

Research Paper: The Effect of Combined Core Stability and Coordination Exercises on the Motor Skills of Intellectual Disability With DCD



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ABSTRACT

Purpose: Developmental Coordination Disorder (DCD) is common among intellectual disability children that can worsen motor problems, especially motor skills. The purpose of the study was to examine the effect of combining core stability exercises with coordination exercises on motor proficiency of intellectual disability children with DCD.

Methods: The population was boys with intellectual disability and DCD studying in Golestan School of Tabriz randomly that were divided into two groups of 15 subjects in the experimental group and 15 in the control group. Motor skills were evaluated using the Bruininks-Oseretsky Test of Motor Proficiency-Short Form in the pre- and post-test. The experimental group performed three sessions (every week) of 60 minutes of combined core stability with coordination training for eight weeks. SPSS v. 21, dependent t-test, and analysis of covariance at the significance level of $P < 0.05$ were used for statistical analysis.

Results: Comparing the means of the two groups showed a positive significant difference in running speed and agility ($P=0.001$), balance ($P=0.001$), two-way coordination ($P=0.001$), strength ($P=0.001$), upper limb coordination ($P=0.001$), response speed ($P=0.001$), speed motor vision control ($P=0.001$), upper limb agility ($P=0.001$), and the overall gross and fine motor skills scores ($P=0.001$) and the combined score of the short scale ($P=0.001$).

Conclusion: The results indicated that combining core stability with a coordination training program can be used to enhance the motor skills of DCD children with intellectual disabilities. Thus, sports coaches and experts, and specialists in other related fields are recommended to use these exercises to enhance the gross and fine motor skills of students with intellectual disabilities, especially those with DCDs.

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Highlights

- Intellectual disabilities people are deficient in physical fitness and balance compared to healthy people.
- These problems affect their academic and social performance maintaining muscle strength and endurance and improving balance.
- Proper posture and posture and strengthening the muscles, stabilize the core stability of the muscles.
- People with intellectual disability have developmental coordination disorders compared to normal people.
- Coordination sports interventions can be extremely effective in creating visual movement control, speed and agility of the upper limbs, speed and agility, balance, strength and coordination of the limbs, and bilateral coordination.

Plain Language Summary

The mentally retarded are those with below-average Intelligence Quotient. Mentally retarded in terms of education is divided into four groups, which include: slow learning (IQ 90-75), teachable group with IQ (70-50), trainable group (30-49) and dependent group (below 29) are. Among the educable mentally retarded are children who have difficulty in coordinating components, in fine and coarse motor skills such as balance, throwing and jumping poorly, and in finger movements and coordination of eye and hand movements compared to ordinary people. They also have delayed motor development compared to their peers, which reduces their balance, and they usually perform slower and less accurate movements. On the other hand, the physical fitness of these people compared to healthy people is defective and they need attention and exercise. Because these problems affect their academic and social performance. In these people, maintaining muscle strength and endurance and balance and improving motor skills to achieve a better life and functional independence are important factors. Therefore, according to the research results, central stability exercises, while maintaining proper posture and posture during functional activities, prevented the occurrence of incorrect movement patterns to some extent, and on the other hand, coordination exercises as improving balance and bilateral coordination, upper limb coordination Improved in other respects was also accepted as a fun and lively game. Therefore, one of the reasons for the effectiveness of the central stability and coordination exercise program on increasing gross and fine motor skills was to increase balance and increase vitality and self-confidence to be appropriate to the needs of these children. All coaches and parents can use the combined central stability and coordination exercise program due to the cheapness and availability of these exercise equipment that one can easily do at home, in leisure time and exercise bell.

1. Introduction

Intellectual Disability (ID) is a condition, in which people have a below-average Intelligence Quotient (IQ) [1]. Among the educable intellectual disabled, there are children who, despite their ability to learn to read and write and simple math operations through education and practice, are different from their normal peers. One of these differences is Developmental Coordination Disorder (DCD) [2]. In spite of the ever-increasing scientific advances, intellectual disability with DCD continues to be a lifelong disability without treatment [3]. DCD includes the inability of the child to coordinate the components of a motor activity according to the child's age [4].

The prevalence of DCDs in the world at the age of 7 years is about 5 to 6% [5]. These children have disorders in performing coordinated movements making it tough for them to perform specialized and sports skills and have coordination problems without any neurological disease or special medical problems that affect their academic and social performance [6]. Furthermore, their walking is unbalanced and unstable showing their overall coordination to be poor [7]. In these people, maintaining muscle strength and endurance, and balance, and improving motor skills to reach a better life and functional independence are important factors [8]. Hence, using physical activity is one of the methods to prevent injuries caused by repeated falls, mostly caused by weakness of physical strength and proper imbalance in intellectual disability patients [9].

