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

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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.

ABSTRACT

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Keywords: Intellectual disability, Developmental coordination disorder, Motor skills, Core stability, Coordination exercises

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1. Introduction

Intellectual Disability (ID) is a condition, in which people have a below-average Intelligence Quotient (IQ) [1]. Among the educable intellectually 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.

İşık et al. studied the effect of hemisball exercises on the motor performance of students with intellectual disability [12]. Their results showed that performing hemisball 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, hemisball 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-hemisball 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,
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-hemisball 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...
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 sub-tests of gross motor skills, three sub-tests of fine motor skills, and one sub-test 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
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.

### Table 1. Combined physioball with hemsball training program

| Warm-up for 10 min (Mid-paced Walk for 7 min and Stretching for 3 min) | Basic Coordination Exercises |
|---|---|
| **Two-person Coordination Exercises** | **Wall Coordination Exercises** |
| **Exc.1:** Roll the ball from one hand to the other through the palm of the hand. | **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). |
| **Exc.2:** Throw the ball from one hand to the other with palms facing each other and held at a hand’s distance. | **Exc.2:** Hold the ball while standing up facing the wall and catching with the same or a different hand. |
| **Exc.3:** Release the ball to the ground while standing, catch it with one or both hands. | **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. |
| **Exc.4:** Catch the ball, which has been released to the ground while standing with one or both hands while hunkering. | **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. |
| **Exc.5:** Dribble the ball during every second step while walking. | **Exc.5:** Catch a ball, which has been released to the ground while standing with one or both hands while hunkering. |

### 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/m²)  | Control  | 19.24±12.34 | 0.59  | 0.55 |

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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

| 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 |      |     |        |             |

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

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.
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

| 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              | 4.6±0.49             | 4.86±0.53 | -1.38 | 0.18 | 5.13±0.89             | 6.93±0.18 | -6.44 | 0.001**  |
| Balance                                | 1.6±0.29             | 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 | 7.82±2.75             | 10.6±1.84 | -8.57  | 0.001**  |
| Combining gross motor scores           | 14.5±6.2             | 15.1±5.1 | -1.71 | 0.1  | 17.73±6.1             | 27.1±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±5.21            | 8.18±5.68 | -0.76  | 0.48 | 9.55±5.33              | 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**  |

Table 6. Mean difference of two-way coordination and response speed in subjects before and after training
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≥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≥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≥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-hemsball 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-hemsball 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-hemsball 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-hemsball exercises showed positive effects on all components of motor skills. Moreover, Işık et al. reported that doing hemsball exercises is highly effective in improving the motor skills of students with intellectual disabilities [12], which is in line 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 could 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-hemsball 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-hemsball 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 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 hemsball [12]. Thus, combined physio-hemsball 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-hemsball 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-hemsball exercises is an effective way to enhance the motor skills of these children. Hence, according to the results, the eight-week combined physio-hemsball 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-hemsball 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 disorder 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.

References

[1] Blomqvist S. Postural balance, physical activity and capacity among young people with intellectual disability. [Ph.D. dissertation]. Umeå: Umeå University; 2013. http://umu.diva-portal.org/smash/record.jsf?pid=diva2%3A622818&

[2] Zamani Alavijeh J. [Comparison of the effect of eight weeks of Plyometric, balance and combined (plyometric and balance) exercises on knee joint Proprioception and static balance (Persian)] [Msc. thesis]. Isfahan: University of Isfahan; 2010. https://www.virascience.com/thesis/521044/

[3] Battaglia A, Carey JC. Diagnostic evaluation of developmental delay/mental retardation: An overview. American Journal of Medical Genetics. 2003; 117C(1):3-14. [DOI:10.1002/ajmg.c.10015] [PMID]

[4] Zolghadr H, Sedaghati P, Daneshmandi H. The effect of selected balance/corrective exercises on the balance performance of mentally-retarded students with developmental coordination disorder. Physical Treatments-Specific Physical Therapy Journal. 2019; 9(1):23-30. [DOI:10.32598/PTJ.9.1.23]

[5] Marin P, Wackenier P, De Surgegoldse D, De Deyn PP, Verhoeven J. Developmental coordination disorder: Disruption of the cerebello-cerebral network evidenced by SPECT. The Cerebellum. 2010; 9(3):405-10. [DOI:10.1007/s12311-010-0177-6] [PMID]

