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Original Article

# The Effects of Selected Training Exercises on Balance Performance, Physical Self-Concept and Self-Esteem of Primary School Male Students with Developmental Coordination Disorders

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## Abstract

**Introduction:** Psychomotor issues can lead to the exclusion of children with disabilities from sports and daily activities. Then, it is imperative to implement movement programs aimed at improving psychomotor skills.
**Objective:** The objective of this study was, therefore, to investigate the impact of specific training exercises on the balance performance, physical self-concept, and self-esteem of primary school male students diagnosed with developmental coordination disorders (DCD).
**Methods:** This research employed an experimental design. A total of 40 primary school male students with DCD were chosen through purposeful sampling method and randomly allocated to either the intervention or control groups (n=20 students). Training phase included 16 sessions of the designated exercise program. The modified stork test and the tandem walking test, Self-Concept Questionnaire Form 5, and the Rosenberg Self-Esteem Scale were used for measuring balance performance, self-concept and self-esteem, respectively. Analysis of covariance was used for data analysis.
**Results:** There were no significant differences observed when comparing the groups in terms of demographic variables (P>0.05). There was a significant difference between the means of static and dynamic balance, physical self-concept and self-esteem in the pre-test and post-test results for the intervention group (P<0.001), indicating an improvement in the scores of the subjects in the intervention group after the application of the designated training exercises, in comparison to the pre-test results.
**Conclusion:** Children experiencing DCD can advance their motor skills in alignment with appropriate timing and circumstances by effectively managing and regulating their actions and behaviors, thereby facilitating social interactions.

*Keywords:* Child, Motor Skills Disorder, Exercise, Balance, Self-Concept

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## 1. Introduction

Approximately 5 to 6 percent of children of school age are affected by developmental coordination disorder (DCD), with reports indicating that boys are three to seven times more likely to experience this condition than girls (1). This disorder is classified as a neuro-motor disability, and individuals affected typically encounter challenges in acquiring and executing both fine and gross motor skills. These difficulties can significantly impact their daily activities and academic achievements, potentially leading to feelings of isolation, depression, and a diminished quality of life (2,3). Children experiencing movement-related issues may exhibit traits such as delayed motor development, balance impairments, perceptual-motor difficulties, poor coordination, and, to a certain extent, mild neurological disorders (4,5). These characteristics suggest a form of developmental delay that lacks a specific medical, environmental, or intellectual origin (6). While these children do not have intellectual disabilities, they struggle with mastering essential motor skills necessary for daily living (7). Furthermore, children and adolescents with DCD often display hesitance towards activities that necessitate physical movement, which can result in feelings of frustration, failure, and a negative self-concept (8). They may also experience challenges in effectively managing their time, completing homework, and developing tactile perception and balance skills, alongside difficulties in motor perception (9).

The designation of DCD has been supplanted by terms such as visual-motor difficulties, developmental passivity, and physical clumsiness (10-12). These terms collectively describe children who experience challenges with movement and specific learning aspects (13,14). There exists a significant interplay and overlap among these conditions. Individuals with developmental disorders exhibit deficiencies in balance-related movements when compared to their typically developing peers (15,16). Their gait tends to be unsteady and erratic, reflecting an overall lack of coordination. Furthermore, issues related to attention

deficits and imprecision contribute to disruptions in spatial awareness, orientation, and accurate assessment (17). Another challenge faced by these children is inconsistency in executing daily tasks. Due to their inability to grasp the timing of sequential movements and their struggle to coordinate limb movements while maintaining balance, they often find it difficult to perform movements and may fail to execute specific movement patterns that necessitate balance, resulting in uncoordinated walking (18,19).

Balance constitutes a crucial element of physical fitness, encompassing both dynamic and static forms. It plays a significant role in nearly all movement activities. From a functional perspective, balance can be categorized into static, semi-dynamic, and dynamic types. The ability to maintain the center of gravity within the limits of the support surface is referred to as the stability range (20). It is essential to maintain a vertical orientation of the body to achieve balance in most functional tasks. Balance is not merely a state, skill, or ability; it is an integral aspect of specific activities that involves various processes (21). A deeper understanding of the factors influencing balance quality and its effects can facilitate the enhancement of this fundamental movement attribute throughout an individual's life. Given that balance and posture issues can lead to the exclusion of children with disabilities from sports and daily activities, it is imperative to implement movement programs aimed at improving this skill. The current research investigates the balance of children with DCD, as their balance deficiencies often result in reduced participation in daily activities and sports (22).

