

Plyometric Training to Enhance Agility, Speed, and Social Interaction in Children Aged 10-12 with Mild Intellectual Disability: Findings from a Special Olympics-Based Study

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Abstract

This research aimed to assess the effectiveness of a plyometric training regimen in improving agility, speed, and social interaction among boys with mild intellectual disability (ID) aged 10-12, within the context of the Special Olympics. The study involved thirty-two boys (average age = 10.69 ± 0.8 years; average IQ = 61 ± 7) from three inclusive education centers. Over a period of 10 weeks, participants engaged in a plyometric training program twice a week. Evaluations were conducted before and after the intervention using the Reaction Time Test, 4-Corner Agility Test, 10-Meter Speed Run, 4x5 Meter Relay Test, and the Friendship Activity Scale (FAS). Significant improvements were observed across all measures. Reaction time decreased by 0.83 seconds ($t = 7.44$, $p < 0.001$), agility improved by 0.77 seconds ($t = 11.93$, $p < 0.001$), 4x5 meter speed increased by 0.61 m/s ($t = 17.37$, $p < 0.001$), and 10-meter run speed improved by 1.55 m/s ($t = -12.76$, $p < 0.001$). Furthermore, the FAS score rose by 0.81 points ($t = 9.59$, $p < 0.001$), indicating a boost in social interactions. The plyometric training program significantly enhanced agility, speed, and social interaction in children with mild intellectual disability, demonstrating its efficacy as an inclusive physical education strategy within the Special Olympics framework.

Key words: motor skills, cognitive function, inclusive education, physical fitness, behavioral improvement, inclusive sports programs

1.Introduction

Individuals with Intellectual Disability (ID) face significant challenges in intellectual functioning and adaptive behavior (Matthews et al., 2021). These challenges highlight the importance of robust support systems that can bridge the gap between their abilities and the expectations of their social environments (Des Portes, 2020; Muntean & Oravitan, 2022). Such support systems encompass resources and strategies that foster physical fitness, education, personal interests, and overall well-being, thereby enhancing individual functioning (Franco et al., 2023). Inclusive training experiences are essential in preparing students with disabilities for community living (Inge et al., 2017), and they emphasize the acceptance of differences among participants as natural aspects of human development (Peebles & Mendaglio, 2014). Specifically, inclusive training programs tailored to help individuals with ID demonstrate competence and adaptive behavior are of significant interest (Leonte et al., 2014).

Children with mild ID encounter various learning difficulties that affect their educational and social development. These difficulties can arise from genetic conditions, prenatal or perinatal complications, or environmental factors. Typically, children with mild ID have an IQ range of 50-70 and exhibit slower cognitive processing, reduced problem-solving skills, and challenges with abstract thinking. They may also experience delays in language development and difficulties with social interactions, making it hard for them to keep pace with their peers in academic and physical activities (Rattat & Collié, 2020).

The Special Olympics is an international sports training and competition program for individuals with ID, aged eight and older, regardless of their abilities (Chandan & Dubon, 2019). Its mission is to provide year-round sports training and competition in various Olympic-type sports for children and adults with ID (Burns, 2018). Various specialists have implemented adapted training programs for children with ID, achieving significant improvements in their physical and social skills (Malekpour et al., 2012; Xu et al., 2020; Ahmedova & Belomazheva-Dimitrova, 2021).

The Special Olympics model emphasizes inclusivity and social integration, providing opportunities for children with mild ID to participate in sports alongside their typically developing peers. This cooperative approach fosters a sense of community, mutual respect, and understanding. By integrating typically developing peers into the training program, Özer et al. (2012) suggest that this approach aims to enhance social attributes such as teamwork, communication, and empathy in children with mild ID. Partnering with peers in physical activities not only boosts the confidence of children with ID but also promotes a more inclusive environment where all children can thrive. This approach aligns with the principles of the Special Olympics, which advocate for the inclusion of individuals with disabilities in all aspects of life, including sports and physical education, as highlighted by Tint et al. (2019).

Agility and speed are critical components of physical fitness that significantly impact a child's ability to perform everyday activities and participate in sports, as noted by Rosu et al. (2024). However, children with mild ID often face difficulties in developing these skills due to physical, cognitive, or sensory limitations. Plyometric training, as described by Patrascan and Stefanica (2019), Jouira et al. (2020), and Cipu and Dragnea (2007), involves exercises that enable muscles to exert maximum force in short intervals, improving power, speed, and agility. These exercises are particularly beneficial for children with mild ID as they can enhance muscle

strength, coordination, and neuromuscular efficiency. Balayi et al. (2022) and Badau et al. (2023) suggest that for these children, plyometric training can be adapted to meet their unique needs, ensuring that the exercises are both accessible and effective.

