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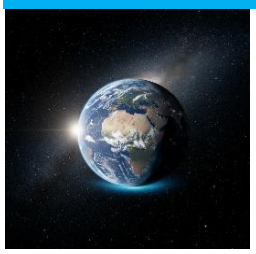

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Beyond Exercise: Sport-Based, Family-Centered, and Technology-Assisted Interventions Supporting Children with Autism Spectrum Disorder

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Abstract

Background

Autism spectrum disorder (ASD) is a heterogeneous neurodevelopmental condition characterized by deficits in social communication and restricted, repetitive behaviors. Its growing prevalence and functional burden have increased interest in non-pharmacological interventions, particularly physical activity and sport-based programs, as potential strategies to improve physical and neurobehavioral outcomes in pediatric populations.

Aim

This narrative review aimed to summarize current evidence on the effects of physical activity and exercise interventions on motor, cognitive, behavioral, and psychosocial outcomes in children and adolescents with ASD.

Material and methods

A narrative literature review was conducted using peer-reviewed studies on exercise-based interventions in pediatric ASD populations. Included were systematic reviews, meta-analyses, randomized controlled trials, and experimental studies assessing outcomes such as motor skills, executive functioning, social interaction, sleep, and behavioral regulation.

Results

Evidence indicates that structured physical activity may positively affect multiple domains in children with ASD. Exercise interventions were associated with improvements in motor skills, executive functions, and social abilities, along with reductions in behavioral problems and anxiety. Some studies also reported improved sleep and overall well-being. However, significant heterogeneity in intervention types, duration, and outcome measures was noted.

Conclusions

Physical activity is a valuable complementary element of multidisciplinary ASD management, supporting both physical health and neurobehavioral functioning. Further well-designed studies with standardized protocols and long-term follow-up are needed to determine optimal intervention strategies and their sustained effects.

Key words

autism spectrum disorder; physical activity; exercise intervention; children motor development; sport medicine;

1. Introduction

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition characterized by persistent deficits in social communication, restricted interests, and repetitive patterns of behavior. In addition to these core features, individuals with ASD frequently experience motor coordination difficulties, sensory processing abnormalities, feeding challenges, disturbed sleep, and heightened anxiety or affective dysregulation. These multifactorial impairments contribute to reduced participation in social, educational, and physical domains and can significantly affect family well-being and quality of life. Consequently, developing integrative,

non-pharmacological strategies to support the multidimensional needs of individuals with ASD has become an emerging priority in clinical and community practice.[1]

Accumulating research evidence highlights the potential of structured physical activity (PA) and exercise interventions to enhance not only motor development but also cognitive, emotional, and social functioning in children and adolescents with ASD. Meta-analyses suggest that programs focused on fundamental motor skills yield large effect sizes for locomotor performance and moderate effects for object control and stability measures. Regular engagement in movement-based therapy has been associated with improvements in executive function, communication, and adaptive behavior, as well as reductions in repetitive or stereotyped actions. Subgroup analyses indicate that preschool children aged 3–6 years derive the greatest benefit when interventions are implemented more than three times per week, lasting over 90 minutes per session, and extending beyond 12 weeks. Such evidence supports the integration of physical activity into early intervention frameworks as a means to attenuate core ASD symptoms, especially deficits in social reciprocity and behavioral rigidity.[2]

Beyond individual exercise programs, group-based organized physical activity (GBOPA) has demonstrated significant benefits in promoting sociability, communication, and functional participation. Optimal outcomes appear to follow high-frequency, cooperative formats—approximately five sessions per week of 50 minutes each during an eight-week foundational cycle—followed by maintenance training once or twice weekly. These findings underscore the importance of social interaction embedded in structured exercise environments for fostering real-world behavioral and communicative competence among children with ASD.[3]

Parallel to these advances, technology-assisted and creative interventions are increasingly being adopted as adjunctive or alternative approaches. Virtual Reality (VR) platforms have emerged as safe and versatile tools for rehabilitation across a broad spectrum of neurological and developmental conditions, including ASD. VR-based training facilitates cortical reorganization and neural connectivity, leveraging perceptual learning and multimodal sensory feedback to improve both motor and cognitive outcomes. In ophthalmology, VR applications have enhanced stereopsis, contrast sensitivity, and visual acuity, while in neurology, they have shown promise in mitigating chronic disability and supporting cognitive restoration. Despite their potential, VR and serious game-based systems remain under-examined in autism research, warranting systematic evaluation of their therapeutic efficacy, implementation barriers, and long-term outcomes.[4]

