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DETERMINATION OF DEVELOPMENTAL COORDINATION DISORDER LEVELS IN PRIMARY SCHOOL STUDENTS

DETERMINAÇÃO DOS NÍVEIS DE DESORDEM DA COORDENAÇÃO DE DESENVOLVIMENTO NOS ALUNOS DO ENSINO FUNDAMENTAL

Eyyüp Sarikol
Iğdır University, Iğdır-Turkey
E-mail: eyupcan-87@hotmail.com

Ramazan Erdoğan
School of Physical Education and Sport, Bitlis Eren University, Bitlis, Turkey
E-mail: ramazner-dogan@hotmail.com

ABSTRACT

Background and Objective: Developmental coordination disorder (DCD) is a common neurodevelopmental disorder, affecting 5-6% of children and youth. Few studies examined the prevalence rate of DCD in a variety of countries; however, there is no published study on the prevalence of DCD in Turkish children. This study therefore aimed to determine the prevalence rate of DCD among school-aged children in Turkey. Methods: A cross-sectional comparative design was adopted in this study. The criteria of the Diagnostic and Statistical Manual of Mental Disorders (5th edition) were used to diagnose children with DCD. Participants were 856 children aged 6-9 years including 439 girls (51.17%) and 417 boys (48.83%) and their parents. Assessments were conducted using the Developmental Coordination Disorder Questionnaire 2007 (DCDQ'07) and the Movement Assessment Battery for Children-2 (MABC-2). Results: The prevalence rate was found to be 8.53% for DCD among Turkish children aged 6 to 9 years. The prevalence rate ranged between 7.25% and 10.05% for the 6- to 9-year age groups. The range of prevalence rate was 7.62% to 15.09% and 4.90% to 8.74% in the girl and boy children, respectively. Despite some not significant differences, the prevalence rate of DCD were found to be similar across age and gender. Conclusion: Regardless of age and gender, the prevalence of DCD is relatively high among school-aged children in Turkey. Implementation of diagnostic and intervention strategies in primary schools is strongly recommended.

Keywords: Developmental coordination disorder; Motor proficiency; Gender differences; MABC-2; DSM-5.

RESUMO

Antecedentes e Objetivo: O distúrbio de coordenação do desenvolvimento (DCD) é um distúrbio neurodevelopmental comum, afetando 5-6% das crianças e jovens. Poucos estudos examinaram a taxa de prevalência do DCD em vários países; entretanto, não há nenhum estudo publicado sobre a prevalência do DCD em crianças turcas. Portanto, este estudo teve como objetivo determinar a taxa de prevalência de DCD entre crianças em idade escolar na Turquia. Métodos: Um desenho comparativo transversal foi adotado neste estudo. Os critérios do Manual de Diagnóstico e Estatística dos Transtornos Mentais (5ª edição) foram usados para diagnosticar crianças com DCD. Os participantes eram 856 crianças de 6-9 anos de idade, incluindo 439 meninas (51,17%) e 417 meninos (48,83%) e seus pais. As avaliações foram realizadas utilizando o Questionário de Distúrbios da Coordenação de Desenvolvimento 2007 (DCDQ'07) e a Bateria de Avaliação de Movimento para Crianças-2 (MABC-2). Resultados: A taxa de pré-licença foi de 8,53% para DCD entre crianças turcas de 6 a 9 anos de idade. A taxa de prevalência variou entre 7,25% e 10,05% para os grupos de 6 a 9 anos de idade. A taxa de prevalência variou de 7,62% a 15,09% e de 4,90% a 8,74% nas crianças de 6 a 9 anos de idade, respectivamente. Apesar de algumas diferenças não significativas, a taxa de prevalência da DCD foi encontrada similar entre idade e sexo. Conclusão: Independentemente da idade e gênero, a prevalência de DCD é relativamente alta entre as crianças em idade escolar na Turquia. A implementação de estratégias de diagnóstico e intervenção nas escolas primárias é fortemente recomendada.