Agility refers to the ability to move quickly and change direction with ease, while speed pertains to the rapidity of movement. Both skills are essential for physical fitness and are often underdeveloped in children with mild ID. Incorporating plyometric exercises, as suggested by Jouira et al. (2024), can significantly improve these abilities, helping children perform better in physical activities and sports, and enhancing their overall quality of life.

This study is aimed at addressing the specific challenges faced by children with mild ID by implementing a structured plyometric training program. The primary goal is to enhance the physical abilities of children aged 10-12 with mild ID, specifically focusing on improving agility, reaction time, and speed. Additionally, the study seeks to foster stronger social relationships and promote inclusivity by integrating activities with typically developing peers. This approach aims to positively influence the attitudes of non-disabled peers and enhance social interactions, all within the inclusive framework of the Special Olympics.

Hypotheses:

H1: The implementation of a tailored plyometric training program will lead to significant improvements in physical capabilities, particularly in reaction time, agility, and speed, for children with mild ID.

H2: Structured training sessions that include typically developing peers will enhance social dynamics, fostering greater inclusivity and improved peer relationships for children with mild ID.

Research Objectives:

1. Initial assessment - to conduct a comprehensive initial assessment to determine the current levels of agility, reaction time, and speed among children with mild ID. This baseline data is crucial for tailoring the plyometric training program to the specific physical needs of each child.

2. Program development - to develop an engaging, safe, and effective plyometric training program based on the initial assessment data, designed to enhance the physical capabilities of children with mild ID.

3. Final evaluation - to conduct a final evaluation to measure the improvements in agility, reaction time, speed, and social interactions among participants. This includes analyzing changes in the attitudes and perceptions of typically developing peers using the Friendship Activity Scale (FAS) to assess the program's impact on promoting inclusivity and fostering positive social dynamics.

2. Materials and Methods

2.1. Research Subjects

The research was conducted across three inclusive education school centers, focusing on the diverse needs and abilities of children with mild ID. The study included a total of 32 boys, each carefully selected to ensure the representativeness and relevance of the findings. The demographic details of the participants were as follows: the mean age was 10.69 ± 0.8 years,

with an average IQ of 61 ± 7 with an average height of 136.7 ± 6.7 cm, weight of 32.9 ± 7.3 kg, and a body mass index (BMI) of 18.8 kg/m^2 .

To distribute the participants, 10 children attended the first institutional center, another 10 children attended the second center, and 12 children were enrolled in the third center. This distribution aimed to encompass a broad spectrum of the mild ID population within the inclusive education framework. These participants were selected in cooperation with the Special Olympics Romania Foundation (Mujea et al., 2019), with assistance from the Ministry of National Education. The plyometric tests and programs implemented by the Special Olympic Romania Foundation are integral to both the development of physical attributes and the identification of athletic talents. These initiatives are specifically designed to prepare teams for participation in the National Unified Football Championship. The focus is on training boys' teams for the 7-a-side football format (Valkova, 2020). A traditional sampling approach was utilized, taking into consideration factors such as age and medical fitness, as confirmed by an individual medical certificate stating "clinically healthy" or "fit for adapted sports activities." Additionally, documentation verifying special educational needs, including a Certificate of educational and vocational guidance or its equivalent, was provided.

Moreover, parental consent was obtained and recorded prior to the start of the study, following the principles outlined in the Declaration of Helsinki. The research protocol received approval from the Ethics Committee of the Doctoral School of Physical Education and Sport Science (ID: 12/23.01.2024), University of Politehnica Bucharest, University Center Pitesti, Romania, ensuring compliance with ethical standards and guidelines for research involving human participants.

2.2. Research Tools and Protocol of Measurement

1. Reaction time Test

The Witty SEM Intelligent Semaphores from Microgate were employed to measure the reaction time of the participants. This advanced tool is designed to enhance the assessment of motor skills by providing immediate visual cues that the children must respond to as quickly as possible. Five semaphores are aligned in a row, and the participant stands in front of them at a short distance, allowing them to reach out and touch each one with an outstretched hand. During the test, participants were required to touch the illuminated semaphore as swiftly as they could. This method effectively evaluates their reaction time, offering precise and reliable data critical for analyzing the effectiveness of the plyometric training program (Stefanica et al., 2024).

2. 4-Corner Agility Test with Partner

To measure agility, we utilized the 4-Corner Agility Test with the TCi Timing System from Brower Timing Systems. This test involves placing four markers in a square pattern, and the participant must move quickly between these points in a specific sequence. A partner stands behind the sensor to encourage the child to complete the test as quickly as possible. The test assesses the ability to change direction rapidly and efficiently, which is a key component of agility. The performance in this test provides valuable insights into the participants' agility levels (Kelly & Williams, 2020).

