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Research Article
Prevalence of Developmental Coordination Disorder in Egyptian Children

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Abstract
Most of children with general coordination disorders and handwriting problems are referred to occupational and physical therapy clinics without clear diagnosis. Lack of definite diagnosis possesses a challenge to children, parents and teachers to understand the problem and how to deal with it. This study aims to calculate the prevalence of developmental coordination disorder in Egyptian children. The 1025 normal children of both sexes age ranged from 5-15 years old participated in this study. They were selected from schools randomly. The subsamples size was based on a stratified random sample proportion to the subpopulation size form according to Central Agency of Public Mobilization and Statistics (CAMPS). The assessment was carried out by the developmental coordination disorder questionnaire'07. The results showed that 5.9% of Egyptian children from 5-15 years old were suspected for DCD. The girls represented 38.3%, while boys were 61.7%. In addition, the higher percentage was found in younger children (48.3%). Finally, 60% showed lower scores in fine motor/handwriting, 10% in control during movement, while 30% had lower scores in general coordination. Our data indicate that developmental coordination disorder is a prevalent disorder that requires more attention and clear diagnosis.

Key words: Developmental coordination disorder, developmental coordination disorder questionnaire'07, postural control

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Developmental Coordination Disorder (DCD) is a common movement disorder of un-known cause seen in preschool and school aged children. There is lack of clear and definite diagnosis of DCD. Many labels are used to describe the movement disorder such as clumsiness, physical awkwardness and minimal cerebral dysfunction with related descriptions like motor learning impairment, motor delay, motor control impairment, sensory integrative dysfunction and hand-eye coordination impairment (Werner *et al*., 2012). It has been suggest that, DCD is a part of the continuum of cerebral palsy; which could be due to prenatal, perinatal or neonatal insult or occurs secondary to neuronal damage at the cellular level in the neurotransmitter or receptor systems (Barnhart *et al*., 2003).

Problems in performing the activity of daily living tasks at home (e.g., tying shoes, dressing), classroom activities (e.g., writing) and playground activities are typical in children with DCD (Green *et al*., 2005; Zwicker *et al*., 2013). Moreover, children with DCD are believed to develop other serious problems. Previous literature addressed other serious problems that are common in children with DCD, such as obesity and cardiovascular problems (Cairney *et al*., 2005; Rivilis *et al*., 2011), anxiety, depression, low self-worth and social isolation (Piek *et al*., 2000; Smyth and Anderson, 2000; Skinner and Piek, 2001; Rose and Larkin, 2002; Francis and Piek, 2003).

Recently, with advances in assessment tools and differential diagnosis the incidence of DCD is increasing, that 6% of the world population is affected and it is believed that one case of DCD could be seen in each classroom (Gibbs *et al*., 2007; APA., 2000).

There is a variety of assessment tools, scales and questionnaires are used to evaluate the impact of coordination problems on children's daily life motor activities. Some of those tools are designed to be used by teachers, parents, or the children themselves, e.g., Movement Assessment Battery for Children (MABC) (Henderson and Sugden, 1992), the Bruininks-Oseretsky Test (BOT) of motor proficiency (Bruininks, 1978) and the Beery-Buktenica Developmental Test of Visual Motor Integration (VMI) (Beery *et al*., 2010).

Developmental Coordination Disorder Questionnaire (DCD-Q) is most common parental questionnaire that is frequently used to identify motor problems in children from 8-14 years of age. It contains 17 items regarding motor coordination (Wilson *et al*., 2009).

A revised form was developed in 2000 known as the DCDQ'07. It is designed for parents of children aged 5-15 years. The questionnaire contains 15 items grouped into three distinct factors: control during movement, fine motor/handwriting' and general coordination'. Internal consistency, test-retest reliability, construct and concurrent validity of DCDQ scores, as well as high sensitivity in identifying children at risk for DCD have been noted in the literature (Wilson *et al*., 2000; Crawford *et al*., 2001; Green *et al*., 2005; Schoemaker *et al*., 2006; Civetta and Hillier, 2008).

Children with coordination disorders as well as poor handwriting face a great challenge in school activities and academic achievement. Those children have no neurological or physical problems with normal intelligence quientent. There is no previous literature that might help in estimating the prevalence of DCD in Egyptian children. The main aim of this work was to calculate the prevalence of developmental coordination disorder at 5-15 years of age among Egyptian children.

MATERIALS AND METHODS

Study design: This study was a survey study to calculate the prevalence of DCD in Egyptian children.

Subjects: One thousand and twenty five normal children participated in this study. Since Egypt has been divided into four geographic areas for sampling selection and design by the Central Agency of Public Mobilization and Statistics (CAMPS). The subsamples size were based on a stratified random sample proportion to the subpopulation size as follows:

- **Great Cairo area:** Cairo governorate was selected to represent the area (484 children)
- **Lower Egypt area:** Alex and Dakahlia governorates were selected to represent the area (358 children)
- **Upper Egypt area:** Giza governorate was selected to represent the area (116 children)
- **Suez-Canal area:** Port-said governorate was selected to represent the area (42 children)

Inclusive criteria:

- Children of both sexes were included
- Their age ranged from 5-15 years
- They were selected from schools randomly (nursery, primary and preparatory)

Random assignment of children was conducted into two stages. Stage one involved random selection of schools in the target governorates from a list of primary and preparatory schools. The second stage involved instructing two persons who were working in the schools to randomly select the children of both sexes, from list names. Full assessment was carried for the selected sample to meet the inclusion criteria.