Some researchers contend that if DCD is not adequately addressed, affected children may encounter challenges in communication and in engaging in their regular activities (23-25). Consequently, they may exhibit reduced physical involvement and experience fewer positive social interactions with their peers. In comparison to their classmates, these children often find themselves spending more time in solitude and may struggle with low self-concept and self-esteem (23,26,27). Self-concept refers to a coherent and stable set of perceptions shaped by individual experiences and the interpretations of those experiences by others (27,28). Individuals with a positive self-concept tend to feel competent and are better equipped to adapt to their environment (26,29). Furthermore, self-esteem, which arises from social interactions and societal values, influences all aspects of daily life and is a crucial element of personality that shapes human behavior (27,30,31). An increase in self-esteem fosters a sense of empowerment and self-worth, leading to positive outcomes such as academic improvement, heightened motivation for success, greater self-confidence, ambition, and a desire for better health. Thus, another key objective of this research is to investigate the self-concept of children diagnosed with DCD (32).

The etiology of DCD remains unclear; however, research indicates that affected children exhibit atypical brain structure and function (3,5-7). As previously noted, it has been observed that a significant number of children with this disorder struggle with balance skills (4,5,15,16) and demonstrate inferior postural control compared to their healthy peers (10,11), resulting in a heightened risk of falls and injuries. Furthermore, these children tend to experience diminished mental well-being (1,4,6) and a lower quality of life (2,3) relative to their healthy counterparts. In light of these factors, researchers advocate for the implementation of therapeutic, motor, and executive interventions for children with DCD. Some experts suggest that timely interventions, including physical activity and exercise, may help mitigate the cognitive and motor challenges faced by these children. Consequently, through targeted exercise and therapeutic strategies, it is feasible to enhance their motor skills and balance. Therefore, identifying the most effective intervention methods could significantly aid in the rehabilitation of these children. Previous studies have focused on physical activity intervention in children with DCD (33-37). This study focused further on this issue by investigating the impact of specific training exercises on the balance performance, physical self-concept, and self-esteem of primary school male students diagnosed with DCD.

## 2. Methods

### *2.1. Participants and Design*

This research employed an experimental design featuring a pre-test- and post-test framework alongside a control group. A total of 40 primary school male students with DCD were chosen through purposeful sampling method. The participants were then randomly allocated to either the intervention or control groups (n = 20 students) using a random number table. The sample size was calculated utilizing G*Power software, which indicated an effect size of 0.80, a statistical power of 0.90, and a significance level of $\alpha$=0.05. Inclusion criteria encompassed the presence of DCD as recognized by the Developmental Coordination Disorder Questionnaire (DCD-Q), acquisition of parental consent, and an age range of 8 to 11 years. Exclusion criteria included failure to complete the questionnaire, tardiness in attending the post-test, and absence from more than two sessions in the training course. All procedures were completed based on the international ethical considerations for human subjects.

### *2.2. Measurements*

#### *2.2.1. Developmental Coordination Disorder Questionnaire (DCD-Q)*

This questionnaire (3) was utilized for the preliminary assessment of individuals diagnosed with DCD. It is filled out based on observations provided by parents or teachers. The instrument is designed for children aged 5 to 15 years and comprises 15 items that assess three aspects: movement control, fine motor skills/handwriting, and overall coordination. Children who receive a score lower than 45 on this questionnaire are deemed to be experiencing difficulties associated with DCD. The reported reliability coefficients for this tool are 0.83 for internal consistency, 0.73 for test-retest reliability, and 0.85 for Cronbach's alpha. In this questionnaire, parents are required to evaluate their child's coordination in comparison to peers of the same age, assigning a score using a 5-point Likert scale. In this study, the Cronbach's alpha coefficient for the questionnaire was found to be 0.88.