3. 10-Meter Speed Run with Partner

For measuring running speed, the Witty Timing System from Microgate was used during the 10-meter speed run test. This system uses photocells to ensure high accuracy in timing the sprint from start to finish. Participants were instructed to run as fast as possible over a distance of 10 meters, with a partner acting as a "rabbit" to motivate them to run faster. The time taken to complete this sprint was recorded. This test is essential for evaluating the baseline speed of the children (Zahirović et al., 2023).

4. 4 x 5 Metres Relay Test with Partner

The 4 x 5 Metres Relay Test was conducted using the Witty Timing System from Microgate to further assess the participants' speed and coordination. In this test, participants ran back and forth between two markers set 5 meters apart, completing four legs of the relay. A partner stood behind the sensor to encourage the child to perform the relay as quickly as possible. This test not only measures speed but also evaluates the participants' endurance and ability to perform repeated sprints. The results from this test are critical for understanding the overall athletic development of the children as influenced by the training program (Bond et al., 2017).

5. The Friendship Activity Scale (FAS)

To gauge the effectiveness of unified sports, it is crucial to have a reliable tool that measures these "friendship activities."

The Friendship Activity Scale (FAS) is designed to assess attitudes toward individuals with mild ID who engage in various activities. Originally consisting of 17 items, the scale asks respondents to use a four-point scale to indicate whether they would (4), probably would (3), probably would not (2), or would not (1) include a child with mild ID in a given activity (Vignes et al., 2008).

2.3. Procedure of the intervention

Stage One: Psychological Records Analysis (February 2024)

In the initial stage of the research, conducted in February 2024, the psychological records of the participants were thoroughly reviewed. These records, maintained by the psychologists at the institutional centers, provided comprehensive insights into the psychological profiles of each subject. The data, collected over the period of their institutionalization, included detailed observations and assessments that were crucial for understanding the baseline mental and emotional state of the participants.

Stage Two: Agility and Speed Testing (March 2024)

The second stage, carried out in March 2024, involved subjecting the participants to a series of tests designed to gather specific information on their agility and speed skills. These tests were meticulously chosen to evaluate the key components of physical performance that the plyometric training program aimed to enhance. The data obtained from these tests offered valuable benchmarks for assessing the initial capabilities of the participants. Additionally, the initial completion of the FAS questionnaire by the partners of children with mild ID was included in this stage. This questionnaire provided critical insights into the social and adaptive functioning of the children, which is crucial for understanding the broader impact of the training program on their overall development.

Following this preliminary research phase, the collected data was processed and analyzed. The insights gained from this analysis were instrumental in selecting the appropriate plyometric

tools and designing the action plans for the plyometric training program. This careful selection process ensured that the program was tailored to meet the specific needs of the participants. Stage Three: Implementation of the Plyometric Training Program (March 2024 to May 2024) In the third stage, the participants were organized into an experimental group and introduced to an adaptive plyometric training program. This program consisted of 20 sessions, each structured into three parts, conducted twice a week for 45 minutes per session from March 2024 to May 2024. The training sessions were designed to progressively enhance the agility and speed skills of the participants, incorporating a variety of plyometric exercises tailored to their individual abilities and needs.

2.4.Plyometric training program for agility and speed

This program is designed to be inclusive, involving typically developing peers as partners in the exercises, promoting cooperation, social interaction, and mutual support. The structure and activities draw from successful interventions documented in the literature, particularly focusing on enhancing psychomotor skills.

Program objectives:

- 1.improve agility and speed - develop quickness and coordination through plyometric exercises.
- 2.promote social interaction - foster teamwork and social skills by pairing mild ID children with typically developing peers.
- 3.enhance confidence and motivation -build self-esteem and enjoyment in physical activity.

Partner interaction:

- 1.pairing -each mild ID child is paired with a typically developing peer.
- 2.role of partners -peers provide encouragement, help demonstrate exercises, and ensure the correct form.
- 3.activities -partner-assisted drills, where one child performs the exercise while the other counts repetitions and offers support.

Simplified instructions: clear, concise, and repeated as necessary.

Visual aids -use of pictures and demonstration to illustrate exercises.

Positive reinforcement -regular encouragement and praise to boost confidence.

Sensory considerations -ensure the environment is suitable for children with sensory processing issues (e.g., reduced noise, clear spaces).

Safety and inclusion:

- 1.ensure all equipment is safe and appropriate for the age group.
- 2.create an inclusive environment where all children feel valued and supported.
- 3.supervise closely to provide assistance and prevent injury.

