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Effects of Sports, Play, and Active Recreation for Kids and Functional Body System Exercises on Physical Fitness in Children with Intellectual Disabilities

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ABSTRACT

Aims Children with intellectual disabilities often exhibit lower levels of physical fitness. This study investigated the effects of sports, play, and active recreation for children, and of functional body system training programs, on selected physical fitness indices in children with intellectual disabilities.
Materials & Methods This semi-experimental study included 36 children with intellectual disabilities from Aligoudarz city. Participants were purposively selected and randomly assigned to three groups: the sports, play, and active recreation for kids training group; the functional body system training group; and the control group (n=12 each). The training groups completed selected sports, play, and active recreation for kids or functional body system protocols over 8 weeks, while the control group received no exercise intervention. Balance was assessed using the timed up-and-go test; muscular endurance using modified pull-up and sit-up tests; flexibility using the sit-and-reach test; and aerobic capacity using the 20-meter shuttle run test. Measurements were taken 48 hours before and after the training period. Data were analyzed using SPSS 25 software.
Findings Both training programs significantly improved balance (15.48% and 12.36%), muscular endurance (26.4% and 25.8%), flexibility (26.13% and 18.36%), and aerobic capacity (10.16% and 12%, respectively) compared to the control group ($p \leq 0.05$). However, no significant differences were found between the two training programs for any of these parameters ($p > 0.05$).
Conclusion Sports, play, and active recreation for kids and functional body system training programs are equally effective, safe, enjoyable, and efficient interventions that enhance physical fitness indices in children with intellectual disabilities.

Keywords Posture Balance; Children; Physical Fitness; Intellectual Disability

CITATION LINKS

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Introduction

Intellectual disability (ID) is a developmental disorder characterized by significantly below-average intellectual functioning and adaptive behaviors compared to the general population [1]. Individuals with an IQ below 70-75, coupled with significant limitations in adaptive behavior, are classified as having ID based on standardized intelligence tests such as the Wechsler scales. Furthermore, IQ classification categorizes individuals with an IQ of approximately 50-70 as having mild ID, those with an IQ of 35-50 as having moderate ID, those with an IQ of 20-35 as having severe ID, and those with an IQ below 20 as having profound ID [2]. ID manifests before age 18 (during the developmental period), and its prevalence is reported to be approximately 1.5 times higher in males than in females [3]. Moreover, the risk of chronic diseases in individuals with ID is approximately twice that of the general population, and their average life expectancy is estimated to be half that of peers with typical development [4]. The reported prevalence of ID can vary depending on data collection methods and operational definitions of the disorder [5].

According to the latest estimates, the global prevalence of this disorder is approximately 2-3% [6]. In Iran as well, based on available statistics, over 1.5 million people live with some form of ID, with approximately 3% having profound ID—a significant figure in relation to the total population [3]. This disorder is one of the most important developmental challenges, beginning in childhood and characterized by limitations in intellectual functioning and adaptive behavior [7]. Children with ID, due to impaired cognitive functioning, frequently exhibit impairments or delays in the development of motor skills [8]. These children often display atypical and inefficient behaviors in activities that require precise bodily coordination. Their motor problems include poor fine- and gross-motor skills, impaired balance, and difficulties with activities of daily living [9]. Numerous studies have shown that children with ID, compared with their typically developing peers, obtain lower scores in physical fitness components such as muscular strength, cardiorespiratory endurance, agility, speed, reaction time, and balance [10]. For instance, Rahmati Aran & Dehghanizade report a significant correlation between cardiorespiratory fitness, muscular strength, static and dynamic balance, and postural abnormalities in this group [11]. Additionally, Fedulova *et al.* demonstrate that children with ID exhibit poorer performance in balance, throwing, catching, and jumping than typically developing children [12]. Given that children with ID exhibit poorer performance on physical fitness measures than their typically developing peers, implementing strategies to enhance their physical abilities is particularly important. In this regard, several studies have shown that children and adolescents with ID, through an active lifestyle and regular participation in sports activities, can improve their muscular strength to levels comparable to those of their typical peers [13, 14].

In light of these findings, individuals with intellectual disabilities often experience premature aging. This condition leads to increased disability and a higher incidence of various diseases, consequently placing them at greater risk of impaired balance and reduced physical fitness indices compared to others. Such problems can increase the likelihood of falls, complicate the performance of occupational and social roles, and restrict activities of daily living [15]. Therefore, the need for high-quality fitness programs in this population is particularly pressing. In this regard, improving neuromuscular function, enhancing coordination, strengthening proprioception, increasing static and dynamic balance, and empowering core muscles through resistance and functional training programs can markedly improve their physical capacity and ability to perform these tasks and activities.

