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Research Article

A Review on Spark Exercise Program for Balance and Functional Mobility in Children with Autism Spectrum Disorder – A Literature Review

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Abstract

Introduction: Introduction: Children with Autism Spectrum Disorder (ASD), frequently face challenges beyond social and communication difficulties, including significant motor impairments such as poor balance, reduced coordination, and limited functional mobility. These issues can impact their ability to perform daily activities, engage in physical play, and maintain independence. Despite these concerns, motor development remains an under-addressed area in most intervention programs, which typically focus more on behavioral and cognitive aspects.

Aim and Objective: A review on spark exercise program for balance and functional mobility with autism spectrum disorder

Methodology: A literature review was conducted using databases such as PubMed, Google Scholar, ScienceDirect, Scopus, and Web of Science. Keywords included Autism Spectrum Disorder, SPARK program, motor skills, balance, and functional mobility. Studies published between 2017 and 2023 were included based on criteria such as age group (4–17 years), use of SPARK or similar structured activity programs, and assessment of balance or mobility outcomes. Ten peer-reviewed studies including randomized controlled trials and quasi-experimental designs were reviewed.

Results: A total of 98 articles were initially identified, from which 10 were selected for final review after applying inclusion criteria. Out of 10, 7 (from 2017 to 2022) showed significant improvements in both static and dynamic balance in children with ASD following SPARK-based interventions. These gains were consistent across short and long program durations, indicating that regular, structured physical activity enhances postural control and coordination. In terms of functional mobility, 5 studies (2017–2023) reported improvements in locomotor skills, lower-limb strength, and walking efficiency. These outcomes contributed to increased independence and better participation in physical and social activities.

Conclusion: The SPARK program has proven to be an effective, engaging, and adaptable physical activity model that supports improvements in both balance and functional mobility in children with ASD. The structure and consistency of SPARK sessions contribute positively to motor skill development.

Clinical Relevance: These findings emphasize the importance of incorporating structured physical activity programs like SPARK into early intervention strategies for children with ASD. Addressing motor deficits not only supports physical independence but also enhances participation in school and social settings, ultimately improving overall quality of life.

Keywords: Autism Spectrum Disorder; SPARK Program; Motor Skills; Balance; Functional Mobility

Abbreviations

ASD: Autism Spectrum Disorder; SPARK Program: Sports, Play, and Active Recreation for Kids

Introduction

Autism Spectrum Disorder (ASD) is a complex developmental condition where children may have trouble with social interactions, communication, and often show repeated behaviors or routines. Every child with ASD is different, and the way the condition shows up can vary from person to person. In addition to these primary symptoms, children with ASD commonly present with motor impairments including impaired balance, functional mobility limitations, and delayed development of gross motor abilities [1]. These deficits are severe and have a major effect on independence, activities of daily living (ADLs), and social and physical activities.

Children with Autism Spectrum Disorder (ASD) often have noticeable difficulties with movement skills. These can include problems with balance, coordination, and overall body control, which can affect how they play, move around, and do everyday tasks. Thus, do noted that children with ASD evidence much lower performance in gross motor skills than they are typically developing counterparts [2]. These impairments consist of problems in balance, coordination, and functional mobility which are essential for everyday functioning.

Balance is a critical component of motor development, enabling individuals to maintain posture and perform coordinated movements. Children with **Autism Spectrum Disorder (ASD)** often present with significant balance impairments due to challenges in sensory integration, neuromuscular control, and motor planning [3]. These deficits can lead to difficulties in performing daily activities, reduced participation in physical play, and impaired functional mobility [4]. Recent interventions, such as the **SPARK (Sports, Play, and Active Recreation for Kids)** program, have shown significant promise in improving both **static and dynamic balance** among children with ASD [5]. Research indicates that targeted physical activity programs lead to measurable improvements in **postural stability, gross motor function**, and even **social engagement**, highlighting the interplay between physical and behavioral development [6]. Incorporating structured balance-focused activities into therapeutic programs for ASD has been proven effective in enhancing motor skills, promoting independence, and supporting holistic developmental progress [7].