This program leverages the principles of plyometric training while adapting to the unique needs of children with mild ID. It emphasizes cooperation, social interaction, and mutual support, aligning with the values promoted by the Special Olympics. By incorporating typically developing peers, the program not only aims to improve physical abilities but also fosters an inclusive and supportive community.

Table 1 provides a comprehensive weekly session outline for a plyometric training program aimed at enhancing agility and speed in children with mild ID.

Tabel 1. Plyometric training program for enhancing agility and speed in children with mild ID

Weekly session outline	
Part	Description
Warm-up (10 minutes)	- Light Jogging (3 minutes): Gentle jogging around the play area to increase heart rate and prepare muscles. - Dynamic Stretching (4 minutes): Leg swings, arm circles, and torso twists to enhance flexibility and range of motion. - Simple Coordination Drills (3 minutes): Activities like marching on the spot and skipping to improve coordination and motor skills.
Main plyometric activities (30 minutes)	
Activity 1: Agility and Speed Circuit (15 minutes)	A combination of agility ladder drills, lateral hops, and reaction drills to enhance overall athletic performance by focusing on agility and speed development. Objectives : 1.Enhance cardiovascular fitness and coordination. 2.Improve lateral agility and balance. Agility Ladder Drills (15 minutes): use an agility ladder for drills like in-and-out footwork, lateral shuffles, and high knees. Perform each drill for 30 seconds, with a 30-second rest between drills. - Reaction to Visual Stimuli Drills (15 minutes): 1.Bidirectional movements with color stimuli -children react to random color signals and perform shuttle runs to the indicated marker. Start with 2 sets of 4 reps, progressing to 3 sets of 5 reps. -2.Multidirectional movements with directional cues - children react to visual directional cues, performing shuttle runs to indicated markers. Begin with 2 sets of 4 reps, advancing to 3 sets of 5 reps.
Activity 2: Strength and Speed Training (15 minutes)	Objective: Increase explosive leg power and coordination. Box Jumps (5 minutes): Using a stable platform, children jump onto and off the box, focusing on soft landings. Perform 2 sets of 8 jumps, with a 1-minute rest between sets to increase explosive leg power and coordination. - Sprint Intervals (5 minutes): Short bursts of sprinting over various distances (10-20 meters), with 30-second rest intervals to improve speed and stamina. - Leg Strength Exercises (5 minutes): Incorporate bodyweight squats and lunges to build leg strength. Perform 2 sets of 10 reps for each exercise, with a 30-second rest between sets.
Cool down (5 minutes)	-Static stretching - stretch hamstrings, quadriceps, calves, and shoulders to promote flexibility and prevent injury. - Breathing exercises - deep breathing exercises to relax and cool down the body.

2.5. Statistical Analysis

Descriptive statistics, including the mean (M) and standard deviation (SD), were calculated for the differences between the initial and final measurements of each variable (agility, speed, and Friendship Activity Scale (FAS) score). The paired t-test was used to determine if there were statistically significant differences in these variables following the 10-week plyometric training program. The t-test results, including the t-values and their associated p-values, were examined to assess the impact of the training program. Statistical significance was set at $p < 0.05$. All statistical analyses were conducted using SPSS software, version 23.0 (Murana & Rahimin, 2021).

3.Results

Table 2 presents the detailed agility and speed profile measurements of subjects both before (Initial) and after (Final) a 10-week plyometric training program. The measurements include reaction time, 4 corners agility, 4x5m speed, 10m run speed, and the FAS score for each subject. This data highlights the changes in performance across different metrics of agility and speed for each individual.

Table 2: Mean Agility, Speed, and FAS Score Profiles of Subjects Before and After Intervention