The functional body system (FBS) training program is a combined therapeutic and physiotherapy-based regimen that incorporates functional, balance, and strengthening exercises. This program is grounded in the theoretical principles of motor control and learning, postural adjustment, and muscle strengthening [16]. The FBS exercises, as a combination of functional, balance, and strengthening training, have been introduced as an effective method for improving health. Among the benefits of FBS exercises are enhanced muscular strength through hyperplasia (increased muscle fibers) and hypertrophy (increased fiber size), improved coordination and synchronization of motor units, a wide variety of exercises, engagement of all systems involved in maintaining static and dynamic posture, and their cost-effective and practical nature. Such training is particularly effective for preserving balance and coordination [17]. In contrast, the sports, play, and active recreation for kids (SPARK) program is a play- and fun-based activity that, beyond physical benefits, positively impacts the mental and emotional well-being of children with intellectual disabilities [18]. This program, designed to enhance physical fitness and motor skills, has been implemented and evaluated in U.S. elementary schools as a health-related physical education curriculum [19]. Domestic studies have also shown that SPARK training has a significant effect on improving gross motor and manipulative skills in children with intellectual disabilities [20].

Despite the effectiveness of both training approaches, no study to date has directly compared the effects of SPARK and FBS exercises on physical fitness indices and aerobic capacity in children with intellectual

disabilities. This research gap underscores the importance of the present study, as maintaining muscular strength, endurance, and dynamic balance is essential for achieving independent living in individuals with intellectual disabilities. Moreover, exercise programs tailored to the physical and psychological characteristics of this population not only improve physical and mental health but also prepare them for more active participation and a better quality of life in society. The present study aimed to examine and compare the effects of a period of SPARK and FBS training on physical fitness indices and aerobic capacity in children with intellectual disabilities.

Materials and Methods

Design and sample

This semi-experimental study using a pre-test/post-test design was conducted on 36 children with intellectual disabilities (Wechsler IQ scores 35–50) attending special education schools in Aligoudarz city in 2025.

The sample size was determined a priori using G*Power 3.1 for repeated-measures ANOVA (time×group interaction) or one-way ANOVA on change scores, using an effect size of 0.25, α=0.05, power=0.8, 3 groups, and 2 measurements. This yielded a minimum of 36-42 (12-14 per group). Due to the limited accessible population (children with IQs of 35-50 in special schools in Aligoudarz), 36 eligible children were purposively selected and randomly assigned to three groups of 12 each (SPARK, FBS, and control). Inclusion criteria were no sensory impairments (e.g., blindness, deafness, or tactile deficits), no illness or inability to perform exercises, and parental satisfaction. Exclusion criteria included withdrawal from the study, injury during training, and absence from more than two sessions.

Instrument

A questionnaire designed by the therapist was used to collect demographic information, including gender, age, medication use, father's occupation, and parents' education level.

The Wechsler Intelligence Scale for Children is an analytical test designed for ages 5-15, scored on a performance basis rather than an all-or-nothing approach. It comprises 12 subtests (two optional: digit span and mazes, which can substitute for others). Subtests are divided into verbal (e.g., general information, similarities, vocabulary, and digit span) and performance (e.g., picture completion, block design, mazes, coding) sections. Internal consistency is high within sections but lower between verbal and performance. The test demonstrates acceptable reliability and validity: internal consistency coefficients of 0.96 (full scale), 0.94 (verbal), and 0.9 (performance); good test-retest reliability over one month and two years; and standard errors of measurement of 3.19 (full), 3.6 (verbal), and 4.66 (performance). The highest error was in digit span, and the lowest was in vocabulary [21]. Studies by Abedi *et al.* confirm good validity and reliability in Iranian samples [22]. In the present study, the Cronbach's α was 0.92 for the full scale, 0.89 for the verbal section, and 0.86 for the performance section.

Standard tests were used to measure physical fitness indices, like flexibility (sit-and-reach), muscular endurance (modified pull-up and trunk curl), dynamic balance (timed up and go; lower time = higher score; validity 0.79, reliability 81.5% [23]), and aerobic capacity (20-meter shuttle run) [24]. The validity and reliability of these tests have been confirmed in prior studies [12, 13, 19].