Palavras-chave: Distúrbio de coordenação do desenvolvimento; Proficiência motora; Diferenças de gênero; MABC-2; DSM-5.

Introdução

Developmental coordination disorder (DCD) is a common neurodevelopmental disorder among school-aged children and teenagers. DCD is diagnosed using four criteria: (1) the acquisition and execution of movements requiring motor coordination (e.g., using stationery, handling a ball, bicycling, or doing sports) are careless, imprecise, slow, and far below the normal level reported for age-matched peers; (2) the lack of motor skills has a substantial and long-term influence on daily tasks, as well as school productivity, career skills, leisure activities, and play; (3) the emergence of symptoms occurs during the early stages of development; 4) intellectual disability, vision impairment, or a neurological or medical illness that affects movement are not better explanations for the motor skills deficit (American Psychiatric Association, 2013).

Internal modeling of action (i.e., predictive control), rhythmic coordination and timing, executive functions (EFs), dynamic regulation of posture and gait, and interceptive action are among the more prominent performance deficiencies associated with DCD (catching and a manual interception) (Wilson et al., 2013). Children with DCD have been reported to be less physically active than their typically developing (TD) peers and are unable to achieve worldwide physical activity (PA) requirements (at least 60 minutes of moderate-to-vigorous PA per day) for health reasons (Green et al., 2011; Kwan et al., 2013). Physical play is a major part of daily PA, in which children with DCD are experiencing significant difficulties (Missiuna et al., 2007). Poor motor skills put children with DCD at risk for withdrawal or exclusion from physical play, sports, and games at the school environment (Watkinson et al., 2001). They are involved and victimized more frequently than their peers in aggression during free-play (Kennedy-Behr et al., 2013a, 2013b). That may be why during recess times and physical education classes, most children with DCD are inactive in the playground, more solitary and spend more time in onlooker behavior than their TD peers (Bouffard et al., 1996). Moreover, children with DCD have lower developmental play age (Kennedy-Behr et al., 2013a, 2013b), lower self-efficacy toward physical play (Cairney et al., 2005), and engage less frequently and fewer organized and recreational play activities (Cairney et al., 2005; Kennedy-Behr et al., 2013a, 2013b), leading to different patterns of social and physical play compared to TD

children (Rosenblum et al., 2017). As a result, children with DCD are more likely to be overweight or obese, and the risk appears to rise with age and severity of motor impairments (Hendrix et al., 2014). Additionally, children with DCD may have challenges with cognitive functions, mental health issues (e.g., depression) (Lingam et al., 2012), problems with self-concept of physical competence (Yu et al., 2016), and limitations in daily living activity participation (Green et al., 2011). Because DCD's motor deficiencies and accompanying psychosocial challenges greatly impede daily functioning, it's been anticipated that children with DCD have a higher risk of having a lower health-related quality of life than their peers (Flapper & Schoemaker, 2008; Zwicker et al., 2013). The existing research supports that DCD significantly affects multiple domains of health-related quality of life in both children with DCD and their parents (Caçola & Killian, 2018; Dewey & Volkovinskaia, 2018; Flapper & Schoemaker, 2008, 2013; Karras et al., 2019; Raz-Silbiger et al., 2015; Wuang et al., 2012).

American Psychiatric Association (2013) reported a prevalence about 5-6% for DCD in school-aged children and teenagers (American Psychiatric Association, 2013). After that, several studies examined the prevalence of DCD in a variety of countries. In a national scale study, Baghernia and Asle Mohammadizadeh (2014) examined 1784 children aged 3-11 years in Iran. The prevalence of DCD was found to be 2.7%, and the male to female prevalence ratio was 2:1 (3.53% in boys and 1.85% in girls). In South African, De Milander et al. (2016) studied 347 Grade K-1 children aged 5-8 years and reported a prevalence of 6% for both DCD and the at-risk for motor difficulties. In a sample of 787 Brazilian children aged 7-10 years, Beltrame et al. (2017) reported a prevalence of 7.1% and 11.3% for DCD and in risk for motor difficulties, respectively. Girls showed more difficulty with the throwing and receiving skills; and the boys with manual dexterity skills. Children aged 7 and 8 years had higher prevalence of DCD (Beltrame et al., 2017). In Spain, Amador-Ruiz et al. (2018) studied 1562 children aged 4-6 years from Castilla-La Mancha. In their study, 9.9% of children were identified as having DCD, and 7.5% were at risk of having movement problems. A 9.5% of boys and a 10.4% of girls presented DCD. Prevalence of at risk of DCD was 10.7% and 3.9% for boys and girls, respectively. No significant differences were found across gender (Amador-Ruiz et al., 2018). In India, Deshmukh et al. (2021) surveyed a total 716 children aged 5–10 years and observed that 23.9% of children had signs of suspected DCD according to the

