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The Impact and Long-term Effects of Exercises and Sports Games on Motor Ability and Quality of Life in Children with Intellectual Impairment: A Randomized Controlled Trial

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ABSTRACT

Background: Children with intellectual impairment have impaired or delayed development of motor skills due to impaired mental function. In the present study, the effect and durability of exercise and sports games on the motor abilities and quality of life (QoL) of children with intellectual impairment were investigated.

Methods: This randomized controlled study assessed sixty boys aged 8-12 years with mild intellectual impairment in three groups: an exercise group (aerobic and resistance training), a sports games group (basketball and futsal), and a control group, for 8 weeks. Motor abilities were assessed using the 4x9 m shuttle run, ball-catching against a wall, stork balance test, and the Timed Up and Go (TUG) test, while BMI and QoL were evaluated using the Pediatric Quality of Life Questionnaire (PedsQL-parent proxy report) questionnaire. Data were analyzed using SPSS, with significance set at $P < 0.05$.

Results: Significant differences were observed between the experimental and control groups in post-test results for motor ability and QoL ($P < 0.05$). During follow-up, static balance ($P = 0.001$) and QoL ($P < 0.05$) also showed significant improvements in the experimental groups compared to the control group. Moreover, coordination improved significantly in the sports games group compared to the control group ($P = 0.016$), while agility improved in the exercise group ($P = 0.006$). Follow-up analysis revealed significant differences in overall QoL, psychosocial health, and school functioning between the exercise and sports games groups ($P = 0.001$). Intra-group analysis showed significant differences in motor abilities (except for BMI) and QoL in both experimental groups and at all-time points ($P = 0.001$).

Conclusion: The interventions demonstrated positive effects on most variables of motor ability and QoL. The exercise group showed superior improvements in motor abilities, while the sports games group exhibited greater enhancements in QoL. Integrating both types of interventions may yield more comprehensive benefits.

1. Introduction

Disability is a complex phenomenon that not only encompasses types of injuries and limitations in activity and participation but also causes disturbances in body function and structure. It reflects the interaction between individual and societal characteristics in which a person lives (Fadaei Dehcheshmeh et al., 2019). The number of people with known types of disabilities worldwide is reported to be around 10%, which is estimated to be around 800 million people (Pejčić & Kocić, 2020). Intellectual Impairment (II) accounts for 1-3% of the disabled population (Özkan & Kale, 2023). According to the statistics provided by the welfare organization, there are more than 1.5 million individuals

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with intellectual disabilities in Iran (Fadaei Dehcheshmeh et al., 2019). Individuals with intellectual disabilities-(ID) are characterized by neurodevelopmental deficits and limitations in intellectual functioning and adaptive behavior, distinguishing them from the general population (Lee et al., 2022). These limitations affect many social and practical skills (Zhang et al., 2021). Intellectual impairment is generally defined by an IQ below 70, with limitations in two or more skill and adaptive levels that can be observed (Walsh et al., 2018) and appears before the age of 18 or 22 (Diz et al., 2024; Kavanagh et al., 2024). Individuals with intellectual impairments face cognitive and social adaptation challenges (Jacinto et al., 2021; Özer et al., 2012), as well as sensory deficits, slower growth, and behavioral difficulties such as irritability, lethargy, or lack of self-control. they may also show learning impairments, hyperactivity, and memory impairment, which in turn impact their cognitive and motor functions (Fadaei-Dehcheshmeh & Shamsi-Majelan, 2018; Fadaei Dehcheshmeh et al., 2019). Reports show that people with intellectual impairment are usually at higher risk for physical and psycho-social problems such as anxiety, depression, and reduced life expectancy compared to normal people of the same age (Fadaei Dehcheshmeh & Shamsi Majelan, 2020; Fadaei Dehcheshmeh et al., 2019). During childhood, individuals with intellectual impairments often exhibit slower learning, poor retention of learned information (Ali et al., 2021), speech difficulties, delayed physical development, and reduced self-care are skills (Phytanza et al., 2018). This group also shows lower physical fitness in all stages of life (Fadaei-Dehcheshmeh & Shamsi-Majelan, 2018; Fadaei Dehcheshmeh et al., 2019). Furthermore, low physical activity has a negative effect on life expectancy and Quality of Life (QoL) (Özkan & Kale, 2023). Intellectual impairments also hinder the ability to perform tasks such as sitting, standing, walking, talking, solving cognitive problems, short-term memory, and understanding social rules and cause-and-effect relationships (Lee et al., 2022). Regular Physical activity (PA) during childhood and adolescence, especially for people with intellectual impairment, is crucial for improving health, promoting proper growth and development (Cowley et al., 2010), preventing non-communicable diseases, enhancing mental and physical development, and increasing emotional stability and motivation (Howie et al., 2012). Opportunities for exercise yield positive results, including improved physical health, enhanced QoL, greater life satisfaction, increased friendships, better social skills, and increased self-confidence. Although some studies have explored interventions to improve physical fitness and mental functioning in children with intellectual impairment, none have examined multiple interventions or addressed the specific physical and psychological characteristics of these children comprehensively. Previous research has investigated the effects of game-based exercises on motor skills in children with Down syndrome (Kakejani et al., 2024), the role of school games in the development of motor skills in children with autism spectrum disorders (Zourmand et al., 2024), the impact of a one-year physical activity intervention on motor skills in boys with severe intellectual disabilities (Zhang et al., 2021); and the effect of the Good Behavior Game on the behavior of students with mild intellectual disabilities during physical education (Tounsi et al., 2024). Children with intellectual impairment have less mastery in abstract thinking, which is why they need special educational services, although this condition cannot be cured (Suhartini et al., 2024). There is no consensus among researchers about the most effective motor exercise interventions for individuals with special needs (Yılmaz & Mirze, 2024). Therefore, designing and implementing appropriate interventions that consider the specific characteristics of people with intellectual impairment and adhere to exercise principles and guidelines is essential, especially during childhood. This study aims to investigate the effects and durability of a course of exercises and sports games on motor ability and QoL in children with intellectual impairments, with the goal of providing recommendations for exceptional centers and schools based on the findings.