In addition to direct child-focused interventions, growing attention has been directed toward family-centered and caregiver-based approaches. Parental stress and psychological burden are well-recognized correlates of raising a child with ASD. Recent randomized controlled trials demonstrate that web-based lifestyle education programs emphasizing balanced 24-hour movement behaviors can improve mental health and psychological well-being among parents. These findings highlight the reciprocal interdependence between child progress and caregiver resilience, suggesting that comprehensive care models should address the well-being of both children and their families.[5]

Emerging lines of evidence further emphasize the multisystemic nature of ASD, where behavioral and somatic features intersect. For instance, toe walking—a frequent gait pattern observed in children with ASD—has been linked to greater symptom severity and comorbid disturbances in sleep, feeding, and gastrointestinal functioning. Such associations reinforce the hypothesis of a gut–brain–motor interaction underlying aspects of the disorder. The routine clinical evaluation of motor and autonomic features may thus serve as a useful marker for broader neurodevelopmental and physiological dysregulation in autism.[6]

Taken together, current literature supports a multidimensional perspective on ASD intervention—one that integrates physical activity, creative expression, digital technology, and family engagement to improve overall functioning and quality of life. This review synthesizes

evidence on the effects of sport, exercise, and related non-pharmacological strategies on the motor, cognitive, social, and emotional development of children with ASD. It further explores innovative approaches—including VR training, serious games, and web-based lifestyle programs—aimed at both children and caregivers. By consolidating current data and identifying critical research gaps, this article aims to inform the design of evidence-based, interdisciplinary rehabilitation strategies that promote inclusion, participation, and long-term well-being in autism spectrum disorder.

2. Methodology

A comprehensive literature search was conducted across the PubMed, Scopus, ScienceDirect, ResearchGate, and Google Scholar databases to identify studies investigating the effects of physical activity, exercise, and sport-based interventions on children and adolescents with autism spectrum disorder (ASD). The search included articles published between January 2018 and December 2025.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to autism, physical activity, and non-pharmacological rehabilitation.

titles and abstracts were screened by three independent reviewers using predefined inclusion criteria. Eligible studies included: Randomized controlled trials (RCTs), quasi-experimental trials, cohort studies, cross-sectional observational studies, and systematic reviews/meta-analyses. Research focusing on individuals aged 3–18 years diagnosed with ASD according to DSM-5 or ICD-10/11 criteria. Interventions explicitly involving physical activity, exercise, sport-based, game-based, or technology-assisted movement therapy. Outcomes assessing motor skills, cognitive or executive function, social and behavioral improvement, communication, affect regulation, sleep quality, feeding behavior, or caregiver well-being.

Exclusion criteria comprised studies not involving ASD populations, interventions lacking a physical activity component, pharmacological-only treatments, abstracts without full-text availability, and non-English publications. Full texts were then appraised for methodological quality, sample characteristics, intervention design, and reported outcomes. Disagreements among reviewers were resolved through consensus discussion. Reference lists of eligible articles were also hand-searched to identify additional relevant studies.

3 Results and Discussion

3.1. Epidemiology, Disease Burden and Developmental Context

Autism spectrum disorder (ASD) represents a major and sustained global health burden with substantial implications for pediatric and adolescent populations—the primary demographic targeted by sport and exercise interventions. According to the Global Burden of Disease Study 2021 Autism Spectrum Collaborators, an estimated 61.8 million individuals worldwide were on the autism spectrum in 2021, corresponding to a global age-standardized prevalence of 788.3 per 100,000 population (approximately 1 in 127 individuals). Prevalence was markedly higher in males (1064.7 per 100,000) compared to females (508.1 per 100,000), reflecting both biological and diagnostic disparities.[7]