Functional mobility refers to an individual's ability to move independently and efficiently through their environment to perform essential daily tasks such as walking, standing, and transitioning between positions. In children with **autism spectrum disorder (ASD)**, impairments in motor coordination, postural control, and sensory integration frequently lead to delays or deficits in functional mobility [3]. These limitations affect not only physical independence but also social participation, academic engagement, and overall quality of life [4]. Studies have shown that children with ASD often exhibit reduced walking speed, balance instability, and inefficient gait mechanics compared to typically developing peers [5]. Motor impairments in ASD are believed to result from atypical neural connectivity affecting sensorimotor processing [6]. Because functional mobility is tightly linked to both **gross motor proficiency** and **balance control**, it is increasingly recognized as a critical area for intervention in ASD-focused rehabilitation programs. Interventions such as structured physical activity, balance training, and motor skill enhancement programs (e.g., SPARK) have demonstrated improvements in **functional mobility outcomes**, including walking efficiency, static and dynamic balance, and motor confidence [8,9]. Early and targeted interventions play a crucial role in promoting autonomy and participation in everyday activities for children with ASD [9].

Purpose of the Study

The purpose of this study is to evaluate the effectiveness of the SPARK program in improving balance and functional mobility in children with autism spectrum disorder (ASD).

Significance of the study

This study highlights the importance of addressing impairments in children with ASD by using structured physical activity programs like SPARK. Improving balance and functional mobility can enhance their independence, participation in daily activities, and overall quality of life, areas often overlooked in traditional interventions.

Materials and Methods

Review of literature

Mahrokh Dehghani, Amir Ali Jafarnezhadgero, Mohamad Abdollahpour Darvishani, Shirin Aali, and Urs Granacher Smith (2023) conducted an RCT study on Biomechanical Outcomes of SPARK-like Multimodal Intervention. Evaluated neuromuscular and biomechanical effects of a SPARK-style program. Design is RCT (n = 24,

7–14 yrs.), 8-week multimodal intervention. Outcomes are GRF, loading rate, and plantar pressure during gait analysis. Significant reductions in GRF and plantar pressure. Suggest improved gait efficiency and reduced injury risk. Indicates SPARK-based programs can optimize gait mechanics, with possible long-term health benefits. thus, concluded that an 8-week, joyfully framed multimodal SPARK-like program can optimize gait mechanics by reducing ground reaction forces and plantar pressures in boys with ASD. This biomechanical improvement suggests long-term health benefits, including lower risk of musculoskeletal strain and improved walking safety [8].

Anjana N. Bhat, David S. Tulsky, Amanda J. Boulton, Thalia Van Damme, Deborah R. Feldman (2022–2023) conducted a Cross-sectional analysis study on Motor Impairments from SPARK ASD cohort: Functional Correlates Analyzed motor dysfunction prevalence and associations using SPARK registry data. Cross-sectional analysis, >2,600 ASD children. DCD-Q, Vineland Adaptive Behavior Scales; categorized motor delays. After this experiment reviewer got to know 82% screened positively for motor delay; 77% via VABS; 70% overlap; only 10–32% received therapy. Motor impairment correlated with social-communication deficits and restricted behavior. This highlights widespread motor challenges in ASD and the need for systematic motor assessments and integrated interventions. Thus, concluded that **motor dysfunction** is not only prevalent but also clinically relevant in the ASD population—and should be a **standard therapeutic target** moving forward [1].

Arabi, M. Sheikh, R. Hemayattalab, and A. H. Memari (2022), conducted a RCT study on Effect of SPARK Physical Education on Gross Motor Skills in ASD provides compelling evidence supporting the effectiveness of the SPARK Physical Education program in enhancing gross motor skills in children with autism spectrum disorder (ASD). This randomized controlled trial, which involved 30 children aged 6–12 years, implemented a 10-week SPARK intervention and assessed outcomes using the Test of Gross Motor Development–2 (TGMD-2). Demonstrated statistically significant improvements ($p = 0.001$) in both locomotor skills (such as running, hopping, and jumping) and object-control skills (like throwing, catching, and kicking). These enhancements are especially important, as children with ASD frequently experience delays in gross motor development, which can negatively impact their ability to participate in physical activities, social play, and daily functional tasks. In conclusion this study not only confirms the motor skill benefits of SPARK but also suggests that consistent, structured physical activity can play a critical role in improving the physical competence, confidence, and participation potential of children with ASD in diverse environments [7].