Evidence shows the positive effect of sports interventions on the daily life and participation in social activities of those with intellectual disability [4-10]. The results also stress the positive effects of exercise interventions on increasing cardiovascular endurance, muscular endurance, increasing strength, motor development, and quality of life in these people. Sharifi et al. examined the effect of motor training based on vestibular stimulation on balance and some motor skills of children with intellectual disability and poor balance [11]. Their results showed that performing motor exercises based on vestibular stimulation can have a significant effect on the balance and some motor skills of these children.

Işık et al. studied the effect of hemsball exercises on the motor performance of students with intellectual disability [12]. Their results showed that performing hemsball exercises had a significant effect on improving the motor performance of students with intellectual disabilities.

Shokati et al. evaluated the effect of vestibular stimulation exercises on motor proficiency in Down syndrome children [13]. Their results showed that at the end of the intervention period, there was a significant difference in the factors of running speed and agility and dexterity, and in total, gross motor skill and fine motor skill in the experimental group.

Pise et al. studied the effect of yoga practices on psycho-motor abilities among intellectually disabled children [14]. The findings of this 12-week research suggested the effectiveness of yoga training in improving motor function of intellectually disabled children.

Kalgotra et al. evaluated the effect of an aerobic fitness program on the motor proficiency of children with mild and moderate intellectual disabilities in India [15]. Their results showed that the intervention was effective in developing visual motor control, upper limb speed and dexterity, running speed and agility, balance, strength, and upper limb coordination.

In another study, Hashemi et al. evaluated the effect of regular exercise on motor function in children with developmental coordination disorder [16]. Their results showed that the training group had a significant improvement in five subtests of balancing, bilateral coordination, response speed, visual-motor control and speed, and dexterity of the upper limb after completion of the course. Significant changes were not seen in the speed and dexterity and power of the subjects.

Considering these studies, it can be stated that these children, despite their natural appearance, are weaker in performing motor skills compared to children of their age. These children usually have fine motor skills and some with both. They usually have slower, less accurate motor movements and are different from their peers. Some children may face difficulties moving their fingers and coordinating eye and hand movements, or some may have poor balance [17]. Moreover, the physical fitness of these people is defective compared to healthy people and they need attention and exercise. Hence, core stability prevents incorrect movement patterns by maintaining proper posture and posture during functional activities. On the other hand, hemsball exercises, as an enhancer of balance and bilateral coordination, improve upper limb coordination and are considered a fun and lively game. Given the need to study people with intellectual disability and DCD, studying the exercises that can simultaneously enhance gross, fine, or motor skills or both of them, as well as the balance and coordination of these people seems important but no studies have been conducted so far. Thus, this study examined the effect of combined physio-hemsball exercises on the motor skills of children with intellectual disability and DCD.

2. Materials and Methods

The study was an experimental and applied research with a pre-test and post-test design with a control group. The population of the study was male students with intellectual disability at Golestan School in the academic year 2020-2021 in Tabriz. After obtaining the permit from education and with the necessary arrangements, the subjects' personal information and medical records were collected. The number of samples was determined using G×Power statistical software, test power of 0.80, the effect size of 0.80, and at a significance level of 0.05. Therefore, 50 trainable boys with intellectual disability with an age range of 6 to 13 years and IQ between 50 and 75 based on inclusion and exclusion criteria, and the results of developmental coordination disorder were included [4]. Also, the selection of these samples was done by simple random sampling and one-way blind based on the entry list of the study subjects. Then, 30 samples were purposefully and accessibly selected from these individuals and randomized into two groups of experimental (n=15) and control (n=15).