No	Agility				Speed				FAS score	
	Reaction time (s)		4 corners agility (s)		4X5 m (m/s)		10m run speed (m/s)		I	F
	I	F	I	F	I	F	I	F		
1	1.91	1.39	4.96	3.58	3.37	2.81	6.01	5.34	1.3	3
2	1.86	1.53	5.01	4.62	3.57	2.79	5.00	4.95	1.6	2.9
3	2.73	1.79	3.52	3.67	3.74	2.80	5.23	4.92	2.5	3.2
4	2.71	1.70	3.36	2.73	3.24	2.75	5.07	4.90	2.3	3.2
5	1.89	1.73	3.69	2.88	3.42	2.56	5.43	4.87	1.4	2.5
6	3.81	2.69	3.78	3.70	3.34	2.62	5.00	4.76	2.9	3.6
7	1.82	2.06	4.95	4.64	3.31	2.48	5.03	4.69	2.3	3.4
8	2.64	1.76	4.16	3.76	3.21	2.30	5.14	4.66	2.7	3.9
9	2.68	1.95	4.01	3.91	3.56	2.15	4.85	4.63	1.7	2.7
10	3.04	2.79	4.38	3.80	4.68	3.24	4.75	4.62	1.9	2.9
11	3.19	3.05	4.96	4.78	3.87	3.20	6.26	5.62	1.6	3
12	3.12	2.54	4.82	4.21	4.57	2.98	5.71	4.39	3.2	3.4
13	2.84	1.78	5.95	5.82	4.52	3.02	5.53	4.32	2.4	3.8
14	2.55	2.04	4.36	3.84	3.89	2.76	5.18	4.45	2.6	2.9
15	3.67	3.12	3.72	3.24	3.58	2.82	5.92	4.86	1.4	2.9
16	3.02	1.40	3.89	3.43	3.76	2.88	6.31	4.98	2.8	3.7
17	2.14	2.08	5.95	4.67	4.39	3.73	6.07	5.27	3	3.9
18	2.43	2.26	4.37	3.52	4.85	3.34	6.12	5.41	2.6	3.8
19	1.78	2.16	4.86	3.05	3.92	3.01	5.85	5.01	2.1	2.9
20	1.92	1.85	4.37	3.25	3.48	2.51	4.95	4.41	1.9	3.6

21	3.18	3.17	4.96	4.65	4.24	2.87	6.05	4.65	2.3	3.5
22	4.01	3.97	5.01	4.87	5.07	4.68	6.28	5.87	3.4	4
23	2.24	2.54	4.22	3.42	4.44	3.94	5.13	4.36	2.1	3.8
24	3.15	2.64	4.56	3.76	4.28	3.39	5.82	4.72	1.6	1.9
25	1.96	1.87	4.69	3.03	3.97	2.41	5.12	4.33	1.3	3.5
26	2.65	2.53	4.73	4.28	4.39	3.86	4.67	4.21	2.4	3.9
27	2.43	2.62	4.38	4.03	4.56	3.93	4.62	4.18	2.9	3.5
28	3.31	3.20	5.11	4.95	5.01	4.76	6.14	5.49	3.2	3.8
29	2.34	2.16	5.14	5.06	5.26	5.08	6.28	4.85	1.4	2.7
30	3.62	3.24	4.87	4.61	4.63	4.22	4.61	4.01	1.8	2.9
31	2.78	1.95	3.96	2.98	4.32	3.58	4.72	4.17	3.7	4
32	3.09	3.12	3.65	3.14	3.95	2.71	4.98	4.57	2.4	3.5

¹ I/F- initial and final test

Table 3 summarizes the statistical analysis of the initial and final test results for agility and speed measurements, detailing the mean differences (M), standard deviations (SD), t-values (t), and significance levels (Sig. (2 tailed)) for each measurement.

Table 3: The effect of the 10-week plyometric training program on agility, speed, and FAS score

Measurements	Test	M ± SD	t	p
Reaction time	I	0.83250 ±0.83277	7.43804	p < 0.001
	F			
4 corners agility	I	0.76859 ±0.38998	11.9274	p < 0.001
	F			
4x5m	I	0.61406 ±0.20323	17.3727	p < 0.001
	F			
10m run speed	I	-1.55344 ±0.77701	-12.7635	p < 0.001
	F			
FAS score	I	0.81031 ±0.57572	9.59399	p < 0.001
	F			

Abbreviations: M: Represents the difference between the initial mean and the final mean. SD: Represents the standard deviation of the differences. t: The t-value of the paired t-test and p: The p-value of the paired t-test, indicating statistical significance. All p-values are less than 0.001, indicating that all differences are statistically significant.

Reaction time: The mean difference is 0.83, with a t-value of 7.44 and a p-value < 0.001. This difference is statistically significant.

4 corners agility: The mean difference is 0.77, with a t-value of 11.93 and a p-value < 0.001. This difference is statistically significant.

4x5m: The mean difference is 0.61, with a t-value of 17.37 and a p-value < 0.001. This difference is statistically significant.

10m run speed: The mean difference is -1.55, with a t-value of -12.76 and a p-value < 0.001. This difference is statistically significant.

FAS score: The mean difference is 0.81, with a t-value of 9.59 and a p-value < 0.001. This difference is statistically significant.

4. Discussion

This study aims to address the gap in physical activity programs tailored specifically for children with intellectual disabilities (ID) by implementing a plyometric training program designed to enhance both physical abilities and social interactions among children with mild ID. The results of this study demonstrate significant improvements in reaction time, agility, speed, and social interaction following a 10-week plyometric training program.