developmental coordination disorder questionnaire 2007 (Wilson et al., 2007). In similar studies conducted by Della Barba et al. (2017) and Delgado-Lobete et al. (2019), the prevalence of suspected DCD in 5-14 year old children in Brazil and in 6-12 years old children in Spain were found to be 30% and 12.5%, respectively. Adding to this body of evidence are the studies conducted in other countries including the UK (Lingam et al., 2009), China (Xia et al., 2012), Korea (Lee et al., 2019), Portugal (Mercê et al., 2019), Israel (Yazdi-Ugav & Zeev, 2006), Canadian, and Greek (Tsiotra et al., 2006).

Based on our search of the literature, there is no study assessing the prevalence of DCD in school-aged children in Turkey. The present study was therefore undertaken to address this knowledge gap, with the objective to determine the prevalence of DCD across age and gender among primary school children in Turkey.

Methods

Ethics committee approval was received from the Non-Interventional Ethics Committee of Bitlis Eren University (2022/15-12).

SAMPLE SELECTION AND PARTICIPANTS

The research group consisted of 856 (439 girls, 417 boys) volunteer students aged 6-9 years studying at primary education level. To select the sample of the study, an invitation letter in which the objectives, significance of the study, and all related procedures have been fully explained, along with a consent form, was sent to the parents of all children and they were asked to sign the consent form if they tended to participate in the study. Overall, a total of 856 children including 439 girls (51.17%) and 417 boys (48.83%) and their parents volunteered to participate in this study. The same procedure of previous studies was adopted to identify children with motor coordination problems (Ferguson et al., 2015; Smits-Engelsman et al., 2017). The four criteria of the DSM-5 to diagnose children with DCD were applied (American Psychiatric Association, 2013). In the first step, the parents were asked to complete the Developmental Coordination Disorder Questionnaire 2007 (Wilson et al., 2007), enquiring about the children's functional motor skills out of school. Secondly, the teachers were asked to specify

children suspected of having motor coordination difficulties without any intellectual or cognitive impairment by highlighting their names on a class roster. In the third step, children were tested for motor proficiency using the second edition of the Movement Assessment Battery for Children (MABC-2; Henderson et al., 2007). Finally, a total of 73 out of 856 children (8.53%), who scored below the 5th percentile on the MABC-2 (Criterion A), who were reported by the teacher or parent as having a motor coordination problem (Criterion B), no medical condition affecting motor ability (Criterion C), and no intellectual or cognitive impairment (Criterion D) were diagnosed with DCD.

Measures

DEVELOPMENTAL COORDINATION DISORDER QUESTIONNAIRE 2007 (DCDQ'07)

The DCDQ'07 was used in the recruitment phase to identify potential children who were experiencing DCD-related motor difficulties out of school. This questionnaire is a valid screening tool to identify children suspected of DCD (Wilson et al., 2009; Wilson et al., 2007). The primary version of the DCDQ'07 was a 17-item questionnaire containing a broad range of functional motor skills, which was developed in Canada (Wilson et al., 2007). Based on the feedback provided by clinicians, researchers, and parents, it was revised to 15 items that can be successfully used for children aged 5 to 15 years (Wilson et al., 2009). The items are rated on a 5-point scale ranging from 1 = "*Not at all like your child*" to 5 = "*Extremely like your child*", with higher scores indicating better motor performance (Wilson et al., 2007). The items represent three factors: *Control during Movement* (six items), *Fine Motor/Handwriting* (four items), and *General Coordination* (five items). There are three different at-risk cut-offs depending on age: <47 (5–7y), <56 (8–9y), and <58 (10–15y) (Wilson et al., 2009).