Inclusion criteria included intellectual disability with IQ 50 to 75, intellectual disability with developmental coordination disorder, male gender, no use of neuroleptics or other agents affecting balance, no history of lower limb injury and the surgery during the last year,

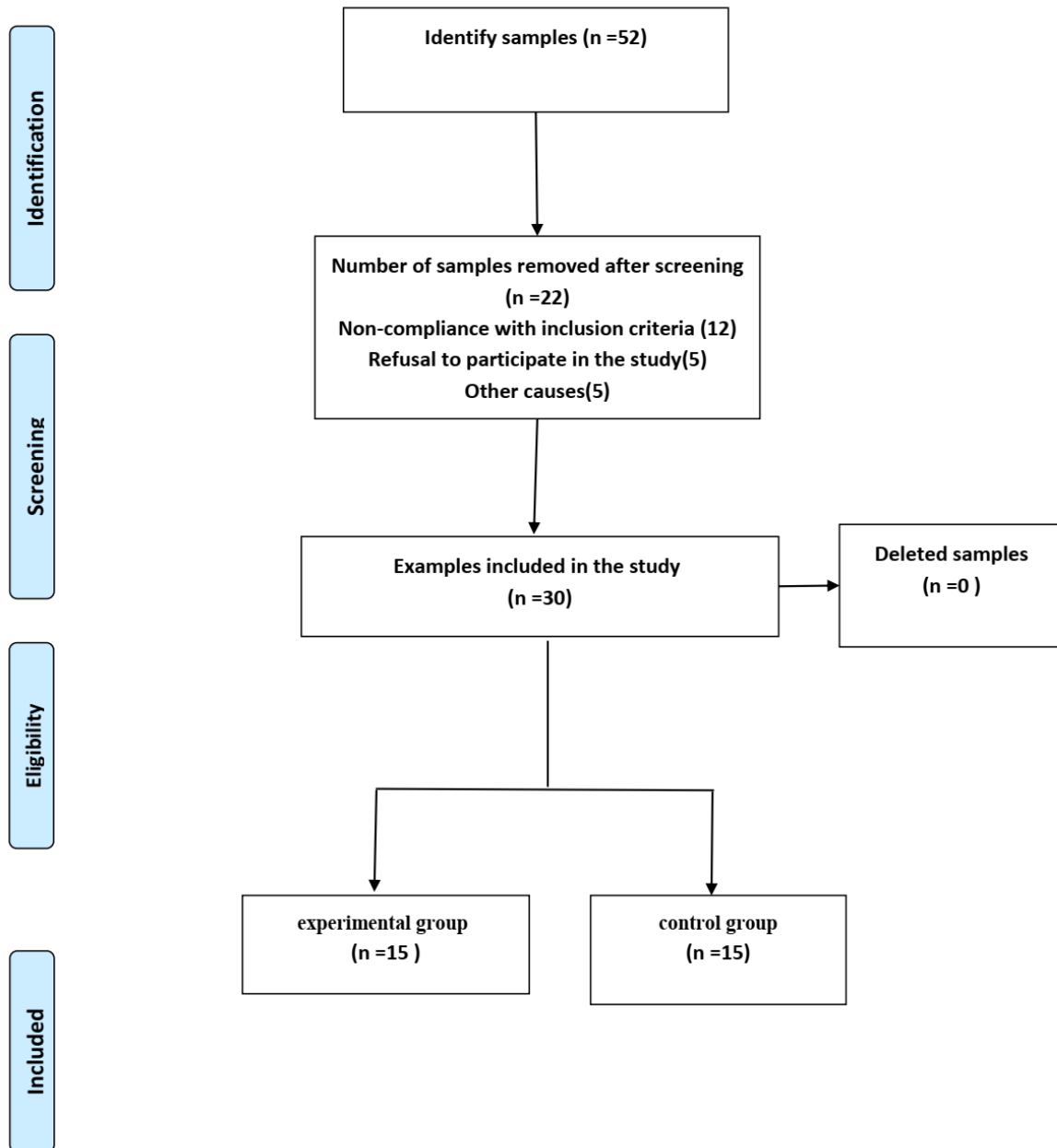


Figure 1. Evaluation process and selection of research samples

no disease in the atrial system and no cochlear implants, no visual impairment and having a normal vision without using glasses, desire and ability to participate in the test, and parental satisfaction. The exclusion criteria included no developmental coordination disorder, the need for support or the use of assistive devices to balance and walk, the development of musculoskeletal pain during the test, having ankle injuries, lower limb and spine surgery in the last year, a history of neuromuscular-muscular diseases, severe hearing and vision problems, taking neuroleptics, a history of lower limb injuries and surgery, and no consent. Then, the DCD questionnaire

was completed by the parents for screening the subjects, and then, the written consent to cooperate in the study was received from the parents.