2. Materials and Methods

2.1 Participants

The study population of the current study was boys aged 8-12 years with mild intellectual impairment, enrolled in special education elementary schools. The sample size was calculated using G*Power statistical software (version 3.1.9.4; University Kiel, Germany), resulting in a total of 60 participants, divided into three groups: two experimental groups and one control group, with 20 people per group. Assessments were conducted at three-time points: pre-test, post-test, and follow-up. The two experimental groups received different interventions, with one group participating in an exercise program and the other in sports games. A summary of the type and process of the research is shown in Figure 1. Inclusion criteria included: (a) having a mild intellectual disability, and (b) being able to follow verbal instructions with minimal physical guidance. Exclusion criteria were: (a) having a physical disability or other health condition that may limit physical movement, (b) participating in similar exercise programs during the research period, and (c) engaging in regular physical activities during the follow-up phase. In addition to examining the medical records of the students, a psychologist working with the school was also asked to confirm the mentally impairment condition of the subjects and put them in the mild category. This study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics committee for human studies (code: IR.SSRC.REC.1402.023). Also, the study was registered as a clinical trial (code: IRCT20230407057840N1), following the subject selection criteria and adherence to the research protocols.

2.2 Study design and perform process

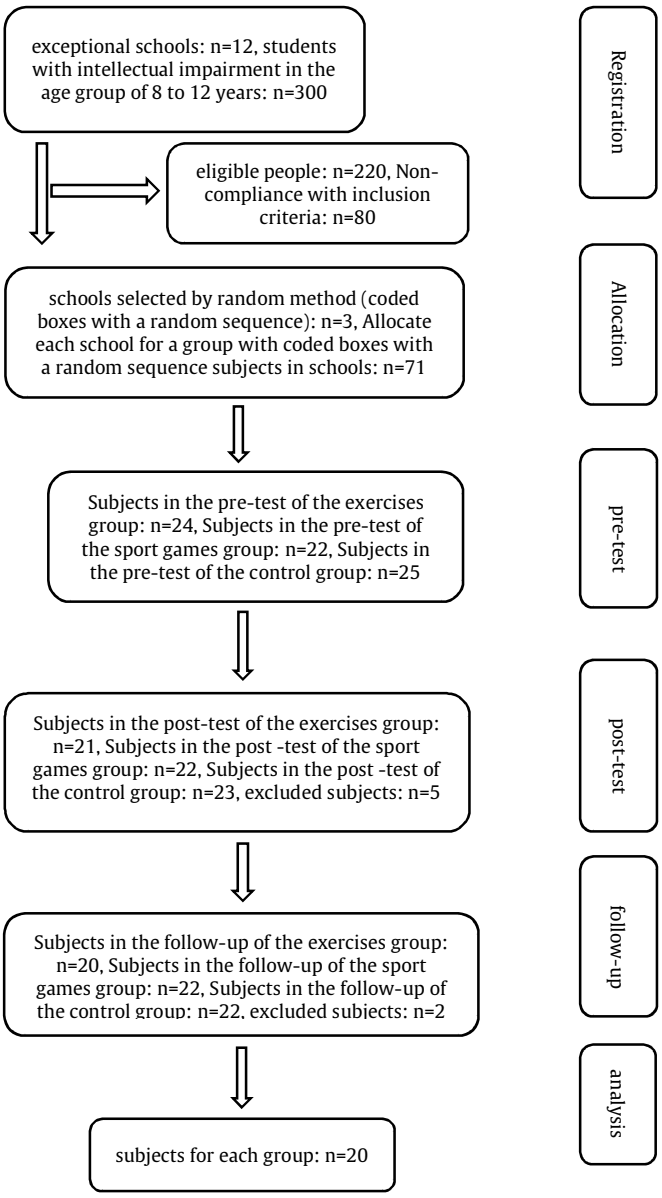

Figure 1. Consort flowchart

2.3 Evaluation tools

2.3.1 Motor Ability

The motor ability tests in this study included agility, coordination, balance, and functional balance tests. Agility was measured using the 4x9 m shuttle run test, coordination was assessed through the catch ball against the wall test, balance was evaluated with the balance stork stand test, and functional balance was measured using the Timed Up & Go (TUG) test. The TUG test measures the time taken for a participant to rise from a standard chair, walk 3 m, turn around, return to the chair, and sit down. The total time was recorded in seconds using a stopwatch, With two trials performed and the best time recorded (Barak et al., 2019; Lee et al., 2016). The balance stork stand test was used to evaluate static balance. In this test, subjects stood comfortably with their hands on their hips and were instructed to stand on one leg while placing the sole of the non-supporting foot against the knee of the supporting leg. The stopwatch was then started and the subjects were told to raise the heel of the support leg to stand on their toes. When the heel touched the ground or the right foot moved past the left knee, the time was recorded in seconds. The best time from two trials was recorded. Agility was evaluated using the 4x9 m shuttle run test. In this test, the participants ran back and forth between