Beyond prevalence, ASD accounted for 11.5 million disability-adjusted life years (DALYs) globally, equivalent to 147.6 age-standardized DALYs per 100,000 people. Importantly, the burden is concentrated early in life: ASD ranks among the top ten causes of non-fatal health burden in individuals under 20 years of age. DALY rates are already substantial in children under 5 years (169.2 per 100,000), remain high through adolescence (163.4 per 100,000), and persist into adulthood. These epidemiological data underscore that ASD is not a niche developmental diagnosis but a lifelong condition with early and sustained functional impact, reinforcing the urgency of scalable, developmentally sensitive interventions.[7]

From a sport medicine perspective, epidemiological burden intersects critically with modifiable lifestyle risk factors. The meta-analytic evidence on accelerometer-assessed behaviors indicates

that children and adolescents with ASD engage in significantly lower levels of moderate-to-vigorous physical activity (MVPA) compared with neurotypical peers, alongside poorer sleep parameters. Notably, the MVPA gap varies across developmental stages, suggesting age-dependent divergence in movement behaviors. Reduced habitual physical activity and sleep dysregulation are not merely comorbidities; both are associated with exacerbation of core ASD symptoms, impaired executive functioning, mood dysregulation, and cardiometabolic risk. This creates a bidirectional vulnerability model: neurodevelopmental characteristics constrain participation in physical activity, while physical inactivity and sleep disruption amplify functional impairments.[8]

Current therapeutic paradigms further contextualize the need for multimodal, non-pharmacological strategies. Contemporary reviews of treatment advances emphasize that ASD remains incurable and lacks validated biological markers, with management focused on symptom reduction and functional optimization. Standard approaches involve behavioral therapies (e.g., cognitive behavioral therapy), individualized pharmacotherapy for comorbid symptoms, and emerging strategies such as sensory integration therapy, dietary interventions, and microbiome-targeted treatments. Increasing attention is also directed toward genetic heterogeneity and pharmacogenetics, highlighting the biological complexity underlying treatment response variability.[8]

Within this therapeutic landscape, exercise and sport-based interventions occupy a strategically important niche. They are inherently multimodal—simultaneously targeting motor competence, executive control, emotional regulation, sleep architecture, and social participation—while remaining scalable, cost-effective, and developmentally adaptable. Given the early onset and sustained burden of ASD, combined with documented deficits in habitual physical activity, sport medicine is positioned not only to address secondary health risks but also to contribute meaningfully to core functional outcomes.[9]

In summary, the high global prevalence, early-life concentration of disability burden, and documented disparities in physical activity and sleep behaviors provide a compelling epidemiological rationale for integrating structured physical activity into ASD management frameworks. For sport medicine, ASD represents both a public health priority and an opportunity to implement biologically plausible, developmentally informed, and system-level interventions capable of modifying long-term functional trajectories.

3.2. Physical Activity and Exercise Interventions: Motor Outcomes

Recent meta-analyses have consistently demonstrated that interventions targeting fundamental motor skills yield significant improvements in the motor performance of children with autism spectrum disorder (ASD). Evidence indicates that enhancements in locomotor skills display large effect sizes, while outcomes related to object control and stability skills show moderate but meaningful effects. These findings collectively underscore the clinical relevance of structured motor-based interventions for promoting motor competence in this population.[10]

ASD is a lifelong neurodevelopmental condition typically emerging in early childhood, characterized by persistent deficits in social communication and restricted, repetitive behaviors. Beyond these core symptoms, children with ASD frequently present with impairments in gross and fine motor functioning. Numerous investigations support the notion that targeted physical activity programs can enhance not only motor performance but also contribute to broader developmental outcomes and improved quality of life. Nevertheless, comprehensive systematic evidence remains limited regarding the long-term sustainability of these motor improvements following intervention cessation.[11]

Empirical data also highlight the benefits of structured participation. In a 12-week program, participation in organized physical activities increased from 45% to 85%, accompanied by large effect sizes for both engagement and motor outcomes (Cohen's $d > 0.8$). Furthermore, sports interventions incorporating sensory integration components have been shown to produce

notable gains in both motor and social functioning, suggesting their potential integration into multidisciplinary therapeutic and educational frameworks.[12]