Firstly, motor skills were measured in the pre-test stage. Then, the experimental group performed combined physio-hemball exercises for eight weeks, three sessions per week, and each session for 60 minutes. During the study period, the control group in the school performed only their daily activities. At the end of eight weeks, all variables of both groups were measured again

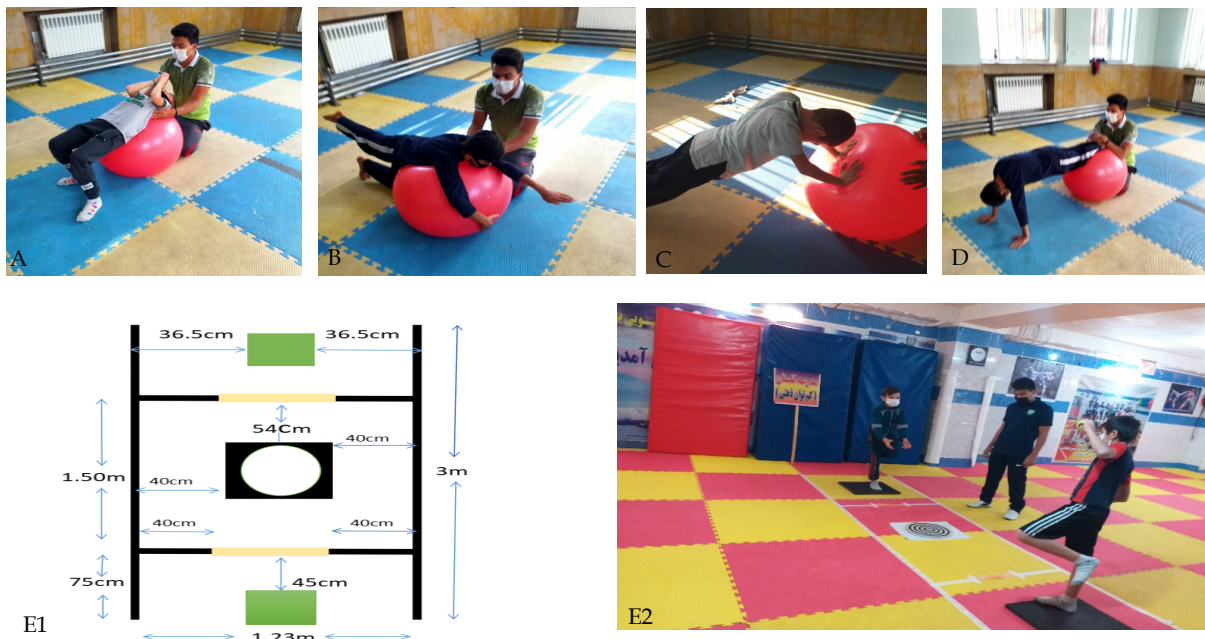


Figure 2. Combined physio-hemisphere training program

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Upper-body roll out: In the prone roll out position, the subject lay with the lower leg and feet only in contact with the surface of the ball (A). The hands were positioned directly underneath the shoulders, with the fingers facing forward. The surface test height (55cm or 65cm) was chosen so that the angle of the shoulder joint and the trunk was approximately 90° (as manually measured with a flexible goniometer). The same surface height was used for both test conditions.

Quadruped exercise: This isometric task was performed in a 2-point stance with a contralateral arm and leg raise (B). The subject was initially positioned in a 4-point stance with knees and hands on the floor (hips flexed to 90° and hands beneath shoulder joint). On a verbal command, the subject flexed the arm and extended the contralateral hip until both upper- and lower-body segments were parallel to the trunk. This position was then held for the 4-second contraction. The command for the alternate limbs to move was given after a 1-minute rest between trials. Three trials were performed for each movement combination. For the unstable condition, a Swiss ball was placed beneath the subject’s abdomen so that there was contact between the torso and a labile surface.

Inclined press-up: The top and bottom positions of an inclined press-up on a 65-cm high surface were recorded. The top position was the initial starting point, with the hands placed on the surface directly beneath the shoulder joint, with arms fully extended, and the trunk positioned as far back as possible so that upper-body position could be maintained (C). The position of each subject’s feet was marked and held consistent during all press-up trials. The bottom of the press-up was recorded after the subject had flexed the elbow joint to approximately 90°, lowering the trunk toward the ball but without making contact. The bottom of the press-up was moved into immediately after the collection period from the top of the press-up.

Balancing Swedish: At first he swam Swedish and put his feet on the ball. He would place the palms of his hands on the floor and spread his arms and legs shoulder-width apart (neither more nor less). And then with straight elbows, he kept the Swedish balance (D).