YuQin Ji, Hao Tian, ZeYu Zheng, ZhuoYan Ye, and Qiang Ye (2022) conducted a meta-analysis study on Exercise Interventions for Motor Skills in ASD: Meta-Analysis synthesized evidence on physical activity interventions, including SPARK, for motor skill improvements. Meta-analysis of 13 studies, ages 5–16; including RCTs and quasi-experimental. Outcomes are Motor skills, standardized mean differences (SMD). Thus, concluded that large effects on locomotor abilities and moderate effects on object control and stability. The findings support the use of structured physical activity—such as SPARK—as an evidence-based intervention to improve motor function in children with ASD [2].

Homa Rafiei Milajerdi, Mahmoud Sheikh, Mahboubeh Ghayour Najafabadi, Behnaz Saghaei, Naser Naghdi, and Deborah Dewey (2021), conducted a RCT study on SPARK vs. Kinect: Manual Dexterity and Balance in ASD, which assessed SPARK's advantage over exergaming for fine motor and balance. Design is RCT (n = 40, 6–11 years), 8 weeks. MABC-2 manual dexterity and balance. Thus, this study concludes that SPARK participants showed superior dexterity and balance improvements. Face-to-face, structured motor training via the SPARK program is more effective than Kinect exergaming at improving manual dexterity and balance in children with ASD, reinforcing its utility in targeted motor development interventions [4].

Fahimeh Hassani, Shahnaz Shahrbanian, Seyed Houtan Shahidi, and Mahmoud Sheikh (2020) conducted an RCT study on Comparison of SPARK and ICPL on Motor Function in ASD. Comparing SPARK with standard inclusive physical education (ICPL). Design is RCT (n = 30, 7–12 yrs.), 16-week program. Outcomes: BOT-2 gross motor subtests. The SPARK group improved more significantly than ICPL group for gross motor skills. SPARK is more effective than standard inclusive PE for motor development. SPARK is more effective than standard inclusive physical education (ICPL) in promoting gross motor development in children with ASD. While both programs benefit motor proficiency, SPARK yields superior improvements in key motor domains due to its intensity and focused skill practice [3].

Mahboubeh Ghayour Najafabadi and Sepehr Rokhsar Niazi (2019), conducted a Quasi-experimental study on 16-week SPARK Model Effects on Motor Proficiency in ASD An extended intervention may yield sustained motor improvement. This Iranian study

concluded an assessment of longer-duration SPARK effects. Methods used: Quasi-experimental (n = 30, 6–12 years) 16 weeks of SPARK, 3-week, 45–60 min sessions. BOTMP assessment. Patient had Significant improvements in static/dynamic balance and coordination ($p < 0.05$), with greater effect sizes than shorter durations. Thus, longer SPARK exposure leads to stronger motor gains. Suggests positive dose-response [5].

Qun Fang, Christopher A. Aiken, Chao Fang and Zhujun Pan (2019) conducted a RCT study on comparing SPARK vs. Kinect Exergaming for Motor and Executive Function in ASD, Digital exergaming is growing in ASD interventions. This RCT compared traditional SPARK to Kinect-based programs. Design used is RCT (n = 60, 6–10 years), 3 arms: SPARK, Kinect, control; 8 weeks, 3-week. Which is Aiming and catching (motor), executive function (cognition). In conclusion SPARK: Greater motor improvements (aiming/catching), Whereas in Kinect: Superior gains in executive function. SPARK is optimal for motor skill regimens; exergaming may better serve cognitive domains [10].

Mahboubeh Ghayour Najafabadi, Mahmoud Sheikh, Rasoul Hemayattalab, Amir Hossein Memari and Maryam Rezaii Aderyani in (2018), conducted a Quasi-experimenta study on the effects of SPARK on social and motor skills of children with autism and this study concluded that children with ASD commonly face deficits in balance, coordination, and social interaction. Few interventions target both domains simultaneously. SPARK—a structured, play-based, motor-enriched physical education program—may offer dual benefits. Method used is Quasi-experimental, within-subject (baseline, pretest, posttest) with participants are 28 ASD children (5–12 years) of ages. Intervention used are 3-week SPARK sessions (45–60 min each) over 8 weeks. BOTMP for motor skills; ATEC, GARS-2 for social behavior are the measurements used with this method patient have seen significant improvements in static/dynamic balance and bilateral coordination also significant gains in social interaction and behavior. Thus, demonstrates SPARK's effectiveness in improving both motor and social domains. Suggests interplay between physical activity and social engagement [6].