Although pharmacological therapy continues to represent the most accessible option for managing some ASD symptoms, it does not address fundamental social and emotional difficulties. Consequently, non-pharmacological modalities—such as art therapy, biofeedback, neuro-motor training ("Brain Gymnastics"), and logorhythmics—have been increasingly explored as adjunctive approaches. Hippotherapy, in particular, has emerged as a complementary method with demonstrated positive effects on motor coordination, social interaction, and emotional regulation. Despite the growing body of supportive evidence, however, no universal standard or "gold-standard" treatment protocol currently exists for motor development in ASD, emphasizing the need for individualized, multimodal therapy strategies.[13]

3.3 Physical Activity and Exercise: Cognitive and Executive Function Outcomes

Accumulating evidence highlights that physical activity interventions can elicit measurable improvements in cognitive and executive functioning among children with autism spectrum disorder (ASD). In recent neuroimaging research employing functional near-infrared spectroscopy (fNIRS), cerebral activation patterns were examined before and after an eight-week sports-based intervention. The study assessed three core domains of executive function (EF): working memory, inhibitory control, and cognitive flexibility. Results demonstrated significant gains in overall EF performance within the intervention group, accompanied by enhanced neural activation in the prefrontal cortex (PFC). Post-training analyses revealed increased engagement of the dorsolateral and orbitofrontal cortices, as well as the frontal pole, during EF task execution. Furthermore, resting-state scans indicated strengthened short-range functional connectivity within the PFC, suggesting that physical activity may facilitate more integrated and efficient cortical information processing in children with ASD.[14]

Evidence comparing the cognitive effects of various exercise types illustrates that intervention specificity plays a critical role in EF outcomes. Mini basketball programs have been shown to markedly enhance inhibitory control and cognitive flexibility, whereas table tennis appears particularly effective in improving cognitive flexibility and working memory. In contrast, stationary cycling interventions have yielded negligible effects across EF dimensions. These results indicate that sports requiring rapid decision-making, coordination, and adaptive responses may stimulate executive networks more effectively than repetitive or monotonous physical activity forms.[15]

Meta-analytic findings further support the positive influence of exercise interventions on executive functioning in children and adolescents with ASD, with observed benefits persisting beyond the intervention period. However, improvements in working memory appear less consistent, reflecting potential domain-specific limitations and heterogeneity across study designs. Subgroup analyses have also revealed age-dependent patterns, showing that school-aged participants experience greater cognitive gains from structured exercise than younger children.[16]

Physical activity is increasingly recognized as a promising non-pharmacological approach for enhancing cognitive performance in neurodevelopmental disorders (NDDs), including ASD and attention-deficit/hyperactivity disorder (ADHD). Comparative analyses across PA modalities suggest that mind–body exercises (MBE), exergaming, and moderate physical activity (MPA) contribute most consistently to improvements in attention, memory, and executive function. In contrast, aerobic exercise (AE) alone has shown limited efficacy. Among these, MBE appears particularly effective in augmenting attentional control, while MPA demonstrates cross-diagnostic benefits for memory and EF domains. Despite these encouraging results, further high-quality randomized controlled trials directly comparing intervention types

are required to refine evidence-based recommendations and delineate optimal therapeutic protocols for cognitive enhancement in ASD.[17]

3.4. Social, Behavioral, and Communication Effects of Exercise

Growing evidence indicates that structured physical activity interventions exert significant positive effects on social behavior, emotional regulation, and communicative abilities in children with autism spectrum disorder (ASD). In a controlled experimental study involving children aged 6–10 years, participation in an eight-week combined physical training (CPT) program—including ball games, rhythmic movement, and resistance exercises—produced measurable benefits across both physical and behavioral domains. Participants exhibited notable improvements in indices of social interaction and communication, alongside reductions in stereotyped behaviors. Physical fitness indicators such as handgrip strength, lower- and upper-body power, flexibility, balance, and agility also improved significantly compared with control participants ($P < 0.05$). These findings underscore the multidimensional impact of integrative exercise programs in promoting both physical and psychosocial adaptation among children with ASD.[19]

Beyond single-modality designs, broader analyses have consistently identified exercise as a critical non-pharmacological factor in mitigating ASD-related social and communicative impairments. Interventions emphasizing sports games, team-based ball activities, combination therapies, and outdoor physical exercises appear particularly effective in enhancing sociability and interpersonal engagement. Similarly, communication outcomes benefit most from programs that combine movement with interactive or mind–body components, suggesting that social reciprocity during physical activity may potentiate therapeutic gains. Collectively, these findings highlight the value of embedding cooperative and dynamic exercises into therapy frameworks to optimize social skill development.[20]