Rules and pitche hemisphere game: The objective of the game is to throw the hemisphere into the hemisphere hoop that is on the hemisphere target board on the floor without hitting the hoop and make it go over to the opponent’s side and into the opponent’s area and to prevent the opponents from achieving the same goal. While sending the ball into the game and opponent’s area they may catch the ball in any way including on the plates where they are stepping. The ball is put into play with a draw in which the loser serves. The player, who serves, throws the ball at the hoop to send it to the rival side. The counting continues until a ball touches inside the hoop, goes out or a player makes a mistake (E1 & E2).

similar to the pre-test stage. The process of evaluating and selecting research samples is shown in Figure 1.

Bruininks-Oseretsky test

Bruininks-Oseretsky test of motor proficiency-short form is a set of tests for 4.5-14.5 years old children that assesses fine and gross motor skills to identify their motor skills and movement disorders. The eight components of running speed and agility, balance, reciprocal coordination, strength, response speed, visual-motor

control, speed, and upper limb agility, and upper limb coordination were used in the study to evaluate the fine and gross motor skills of children with intellectual disability and DCD. These components measure four subtests of gross motor skills, three subtests of fine motor skills, and one subtest of both gross and fine motor skills [18]. The test has the necessary validity and reliability so that the coefficient of validity of Bruininks-Oseretsky Test scores in the study of motor skills was 90%. The test-retest reliability coefficient of this collection has

Table 1. Combined physioball with hemsball training program

First and Second Weeks (10×3)	Third, Fourth, and Fifth Weeks (12×3)	Sixth, Seventh, and Eighth Weeks (15×3)
Warm-up for 10 min (Mid-paced Walk for 7 min and Stretching for 3 min)		
Two-person Coordination Exercises	Wall Coordination Exercises	Basic Coordination Exercises
<p>Exc.1: Roll the ball from one hand to the other through the palm of the hand.</p> <p>Exc.2: Throw the ball from one hand to the other with palms facing each other and held at a hand's distance.</p> <p>Exc.3: Release the ball from the fingertips while pushing the arm upwards.</p> <p>Exc.4: Release the ball to the ground while standing, catch it with one or both hands.</p> <p>Exc.5: Catch the ball, which has been released to the ground while standing with one or both hands while hunkering.</p> <p>Exc.6: Dribble the ball during every second step while walking.</p>	<p>Exc.1: Catch a ball that is thrown against a wall and bounces back while in a sitting position facing the wall with one or both hands (1-2-3 m).</p> <p>Exc.2: Hold the ball while standing up facing the wall and catching with the same or a different hand.</p> <p>Exc.3: Catch a ball that is thrown onto the ground and bounces back from the wall with one or both hands while standing and facing the wall.</p> <p>Exc.4: Catch a ball with one or both hands that are thrown into a hoop left in front of a wall and rebounds from the wall.</p>	<p>Exc.1: Two students with ID standing in alignment facing the wall catch a ball thrown onto the ground and rebounding from the wall with both hands.</p> <p>Exc.2: An ID student catches a ball that is thrown directly at the wall by the trainer and falls to the ground from the wall.</p> <p>Exc.3: The trainer standing behind the ID student facing the wall throws the ball on the ground and the ball rebounding from the wall is caught by the ID student.</p> <p>Exc.4: An ID student standing on a footplate catches a ball that is thrown by the trainer at different speeds.</p> <p>Exc.5: Two ID students face each other on the footplates in the game area and throw a ball at the target board with one hand and catch the ball with two hands.</p> <p>Exc.6: The trainer and student practice throwing on the game court on one foot and on two feet.</p>
<p>1- Upper-body roll out</p> <p>2- Inclined press-up</p> <p>3- Contralateral single-leg holding</p> <p>4- Quadruped exercise</p>	<p>1- Upper-body roll out</p> <p>2- Inclined press-up</p> <p>3- Contralateral single-leg holding</p> <p>4- Quadruped exercise</p>	<p>1- Upper-body roll out</p> <p>2- Inclined press-up</p> <p>3- Contralateral single-leg holding</p> <p>4- Quadruped exercise</p>
<p>3 sets with 3 repetitions</p> <p>Hold time for 4 seconds and 30 seconds of rest</p>	<p>2 sets with 3 repetitions</p> <p>Holding time for 4 seconds and 30 seconds of rest</p>	<p>1 set with 3 repetitions</p> <p>Holding time for 4 seconds and 30 seconds of rest</p>
Cooling down for 5 min (Low-paced walking for 2 min and Stretching for 3 min)		

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been reported to be 0.78 in the long and 0.86 in its short form. The short-form measures children’s motor skills in general, and the total score shows the general skills of the children, including gross and fine skills [19]. The short test form was used in the study.