MOVEMENT ASSESSMENT BATTERY FOR CHILDREN-2 (MABC-2)

The MABC-2 was used in the recruitment to ensure that the motor abilities of identified children with DCD were far below the expected level for their age. The MABC-2 is one of the most widely used tests of motor proficiency in children, which assesses fine and gross motor skills. The test is applicable to three age groups: 3–6 years; 7–10 years; and 11–16 years (Henderson et al., 2007). The test has eight items, which are classified into three components: manual dexterity; aiming and catching, and static and dynamic balance. According to the test's manual, raw scores of items are converted into standard scores and summed to calculate the Total Standard Score, which indicates overall motor proficiency (Henderson et al., 2007). In children with DCD, internal consistency (Cronbach's alpha = 0.90) and test-retest reliability (ICC = 0.97) of the MABC-2 have been reported to be high and excellent, respectively (Henderson et al., 2007; Smits-Engelsman, 2010).

DATA ANALYSIS

A series of independent-samples *t* test was used to compare TD and DCD groups in terms of age, weight, height, and body mass index (BMI). The prevalence of DCD was considered as the percentage (%) of children who were diagnosed with DCD in each age and gender category as well as in total sample. Pearson's chi-square test ($\chi 2$) then was used to compare the prevalence of DCD across age and gender. Three separate comparisons were conducted for the girls, boys, and total sample to examine whether or not there is a significant difference in DCD prevalence across age groups. In addition, five separate comparisons were run to identify any gender differences of DCD prevalence in each age groups and total sample. The significance level was set at 0.05 for all analyses. Statistical analyses were performed using IBM SPSS version 24 (IBM Corporation, 2016).

Results

Table 1 shows the participants age, height, weight, and BMI of the TD and DCD children. The independent-samples *t* test revealed no significant differences between TD and DCD in terms of age, height, weight, and BMI (all $p > 0.05$).

Table 1 – Descriptive Statistics of Participants' Characteristics

Characteristics	Total Sample (N = 856)	Groups		Groups Comparison	
		TD (n = 783)	DCD (n = 73)	*t*	*P*
Age (years)	7.37 ± 0.87	7.37 ± 0.87	7.49 ± 0.83	-0.562	0.624
Weight (kg)	24.27 ± 3.27	24.10 ± 3.61	24.44 ± 3.43	-0.138	0.895
Height (cm)	124.60 ± 7.18	124.53 ± 7.82	124.68 ± 7.69	-0.027	0.979
BMI ($kg.m^{-2}$)	15.55 ± 0.34	15.46 ± 0.40	15.65 ± 0.30	-0.766	0.473

Note: Data were presented as $M \pm SD$. TD = Typically Developing Children; DCD = Children with Developmental Coordination Disorder; BMI = Body Mass Index.

Table 2 shows the prevalence of DCD across age and gender. Out of 856 participants, 73 children (8.53%) were diagnosed with DCD. In terms of age groups, a prevalence of 10.05%, 8.29%, 8.52%, and 7.25% were found for the six-, seven-, eight-, and nine-year age groups, respectively (Figure 1). There was no significant difference in DCD prevalence across age in the total sample ($\chi2 = 4.87$, $p = 0.182$). In addition, no significant differences were observed in the prevalence of DCD between girl and boy children in the six-year ($\chi2 = 2.01$, $p = 0.157$), seven-year ($\chi2 = 0.82$, $p = 0.365$), eight-year ($\chi2 = 0.29$, $p = 0.592$), or nine-year ($\chi2 = 0.65$, $p = 0.42$) age groups as well as in the total sample ($\chi2 = 3.43$, $p = 0.064$). However, there was a statistically significant difference between girl and boy children in the total sample at the 90% confidence level, with a higher DCD prevalence for girl children (10.25% *vs.* 6.71%).