Meta-analytic data reaffirm that exercise interventions improve not only social and communicative domains but also flexibility, motor coordination, cognitive control, and behavioral regulation. Importantly, heterogeneity across studies suggests that intervention design—specifically duration, frequency, and total intervention period—modulates efficacy across cognitive and psychosocial outcomes. Subgroup analyses have revealed a nonlinear dose–response pattern: shorter yet more frequent sessions tend to yield stronger improvements in communication and social functioning, whereas executive function enhancement is more closely linked to sustained, long-term programs.[21]

Taken together, recent research establishes regular physical activity as an effective adjunct strategy for the holistic development of children with ASD, enhancing motor competence while simultaneously fostering communication and social integration. Future investigations should prioritize large-scale randomized controlled trials with extended follow-up to determine the durability of these effects and to identify optimal intervention parameters for individualized clinical applications.[22]

3.5. Sleep, Anxiety, and Affective Regulation

Emerging evidence underscores the important role of physical activity (PA) in improving sleep quality, emotional well-being, and anxiety regulation in children with autism spectrum disorder (ASD). Comparative analyses with non-intervention control groups have shown that PA programs exert large positive effects on parent-reported sleep outcomes, including overall sleep quality, nocturnal awakenings, sleep resistance, and total sleep duration. Objective actigraphy data further confirm significant enhancements in sleep efficiency, supporting the utility of regular PA as a non-pharmacological strategy to address common sleep disturbances in children and adolescents with ASD.[23]

In addition to sleep improvements, structured physical exercise demonstrates notable potential in alleviating anxiety and promoting emotional stability. Sports-based training programs have

been identified as valuable adjuncts within comprehensive rehabilitation frameworks, contributing to reductions in anxiety symptoms while simultaneously fostering adaptive emotional responses and self-regulatory capacities. These benefits highlight the role of physical activity not only as a facilitator of physical health but also as a key contributor to psychological functioning and quality of life in pediatric ASD populations.[24]

Recent innovations have further expanded this field to include technology-assisted exercise modalities. A growing number of studies have investigated virtual-reality (VR)-based physical activity programs designed to target emotion regulation (ER) and executive function (EF) deficits commonly observed in autism. Preliminary findings indicate that VR-supported exercises can effectively enhance both ER and EF, potentially serving as complementary interventions alongside traditional therapeutic and educational strategies. Such approaches may help mitigate future psychological and behavioral challenges by improving children's capacity to manage emotions and adapt to environmental demands.[25]

Collectively, these findings suggest that physical activity interventions—whether traditional or technology-enhanced—represent a promising, non-invasive avenue for improving sleep health, anxiety control, and affective regulation among children with ASD. Further longitudinal and mechanistic studies are warranted to elucidate the neural and behavioral pathways underlying these benefits and to establish optimized exercise protocols for clinical implementation.

3.6. Creative, Game-Based, and Technology-Assisted Interventions

Contemporary approaches to autism spectrum disorder (ASD) increasingly emphasize the integration of creative and technology-mediated therapies alongside traditional behavioral and pharmacological treatments. Evidence from recent reviews highlights the clinical potential of art and music therapy in supporting children with ASD, as well as those with hyperactivity, developmental language disorders, and learning difficulties. Both modalities have demonstrated significant benefits across multiple functional domains, including symptom reduction, behavioral adaptation, social interaction, and cognitive-emotional development. Participants and clinicians consistently report high satisfaction and adaptability of these interventions across diverse educational and clinical contexts, underscoring their value as complementary or alternative therapeutic options to standard care.[26]

Within this spectrum of creative modalities, music training holds particular promise for enhancing executive functioning, notably in the domain of inhibitory control. Comparative analyses suggest that music-based interventions may yield superior outcomes relative to other creative activities such as sports, visual arts, or drama, owing to their structured rhythmic and attentional demands. Consequently, structured music training is recommended as both an educational enrichment strategy and a clinical tool targeting inhibitory control deficits commonly observed in ASD and attention-deficit/hyperactivity disorder (ADHD).[27]