two parallel lines, 9 m apart, as fast as possible. After picking up and placing wooden blocks on the opposite side during each run, the total time to complete the task was recorded in seconds. Coordination was measured using the catch ball against the wall test. A mark was placed 2 m from the wall, and participants stood behind the line, facing the wall. The task involved throwing a ball underhand against the wall with one hand and catching it with the opposite hand, then repeating the process within 30 seconds. The number of successful catches was recorded (Ali et al., 2021; Pise et al., 2018). A portable stadiometer (No. 26SM, Yongtai, Zhejiang, China) was used to measure the height (2 m). The participants stood barefoot with their heels, hips, and head against the wall, and height was recorded in centimeters. The weight of the subjects was equally distributed on the legs, the head, and the eyes parallel to the horizon. Then the wall height meter was placed on the subject's head by the examiner (Fadaei-Dehcheshmeh & Shamsi-Majelan, 2018; Zhang et al., 2021). A portable digital scale (Tanita 800S; Tanita, Tokyo, Japan) was used to measure weight, while the participants were barefoot and in minimal clothing. Weight was recorded in grams and kilograms (Fadaei-Dehcheshmeh & Shamsi-Majelan, 2018; Zhang et al., 2021). Body composition was evaluated using the Body Mass Index (BMI) test, calculated by dividing weight in kilograms by height in meters squared (Fadaei-Dehcheshmeh & Shamsi-Majelan, 2018; Yılmaz & Mirze, 2024; Zhang et al., 2021). Then, using the Z-Score method of World Health Organization, the standard deviation relative to the age group mean was calculated.

2.3.2 QoL

In assessing QoL in children, especially those who are very young, cognitively impaired, or unable to complete QoL questionnaires due to illness or fatigue, parent proxy reports are often reliable and valid (Varni et al., 2007). The PedsQL Version 4.0 was used to measure health-related QoL of children aged 2 to 18 years. The parent proxy report form, designed for children aged 8 to 12 years, was used (Nikolašević et al., 2024; Özkan & Kale, 2023). In a population of Iranian children, Cronbach's alpha for the total score was 0.82, with subscale reliability ranging between 0.65 and 0.77 (Mohamadian et al., 2014). The PedsQL is a Likert-type scale with five response options, where scores range from 0 and 100, with higher scores indicating better QoL. The PedsQL includes total score QoL, physical functioning, psychosocial health summary score, school functioning, emotional functioning, and social functioning. The PedsQL™ 4.0 scale

includes 23 items across four subscales: (1) physical functioning (8 items), (2) emotional functioning (5 items), (3) social functioning (5 items) and (4) school functioning (5 items). It takes approximately 5 minutes to complete. Both child self-report and parent proxy report formats are available, and the parent proxy report evaluates the parents' perception of their child's QoL. The components of both forms are basically the same. Higher scores indicate better QoL (Varni et al., 2007).