Reaction Time

The significant decrease in reaction time among participants highlights enhanced neuromuscular response and coordination. These findings are in line with those of Kurtoğlu et al. (2022), who reported improvements in neuromotor skills such as vertical jump and shuttle test performance following an 8-week plyometric exercise program for children with moderate to mild intellectual disabilities. The reduction in reaction time seen in our study further supports the notion that plyometric training can effectively enhance rapid neuromotor responses in children with mild ID, making everyday activities and sports more accessible.

Agility

The improvements in agility observed in this study, as indicated by the 4-corner agility test and the 4x5 meter relay, align with the results from Jouira et al. (2024). Their research found that combining balance, plyometric, and strength training significantly enhanced agility in athletes with ID. Our study corroborates these findings, demonstrating that even a focused plyometric program can substantially improve agility. This improvement is crucial for developing better motor skills and facilitating quicker directional changes, which are beneficial in both sports and daily activities.

Speed

The increase in participants' speed, both in the 10-meter run and 4x5 meter relay, is indicative of enhanced muscular power and endurance. These results echo those of Stefanica et al. (2024) investigated the effects of a combined psychomotor training and Unified Sports football program on young Special Olympics athletes with intellectual disabilities in Romania. The study found significant improvements in psychomotor skills and social interactions among participants, suggesting that such integrated programs can effectively enhance both physical and social abilities in this population.

The positive changes in the Friendship Activity Scale (FAS) scores suggest improved social interactions and inclusivity among participants and their typically developing peers. This finding is consistent with the outcomes of Stefanica et al. (2024), who noted that personalized psychomotor programs could significantly enhance social interactions among children with ID. Similarly, Rosu et al. (2023) found that a structured program aimed at enhancing psychomotor abilities led to better social engagement. Our study extends these findings by showing that even a specific plyometric program, when inclusive of typically developing peers, can foster social bonds and promote a supportive community environment.

While the studies by Kurtoğlu et al. (2022) and Jouira et al. (2024) underline the physical benefits of tailored training programs, our findings particularly emphasize the dual impact of such programs on both physical and social dimensions. Unlike the study by Golubović et al. (2012), which reported that children with ID scored lower on fitness tests than their typically developing peers despite participating in exercise programs, our results suggest that with targeted plyometric training and inclusive strategies, children with mild ID can achieve significant gains in physical fitness and social integration, narrowing the gap between them and their typically developing peers. This supports the importance of inclusivity and tailored programming in enhancing both physical abilities and social cohesion.

The integration of typically developing peers as partners in these programs promotes inclusivity and mutual support, benefiting all participants. Such programs not only enhance physical abilities but also foster a sense of community and improve the social fabric within inclusive educational settings. The findings suggest that implementing similar programs in other settings could yield substantial benefits, improving the overall well-being and social integration of children with mild ID.

5.Limitations

This study has several limitations that should be considered when interpreting the findings. First, the sample size was relatively small, which may limit the generalizability of the results to a broader population of children with mild intellectual disabilities (ID). Second, the study's duration was limited to a 10-week period, which may not capture the long-term effects or sustainability of the improvements observed in agility, reaction time, speed, and social interactions. Additionally, the study relied on self-reported measures from typically developing peers to assess changes in social interactions, which could introduce bias or inaccuracies in the data. Future research should address these limitations by including larger and more diverse samples, extending the study duration, incorporating objective measures of social interaction, and using control groups to strengthen the validity of the findings.

6.Conclusions

The research was driven by well-defined hypotheses and employed a rigorous methodological framework, ensuring the reliability and validity of the findings. The implementation of a structured, adaptive plyometric training regimen led to substantial improvements in key physical performance metrics, including agility, reaction time, and speed. The data collected before and after the intervention showed marked progress, highlighting the efficacy of plyometric exercises in enhancing neuromuscular coordination and overall physical fitness in boys aged 10-12 with mild ID.

The study extended beyond physical improvements to address the social aspects of development. The inclusion of typically developing peers in the training sessions was a strategic move to foster an inclusive environment that promotes social integration. The positive changes observed in the Friendship Activity Scale (FAS) scores following the intervention indicate a meaningful enhancement in social interactions and inclusivity among the participants. This suggests that the training program not only helped improve physical

capabilities but also encouraged social engagement and peer relationships, which are crucial for the holistic development of children with mild ID.

These findings underscore the dual impact of tailored physical activity programs on both the physical and social dimensions of development for children with mild ID. The study demonstrates that with appropriate training interventions, it is possible to significantly improve physical fitness while simultaneously fostering a more inclusive and supportive social environment. Such outcomes highlight the importance of inclusive physical education strategies that cater to the diverse needs of children with disabilities, contributing to their overall well-being and integration into society.

