

Associations between Physical Activity and Fundamental Motor Skills in Children with Developmental Coordination Disorder

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ABSTRACT: Background and Aim: Physical activity is associated with numerous positive health outcomes, suggesting its potential role in enhancing a child's overall motor skills performance. Consequently, this study aimed to explore the connections between engagement in physical activity and the development of gross and fine motor skills in school-aged children diagnosed with Developmental Coordination Disorder (DCD).

Methods: A descriptive-correlational methodology was utilized in this investigation. The sample consisted of 152 children diagnosed with Developmental Coordination Disorder (DCD), including 58 females, recruited from various special education facilities. The participants' ages varied from 7 to 9 years, with an average age of 7.49 ± 0.48 years. Selection of participants was conducted using a convenience sampling technique. Standard tests were used to collect data. Pearson correlation test and independent t test were used for data analysis.

Results: boys had significantly better performance in gross motor skills than girls ($P < 0.001$). On the other hand, girls had significantly better performance in fine motor skills than girls ($P < 0.001$). Results revealed significant direct relationship between physical activity with gross motor skills ($P < 0.001$). Moreover, physical activity was directly and significantly associated with fine motor skills ($P < 0.001$).

Conclusion: These findings highlight the necessity of enhancing physical activity among children with DCD, particularly in the female demographic. Also, the results emphasize the importance of promoting increased of physical activity to facilitate optimal motor development in children with DCD. Consequently, it is recommended to incorporate programs aimed at improving motor skills for this population.

Keywords: Physical activity, motor proficiency, children, DCD, gender

INTRODUCTION

Childhood is widely recognized as a critical phase for motor development. This development encompasses alterations in motor behavior along with the processes that facilitate these changes. Fundamental motor skills serve as the foundation for this development and are categorized into gross and fine motor skills. These skills are essential for acquiring everyday motor abilities and engaging in sports (Baniasadi et al. 2022; Farhat et al. 2024). Gross motor skills involve the coordination of large muscle groups, including those in the chest, arms, and legs. Such skills are integral to numerous daily activities, as they underpin movements like running, walking, and throwing. Mastery of

these skills is crucial for the progression to more specialized movement abilities, particularly in sports and physical activities. For instance, fundamental skills such as jumping and throwing are prerequisites for developing sports-specific skills in games like basketball and volleyball (Chaharbaghi et al. 2022; Khosravi et al. 2023, Ilkim et al. 2021, Ilkim & Mergan 2021). A deficiency in gross motor skills can hinder the acquisition of finer motor skills, which necessitate a combination of these foundational movements. Furthermore, such deficiencies can adversely impact children's social and emotional development, diminishing their motivation to engage in sports and physical activities (Joshi et al. 2015; Lloyd et al. 2014).

Fine motor skills serve as fundamental components essential for various daily activities, encompassing work, self-care, and recreational pursuits. These skills can be divided into two main categories: gross hand skills and fine finger skills (Ghorbani et al. 2020; Monteiro et al. 2022; Ilkim et al. 2017; Ilkim et al. 2021). Gross hand skills pertain to the manipulation of larger objects through coordinated movements of the arms and hands, whereas fine finger skills involve the precise handling of smaller items through intricate movements of the fingers and hands (Baniasadi et al. 2022). Fine motor skills are generally more susceptible to impairment than gross motor skills for several reasons, including the significant allocation of motor and pre-motor cortex regions of the brain to these skills, as well as the reliance on smaller muscle groups, which tend to exhibit greater functional deficits following injury or illness (Cairney & Veldhuizen, 2013).

Research indicates that children with physical or mental disorders typically exhibit lower levels of fundamental motor skills compared to their peers. This observation underscores the importance of thoroughly assessing the fundamental motor skills of children facing such challenges, as well as identifying effective factors that could enhance their motor skill performance. One of the common disorders in childhood is Developmental Coordination Disorder (DCD) (Baniasadi, 2024; Nobre et al. 2023). Children diagnosed with DCD exhibit significant deficits in motor coordination, which adversely affects their ability to perform daily activities, succeed academically, and maintain overall health. In contrast to their typically developing (TD) peers, children with DCD tend to have higher rates of obesity, lower levels of physical activity, and an increased susceptibility to chronic diseases associated with obesity (Najafzadeh et al. 2024; Raz-Silbiger et al. 2015).