2.3.3 Exercise and Sport Game Programs

The 8-week exercise and sports game programs (three sessions per week, 50 to 65 minutes per session) were conducted in a group format, following the protocols of similar studies (Ali et al., 2021; Ghaeeni et al., 2015; Guidetti et al., 2009; Jacinto et al., 2021; Jo et al., 2018; Oviedo et al., 2020; Özer et al., 2012; Pejčić & Kocić, 2020; Phytanza et al., 2018). Before implementation, feedback from several experts in the fields of physical therapy and sports sciences in Iran was obtained regarding the type of exercises (Tables 1 and 2). In addition to the present researchers, several sports science students and trainers specialized in working with individuals with special needs in Zanjan City played a role in the performance of interventions, under the supervision of the main researcher. The interventions were divided into two groups: the exercise group, which performed aerobic and resistance exercises with emphasis on core training, and the sports game group, which engaged in basketball and futsal games performing their skills. The interventions were performed over eight weeks, with three sessions per week, each lasting between 50 to 65 minutes which was exceptional during the children's time at school. The interventions started following the Nowruz holiday, and post-test evaluations were conducted at the start of the summer break. The follow-up assessments were completed after three months, coinciding with the beginning of the new academic year.

Table 1. Overview of the exercises program

program	type of exercise
	warm-up
type	running and stretching exercises
time	10 minutes
	aerobic exercises
intensity	9-14 RPE*
type	rhythmic exercises with music (basic aerobics exercises), interval sprints
time	25 minutes
rest	5 minutes
	resistance exercises
intensity	8 – 15 RM**
type	crunch, reverse fly, biceps curl, lateral raise, chest press, squats, contracting abdominal muscles while lying in supine position, contracting abdominal muscles while lying in a supine position with one leg stretched and the other bent at the knee and pressed against the abdomen, raising the opposite arm and leg while doing squats
time	20 minutes
	cool down
type	stretching exercises
time	5 minutes

* rating of perceived exertion
** maximum repetition

Table 2. Overview of the sports games program

program	type of exercise
	general warm-up
type	running and stretching exercises
time	5 minutes
	specific warm-up
type	reviewing previous exercises and working with the ball
time	5 minutes
	Futsal training
type	controlling the ball, passing the ball, carrying the ball, dribbling, and shooting the ball toward the goal
time	20 minutes
rest	5 minutes
	Basketball training
type	carrying the ball, catching the ball, passing the ball, dribbling, changing direction with the ball, and shooting toward the basket
time	20 minutes
	cool down
type	stretching exercises
time	5 minutes

2.4 Statistics

After collecting the data, the Shapiro-Wilk test was used to assess the normality of the data distribution. Descriptive statistics, including tables, means, and standard deviations, were used to describe and explain the findings. For data analysis, inferential statistics were applied, including one-way ANOVA, repeated measures, Bonferroni, and T-tests to compare the results between the experimental and control groups. The level of significance in this research was considered $p < 0.05$, and all statistical analyses were done using SPSS version 25 software (IBM Corp., released 2010; Armonk, New York, USA).

3. Results and Discussion

Table 3 presents the demographic information of the participants.

Table 3. Individual information of the participants (mean ± standard deviation)

Variable	Exercises group	Sports games group	control group	*P*
	mean ± SD	mean ± SD	mean ± SD	
age (years)	9.90 ± 1.16	9.80 ± 1.15	9.70 ± 1.08	0.856
Height (meters)	1.34 ± 0.01	1.34 ± 0.03	1.34 ± 0.02	0.824
weight (kg)	35.05 ± 1.50	35.20 ± 2.39	35.25 ± 1.91	0.946
BMI (kg/m^2)	19.33 ± 0.54	19.41 ± 0.52	19.58 ± 0.46	0.288