By adopting a comprehensive and inclusive approach, the study not only addressed the immediate physical challenges faced by these children but also contributed to a broader understanding of how structured physical activities can promote inclusivity and social cohesion. These results advocate for the integration of similar tailored training programs within educational and recreational settings, thereby supporting the development of a more inclusive and empathetic community.

References

1. Ahmedova, A., & Belomazheva-Dimitrova, S. (2021). Development of Speed and Speed Reaction in Paralympic Swimmers. *Journal Pedagogical Almanac*, 31 (2), 276-281
<https://doi.org/10.54664/BUEQ2474>
2. Badau D., Badau A., Joksimović M, Oancea B.M., Manescu C.O., Graur C, Cornea G.G., Ene-Voiculescu V., Cojanu F., Stefanica V., Cojocar A., Mocanu G., Silisteanu S.C. - The effects of 6-weeks program of physical therapeutic exergames on cognitive flexibility focused by reaction times in relation to manual and podal motor abilities, *Balneo and PRM Research Journal*, 2023, 14(3): 570.
<https://doi.org/10.12680/balneo.2023.570>
3. Balayi, E., Sedaghati, P., & Ahmadabadi, S. (2022). Effects of neuromuscular training on postural control of children with intellectual disability and developmental coordination disorders: Neuromuscular training and postural control. *BMC musculoskeletal disorders*, 23(1), 631.
4. Bond, C. W., Willaert, E. M., & Noonan, B. C. (2017). Comparison of three timing systems: reliability and best practice recommendations in timing short-duration sprints. *The Journal of Strength & Conditioning Research*, 31(4), 1062-1071.
5. Burns, J. (2018). Intellectual disability, special olympics and parasport. *The Palgrave handbook of paralympic studies*, 417-437.
6. Chandan, P., & Dubon, M. E. (2019). Clinical considerations and resources for youth athletes with intellectual disability: a review with a focus on Special Olympics international. *Current Physical Medicine and Rehabilitation Reports*, 7, 116-125.
7. Cipu, E. C., & Dragnea, C. (2007). Life tables for Romania survival function. Life expectancy for romanian people. *University Politehnica of Bucharest Scientific Bulletin-series A-Applied mathematics and physics*, 69(1), 27-36.

8. Des Portes, V. (2020). Intellectual disability. In Handbook of clinical neurology (Vol. 174, pp. 113-126). Elsevier.
9. Franco, E., Ocete, C., Pérez-Calzado, E., & Berástegui, A. (2023). Physical activity and quality of life among people with intellectual disabilities: The role of gender and the practice characteristics. *Behavioral Sciences*, 13(9), 773.
10. Golubović, Š., Maksimović, J., Golubović, B., & Glumbić, N. (2012). Effects of exercise on physical fitness in children with intellectual disability. *Research in developmental disabilities*, 33(2), 608-614.
11. Inge, K. J., Wehman, P., & Seward, H. (2017). Preparing students with low-incidence disabilities to work in the community. In Handbook of special education (pp. 741-757). Routledge.
12. Jouira, G., Rebai, H., Alexe, D. I., & Sahli, S. (2024). Effect of Combined Training With Balance, Strength, and Plyometrics on Physical Performance in Male Sprint Athletes With Intellectual Disabilities. *Adapted Physical Activity Quarterly*, 1(aop), 1-20.
13. Jouira, G., Srihi, S., Waer, F. B., Rebai, H., & Sahli, S. (2020). Dynamic balance in athletes with intellectual disability: Effect of dynamic stretching and plyometric warm-ups. *Journal of Sport Rehabilitation*, 30(3), 401-407.
14. Kelly, A. L., & Williams, C. A. (2020). Physical characteristics and the talent identification and development processes in male youth soccer: A narrative review. *Strength & Conditioning Journal*, 42(6), 15-34.
15. Kurtoğlu, A., Çar, B., & Konar, N. (2022). The effect of 8 weeks plyometric exercise on physical and motoric features of mental disabled. *Pedagogy of Physical Culture and Sports*, 26(4), 228-232.
16. Leonte, N., Drăgulin, I., Pricop, A., Becea, L., Popescu, O., & Netolitzchi, M. (2014). Research regarding the influences of the human motricity on the emotional intelligence. *Applied Mechanics and Materials*, 555, 609-615.
17. Malekpour, M., Isfahani, A. S., Amiri, S., Faramarzi, S., Heidari, T., & Shahidi, M. A. (2012). The effect of adapted play training on motor development of students with intellectual disabilities. *International Journal of Developmental Disabilities*, 58(2), 120-127.
18. Matthews, N. L., Christenson, K., Kiefer, S., & Smith, C. J. (2021). A mixed-methods examination of the gap between intelligence and adaptive functioning in autistic young adults without intellectual disability. *Autism*, 25(8), 2317-2330.
19. Mujea, A. M., Gherghel, C. L., & Bălan, V. (2019). Bocce-sport discipline practised by the mental disabled persons in Romania. *Discobolul-Physical Education, Sport & Kinetotherapy Journal*, 56(1).
20. Muntean, R.I., & Oravitan, M. (2022). Revisión sistemática del impacto de la actividad física en los síntomas de depresión y ansiedad. *Journal of Physical Education and Human Movement*, 4(2), 61-68.
<https://doi.org/10.24310/IPEHMjpehmjpehm.v4i215703>