Exercise program

Given studies conducted on balance exercises and postural stability and coordination in people with intellectual disability and DCD, a protocol with good quality in terms of comprehensive movements and using systems

Table 2. Demographic characteristics of the study samples

Variables	Groups	Mean±SD	t	P
Age (y)	Control	9.20±1.24	1.44	0.15
	Intervention	10.06±1.83		
Height (m)	Control	1.37±0.10	1.79	0.08
	Intervention	1.44±0.12		
Weight (kg)	Control	36.95±10.47	1.31	0.2
	Intervention	42.26±11.65		
Body Mass Index (kg/m ²)	Control	19.24±2.34	0.59	0.55

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Table 3. Comparison of post-test variables between the groups

Variables	Stages	Groups	Mean*	F	df	P#	Eta Squared
Running speed and agility	Post-test	Control	4.86	37.84	1	0.001**	0.58
	Post-test	Experimental	6.93				
Balance	Post-test	Control	1.93	158.49	1	0.001**	0.85
	Post-test	Experimental	6.13				
Power	Post-test	Control	7.06	76.09	1	0.001**	0.73
	Post-test	Experimental	10.6				
Combining gross motor scores	Post-test	Control	15.13	76.09	1	0.001**	0.9
	Post-test	Experimental	27.13				
Upper limb coordination	Post-test	Control	2.8	94.14	1	0.001**	0.77
	Post-test	Experimental	5.46				
Motor vision control	Post-test	Control	2.4	93.33	1	0.001**	0.77
	Post-test	Experimental	5.26				
Speed of agility and upper limbs	Post-test	Control	4.8	76.46	1	0.001**	0.73
	Post-test	Experimental	10.46				
Combining fine motor scores	Post-test	Control	8.18	135.95	1	0.001**	0.83
	Post-test	Experimental	16.1				
Short test composite score	Post-test	Control	26.9	259.05	1	0.001**	0.9
	Post-test	Experimental	50.0				

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#Analysis of covariance; *Pre-test (covariate agent); **Significance at the level of P<0.01.

involved in postural balance and stability and coordination was examined and the combined physioball with hemsball protocol [12, 20] (Figure 2) was used as the exercise protocol. The control group did not have any exercise program during the study, but the experimental groups performed the exercise program for eight weeks, three sessions per week, and 60 minutes per session. The

subjects first had ten minutes (7 minutes of walking and 3 minutes of stretching) for warm-up and then, were divided into two groups, and with the command of the examiner of group one, the program began to run and after the end of each movement, group two began the same exercise. Finally, cool down for 5 minutes (2 minutes of walking and 3 minutes of stretching) was done. All the

Table 4. Comparison of two-way coordination and response speed variables in pre-test and post-test between groups

Variables	Stages	z	U	p#
Two-way coordination	Pre-test	-0.83	94.5	0.46
	Post-test	-4.33	12.00	0.001**
Response speed	Pre-test	-1.72	0.72	0.1
	Post-test	-4.21	13.00	0.001**

#Mann-Whitney U; ** Significance at the level of P<0.01.

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Table 5. Difference between mean of the variables in before and after training sessions

Variables	Control Group (n=15)				Experimental Group (n=15)			
	Mean±SD		t	P	Mean±SD		t	P
	Pre-test	Post-test			Pre-test	Post-test		
Running speed and agility	4.66±2.49	4.86±2.53	-1.38	0.18	5.13±2.89	6.93±2.18	-6.44	0.001**
Balance	1.6±1.29	1.93±1.03	-1.78	0.09	2.26±1.03	6.13±1.24	-16.35	0.001**
Power	6.6±2.99	7.06±2.49	-1.7	0.11	7.8±2.75	10.6±1.84	-8.57	0.001**
Combining gross motor scores	14.53±6.2	15.13±5.1	-1.71	0.1	17.73±6.1	27.13±3.9	-9.69	0.001**
Upper limb coordination	3.06±1.03	2.8±1.01	-1.74	0.1	3.26±0.88	5.46±0.74	-8.4	0.001**
Motor vision control	2.2±1.37	2.4±1.01	-1.38	0.18	3.06±0.96	5.26±0.88	-15.19	0.001**
Speed of agility and upper limbs	4.7±3.21	4.8±3.18	-0.36	0.71	6.93±2.91	10.46±1.4	-6.85	0.001**
Combining fine motor scores	8.05±5.81	8.18±5.68	-0.76	0.48	9.55±3.33	16.1±1.92	-11.03	0.001**
Short test composite score	26.0±12.47	26.9±10.9	-0.97	0.24	30.6±8.27	50.0±5.02	-15.46	0.001**