SD = standard deviation

The results of the Levene's Test showed that the individual information of the subjects was homogeneously distributed in three groups ($p < 0.05$). Using the Z-Score method, the subjects' BMI is approximately 0.92 standard deviations above the reference mean. This value falls within the normal range but is close to its upper limit. Tables 4 and 5 summarize and present the results of inter-group and intra-group comparisons of motor ability and QoL tests. According to Table 4, in the comparison between groups, significant differences were observed in motor ability variables-functional balance, static balance, coordination, and agility-between both intervention groups (exercises and sports games) and the control group in the post-test. Moreover, in the follow-up period, significant differences were noted for static balance in both intervention groups compared to the control group, and for agility in the exercises group

compared to the control group. For body composition, a significant difference was observed only in the post-test and between the exercise group and the control group. In the within-group comparisons, significant differences were found in functional balance, static balance, coordination, and agility in the exercises and sports games groups between pre-test and post-test, pre-test and follow-up, as well as post-test and follow-up. No statistically significant differences were reported for the remaining inter-group and intra-group comparisons.

Table 4. Summary of Bonferroni test results for intra-group and inter-group comparison of motor ability

Variable	group	Intra-group comparison				Inter-group comparison		
		pre v post	pre v fol	post v fol		pre-test	post-test	follow-up
functional balance (s)	Exercises	0.001*	0.001*	0.001*	exe v spo	1.000	1.000	1.000
	Sports games	0.001*	0.001*	0.001*	exe v con	1.000	0.007*	0.271
	control	1.000	1.000	0.536	spo v con	1.000	0.009*	0.258
static balance (s)	Exercises	0.001*	0.001*	0.001*	exe v spo	1.000	0.796	0.001*
	Sports games	0.001*	0.001*	0.001*	exe v con	1.000	0.001*	0.001*
	control	1.000	1.000	1.000	spo v con	1.000	0.001*	0.090
BMI (kg/m^2)	Exercises	0.103	0.665	1.000	exe v spo	1.000	0.505	1.000
	Sports games	1.000	1.000	1.000	exe v con	0.368	0.013*	0.096
	control	1.000	1.000	1.000	spo v con	0.905	0.353	0.478
hand-eye coordination (n)	Exercises	0.001*	0.001*	0.001*	exe v spo	0.638	0.275	0.193
	Sports games	0.001*	0.001*	0.001*	exe v con	1.000	0.001*	0.496
	control	0.703	1.000	0.604	spo v con	0.236	0.001*	0.016*
agility (s)	Exercises	0.001*	0.001*	0.001*	exe v spo	1.000	0.180	0.892
	Sports games	0.001*	0.001*	0.001*	exe v con	1.000	0.001*	0.006*
	control	0.245	1.000	0.864	spo v con	1.000	0.001*	0.263

pre v post = pre-test with post-test; pre v fol = pre-test with follow-up; post v fol = post-test with follow-up. exe v spo = exercises with sports games; exe v con = exercises with control; spo v con = sports games with control. *significance level of $p < 0.05$ was considered.

Table 5. Summary of Bonferroni test results for intra-group and inter-group comparison of QoL

Variable	group	Intra-group comparison				Inter-group comparison		
		pre v post	pre v fol	post v fol		pre-test	post-test	follow-up
total score of QoL	Exercises	0.001*	0.001*	0.001*	exe v spo	1.000	0.218	0.001*
	Sports games	0.001*	0.001*	0.001*	exe v con	0.219	0.001*	0.001*
	control	1.000	1.000	1.000	spo v con	0.787	0.001*	0.001*
psychosocial health summary score	Exercises	0.001*	0.001*	0.001*	exe v spo	0.682	0.297	0.001*
	Sports games	0.001*	0.001*	0.001*	exe v con	0.320	0.001*	0.001*
	control	1.000	1.000	1.000	spo v con	1.000	0.001*	0.001*
physical functioning	Exercises	0.001*	0.001*	0.001*	exe v spo	1.000	0.639	0.093
	Sports games	0.001*	0.001*	0.001*	exe v con	0.662	0.001*	0.001*
	control	0.675	1.000	1.000	spo v con	0.312	0.001*	0.001*
emotional functioning	Exercises	0.001*	0.001*	0.001*	exe v spo	1.000	0.845	0.082
	Sports games	0.001*	0.001*	0.001*	exe v con	1.000	0.001*	0.001*
	control	0.405	1.000	0.169	spo v con	1.000	0.001*	0.001*
social functioning	Exercises	0.001*	0.001*	0.001*	exe v spo	1.000	0.451	0.127
	Sports games	0.001*	0.001*	0.001*	exe v con	0.633	0.001*	0.001*
	control	1.000	0.345	0.488	spo v con	1.000	0.001*	0.001*
school functioning	Exercises	0.001*	0.001*	0.001*	exe v spo	0.479	0.742	0.035*
	Sports games	0.001*	0.001*	0.001*	exe v con	0.241	0.001*	0.001*
	control	1.000	0.857	0.809	spo v con	1.000	0.001*	0.001*

pre v post = pre-test with post-test; pre v fol = pre-test with follow-up; post v fol = post-test with follow-up. exe v spo = exercises with sports games; exe v con = exercises with control; spo v con = sports games with control. *significance level of $p < 0.05$ was considered.