21. Murana, J., & Rahimin, M. (2021). Statistical analysis using SPSS version 23.0.
22. Özer, D., Baran, F., Aktop, A., Nalbant, S., Ağlamış, E., & Hutzler, Y. S. W. A. I. (2012). Effects of a Special Olympics Unified Sports soccer program on psycho-social attributes of youth with and without intellectual disability. *Research in developmental disabilities*, 33(1), 229-239.
23. Pătrășcan, G. & Stefanica, V. (2019). Developing strength and speed in children with special educational needs aged 16–18 in order to optimise adapted football game. *Discobolul—Phys. Educ. Sport Kinetotherapy* 2019, XV, 23–28. *Discobolul – Physical Education, Sport and Kinetotherapy Journal*, XV, no. 1(55), 23-28. <https://discobolulunefs.ro/wp-content/uploads/2019/06/Discobolul-No.-55-March-2019.pdf#page=21>
24. Peebles, J., & Mendaglio, S. (2014). Preparing teachers for inclusive classrooms: Introducing the individual direct experience approach. *LEARNing Landscapes*, 7(2), 245-257.
25. Rattat, A. C., & Collié, I. (2020). Duration judgments in children and adolescents with and without mild intellectual disability. *Heliyon*, 6(11).
26. Roșu, D., Cojanu, F., Vișan, P. F., Samarescu, N., Ene, M. A., Muntean, R. I., & Ursu, V. E. (2024). Structured Program for Developing the Psychomotor Skills of Institutionalized Children with Special Educational Needs. *Children*, 11(1), 102.
27. Rosu, D., Enache, I-S., Muntean, R-I., Stefanica, V. (2024). Effects of Kin Ball initiation: Pre- and post-pandemic impact on palmar muscle strength, endurance, and coordination in non-athlete participants. *Sport*, 12(6):158. <https://doi.org/10.3390/sports12060158>
28. Stefanica, V., Mihai, I., Cojanu, F., Vișan, P.-F., Roșu, D., & Potop, V. (2024). Determining the changes in psychomotor behavior of adolescents with special needs. *Revista Românească pentru Educație Multidimensională*, 16(1), 46-70. <https://doi.org/10.18662/rrem/16.1/811>
29. Stefanica, V., Mercea, I.-T., Ursu, V. E., Gorban, C. F., Dragoș, G. C., Mihaiu, C., & Groza, G. G. (2024). Developing psychomotor skills and social attributes through integrated psychomotor and unified football training: a special olympics intervention study. *Revista Românească pentru Educație Multidimensională*, 16(3), 224-242. <https://doi.org/10.18662/rrem/16.3/892>
30. Tint, A., Thomson, K., & Weiss, J. A. (2017). A systematic literature review of the physical and psychosocial correlates of Special Olympics participation among individuals with intellectual disability. *Journal of Intellectual Disability Research*, 61(4), 301-324.
31. Valkova, H. (2020). Special Olympics unified sports as the possible model in special education (example of athletes-partners cooperation in unified football). *Approaches and Models in Special Education and Rehabilitation-Thematic Collection of International Importance*, Belgrade, 2020, 99-116.

32. Vignes, C., Coley, N., Grandjean, H., Godeau, E., & Arnaud, C. (2008). Measuring children's attitudes towards peers with disabilities: a review of instruments. *Developmental Medicine & Child Neurology*, 50(3), 182-189.
33. Xu, C., Yao, M., Kang, M., & Duan, G. (2020). Improving physical fitness of children with intellectual and developmental disabilities through an adapted rhythmic gymnastics program in China. *BioMed research international*, 2020.
34. Zahirović, M., Alić, H., Čović, N., Ibrahimović, M., Talović, M., Jelešković, E., ... & Hadžimehmedović, D. V. (2023). Short term agility and speed training programme effects on speed, agility and dribbling in young football players. *Homo Sporticus*, 25(1).

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- the authors requested the consent of the subjects involved in the research before carrying out any procedures;
- the authors have evidence regarding the freely expressed consent of the subjects regarding their participation in the study;
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