Table 1. Sports, play, and active recreation for kids (SPARK) exercise

Session	Exercise
1	- Static and dynamic balance - Visual, auditory, and shape perception (spatial and temporal) - Locomotion and manipulation skills - Lateral dominance and body awareness - Coordinated and simultaneous movements and movement patterns - Combined activities
2	- Hopping backward and sideways on a straight line - Drawing shapes on the board and having the child describe their direction - Crumpling newspaper - Hopping on the dominant foot inside squares - Searching in sand to find small hidden objects - Review of previous exercises
3	- Double-leg jump inside a square - Moving inside squares with pre-marked left and right foot positions - While performing double-leg jumps, hitting a ball to the ground with both hands - Holding paper with the non-dominant hand and cutting with the dominant hand - Imitating animal walking - Opening and closing nuts and bolts
4	- Standing on a balance board - Running and kicking a ball thrown by the instructor - Butterfly movement (jumping jacks) - Completing a human body puzzle - Hitting a balloon in space - Review of previous exercises
5	- Standing on one leg with eyes closed - Zigzag passing through obstacles - Hitting a tennis ball with the back and front of a racket - Hopping on the dominant foot and landing on both feet in the eight-square game - Guessing the structure of shapes with eyes closed - Building shapes with play dough
6	- Standing on one leg on a soft surface - Tracking a pendulum ball with the eyes - Throwing a ball into a basket - Drawing the human body and naming body parts - Touching the tip of the nose with eyes closed - Review of previous exercises
7	- Walking on a balance board - Coordinated striking with the instructor using two wooden sticks - Double-leg jump over a small obstacle - Instructor touches a limb and the child repeats the movement - Throwing a rubber ring into a designated area - Building shapes with play dough
8	- Standing on a tube - Drawing shapes on paper and recreating them with play dough - Passing through a hoop (frontally) - Passing sideways through a hoop - Standing on a tube and imitating the instructor's movements - Review of exercises
9	- Hopping and rotating on one leg - Throwing a ball to different areas - Hopping and rotating on one leg while holding a ball - Learning the function of different body parts - Hitting a ball to a specific area on the wall - Review of previous exercises

Procedure

Written informed consent was obtained from all parents. Participant information remained confidential, and voluntary withdrawal was permitted at any stage. No exercise intervention was provided to the control group during the study. They continued their usual lifestyle and only participated in pre- and post-testing.

The 8-week SPARK program consisted of three 45-60-minute sessions per week, structured in four parts: warm-up, locomotion skills, manipulation skills, and cool-down [25]. Sessions 10-24 repeated earlier sessions for continuity and consolidation (Table 1).

The FBS intervention group also performed combined functional, balance, and strengthening exercises in supine, sitting, and standing positions over eight weeks, with three sessions per week, each lasting approximately 45-60 minutes. The FBS exercises comprised activities that integrated all three characteristics—functional, balance, and strengthening—within a single exercise (Table 2) [26].

Data analysis

The normality of the data was assessed using the Shapiro-Wilk test, and the homogeneity of variances was evaluated with Levene's test. Given that the assumptions for parametric tests were met, paired t-tests, one-way analysis of variance (ANOVA), and Tukey's post-hoc test were employed. All analyses were conducted using SPSS 25.

Table 2. Functional body system (FBS) exercise

Session	Exercise	Repetitions (week) 1-2	3-4	5-6	7-8	Notes
1	Pressing a small Pilates ball with the back of the head against the wall	38	310	312	312	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
2	From the prone position, forehead on rolled hands, rolling head backward and upward	38	310	312	312	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
3	Sitting, placing the Pilates band behind the head and pressing the head backward	38	310	312	312	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
4	Hands behind the body, lifting the abdomen forward with straight legs	308	301	3912	3512	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
5	Standing on both feet, holding the band in front at the horizontal level, opening arms (scapular retraction)	208	3010	2012	3012	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
6	Angel movement with band under one foot and opening arms to the sides	208	2010	2012	3912	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
7	On all fours, simultaneously lifting opposite arm and leg	358	3510	2012	3912	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
8	On all fours, band under one hand, pulling the other end of the band sideways	308	3010	2012	3312	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
9	Prone on a Swiss ball, arm flexion forward	208	3510	3512	3012	Each movement: 6-8 sec hold Rest between sets: 1.5×duration of set
10	Standing on both feet, band under both feet, arm flexion forward to overhead	358	3510	2012	3912	Each movement: 6-8 sec hold
11	Plank position, one hand on the ground, opposite hand to the side	308	3510	3512	3012	Each movement: 6-8 sec hold
12	Prone on a Swiss ball, raising arms upward from the sides	308	301	2012	3512	Each movement: 6-8 sec hold