According to Table 5, significant differences were observed between the intervention groups and the control group in the post-test for all components of the Quality of Life (QoL). At the follow-up stage, significant differences were found for the total score of QoL, psychosocial health summary score, and school functioning across all groups_ exercises vs. sports games, exercises vs. control, and sports games vs. control. Furthermore, for physical functioning, emotional functioning, and social functioning, significant differences were observed only between the intervention and control groups. In the intra-group comparisons, significant differences were noted across all components in the pre-test vs. post-test, pre-test vs. follow-up, and post-test vs. follow-up periods for each group. The remaining results did not show statistically significant differences. Unfortunately, no study has been observed by the current researchers in which different exercise models are compared in terms of effects on motor ability and QoL. However, several studies have investigated motor ability and QoL in children and adolescents with intellectual impairment without emphasizing a specific method of exercise or games. For instance, Kakejani et al. (2024) examined the impact of game-based exercises on motor skills in children with Down syndrome, and found that motor skills scores improved but no significant improvement was observed in active memory scores (Kakejani et al., 2024). Zourmand et al. (2024) explored the effects of school games on motor skills development in children with autism spectrum disorder, highlighting improvements in motor skills and the importance of physical, cognitive, and social development

through appropriate sports programs. Zhang et al. (2021) evaluated the effect of a one-year physical activity intervention on the motor skills of boys with severe intellectual disability and found that motor skill performance could be improved, although significant effects may only occur after a long time (1 year) rather than short-term (6 months) (recommendation of long-term interventions). Pejčić and Kocić (2020) reported significant development in specific motor skills, such as those needed for football and basketball, following sport games exercises in adolescents with intellectual impairment. Ghaeeni et al. (2015) observed that core stability exercises enhanced static balance in children with Down syndrome, recommending such exercises for rehabilitation program. Tounsi et al. (2024) investigated the effect of the good behavior game on the behavior of students with mild intellectual disability in physical education activities and times and reported that the effectiveness of the good behavior game as an intervention to promote interaction and reduce destructive behaviors when performed in physical education environments was validated with students with mild intellectual disabilities. Özkan and Kale (2023) concluded that physical education activities positively impacted both motor skills and QoL in children with intellectual disabilities, while Özer et al. (2012) found that the Special Olympics football program decreased problematic behaviors and increased social competence among youth with intellectual disabilities. In addition, the program was effective in improving the attitudes of youth without disabilities toward participants with disabilities. The findings of the present study were also in line with the mentioned studies, though differences in the type of intellectual impairment, age of participants, and evaluation tools make it challenging to generalize results across studies and populations. Sports have been shown to bring positive physical (e.g., physical fitness) and cognitive (e.g. Intelligence) results by active participation (Aksović et al., 2023). On the other hand, children with intellectual impairment often exhibit suboptimal information processing and cognitive abilities, which can hinder their motor development and the acquisition of motor skills (Zhang et al., 2021). In addition, it has been reported that children with intellectual impairment get tired more easily, and their learning needs are usually not properly met (Suhartini et al., 2024). Studies have shown that the level of physical fitness affects motor and mental development (Bondár et al., 2020; Özkan & Kale, 2023). For example, Bondár et al. (2020) found in their systematic review that PA and sports-related activities improve psychological status, social and cognitive functioning, and QoL, while reducing challenging behaviors in adults with intellectual impairment (Bondár et al., 2020). Physical and recreational activities are thus considered essential to the growth and development of children and adolescents, including those with intellectual impairment. Therefore, the desire to sport and participate in PA should be creatively organized from childhood to enhance adaptation to the surrounding environment (Kakejani et al., 2024). Regarding motor ability, both interventions (exercises and sports games) improved the conditions of children with intellectual impairment following the 8-week intervention period. No significant difference was observed between the two intervention groups after this period, which indicates almost the same effects on the variables. However, in most motor ability variables, the exercise group showed slightly better outcomes than the sports games group. It can be said that focusing more on strengthening muscles, especially the core muscles, as well as performing rhythmic movements and low-intensity aerobic exercises, can have a better effect on functional balance, static balance and agility tests. In contrast, for eye-hand coordination, the sports games group, which included activities such as dribbling, catching, and passing a basketball, was more effective in improving the coordination. The improvement in motor abilities can be attributed to the strengthening and coordination of muscles (Wojtara et al., 2014) and the frequency of exercise (three sessions peer week) may have reinforced learning along with PA. Fatigue is a key factor affecting balance (Zavalishina et al., 2021) and considering that children with intellectual impairment get tired more quickly (Suhartini et al., 2024), this issue affects the occurrence of some disorders including balance. However, the emphasis on muscle strengthening in the exercise likely to reduce muscle fatigue, leading to better balance performance. In addition to the balance, the TUG and the shuttle run tests require both balance and rapid displacement movements. Both intervention groups targeted balance maintenance, but the rhythmic movements and focus on muscle strengthening in the exercise group produced more favorable results. Priyono et al. (2021) investigated the effects of games on the gross motor skills of students with intellectual impairments and found that games improved motor skills (shuttle run, coordination, speed and balance) of students. The study also indicated that these individuals could follow simple instructions to participate in game activities. Although sports games have an effect on motor ability, no previous research was identified comparing the effects of exercises versus sports games in this population. Hand-eye coordination, a perceptual-motor skill, involves the integration of visual information and manual actions, requiring both learning and coordination. Since children with intellectual impairment face difficulties in acquiring new skills and tend to learn at a slower pace (Praskidou et al., 2024), engaging in both exercises and sports games may enhance their coordination and learning abilities. (Ali et al., 2021). Therefore, it can be said that performing exercises and sports games can improve the coordination and learning of children with intellectual impairment. Optimal execution of fine and gross motor skills is also essential for performing movements and skills. Considering the motor skill deficits in children with intellectual impairment (Zhang et al., 2021), the intervention programs likely contributed to strengthening these skills. Bellamy et al. (2020) also after examining a 16-week school-based group sports intervention in children with moderate to severe intellectual impairment, found that the participation of these groups in school group sports is possible to help participation in PA, although no significant changes were observed in body composition and aerobic