#### 2.2.2. Balance Performance

Balance assessment was conducted using the modified stork test and the tandem walking test. The modified stork test evaluates static balance, requiring the subject to stand on one leg on a flat surface while raising the opposite leg to knee level, with both hands positioned alongside the body. The hands are allowed to move freely. The examiner utilizes a timer to measure the maximum duration the subject can maintain this position, stopping the timer when the free foot touches the ground. This test is administered twice for each leg, and the best time achieved is recorded. The tandem walking test assesses dynamic balance by evaluating the subject's ability to walk in a straight line. In this test, the subject is instructed to take 15 steps in a straight line, placing the heel of one foot directly in front of the toes of the other. The highest possible score for this test is 15. If the subject strays from the designated path before completing the 15 steps, the test is halted, and the number of completed steps is noted as the subject's score. This test is also performed twice, with the best score recorded. In this study, the Cronbach's alpha coefficient for the static and dynamic balance were found to be 0.90 and 0.92, respectively.

#### 2.2.3. Self-Concept Questionnaire Form 5

This questionnaire was created by García and Musitu (38), and the current version was employed to gather data regarding physical self-concept. It evaluates self-concept from a multidimensional viewpoint, categorizing it into five distinct dimensions: academic, emotional, social, physical, and family. The scale comprises 30 items, with six items dedicated to each dimension. Participants are required to assess statements using a continuous response format on a 99-point scale, where 1 indicates complete disagreement and 99 signifies complete agreement. For this study, the section of the scale pertaining to physical self-concept, which includes six items, was utilized. In this study, the Cronbach's alpha of this scale was 0.93, and its validity was confirmed by eight experts (CVI=0.92, CVR=0.90).

#### 2.2.4. The Rosenberg Self-Esteem Scale

This scale (39) was employed to assess the self-esteem of students. It consists of 10 items using a four-point Likert format, ranging from strongly disagree (0) to strongly agree (3). The total score on the scale can vary from 0 to 30, with a maximum score of 30 representing the highest level of self-esteem. In this study, the Cronbach's alpha of this scale was 0.93, and its validity was confirmed by eight experts (CVI=0.88, CVR=0.88).

### 2.3. Procedure

Following the acquisition of ethical approval and the identification of suitable candidates for the research, an informative meeting was conducted to provide details about the study, and informed consent was secured from each participant. Subsequently, the participants were randomly assigned to either the intervention or control groups, with both groups undergoing a baseline pre-test. Following the pre-test, the intervention group engaged in 16 sessions of the designated exercise program. The exercise program utilized in this study focuses on enhancing children's fundamental skills through sports, games, and active creativity. Each session lasts for 30 minutes and is divided into three segments. The initial minute is dedicated to warming up (5 minutes), followed by 20 minutes of play that emphasizes balance and motor skills, and concludes with a 5-minute cool-down period. The control group did not undergo this training during the specified period. The post-test was conducted following the completion of the training for the experimental group.

### 2.4. Statistical Analysis

Descriptive statistics, such as means and standard deviations (SD), were utilized to examine the central tendency and variability of the data. The normality of the dependent variables across all groups was evaluated using the Kolmogorov-Smirnov test. To compare the scores of research variables in the pre-test, an independent t test was performed. Finally, analysis of covariance was used to compare pre-test and post-test of reach group. A significance level of 0.05 was established for this study.

## 3. Results

The research sample consisted of 40 male students from grades two to five in primary school, evenly distributed between the intervention and control groups. Participants were aged between 8 and 11 years, with a mean age of 9.58±0.91 years. Specifically, the average age for the intervention group was 9.46±0.87 years, while for the control group it was 9.59±0.97 years (P=0.524). There were no statistically significant differences observed when comparing the groups in terms of demographic variables (refer to Table 1).

**Table 1.** Demographic Data of the Participants.

| | Intervention | Control | Group Differences |
|---|---|---|---|
| **Age (Years)** | 9.46 ± 0.87 | 9.59 ± 0.97 | t=0.485<br>P=0.524 |
| **Height (m)** | 1.29 ± 0.06 | 1.26 ± 0.08 | t=0.362<br>P=0.741 |
| **Weight (kg)** | 30.42 ± 2.16 | 29.52 ± 2.06 | t= - 0.214<br>P=0.869 |
| **BMI** | 18.11 ± 0.63 | 18.59 ± 0.58 | t=0.036<br>P=0.986 |