An essential area of investigation within this domain pertains to the physical challenges faced by children with DCD in comparison to their typically developing peers. Research indicates that motor skills in children diagnosed with DCD are markedly inferior to those of healthy children, with their motor abilities falling significantly short of what is anticipated for their age and cognitive level (Kwan et al. 2022; Seyedi Asl et al. 2020). These children exhibit difficulties across various domains, including gross motor skills, motor coordination, fine motor skills, manual dexterity, and bilateral coordination. Additionally, they often experience delays in reaching developmental milestones related to motor skills, as well as disruptions in movement planning and execution, balance, and postural control. Overall, children with DCD tend to display characteristics of poor motor coordination and clumsiness, with these traits being associated with inadequate balance and diminished motor proficiency. Furthermore, they encounter balance difficulties when compared to age-matched peers (Taghva et al. 2020; Valentini et al. 2023).

It is essential to recognize the elements that may influence the development of fine and gross motor skills in children diagnosed with DCD. This research aimed to consider the physical activity and its effects on the execution of fine and gross motor skills in this population. Physical activity encompasses any form of bodily movement that contributes to improved physical fitness and overall well-being (Baniasadi et al. 2022; Omidvar et al. 2018). Research has consistently demonstrated that engaging in regular physical activity enhances muscular strength, cardiovascular function, motor skills, and weight control. Additionally, it strengthens the immune system and plays a crucial role in the prevention of various health conditions, including heart disease, diabetes, and obesity. Beyond physical benefits, physical activity is also linked to improved mental health outcomes, as it can decrease the likelihood of depression, enhance self-esteem, and promote a positive body image and perceptions of attractiveness (Green et al. 2011; Malambo et al. 2022). Conversely, insufficient levels of physical activity are correlated with a heightened risk of numerous chronic illnesses, such as type 2 diabetes, coronary artery disease, stroke, hypertension, osteoporosis, certain types of cancer, and particularly obesity. Moreover, engaging in physical activity during childhood and adolescence is believed to have lasting positive effects on health and well-being in later life (Abdoshahi & Ghorbani, 2022). Consequently, it is reasonable to suggest that physical activity may significantly contribute to a child's overall motor skills performance. Thus, the study sought to examine the relationships between participation in physical activity and the advancement of gross and fine motor skills in school-aged children with DCD.

METHODS

A descriptive-correlational methodology was utilized in this investigation. The sample consisted of 152

children diagnosed with Developmental Coordination Disorder (DCD), including 58 females, recruited from various special education facilities. The participants' ages varied from 7 to 9 years, with an average age of 7.49 ± 0.48 years. Selection of participants was conducted using a convenience sampling technique.

The assessment of physical activity was performed using the Rapid Assessment of Physical Activity (RAPA) scale (Seyedi Asl et al. 2016), which consists of seven items requiring dichotomous responses of 'Yes' or 'No'. The total score on this scale ranges from 0 to 7. In this study, the internal consistency reliability of the RAPA scale, as measured by Cronbach's alpha, was found to be 0.92. Furthermore, the validity of this tool has been established by a panel of ten experts, resulting in a Content Validity Index (CVI) of 0.90 and a Content Validity Ratio (CVR) of 1.00.

The Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (Wrotniak et al. 2006), serves as an assessment tool for fundamental motor skills. This comprehensive test comprises eight sub-tests: four focused on gross motor skills, three on fine motor skills, and one assessing upper body coordination, making it an effective instrument for evaluating both gross and fine motor abilities. The test provides a detailed index of motor proficiency along with separate scales for fine and gross motor skills, applicable to individuals aged 4 to 21 years. The long version of the test requires 45 to 60 minutes to administer, while the short version can be completed in 15 to 20 minutes. In the current study, the short form, which consists of 14 items, was utilized as a rapid screening tool. Each child receives a raw score that is subsequently converted into points based on a reference table. Scores for gross motor skills can vary from 0 to 53, and for fine motor skills, from 0 to 51, with higher scores indicating greater motor proficiency. The short form of the test demonstrates a test-retest reliability coefficient of 0.86. Additionally, the validity of this assessment tool has been corroborated by ten experts, yielding a Content Validity Index (CVI) of 1.00 and a Content Validity Ratio (CVR) of 1.00.

Data analysis was performed utilizing SPSS-26 software. Descriptive statistics, such as means and standard deviations, were employed to characterize the variables. The Kolmogorov-Smirnov test was applied to assess the normality of the data distribution. Additionally, an independent t-test was conducted to examine gender differences. To investigate the relationships between the variables, a Pearson correlation test was executed. A significance threshold of $P < 0.05$ was set.

RESULTS

The research included a cohort of 152 children diagnosed with Developmental Coordination Disorder (DCD), of which 58 were female. The participants' ages varied from 7 to 10 years, with an overall mean age of 7.49 ± 0.48 years. Notably, the average age for male participants was 7.51 ± 0.43 years, whereas female participants had a mean age of 7.47 ± 0.52 years ($P=0.963$). Additionally, the analysis revealed no statistically significant differences between genders regarding height, weight, and Body Mass Index (BMI) (refer to Table 1).

Table 1. Demographic data of the participants

	Boys	Girls	Gender differences
Age (years)	7.51 ± 0.43	7.47 ± 0.52	$t=0.026$ $P=0.963$
Height (m)	1.22 ± 0.04	1.21 ± 0.03	$t=0.012$ $P=0.983$
Weight (kg)	22.50 ± 1.63	22.53 ± 1.57	$t=0.021$ $P=0.971$
BMI	19.51 ± 0.46	19.53 ± 0.40	$t=0.023$ $P=0.969$

Table 2 shows the results of normal distribution. The results of Kolmogorov-Smirnov tests revealed that all variables were normally distributed (all $P>0.05$).

Table 2. Results of normal distribution

	Physical activity	Gross motor skills	Fine motor skills
Statistics	0.986	0.867	0.908
P-value	0.200	0.200	0.200

Descriptive data are presented in [Table 3](#). Descriptive results show that in general the level of physical activity is lower than the average. However, gross and fine motor skills were at medium level. Results of Independent t tests showed that there were no significant differences between boys and girls in physical activity ($P>0.05$). However, boys had significantly better performance in gross motor skills than girls ($P<0.001$). On the other hand, girls had significantly better performance in fine motor skills than girls ($P<0.001$).

Table 3. Descriptive data along with gender differences

	Boys	Girls	Gender differences
Physical activity	1.22±0.36	1.21±0.33	t=0.022 P=0.970
Gross motor skills	27.25±4.14	23.96±3.99	t=5.967 P<0.001
Fine motor skills	25.31±4.10	30.01±4.28	t=6.584 P<0.001

Bivariate relationships between physical activity with gross and fine motor skills are demonstrated in [Table 4](#). Results revealed significant direct relationship between physical activity with gross motor skills ($P<0.001$). Moreover, physical activity was directly and significantly associated with fine motor skills ($P<0.001$).