Parallel to artistic interventions, serious games and game-based learning environments have emerged as innovative platforms for social and emotional development in autism. Studies report positive effects on social communication skills, including emotion recognition and decoding, eye-gaze coordination, joint attention, and behavioral self-regulation. Despite promising preliminary results, the current evidence base remains limited by small sample sizes and methodological heterogeneity, highlighting the need for rigorously designed randomized controlled trials to confirm efficacy and inform evidence-based implementation strategies.[28]

Technological innovation is also extending into the digital delivery of physical activity interventions. Experimental applications of AI-assisted platforms, such as ChatGPT-guided exercise programs, have demonstrated feasibility and acceptability among parents of children with ASD. Participants reported increases in physical activity engagement and enjoyment, corroborated by quantitative improvements in activity levels measured via the Leisure-Time Exercise Questionnaire (LTEQ). These findings point toward the potential of AI-mediated, personalized activity programming as a scalable adjunct to conventional rehabilitation. Further

evaluation is warranted to determine long-term outcomes and optimize its role in integrative, technology-enhanced autism care.[29]

3.7. Behavioral, Family-Centered, and Feeding Interventions

Recent systematic investigations underscore the importance of family-centered and behavioral frameworks in intervention strategies for children with autism spectrum disorder (ASD). A growing body of evidence supports caregiver-focused coaching models as effective tools for improving both child and parent outcomes. These approaches enhance caregiver competence, self-efficacy, and empowerment while promoting measurable progress in children's occupational performance and adaptive behaviors. Parents frequently report increased satisfaction with their child's functional gains, emphasizing the reciprocal benefits derived from interventions that actively engage family members in the therapeutic process.[30]

Meta-analytic findings further refine understanding of the factors that influence intervention efficacy. Stronger post-intervention outcomes have been observed among children with higher baseline cognitive, linguistic, and adaptive functioning, as well as those exhibiting fewer autism-related symptoms. Prolonged duration and greater cumulative intervention hours correlate positively with improved developmental outcomes, whereas the specific intervention model—such as Early Intensive Behavioral Intervention (EIBI), Naturalistic Developmental Behavioral Interventions (NDBI), or Developmental Interventions (DI)—appears less predictive of success. Similarly, neither the identity of the delivery agent nor the age of the child at therapy onset significantly affected outcome strength. These findings advocate for individualized, capacity-based intervention design and have implications for optimizing resource allocation and service planning at policy and clinical levels.[31]

An additional and often underrecognized therapeutic domain concerns feeding and nutritional behaviors. A comprehensive review of studies encompassing 449 children and 203 caregivers identified five frequently employed intervention components: nutrition education and consultation, environmental adjustments, sensory exposure techniques, cognitive-behavioral elements, and behavioral modification strategies. Collectively, these interdisciplinary, multi-component interventions demonstrated preliminary but consistent efficacy in reducing feeding difficulties in children with ASD. Implementation analyses using the RE-AIM framework (Reach, Efficacy, Adoption, Implementation, and Maintenance) suggested strong feasibility and sustainability of such multi-modal strategies, supporting their integration into broader developmental rehabilitation programs.[32]

Finally, in the realm of behavioral motor training, innovative pedagogical techniques such as errorless learning have shown encouraging results. In experimental comparisons, children who practiced motor tasks (e.g., putting accuracy) through errorless learning demonstrated superior retention and transfer performance relative to peers receiving explicit instruction ($p < 0.05$). These outcomes reinforce the potential of implicit, success-oriented learning environments to strengthen task mastery and generalization in ASD populations.[33]

Collectively, these findings highlight the comprehensive potential of tailored behavioral, family-centered, and feeding interventions. When integrated with evidence-based physical and cognitive programs, such multimodal frameworks offer promising pathways toward enhancing functional independence, family well-being, and quality of life for children on the autism spectrum.

