In Indonesia, the implementation of adaptive physical education for children with ADHD is still developing. Many special needs schools continue to face challenges related to limited facilities, insufficient teacher training, and the absence of structured physical activity programs specifically designed for children with ADHD [37]. Similar challenges are also reported in several developing countries, including Sri Lanka, where limited understanding of ADHD among educators affects the effectiveness of school-based interventions. Meanwhile, research and practical implementation related to adaptive physical education for children with ADHD remain relatively limited in Azerbaijan, particularly regarding its therapeutic function within inclusive education systems. Therefore, international collaboration involving researchers from Indonesia, Azerbaijan, and Sri Lanka provides valuable cross-cultural perspectives in understanding how physical activity and physical education may support children with ADHD in different educational and social contexts.

The involvement of researchers from Indonesia, Azerbaijan, and Sri Lanka strengthens the cross-cultural perspective of this study regarding the implementation of physical activity interventions for children with ADHD. Indonesia, as a developing country with a growing inclusive education system, still faces challenges related to limited facilities and trained adaptive physical education teachers. Similarly, Sri Lanka encounters constraints in public awareness, school-based therapeutic programs, and educational support for children with ADHD, particularly in rural educational settings [38]. In contrast, Azerbaijan has shown increasing institutional attention toward sports science and physical education development, although research focusing specifically on adaptive physical education for children with ADHD remains limited [39], [40]. These differing educational and socio-cultural contexts highlight the importance of examining how physical activity and physical education can function as holistic therapeutic interventions across diverse developing-country settings.

This study was conducted at Bina Anak Bangsa Special Needs School in Pontianak, Indonesia, which actively serves children with developmental disorders, including ADHD. Using a qualitative case study with a life story approach, this research aims to explore how physical activity and adaptive physical education function as therapeutic interventions for children with ADHD. The study focuses on understanding children's behavioral experiences, emotional responses, social interaction, and developmental progress during physical activity participation. The findings of this study are expected to contribute to the development of adaptive physical education practices, strengthen non-pharmacological intervention strategies, and provide practical recommendations for teachers, parents, therapists, and policymakers in supporting children with ADHD through school-based physical activity programs.

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.

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 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. Jamaludin, S.Pd., explained this mechanism very clearly: Physical activity is a reflection of physical fitness, and this is also what must be developed in children with ADHD syndrome. 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 his 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, 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 ADHD children 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 For all age
Tai Chi	Moving meditation, training focus, reducing impulsivity and anxiety	★★★★☆	6- week study : hyperactivity reduce
Badminton	Eye contact, hand-eye coordination, quick reactions, and high enthusiasm in children with ADHD	★★★★☆	In accordance 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 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.

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.

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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.

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