Table 4. Results of bivariate relationships between variables

	1	2	3
1. Physical activity	-		
2. Gross motor skills	r=0.593 P<0.001	-	
3. Fine motor skills	r=0.715 P<0.001	r=0.669 P<0.001	-

DISCUSSION

Physical activity is associated with numerous positive health outcomes, suggesting its potential role in enhancing a child's overall motor skills performance. Consequently, this study aimed to explore the connections between engagement in physical activity and the development of gross and fine motor skills in school-aged children diagnosed with Developmental Coordination Disorder (DCD). The findings indicated that the study participants exhibited low levels of physical activity, which corroborates previous research highlighting the generally low activity levels among children with DCD. This suggests a prevalent lack of movement within this population. The reasons for the diminished activity levels in children with DCD may include physical and psychological limitations, restricted access to sports facilities and equipment, financial barriers related to certain sports, and cultural influences ([Farhat et al. 2015](#); [Holfelder & Schott, 2014](#)). Given the numerous benefits linked to regular physical activity, it is crucial to explore diverse strategies and implement effective intervention exercises to increase the participation of children with DCD in physical activities. Therefore, it is essential to focus on the physical activity patterns of these children through targeted health interventions and programs. Additionally, developing strategies to enhance and sustain motivation among children with DCD for regular physical activity is of paramount importance ([Lee, 2024](#); [Najafzadeh et al. 2024](#)).

The results of this study concerning gross and fine motor skills reveal that the participating children exhibited an average level of motor proficiency, indicating that their motor skills are not optimally developed. Notably, boys demonstrated significantly greater proficiency in gross motor skills than girls, while girls showed a marked advantage in fine motor skills compared to boys. These findings are consistent with prior research. The differences observed in the execution of gross motor skills can be linked to physiological factors, such as boys possessing greater muscle mass and girls having a lower stroke volume ([Rivlis et al. 2011](#)). Additionally, boys are more likely to engage in physical activities that necessitate the use of larger muscle groups, which facilitates the development and enhancement of their gross motor skills. Conversely, girls often favor sedentary activities that engage smaller muscle groups, thereby improving their fine motor skill capabilities. Furthermore, research indicates that girls generally reach an earlier stage of motor development; however, their ongoing motor skills are frequently shaped by cultural norms and societal expectations regarding gender roles ([Shafaei et al. 2024](#)). In many cultures, boys are more likely to participate in activities that emphasize throwing, jumping, and ball skills, whereas girls often

encounter fewer opportunities to engage in these types of activities. This disparity in preferred sports and games, coupled with the greater focus that parents and educators place on boys' motor skill development, may explain the observed superiority in gross motor skills among boys relative to girls. Additionally, children diagnosed with DCD may exhibit lower proficiency in motor skills due to prolonged response times and a higher incidence of errors. Although these children tend to respond rapidly, this quickness often leads to an increase in mistakes, while the frequency of omission errors tends to decrease. This suggests that while children with DCD are attempting to quickly identify target items, their responses may lack the necessary attention and precision (Shafaei et al. 2024; Tran et al. 2024).

The results of this research highlight the significant role of physical activity in the development of motor skills among children diagnosed with DCD. Evidence indicates that children engaging in higher levels of physical activity show superior capabilities in both gross and fine motor skills. Involvement in physical activity contributes not only to improved physical fitness but also to increased muscular strength (Valentini et al. 2015; Wright et al. 2019). This enhancement in muscular fitness is associated with better motor function, suggesting that children who are more physically active are likely to achieve higher levels of physical fitness, which in turn facilitates improved performance in motor skills (Xin et al. 2020; Yu et al. 2016, 2021).

A notable limitation of this study was the reliance on a questionnaire to evaluate physical activity, which may result in inaccuracies due to self-reporting biases. To address this issue, future research should consider the integration of device-based measurement tools, such as accelerometers, to achieve a more accurate assessment of physical activity. Furthermore, given the low levels of physical activity identified among the participants, it is strongly recommended that practitioners develop and implement programs and interventions specifically designed to increase physical activity levels in children with DCD.

CONCLUSION

In summary, the present study reveals that participants exhibited a low level of physical activity. These findings highlight the necessity of enhancing physical activity among children with DCD, particularly in the female demographic. The research also established a positive correlation between physical activity and both gross and fine motor skills. These results emphasize the importance of promoting increased physical activity to facilitate optimal motor development in children with DCD. Consequently, it is recommended to incorporate programs aimed at improving motor skills for this population.

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