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exercises were done in the school gym. The purpose of the game is to throw the ball into the ring (like a circle) without hitting the hoop and prevent it from reaching the opponent's area. While sending the ball into the game and the opponent's area, they may catch the ball in any way like by the plates on which they stand. The ball is played with a draw, in which the loser serves. The serving player throws the ball into the hoop to send it to the opponent. This count continues until a ball touches the inside of the hoop, goes out or the player makes a mistake. The player who gets a point is the serving player. The play area is 3×1.23 cm for young players and 1.55×4 cm for adults and 4.15×2.10 cm of the field for two players is flat, smooth, and hard. This area should be adjusted so that it is 2 meters away in any direction to the throwing area. While throwing, the whole body is rotated in the direction of the target and the eyes are focused on the target point, and the hand that throws the ball to the hoop moves forward while the foot is raised on the same side of the ground and the shoulders are brought forward. When the ball gets out of hand, the arm continues

to move the ball in the direction of the ball (Figure 2). These exercises were routinely performed and were explained orally by the researcher prior to the exercise and are described in detail in Table 1.

To measure the normality of the information, the Shapiro-Wilk test was exploited, and to analyze the pre-test and post-test outcomes, a dependent t-test and covariance analysis were exerted at a significance level of P<0.05, and the pre-test was used as a covariate factor from the covariance test using SPSS software v. 25.

3. Results

Table 2 shows the demographic characteristics of the two groups. According to the results, both groups were homogenous in terms of demographic characteristics and there was no significant difference between the groups.

The pre-test was used as a covariate factor from the covariance test to compare the mean results between the two groups, indicating a significant difference in

Table 6. Mean difference of two-way coordination and response speed in subjects before and after training

Variables	Control Group (n=15)				Experimental Group (n=15)			
	Mean±SD		Z	P	Mean±SD		Z	P
	Pre-test	Post-test			Pre-test	Post-test		
Two-way coordination	1.6±0.82	1.46±0.74	-1.41	0.15	1.86±0.63	3.6±0.63	-3.57	0.001
Response speed	0.05±0.09	0.07±0.15	-1.19	0.23	0.08±0.12	0.74±0.55	-3.43	0.01

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the overall score of running speed and agility, balance, strength, and combination of gross motor scores, upper limb coordination, motor visual control, the speed of agility and upper limbs and the combination of fine motor scores and the combined score of the short form test ($P \geq 0.05$) (Table 3).

The non-parametric Mann–Whitney U test was used to examine the differences between the control and experimental groups given the abnormality of the two-way coordination score and response speed, which showed a significant difference in the two-way coordination test and response speed ($P \geq 0.05$) (Table 4). Paired sample t-test (parametric variables) was used to evaluate the difference between pre-test and post-test in the two groups separately, indicating a significant difference in the overall score of running speed and agility, balance, strength, and combination of large motor scores, upper limb coordination, motor vision control, agility, and upper limb agility speed and a combination of fine motor scores and composite score in the short test ($P \geq 0.01$) (Table 5). Wilcoxon test (non-parametric variable) was used to examine the differences in pre-test and post-test in the two groups separately, revealing a significant difference in two-way coordination test and response speed between the two groups ($P < 0.01$) (Table 6).

4. Discussion

The purpose of the study was to examine the effect of eight weeks of combined physio-hemball exercises on the motor skills of children with intellectual disability and DCD. The results were indicative of the fact that performing eight weeks of combined physio-hemball exercises had a significant positive effect on motor skills. The results of the study are in line with the results of some studies in terms of motor skills and the fact that physical exercise can improve motor skills and physical fitness [11-13, 21-26]. However, our results are inconsistent with those of Sharifi et al. in terms of speed of response [11]. The reason for the inconsistency was the difference in duration, intensity, and type of exercise program. Moreover, using physical activity or preferably sports, can help enhance motor skills in people with DCD, but there were no studies examining the effect of combined physio-hemball exercises on motor skills of people with disabilities with coordination disorder according to the literature review. As one of the characteristics of children with DCDs in physical fitness factors, upper limb coordination, and balance are difficult to learn motor skills [27].