In the girl group, 45 out of 439 children (10.25%) were diagnosed as having DCD. In terms of age groups, a prevalence of 15.09%, 8.93%, 9.48%, and 7.62% were found for the six-, seven-, eight-, and nine-year age groups, respectively (Figure 1). There was no significant difference in DCD prevalence across age in the girl children ($\chi2 = 3.78$, $p = 0.286$).

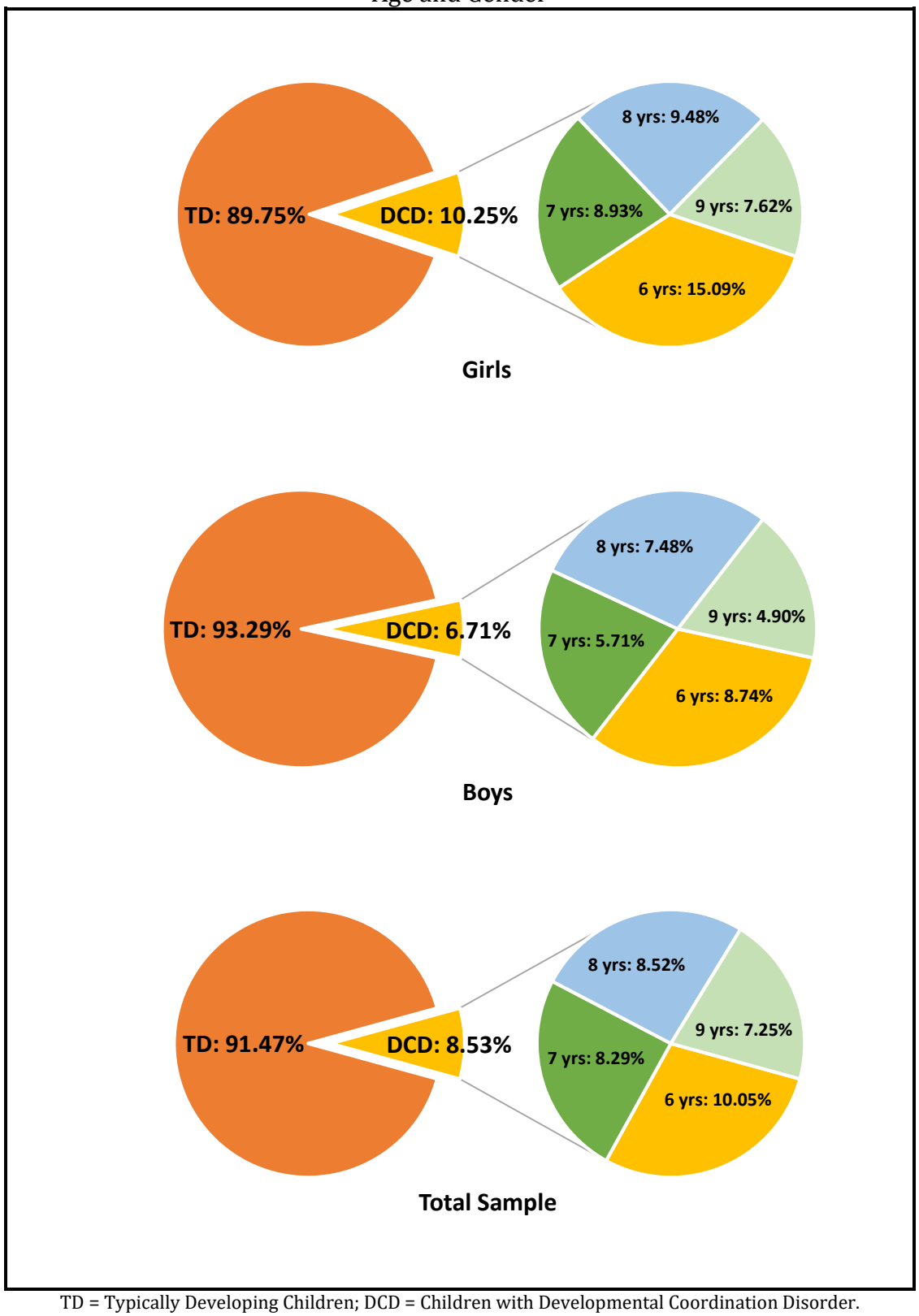
In the boy group, 28 out of 417 children (6.71%) were found to have DCD. The prevalence rates of DCD were 8.74%, 5.71%, 7.48%, and 4.90% in the six-, seven-, eight-, and nine-year age groups, respectively (Figure 1). There was no significant difference in DCD prevalence across age in the boy children ($\chi2 = 1.47$, $p = 0.688$).