capacity variables. These findings suggest that even children with more severe impairments can engage in sports activities, but to achieve significant effects on various health variables, interventions may need to be extended in duration. However, during the follow-up period, different conditions were observed. Most of the post-test results regressed to levels close to the pre-test, with statistically significant differences only for static balance and between the groups of exercises with sports games and also control. For agility, there was a significant difference between the exercise and control groups. These results suggest that the effects of the exercise interventions on these variables remained stable even after nearly three months, indicating a degree of retention. In contrast, the coordination improvements achieved through sports games were also maintained, as evidenced by the significant differences between the sports game and control groups. Due to some neurological disorders in people with intellectual impairment, their motor function is also delayed. Neurophysiological adaptations and it also seems that changes in the brain such as cell complexes and phase-sequences, may require more time to fully developed. Exercise-induced neurophysiological adaptations-such as increases in neurotransmitters levels and improvements in neuron diameter related to motor functions-can enhance motor performance, create stronger neural network, and interact more with the environment (Kakejani et al., 2024). These effects were observed in the post-test period, yet without consistent and regular participation in physical activity (PA), individuals tend to regress toward their pre-exercise state. One of the primary challenges faced by children and adolescents with intellectual impairments is their cognitive limitations, which hinder the learning process (Praskidou et al., 2024). However, it has been reported that engaging in sports can improve cognitive function and skill development (Campos et al., 2016). Intellectual impairments are often characterized by slow learning, a tendency to forget learned information quickly (Ali et al., 2021), and underdeveloped motor and physical abilities (Phytanza et al., 2018). These factors, along with delays in physical and motor fitness development, can make functional activities increasingly uninteresting, leading to reduced participation in PA and diminished motor control and coordination over time (Lee et al., 2016). Consequently, these individuals may experience a decline in physical capacity and a reluctance to engage in sports as they age. Considering the critical role that learning plays in maintaining physical condition and health, educators must focus on sustaining the involvement of students with intellectual impairments in PA and increasing their learning time (Tounsi et al., 2024). Therefore, permanent or long-term participation in exercises and sports games can improve the physical and functional condition of this population. Many factors negatively affect the QoL of people with disabilities, including lack of access to transportation, participation in sports, awareness, financial problems, as well as physical and cognitive problems. Health-related factors may also hinder achieving an optimal QoL (Özkan & Kale, 2023). In general, QoL is defined as a mental construct related to a person's satisfaction with life and its correlation with culture, value systems, goals, expectations, standards and concerns (Mahjoob et al., 2024). Specifically for people with intellectual impairment, QoL refers to their perception of their position in life, goals, standards, values and cultural and personal expectations in different dimensions, which are influenced by personal characteristics and environmental factors that change during life (Diz et al., 2024). Participation in sports improves self-esteem, fosters social competence, and encourages social interaction, especially in children and adolescents (Thomson et al., 2021). Diz et al. (2024) have indicated that exercise and sports are closely associated with improvements in well-being and QoL of people with intellectual impairment, with higher functional capacity contribute to better values QoL outcomes. The positive effects of exercise and sports games on QoL components evident in this study. Among the interventions, the sports games showed a better effect. Thomson et al. (2021) pointed out that sports participation can reduce social and economic distance, increase a sense of belonging and acceptance, create opportunities for skills development, and empower individuals. Furthermore, game-based activities can help in the recovery of learning techniques and create a fun environment that boosts children's self-confidence and satisfaction, fostering cooperation and interaction (Praskidou et al., 2024). Playing a game is necessary for the development of children, because it improves their cognitive, physical, social and emotional functioning (Kuznetsova et al., 2022). By creating positive cognitive changes, sport can also increase participation and engagement (Campos et al., 2016). The exercise process as an uninterrupted period in parallel with developmental growth affects not only movement aspects but also cognitive and emotional-social processes. The persistence of PA and game effects on QoL during the follow-up period shows that children with intellectual impairment enjoy and are enthusiastic about participating in sports, especially games. Engaging in games within motor activities allows for unforced participation, contributing to increased happiness (Suhartini et al., 2024). Games can improve motor skills of children with intellectual impairment and can help children in the development of physical, motor, social, emotional and cognitive aspects optimally (Ali et al., 2021), likely due to their compatibility with children's needs (Zourmand et al., 2024). When designing interventions for individuals with intellectual impairments, it is crucial to select evidence-based programs that improve their outcomes and overall well-being. Therefore, it is important to know the most effective evidence-based interventions or programs for such a population. Most previous studies on athletes with intellectual impairment have focused on PA, physical fitness and the associated benefits through structured coaching and exercises. However, many of these studies have primarily investigated specific exercises, neglecting to explore broader factors influencing the health and behavior of these individuals. Offering engaging sports programs and preparing individuals for potential participation in sports competitions can serve as a catalyst for increased PA