Descriptive data of the research variables in the pre-test and the results of normal distribution are presented in Table 2. Descriptive results show that mean score of static balance for the intervention and control groups were 7.86 and 7.45 seconds, respectively. Also, mean score of dynamic balance for the intervention and control groups were 11.52 and 11.24 seconds, respectively. Moreover, mean score of physical self-concept for the intervention and control groups were 41.34 and 40.85, respectively. Finally, mean score of self-esteem for the intervention and control groups were 13.74 and 14.04, respectively. The results of

Kolmogorov-Smirnov tests revealed that all variables were normally distributed (P>0.05). Moreover, the results of independent t test showed no significant differences between research variables in the pretest (P>0.05).

**Table 2.** Mean and SD of the Research Variables in the Pre-Test along with the Results of Normal Distribution.

| Variable | | Intervention | Control | Comparison |
|---|---|---|---|---|
| Static Balance | Mean ± SD | 7.86 ± 0.96 | 7.45 ± 0.68 | t=0.074 P=0.847 |
| | K-S | D=0.102 P=0.200 | D=0.087 P=0.200 | |
| Dynamic Balance | Mean ± SD | 11.52 ± 1.56 | 11.24 ± 1.63 | t=0.125 P=0.689 |
| | K-S | D=0.093 P=0.200 | D=0.103 P=0.200 | |
| Physical Self-Concept | Mean ± SD | 41.34 ± 3.85 | 40.85± 2.14 | t= - 0.305 P=0.528 |
| | K-S | D=0.098 P=0.200 | D=0.086 P=0.200 | |
| Self-Esteem | Mean ± SD | 13.74 ± 1.68 | 14.04 ± 1.22 | t=0.457 P=0.535 |
| | K-S | D=0.090 P=0.200 | D=0.104 P=0.200 | |

The analysis of covariance was utilized to evaluate the performance of participants in the current study during both the pre-test and post-test phases, with the findings detailed in Table 3. The results indicate a significant difference between the means of static and dynamic balance, physical self-concept and self-esteem in the pre-test and post-test results for the intervention group. The positive value of this difference implies an improvement in the performance of the subjects in the intervention group after the application of the designated training exercises, in comparison to the pre-test results.

**Table 3.** Analysis of Covariance Results for Research Variables.

| Variable | Group | Mean Difference | F | P |
|---|---|---|---|---|
| Static Balance | Intervention | 2.84 | F=7.964 | P<0.001 |
| | Control | 0.54 | | |
| Dynamic Balance | Intervention | 5.45 | F=6.759 | P<0.001 |
| | Control | 1.03 | | |
| Physical Self-Concept | Intervention | 5.97 | F=10.128 | P<0.001 |
| | Control | 0.38 | | |
| Self-Esteem | Intervention | 4.14 | F=12.746 | P<0.001 |
| | Control | 0.47 | | |

## 4. Discussion

The objective of this study was to investigate the impact of specific training exercises on the balance performance, physical self-concept, and self-esteem of primary school male students diagnosed with DCD. First, the results of this study showed an improvement in the static and dynamic balance of the subjects in the intervention group after the application of the designated training exercises, in comparison to the pre-test results. However, no significant improvement was observed in the control group. The results of the current study align with those of numerous other investigations (12,15-17,20,22), indicating that physical exercise positively influences the enhancement of movement and balance skills in children with DCD. To elucidate these findings, it can be stated that the ability to maintain balance is crucial for effectively carrying out nearly all daily tasks (11). A novel theory that has recently informed researchers' investigations into movement and balance is the systems theory. This perspective posits that the capacity to sustain and regulate the body's position in space arises from the intricate interactions among various muscular, skeletal, and nervous systems, with the significance of each system fluctuating based on the movement's objective and environmental factors (13,14,19). Within this framework, the central nervous system integrates information from the visual, vestibular, and proprioceptive systems to assess the body's center of gravity in relation to gravitational forces and the characteristics of the supporting surface, thereby facilitating appropriate movement responses through pre-established movement patterns (20,21). Furthermore, studies indicate that individuals who participate in sports and physical activities exhibit superior balance compared to their sedentary counterparts; however, the underlying reasons for this phenomenon remain unclear. Additionally, the impact of physical activity programs tailored to the specific needs of participants may contribute to improvements in balance skills, particularly in relation to stable movements, as highlighted in this research (13,15,19).