Table 2 – Prevalence of DCD across Age and Gender

Gender	Age (Grade)	Total Sample		Developmental Status				Comparison of DCD Prevalence across Age and Gender			
				TD		DCD		Age		Gender	
		n	%	*n*	%	*n*	%	χ^2	*P*	χ^2	*P*
Girls		**394**	**51.29**	**375**	**89.84**	**25**	**10.15**	3.78	0.286		
	Six (K-1)	106	12.38	91	84.09	15	15.09				
	Seven (K-2)	112	13.08	102	91.07	10	8.93				
	Eight (K-3)	116	13.55	105	90.52	11	9.48				
	Nine (K-4)	105	12.27	97	92.38	8	7.62				
Boys		**417**	**48.71**	**389**	**93.29**	**28**	**6.71**	1.47	0.688		
	Six (K-1)	103	12.28	91	88.34	12	11.66				
	Seven (K-2)	105	12.39	99	94.29	6	5.71				
	Eight (K-3)	107	12.98	99	92.52	8	7.48				
	Nine (K-4)	102	12.28	100	98.04	2	1.96				
Total Sample		**811**	**100.0**	**764**	**94.20**	**53**	**5.80**	4.87	0.182	3.43	0.064
	Six (K-1)	209	24.42	188	89.95	21	10.05			2.01	0.157
	Seven (K-2)	217	25.35	199	91.71	18	8.29			0.82	0.365
	Eight (K-3)	223	26.05	204	91.48	19	8.52			0.29	0.592
	Nine (K-4)	207	24.18	192	92.75	15	7.25			0.65	0.42

Note: TD = Typically Developing Children; DCD = Children with Developmental Coordination Disorder; χ^2 = Pearson's Chi-square Test.

Figure 1 – Prevalence of DCD in Primary School Children Aged 6-9 Years across Age and Gender



TD = Typically Developing Children; DCD = Children with Developmental Coordination Disorder.

Discussion

The purpose of this study was to determine the prevalence of DCD among girl and boy children aged 6 to 9 years in Turkey. Our findings showed a prevalence of 8.53% for the sample studied. This rate of DCD prevalence was 2.5-3.5% higher than that of reported by the American Psychiatric Association (2013). Furthermore, the prevalence of DCD for Turkish children in the current study was higher than that of reported for children in Brazil (7.1% for ages 7-10 years) (Beltrame et al., 2017), Iran (2.7% for ages 3-11 years) (Baghernia & Asle Mohammadizadeh, 2014), and South African (6% for ages 5-8 years) (De Milander et al., 2016) and was lower than that of reported for Spanish children (9.9% for ages 4-6 years) (Amador-Ruiz et al., 2018). Cross-cultural differences of DCD prevalence in age- and gender-matched samples may related to differences in life style, physical activity level, and living environment across countries. For instance, Amador-Ruiz et al. (2018) found out that children living in rural areas and those attending to public schools obtained better scores in some motor skills (i.e., aiming and catching) than those from urban areas and private schools. Unfortunately, there is no prior study on the prevalence of DCD in Turkish children to be able to compare the findings of this study in the similar cultural context.