Findings

Participants in the SPARK group had a mean age of 8.25±0.96 years, weight of 38.42±3.70kg, and height of 148.00±6.42cm. The FBS group showed similar values, with a mean age of 8.75±0.96 years, weight of 38.25±3.28kg, and height of 145.00±6.66 cm. In the control group, the mean age was 9.08±0.79 years, weight was 39.08±2.31kg, and height was 146.30±4.69cm.

The groups exhibited comparable baseline anthropometric profiles.

Levene's test for equality of variances was conducted to assess the homogeneity assumption of the dependent parameters across groups at the pre-test and post-test time points. For all parameters—balance, muscular endurance, flexibility, and aerobic capacity—the test results indicated homogeneous variances (all p>0.05).

Paired t-tests were performed to evaluate within-group changes in the dependent parameters from pre-test to post-test. In the SPARK group, significant improvements were observed across all parameters. Balance improved by 15.48% (t=9.75; p=0.001), muscular endurance increased by 26.4% (t=-9.89; p=0.001), flexibility increased by 26.13% (t=-12.09; p=0.001), and aerobic capacity increased by 10.16% (t=-18.99; p=0.001).

Similarly, the FBS group demonstrated significant positive changes: Balance improved by 12.36% (t=18.1; p=0.001), muscular endurance by 25.8% (t=-18.1; p=0.001), flexibility by 18.36% (t=-13.47; p=0.001), and aerobic capacity by 12% (t=-12.59; p=0.001). In contrast, the control group showed no significant changes in any parameter (all p>0.05), with percentage changes ranging from -0.38% for balance to +1.95% for flexibility (Table 3).

Table 3. Comparison of mean scores of physical fitness indices across the functional body system (FBS), sports, play, and active recreation for kids (SPARK), and control groups

Parameter	Group	Pre-test	Post-test	Change (%)	t	p-Value
Balance	SPARK	2.52±0.36	2.13±0.28	-15.48	9.75	0.001
	FBS	2.67±0.40	2.34±0.39	-12.36	18.1	0.001
	Control	2.65±0.29	2.64±0.26	-0.38	0.19	0.85
Muscular endurance	SPARK	12.33±2.35	15.58±2.27	+26.4	-9.89	0.001
	FBS	12.58±2.02	15.83±1.89	+25.8	-18.1	0.001
	Control	13.58±2.11	13.67±2.74	+0.74	-0.17	0.87
Flexibility	SPARK	15.92±1.83	20.08±1.78	+26.13	-12.09	0.001
	FBS	16.83±1.64	19.92±1.44	+18.36	-13.47	0.001
	Control	16.92±2.15	17.25±2.71	+1.95	-0.89	0.39
Aerobic capacity	SPARK	19.99±1.41	22.02±1.22	+10.16	-18.99	0.001
	FBS	19.58±1.12	21.93±1.09	+12	-12.59	0.001
	Control	19.97±0.91	19.98±0.88	+0.05	-0.18	0.86

Discussion

This study aimed to examine and compare the effects of a period of SPARK and FBS training on physical fitness indices in children with ID. Eight weeks of implementing the SPARK and FBS exercise programs (three sessions per week, each session lasting 45-60 minutes) significantly improved balance, muscular endurance, flexibility, and aerobic capacity in children with ID, whereas the control group showed no significant changes. Direct comparison of the two exercise programs also revealed no significant differences across any parameters, indicating that both methods were approximately equally effective.

Balance in children improved by 15.48% in the SPARK group and 12.36% in the FBS group. These results are fully consistent with many studies, including those by Rajabi *et al.* [27] and Moradi *et al.* [28]. However, some studies have reported different findings; Shafizadeh & Mohamadi report only a 4.7% improvement in dynamic balance and no change in static balance after eight weeks of SPARK [29], and Babadi *et al.* declare improvement only in static balance following functional-balance exercises in children with autism spectrum disorder accompanied by ID [30]. The observed improvements in the present study are likely due to the progressive increase in training load, the appropriate combination of static and dynamic tasks, and the high motivation of the children resulting from the play-based nature of the SPARK program and the engaging structure of FBS. From a neurophysiological perspective, cerebellar abnormalities are a consistent feature of intellectual disability [31]. Both programs, by creating tasks that require rapid shifts in the base of support, reactive responses, and continuous postural adjustments, strongly activate spinocerebellar and cerebello-cortical pathways, leading to increased synaptic plasticity in lobule VI and Crus I of the cerebellum [31].