3.8. Participation, Inclusion, and Real-World Functioning

Participation and social inclusion are essential indicators of functional adaptation and overall quality of life in individuals with autism spectrum disorder (ASD) and other developmental or physical disabilities. Engagement in structured physical activity not only promotes physical health but also supports psychological well-being, social connectedness, and self-efficacy. Research among people with disabilities employed in inclusive enterprises, such as the multidisciplinary "Łuczniczka" center in Tuchola, emphasizes similar themes. Survey data

collected from 55 participants revealed that the principal motivations for engaging in physical activity include enhancing personal satisfaction, improving subjective well-being, and reducing perceived differences between disabled and nondisabled individuals. Cycling emerged as the most favored activity, and participants generally endorsed a preference for health-oriented, active lifestyles. Notably, men reported more consistent physical activity participation than women, suggesting gender-specific patterns that may warrant targeted health-promotion efforts.[34]

In the context of ASD, real-world participation benefits significantly from group-based organized physical activity (GBOPA) programs. These interventions have been shown to strengthen children's social abilities, social functioning, and communication skills when implemented within interactive, community-oriented environments. Evidence indicates a dose-dependent relationship between training intensity and social outcomes, with optimal effects achieved through a regimen of approximately five sessions per week lasting 50 minutes each over an eight-week foundational cycle (totaling about 2,000 minutes of engagement). Following this baseline phase, maintenance sessions conducted one to two times weekly can help sustain social and behavioral gains.[35]

Collectively, these findings highlight the broader societal value of inclusive, group-based exercise initiatives that not only target symptom reduction but also foster community participation and social integration. Promoting accessible opportunities for physical engagement—whether in specialized programs for individuals with ASD or inclusive workplace contexts—represents a key avenue for improving autonomy, participation, and lifelong well-being among people with developmental and physical disabilities.[36]

4. Conclusion

Collectively, the available evidence indicates that structured physical activity represents a promising supportive strategy in the management of autism spectrum disorder (ASD). Across the reviewed studies, exercise-based interventions were associated with improvements in multiple functional domains, including motor competence, executive functioning, social interaction, and behavioral regulation. In addition to these neurodevelopmental outcomes, physical activity may also contribute to improvements in sleep quality and overall well-being, which are frequently compromised in children and adolescents with ASD. These multidimensional benefits highlight the unique capacity of sport and movement-based interventions to simultaneously address several challenges characteristic of the disorder.

From a sport medicine perspective, the integration of structured exercise programs into therapeutic frameworks may offer a practical and scalable complement to established behavioral and psychosocial interventions. Physical activity is inherently adaptable to different developmental stages and functional capacities, allowing programs to be tailored to the heterogeneous profiles observed in ASD. Moreover, interventions based on games, sports training, equine-assisted therapy, or technology-supported approaches may increase motivation and adherence, which are critical factors for sustained behavioral change.

Nevertheless, several limitations within the current literature should be acknowledged. Many studies differ substantially in intervention protocols, intensity, duration, and outcome measures, which complicates direct comparison and synthesis of results. Sample sizes are often modest, and long-term follow-up data remain limited, restricting conclusions about sustained benefits. Furthermore, variability in symptom severity, comorbidities, and environmental factors may influence responsiveness to exercise interventions, underscoring the need for more individualized and stratified research designs.

Future investigations should therefore prioritize well-designed randomized controlled trials with standardized outcome measures and longer observation periods. Research exploring dose–response relationships, age-specific effects, and neurophysiological mechanisms underlying

exercise-related benefits will also be important. Additionally, interdisciplinary collaboration between sport medicine specialists, pediatricians, psychologists, and rehabilitation professionals may facilitate the development of integrated intervention models that more effectively address the complex needs of individuals with ASD.

In summary, while physical activity should not be considered a standalone treatment for ASD, the growing body of evidence suggests that it may serve as an important component of comprehensive care. The incorporation of structured exercise into therapeutic strategies has the potential to enhance functional outcomes and quality of life for children and adolescents on the autism spectrum.

Disclossure

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AI.

AI was utilized for two specific purposes in this research. Text analysis of clinical reasoning narratives to identify linguistic patterns associated with specific logical fallacies. Assistance in refining the academic English language of the manuscript, ensuring clarity, consistency, and adherence to scientific writing standards. AI were used for additional linguistic refinement of the research manuscript, ensuring proper English grammar, style, and clarity in the presentation of results. It is important to emphasize that all AI tools were used strictly as assistive instruments under human supervision. The final interpretation of results, classification of errors, and conclusions were determined by human experts in clinical medicine and formal logic. The AI tools served primarily to enhance efficiency in data processing, pattern recognition, and linguistic refinement, rather than replacing human judgment in the analytical process.

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