engagement. As we increase our understanding of the causes of various disabilities, our ability to prevent those causes or support affected individuals and their families should also increase. Therefore, enhanced knowledge of the factors affecting the sports participation among people with intellectual impairment will help us in designing more effective interventions and strategies. Despite the valuable contribution of the current research to the researchers, there are several limitations. The small sample size, due to conducting the study in a single province, as well as challenges related to evaluating (motor ability and QoL). Moreover, the lack of female participants limited the findings to male subjects, and of the researchers had no control over the subjects' PA levels outside of school or during school closures until the follow-up.

4. Conclusion

The formation of habits during childhood plays a critical role in shaping lifelong behaviors, making it essential to encourage children's participation in physical activity (PA) during this developmental period. Engaging in different exercise models, not only benefits physical fitness but also enhances QoL. According to the results of the present study, it can be concluded that planning for the participation of children with intellectual impairment in PA can improve the QoL in addition to the positive physical effects. Also, by comparing exercises and sports games, it can be said that sports games can create more motivation to participate in sports and improve and maintain the QoL even long after the implementation of a games course. On the other hand, due to the favorable effects of the type of exercise on physical conditions, maybe the integration of these two types of PA could yield even more beneficial outcomes. Implementing motor-based interventions, similar to those performed in the present study, can foster increased PA engagement and improve QoL for children with intellectual impairment. Considering the attractiveness of sport games, it is possible to increase the motivation of children with intellectual impairment for PA by integrating exercises in games.

Authors' Contributions

Milad Fadaei Dehcheshmeh: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Resources; Supervision; Project administration; Validation; Visualization; Writing-original draft; Writing-review & editing. Ali Shamsi Majelan: Conceptualization; Data curation; Formal analysis; Methodology; Supervision; Project administration; Validation; Visualization; Writing-review & editing. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declared no conflict of interest.

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Ethical considerations

This study was approved by the Ethics Committee of Sport Sciences Research Institute (Code: IR.SSRC.REC.1402.023), and was registered at the Iranian Registry of Clinical Trials (IRCT) (Code: IRCT20230407057840N1).

Using artificial intelligence

Not used.

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