Rafiei, S., Hassani, S. M., Arabi, A., Sheikh, M., Hemayattalab, R., and Memari, A. H. (2017) conducted a randomized controlled trial to investigate the effectiveness of the SPARK (Sports, Play, and Active Recreation for Kids) program on selected motor skills in children with autism spectrum disorder (ASD). This study included 20 children around the age of 9, divided into parallel groups, and implemented an 8-week intervention with SPARK sessions conducted three times per week. The study demonstrated statistically significant improvements in static balance and lower-limb strength, as indicated by increased standing long jump distance. No significant improvement was observed in agility. These findings suggest that the SPARK program is effective in enhancing specific motor domains, particularly balance and lower-limb power [9].

Procedure

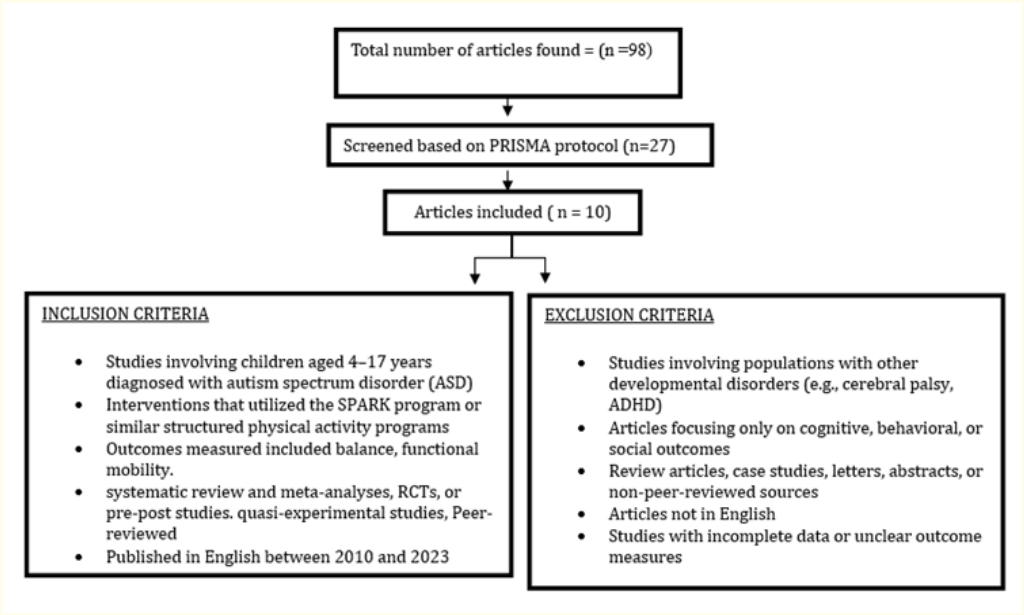

Figure 1

Result

The analysis of ten peer-reviewed studies revealed consistent evidence supporting the effectiveness of the SPARK program in enhancing balance and functional mobility in children with autism spectrum disorder (ASD). Improvements in balance were observed across multiple studies [5]. Significant gains in static and dynamic balance following a targeted balance training program [6], Improved postural control and increased single-leg stance duration after structured physical activities based on SPARK principles. Similarly [4], balance as part of improved locomotor skills using the Test of Gross Motor Development–2 (TGMD-2).

Functional mobility, though not always directly measured, showed noticeable improvements through gross motor assessments [7]. Reviewed studies indicating positive changes in functional tasks such as walking, stair climbing, and running after structured physical activity interventions. increased endurance and movement capacity among children with ASD who participated in selected physical exercise programs modeled on SPARK.

Out of the 10 studies reviewed, 7 studies reported clear and significant improvements in balance in children with autism spectrum disorder (ASD) following SPARK or SPARK-like interventions. These studies measured both static balance (such as standing on one leg) and dynamic balance (like balance during walking or jumping), using tools like the BOTMP and MABC-2. The improvements were consistent across short-duration programs (8 weeks) and extended sessions (up to 16 weeks), suggesting that regular and structured physical activities offered by SPARK help improve postural control and coordination.

Regarding functional mobility, which refers to the child's ability to move independently and perform everyday tasks like walking, running, and jumping, 5 studies (2017, 2019, 2020, 2022, 2023) showed notable progress. These studies demonstrated improvements in locomotor skills (such as running and hopping), lower-limb strength (e.g., jumping distance), and gait efficiency (better walking patterns and reduced ground reaction forces). Functional mobility gains were linked to better engagement in physical tasks and more confident participation in social and recreational activities.