Enhancing balance through physical exercises is supported by sound reasoning. The maintenance of balance by the body necessitates the coordination of nerves and muscles across all moving joints, both in the proximal and distal regions (13,16). The core muscles play a crucial role in stabilizing the spine, thereby facilitating the body's capacity to manage dynamic movements effectively. Balance is a fundamental and essential element in both everyday activities and athletic performance (18). To achieve body stabilization, a mechanism known as the posture control system is required, which aids in maintaining equilibrium. The control of body posture involves a sophisticated interplay of sensory inputs, biomechanical data, and muscular responses to external forces. Any disruption in these components can lead to increased postural instability and diminish the capacity to control either specific body parts or the entire body during movement and athletic endeavors (18,19,22). Specifically, the sensory systems related to the body, vision, and vestibular functions, along with muscular activity, contribute significantly to maintaining situational awareness and control. If any of the visual, vestibular, or somatosensory systems provide inaccurate information, or if the central nervous system is compromised, balance will be adversely affected (11,14). Key functional factors influencing postural stability include muscle

weakness, reduced depth perception, and limited range of motion. Children with DCD often experience greater challenges in maintaining balance compared to their peers due to muscle weakness and joint laxity; therefore, incorporating central body exercises may prove beneficial in enhancing balance for these children (12,17,18).

Moreover, the findings of this study indicated that the participants in the intervention group experienced an enhancement in their physical self-concept and self-esteem following the implementation of the specified training exercises, as compared to their pre-test evaluations. In contrast, the control group did not exhibit any notable improvement. These results are consistent with a variety of other studies (24-26), suggesting that physical exercise has a beneficial effect on the development of physical self-concept and self-esteem in children with DCD disorder pertains to coordinated movements, it is also linked to a range of psychological challenges (24,27). Stress emerges as a key factor, leading to exposure to a complex array of secondary stressors that collectively contribute to psychological distress. Low self-esteem is identified as one of these secondary factors. The movement difficulties experienced by these children hinder their ability to develop functional and academic skills, consequently diminishing their self-esteem and self-concept due to a negative impact on their sense of competence (29,30). A common therapeutic approach employed by specialists involves enhancing fundamental movements through group therapy. Thus, through environmental interaction, children can grow, with activities, play, and motor development playing a crucial role in fostering a sense of competence (31,32).

Children with DCD often experience atypical and delayed phases of motor development, making it essential to incorporate motor activities into their daily routines. Engaging in motor skills provides these children with a wealth of movement experiences and allows them to explore and refine their perceptual-motor abilities. Given that a child's initial responses are primarily motor in nature, the instruction and acquisition of motor skills during the early developmental stages are of paramount importance compared to other competencies. Furthermore, the integration of physical activities, particularly sports, can significantly assist individuals with DCD in enhancing their movement capabilities.

The principal strength of this research is its implementation of an intervention aimed at enhancing psychomotor skills in children diagnosed with DCD, thereby providing insights into potential improvements in the health outcomes for this demographic. However, a significant limitation of the study is its sole concentration on male participants, which complicates the generalization of the results to female populations.

### *4.1. Conclusion*

The research findings indicate that the enhancement of motor and cognitive skills represents a significant milestone in childhood development. Children experiencing DCD can advance their motor skills in alignment with appropriate timing and circumstances by effectively managing and regulating their actions and behaviors, thereby facilitating social interactions. Hence, to effectively utilize the findings from prominent research in a scientific manner, it is recommended that organizations focused on children with DCD implement specialized physical activity programs aimed at enhancing the motor skills of these children. This should be done in conjunction with other educational initiatives, as well as within supervised centers and schools. It is essential to establish a physical education framework that ensures children experiencing movement difficulties and perceptual-motor deficits are engaged in suitable exercises.

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## Footnotes

**Authors' Contribution:** This study was carried out solely by the corresponding author.

**Conflict of Interests:** The researchers confirms that there is no conflict of interests in this study with any participant.

**Data Availability:** The data that support the findings of this study are openly available upon request from the corresponding author.

**Ethical Approval:** The author confirms that all steps and requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

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