[6] Carmeli E, Bar-Yossif T, Ariav C, Levy R, Lieberman DG. Perceptual-motor coordination in persons with mild intellectual disability. Disability and Rehabilitation. 2008; 30(5):323-9. [DOI:10.1080/09638280701265398]

Balasi E & Sedaghati P. Effect Core Stability and Coordination Exercises on Motor Skills. PTJ. 2021; 11(4):249-260.
[7] Smits-Engelsman B, Wilson P, Westenberg Y, Duyssens J. Fine motor deficiencies in children with developmental coordination disorder and learning disabilities: An underlying open-loop control deficit. Human Movement Science. 2003; 22(4-5):495-513. [DOI:10.1016/j.humov.2003.09.006] [PMID]

[8] Kajbaf M, Mansour M, Ejei J, Parirokh D. Survey and diagnosis of mental retardation based Piaget tests and Lambert scale. Psychology. 2000; 3(4):341-57. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=26hl%3Den&as_vis=1&oi=scholar&pt=.Minute+on+Motor+Proficiency+in+Children+with+Down+Syndrome+and+normal+Peers.2017+44(4):299-310.26hl%3Den

[9] Hertel J, Miller SJ, Denega CR. Intratesser and intertesser reliability during the star excursion balance tests. Journal of Sport Rehabilitation. 2000; 9(2):104-16. [DOI:10.1123/jsr.9.2.114]

[10] Salehzadeh K, Esrafilzadeh S. [Effects of an eight-week Pilates exercise program on some physical fitness factors and kinetic performance in girl students with intellectual disability (Persian)]. Journal of Research Rehabilitation Sciences. 2016; 12(5):259-66. http://jprs.mui.ac.ir/index.php/jprs/article/view/2747

[11] Shariﬁ M. [The effect of vestibular stimulation-based motor exercises on balance and some motor skills of children with mental retardation [MSc. thesis] (Persian)]. Rasht: University of Science & Research. 2011.

[12] Işık M, Zorba E. The effects of hemsball on the motor proficiency of students with intellectual disabilities. International Journal of Developmental Disabilities. 2016; 51(4):260-8. [DOI:10.1177/0269215514527956] [PMID]

[13] Bahmani F, Kaykhosravi H, Bakhshaish SH. [The Effect of morning exercise on gross and fine motor skills in children with educable mentally retarded (Persian)]. 5th International Conference on Sports Science. July 2017, Tehran, Iran. 2018. https://www.sid.ir/fa/seminar/ViewPaper.aspx?Id=93909

[14] Mousavizadeh VS, Daneshmandi H, Sedaghati P. The effect of six weeks of vestibular stimulation exercises on static and dynamic balance in children with hearing impairment. Medical Journal of Tabriz University of Medical Sciences & Health Services. 2021; 43(2):Online. https://mj.tbzmed.ac.ir/Inpress/27134.pdf

[15] Seiler S, Skaanes PT, Kirskeola G, Katch FI. Effects of sling exercise training on maximal onclub head velocity in junior golfers. Medicine & Science in Sports & Exercise. 2006; 38(5):S286. [DOI:10.1249/00005768-200605001-02115]

[16] Missiuna C. Poor handwriting is only a symptom: Children with developmental coordination disorder. Occupational Therapy Now. 2002; 4:4-6. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Poor+handwriting+is+only+a+symptom:+Children+with+developmental+coordination+disorder.+Occupational+Therapy+Now.+2002.+4:4-6.26hl%3Den

[17] Balasavojzadeh K, Daneshmandi H, Sedaghati P. The effect of a se-lective combined training program on motor performance, balance and muscle strength in boys with Down Syndrome (DS). Journal of Paramedical Sciences & Rehabilitation. 2018; 64(2):96-104. [DOI:10.1080/20473869.2016.1267302] [PMID]

[18] Bahrai ne S, Daneshmendi H, Sedaghati P. The effect of a selective combined training program on motor performance, balance and muscle strength in boys with Down Syndrome (DS). Journal of Paramedical Sciences & Rehabilitation. 2017; 64(4):40-5. http://jpsr.mums.ac.ir/article_9642.html

[19] Visscher C, Houwson S, Scherder EJ, Moolenaar B, Hartman E. Motor profile of children with developmental speech and language disorders. Pediatrics. 2007; 120(1):e158-63. [DOI:10.1542/peds.2006-2462] [PMID]
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