Overall, these findings demonstrate that SPARK is an effective, evidence-based intervention that helps improve both balance and functional mobility in children with ASD, contributing to better physical independence and overall quality of life.

Despite strong evidence for their benefits, motor-based programs remain underutilized, with many children receiving limited or no intervention targeting motor development [3,4]. Given the high co-occurrence of motor deficits with social and behavioral challenges, there is a compelling need for early motor screening and the integration of structured physical activity into intervention plans.

Discussion

Children with Autism Spectrum Disorder (ASD) frequently display deficits in motor coordination, postural control, and balance, all of which significantly impact their functional mobility and daily participation [1]. These impairments may be attributed to atypical sensory integration, delayed motor planning, and poor neuromuscular control, which are characteristic of neurodevelopmental disorders like ASD [2]. As a result, interventions targeting balance and functional mobility are essential to improve independence and physical engagement in this population.

studies have demonstrated significant improvements in motor coordination and gross motor skills through the SPARK program. Najafabadi., *et al*. (2018), Najafabadi and Niazi (2019), and Arabi., *et al*. (2022) reported enhancements in both static and dynamic balance, while Hassani., *et al*. (2020) found SPARK superior to inclusive physical education in promoting motor unit recruitment and skill acquisition. Ji., *et al*. (2022), in a meta-analysis, confirmed these effects with large improvements in locomotor skills and moderate gains in object control. Physiologically, these outcomes are attributed to improved neuromuscular coordination involving the cerebellum, basal ganglia, and corticospinal tracts. Prolonged SPARK engagement, such as the 16-week intervention in Najafabadi and Niazi (2019), may further enhance synaptic plasticity and reinforce motor patterning, suggesting a dose-response relationship.

Studies by Rafiei., *et al*. (2017) and Milajerdi., *et al*. (2021) demonstrated significant improvements in static balance and postural control using assessments like MABC-2, standing long jump, and one-foot stand. Supporting these findings, Dehghani., *et al*. (2023) provided biomechanical evidence showing reduced ground reaction forces and improved plantar pressure distribution, indicating enhanced neuromuscular efficiency and safer gait mechanics. Physiologically, these improvements suggest better integration of vestibular, proprioceptive, and visual systems, with increased activity in the somatosensory cortex and cerebellum facilitating more efficient postural adjustments and load distribution.

Milajerdi., *et al*. (2021) found that the SPARK program was more effective than Kinect-based exergaming in improving manual dexterity. This enhancement is likely due to greater engagement of fine motor pathways, particularly the corticospinal tract and premotor cortex. The structured, hands-on activities in SPARK may provide richer sensory-motor integration compared to screen-based training, leading to more effective development of fine motor control.

Najafabadi., *et al*. (2018) reported notable social improvements in children with ASD following SPARK participation, while Fang., *et al*. (2019) found that although Kinect training enhanced executive function, SPARK led to superior motor gains. Bhat., *et al*. (2022–2023) further highlighted a strong link between motor impairments and social-communication challenges, underscoring the neurodevelopmental connection between motor and cognitive functions. Physiologically, these social and cognitive gains may be driven by activation of the prefrontal cortex, mirror neuron systems, and limbic structures, as physical play in SPARK promotes joint attention, imitation, and emotional regulation—core areas of difficulty in ASD.

Conclusion

Children with Autism Spectrum Disorder (ASD) frequently experience motor impairments including poor balance, delayed coordination, and reduced functional mobility, which can negatively affect their daily activities and social engagement [1,4]. A consistent body of research supports the effectiveness of structured physical activity programs—particularly SPARK (Sports, Play and Active Recreation for Kids)—in addressing these deficits [5,9,15]. The SPARK program, built on a foundation of structured, repetitive, and engaging movement activities, has shown significant improvements in static and dynamic balance, locomotor and object control skills, and overall gross motor function in children with ASD.

In conclusion, the SPARK program has emerged as a robust, adaptable, and evidence-based approach to improving balance, coordination, and functional mobility in children with ASD. Its structured delivery and multifaceted benefits support its inclusion as a standard component of therapeutic and educational strategies for this population. Future research should explore optimal intervention durations, long-term effects, and integration with cognitive-behavioral therapies to maximize outcomes.

Conflict of Interest

No conflict of interest.

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