In terms of DCD prevalence across age groups, our findings showed a prevalence of 7.25% to 10.05% for ages 6-9 years. This rate was 7.62% to 15.09% in the girl children and 4.90% to 8.74% in the boy children. The highest prevalence rate was related to the six-year-old girls and the lowest rate was related to the nine-year-old boys. Despite these differences, the results revealed no significant age differences of DCD prevalence in the total sample as well as in the girl or boy children. Few studies have reported age differences in DCD prevalence. For instance, Beltrame et al. (2017) studied a sample of Brazilian children aged 7-10 years and reported that children aged 7 and 8 years had a higher prevalence of DCD, suggesting that younger children may have a higher rate of DCD prevalence, which is in line with the present study. Although no significant age differences of DCD prevalence were found in our study, the younger age groups had a higher rate of DCD prevalence.

Our findings showed no significant gender differences in the prevalence rate of DCD in the age groups as well as in the total sample at the 95% confidence level. However, the prevalence rate of girl and boy children in the total sample was statistically significant at the 90% confidence level, with a higher DCD prevalence for girl children (10.25% *vs.* 6.71%). Boys are often diagnosed with DCD about 2 to 7 times more than girls (Blank et al., 2012). However, some researchers has concluded that the prevalence rate is more similar across gender, suggesting that girls may be underdiagnosed, possibly because parents lay less emphasis on poor motor coordination in girls (Missiuna et al., 2011). Our results support the notion that DCD prevalence rate is more similar across gender, and even the prevalence of DCD can be higher in girls. A few studies provided some evidence in support of this notion. For instance, Mercê et al. (2019) reported no significant gender differences in DCD prevalence among children aged 3-4 years in Portugal. In a study of Brazilian children aged 7-10 years, girls showed more difficulty with the throwing and receiving skills; and the boys with manual dexterity skills (Beltrame et al., 2017). Similarly in Spain, Amador-Ruiz et al. (2018) reported a higher rate of DCD prevalence in girls aged 4-6 years (10.4% *vs.* 9.5%). On the other hand, few studies have shown that boys are more likely to be diagnosed with DCD. For example, Baghernia and Asle Mohammadizadeh (2014) reported a male to female prevalence ratio of 2:1 (3.53% in boys and 1.85% in girls) for ages 3-11 years in Iran. Given the heterogeneous findings in the literature and the multiplicity of factors influencing DCD, it is not possible to reach a final conclusion regarding gender differences in the prevalence of DCD.

The present study contributes to the belief that DCD is a major health problem in school-aged children (Blank et al., 2012; Missiuna et al., 2007), which can cause problems beyond motor difficulties. DCD is a so-called hidden disorder meaning that peers do not recognize the motor problems as signs of a disorder. Consequently, TD children, but also teachers and parents, are generally not aware that the coordination difficulties are caused by an underlying disorder and attribute the motor problems to laziness or lack of effort. Negative reactions from peers may lead to withdrawal from sports and games, which in turn negatively influences their motor performance and social acceptance. Less acceptance and criticisms by peers

may lead to lower health-related quality of life in children with DCD (Schoemaker & Houwen, 2021). Early diagnosis and treatment using personalized interventions can be effective in preventing the psychosocial consequences of this developmental disorder.

Conclusions

The findings of this study revealed a prevalence rate of 8.53% for DCD among Turkish children aged 6 to 9 years, which was higher than that of reported for children in several countries. The prevalence rate ranged between 7.25% and 10.05% for the 6- to 9-year age groups. The range of prevalence rate was 7.62% to 15.09% and 4.90% to 8.74% in the girl and boy children, respectively. Despite some not significant differences, the prevalence rate of DCD were found to be similar across age and gender. Future studies can contribute to estimating the prevalence rate of DCD in Turkey by examining children in other cities. Given the significant prevalence rate of DCD observed in this study, it is suggested that policy-makers and managers in education, health and physical education sections implement programs to identify and treat DCD in primary schools in Turkey.

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