Combined physio-hemball exercises showed positive effects on all components of motor skills. Moreover, Işık

et al. reported that doing hemball exercises is highly effective in improving the motor skills of students with intellectual disabilities [12], which is in with the present study. The reason for this consistency is that as people with intellectual disability and DCDs have disorders in fine and gross motor skills, reduced coordination in the upper limbs, and poor hand-eye coordination, performing these training interventions affect most of the components of motor skills. Other studies showed that some children with intellectual disability and motor problems have characteristics, like motor developmental delay, imbalance, cognitive-motor impairment, poor motor coordination, and mild neurological disorders to some extent [28].

Ming-Sui Kao et al. stated that the Frisbee game course can improve upper limb strength, power, coordination ability, and motor skills of students with intellectual disabilities [27]. In another study, Bahiraei et al. showed a significant effect of combination exercises on motor function, balance, and muscle strength in boys with Down syndrome [28], which is in line with the results of the present study. Kalgotra et al. showed the positive effect of a period of aerobic fitness program on the motor skills of children with mild to moderate intellectual disability in India [15]. Thus, these exercises can be extremely effective in creating visual movement control, upper limb speed and agility, speed and agility, balance, strength, and limb coordination. Furthermore, they can be effective in enhancing mutual coordination in children with intellectual disability.

Visscher et al. found that children with intellectual disabilities were less socially accepted and less likely to play with their peers; thus, lack of motor skill experiences causes weakness in motor skills of this group of children [29]. From another perspective, the scholars have concluded that children with mental retardation or children with developmental delays are limited in terms of play space and physical activity at home, which can have detrimental effects on motor skills. One of the reasons for the effectiveness of the physio-hemball exercise program is on the gross and fine motor skills and its suitability to the needs of these children. Hence, one of the low-cost approaches to compensate for these shortcomings as much as possible is to consider an appropriate exercise program with developmental quality [13]. Furthermore, as a non-pharmacological approach, exercise can properly enhance motor skills and fitness problems of individuals with intellectual disabilities suffering from DCDs. Additionally, it can increase vitality and self-confidence and reduce isolation in this group of people with disabilities through the social participation that exists in sports and sports environments.

Thus, given the results of the present study, educational games and special movement exercises as different branches of sports are important in the development of motor skills and coordination. One of these sport branches is a combination of physio-hemisphere exercises with the movements required for the game (like reaching, squatting, catching, and throwing) and a basic training program that can be effective in developing individual motor skills and is a completely new approach. Moreover, these combined exercises are especially good for a happy and fun new sport that can be played by people of any age easily in both outdoor and indoor. It is especially important to have good hand-eye coordination, high concentration to catch the ball and throw it during hemisphere [12]. Thus, combined physio-hemisphere exercises can enhance balance, bilateral coordination, and upper limb coordination, thus, they could be effective for all motor skills tests in people with intellectual disabilities [12]. Therefore, in combined physio-hemisphere exercises, selecting corrective movements are prescribed and recommended by these therapists to increase balance and coordination, to prevent falls.

5. Conclusion

The provision of rehabilitation strategies based on motor activities, like combined physio-hemisphere exercises is an effective way to enhance the motor skills of these children. Hence, according to the results, the eight-week combined physio-hemisphere exercise program has positive effects on improving the motor skills of these children, including gross and fine motor skills. It is hoped that the results of the present study will be used by all trainers, therapists, sports professionals, and even parents, as the combined physio-hemisphere exercise program can easily be done at home or as an effective activity in leisure time, for rehabilitation purposes, and Physical Education (PE) course for children with intellectual disabilities with DCD given the low cost and availability.

One of the limitations of this study was to compare the effectiveness of interventions separately in gross and fine motor skills and balance in different age groups. Also, the limitation of the research can be the lack of evaluation of the effectiveness of exercises in a long time and also the lack of use of other evaluation tools. In future research, it is recommended that the current research program be considered among girls with intellectual disabilities with developmental coordination disorders and other disabilities, such as autism and Down syndrome.

Ethical Considerations

Compliance with ethical guidelines

Compliance with ethical guidelines The study was approved (Code: IR.GUMS.REC.1398.464) by the Ethics Committee of the Vice-Chancellor of Research of Guilan University of Medical Sciences in Iran and was registered at the clinical trial centers of Iran (Code: IRCT20200125046254N1).

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Authors' contributions

Both authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interests.

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