On the other hand, muscular endurance of the upper and lower limbs increased by 26.4% and 25.8%, respectively, which is consistent with the studies by Bouzas *et al.* [32] and Štrucelj *et al.* [33]. In contrast, Dehghani & Ghasemi report significant improvement only in the sit-up test and no change in the push-up test [34].

The differences in results are likely related to exercise intensity, the actual volume performed, and the level of intellectual disability among participants. Both the SPARK and FBS programs, due to their circuit-based, multi-joint nature and lack of long rest periods, create high oxygen demands, leading to increased mitochondrial density, angiogenesis, conversion of type IIx fibers to IIa, and improved intra- and inter-muscular coordination [35]. These adaptations are of double importance in children with intellectual disabilities, who naturally have lower oxidative capacity.

Flexibility increased by 13.26% in the SPARK group and approximately 18.36% in the FBS group. This finding is consistent with other studies, including those by Salehian *et al.* [7] and Samatovich [36]; However, Rahmani Chegni *et al.* report only a non-significant 3.8% improvement following a SPARK training period [37]. Additionally, Konrad *et al.* emphasize that dynamic stretches typically have less effect than static stretches when performed for less than eight weeks [38]. The intelligent combination of prolonged static stretches with mental focus (SPARK) and repetitive dynamic stretches (FBS), along with stretching durations exceeding 60 seconds per muscle group, led to strong activation of Golgi tendon organs, reduced stretch reflex, sarcomere lengthening, and increased stretch tolerance.

Additionally, following eight weeks of SPARK and FBS training, aerobic capacity increased by 10.16% in the SPARK group and by 12% in the FBS group, representing the first direct report comparing the effects of these two programs on VO_2peak in children with ID. Our results are consistent with studies by Khaliq & Dehghani Zadeh [39] and Maicas-Pérez *et al.* [40]. These studies have shown that SPARK and FBS training likely increase participants' aerobic capacity by enhancing core and lower-body muscle engagement and improving neuromuscular coordination. On the other hand, Koufaki *et al.* report only a non-significant 4.2% increase in aerobic capacity and suggest that more time may be required to induce aerobic adaptations from these exercises [41].

The greater improvement in the present study is due to the inclusion of continuous jumping and rope-

skipping activities, as well as the interval-like structure of the programs (particularly SPARK), which led to increases in stroke volume, muscular angiogenesis, mitochondrial density, and movement economy [42].

In summary, both SPARK and FBS training programs, as non-pharmacological, safe, low-cost, enjoyable, and feasible interventions in special education schools and rehabilitation centers, demonstrated equal effectiveness in improving physical fitness indices in children with intellectual disabilities. This equivalence, despite apparent differences in the programs' structures, stems from a high degree of overlap among physiological, neurophysiological, and motivational mechanisms. The results of the study emphasize the importance of multidimensional, play-based, and functional programs and indicate that there is no need to choose exclusively between these two methods; rather, either one or a combination of them can be used. Therefore, it is recommended that these programs be incorporated into the physical education curriculum of special education schools, that coaches receive training, and that the programs continue at home and in rehabilitation centers. For future research, it is suggested to investigate long-term effects (more than 12 weeks), post-intervention retention, impacts on cognitive-emotional parameters, and structural brain changes using functional imaging. Additionally, it is recommended to compare these programs with modern methods such as aquatic exercise, virtual reality, and active gaming.

Our results provide strong evidence that SPARK and FBS exercises are effective, generalizable, and sustainable options for improving physical fitness indices in children with intellectual disabilities. They can be integrated into comprehensive rehabilitation programs for these children.

Conclusion

Sports, play, and active recreation for kids, as well as functional body system training programs, are effective, generalizable, and sustainable options for improving physical fitness indices in children with intellectual disabilities.

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Ethical Permissions: This research has been approved by the Research Ethics Committee of Yazd University (ID number: IR.YAZD.REC.1405.016).

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