The randomization process was carried out by a registration clerk who was not involved in any part of the study. A written informed consent form giving agreement to participation and publication of results was signed by the children's parents. The study was approved by the ethics committee of the Faculty of Physical Therapy, Cairo University.

Total sample size was selected and computed according to the following criteria: The sample estimated guaranteed 95% confidence level and a margin of error 0.032 and for 1025 is 0.031, which means that the difference between true population values (means or percentages) was different from there corresponding sample values by this amount (sample estimated-population approximately 0.031).

Exclusion criteria:

- Children who were born as preterm babies (gestational age <37 weeks)
- Neuromuscular or musculoskeletal disorders
- Upper and lower limbs deformities
- Visual or auditory problems
- Mental sub-normality (IQ<70)

Instrumentation for evaluation

Developmental coordination disorder questionnaire (DCDQ'07): The DCDQ'07 version of the questionnaire was used in this study. It is a screening tool to assess coordination disorders in children aged 5-15 years. It is a parental questionnaire consists of 15-item including three distinct factors. The first factor (items 1-6) is related to motor control while the child was moving or while an object was in motion and is labeled "control during movement". The second factor "fine motor and handwriting" (items 7-10) and the third factor relates to "general coordination" (items 11-15). The copy of DCDQ'07 given to the parents was labeled as "The Coordination Questionnaire". This is an important procedure as this helps to avoid parents becoming concerned that a medical condition is being diagnosed, which may interfere with evaluating of their children. Therefore, it was recommended that parents were not given the score sheet.

Scoring system was explained to each parent. The parents were instructed to grade the performance of their child in each question on a five-point Likert scale when comparing the motor performance between their child and his/her peers. This is considered to provide a standard method to evaluate a child's motor coordination in everyday, functional activities. Each question is scored from 1-5 points, giving a total score of from 15-75 points and a high score suggests no DCD. While scores lower than 46 are considered to be probable DCD (Wilson *et al*., 2009).

The DCDQ'07 correlates well with other well-established tests such as the Bruininks-Oseretsky Test of Motor Proficiency and the Movement Assessment Battery for Children and the high internal consistency and discriminate function makes it suitable as a screening tool (Wilson *et al*., 2009).

Procedure for evaluation

Prior to administration: The first two pages of the questionnaire were translated in to Arabic to make it easier on the parents to complete. They were instructed to complete the personal data correctly and clearly. Translation of the first two papers of the questionnaire (contain the personal information and the questionnaire15 questions) in to Arabic was carried out before starting the study. A pilot study was conducted on 10 mothers of normal children with age ranged from 5-15 years, to find out the phrases that they use and that they can understand. The quality of life and cultural aspects of Egyptian society was taken into consideration during forming the questionnaire.

They were also instructed to write the name and phone number be written into the space on the first page of both the parents and the authors, so the parents could call if they had questions about the meaning of an item and we could easily reach the parents if any data was missing during the application . This way the validity of the results was increased if parents have the opportunity to clarify the intent of an item.

Parents had to compare the degree of coordination their child had with other children of the same age when answering the questions and put a circle on the one number that best describes their child. If they changed their answer and wanted to circle another number, it was allowed to circle the correct response twice. Scoring usually takes parents about 10-15 min for administration. It is important to perform the scoring in a non-distracting environment to guarantee accurate scoring. The scoring sheet was carefully reviewed before receiving the parents scoring for missing items because missing one score will prevent obtaining a total score and having an indication of DCD. If the parents had any problem during grading their child an item or had not seen their child perform a particular

Table 1: Interpretation of scores on the DCDQ'07

Age groups	Suspect for DCD	Probably not DCD
5 years 0 month to 7 years 11 months	15-46	47-75
8 years 0 month to 9 years 11 months	15-55	56-75
10 years 0 month to 15 years	15-57	58-75

DCD: Development coordination disorder

activity, they were allowed to make an arrangement to consult persons who might know about the child's ability (e.g., the other parent, a caregiver, a teacher or a coach).

After the scoring procedure was completed, we arranged the children in to 3 groups according to the child's chronological age at the time the questionnaire was completed (Table 1). Then we scanned across that row to find the range of scores which the child's score falls within. Depending on the score the child was defined as indicated "Indication of or Suspect for, DCD" or "Probably not DCD" (Wilson *et al*., 2009).

RESULTS

Sample design and selection: Allocation of stratified random sample from the selected governorates that proportion to size of sampled population stratas as follows: let N1, N2, N3, N4 be the population stratas and let n1, n2, n3, n4 be the sample stratas. Then the sample of total size (n) was allocated to each strata according to the relationship:
Where:

$$\frac{n1}{N1} = \frac{n2}{N2} = \frac{n3}{N3} = \frac{n4}{N4} = \frac{n}{N} = \frac{\text{Total sample size}}{\text{Total population}}$$

$\frac{n}{N}$ is called the sample fraction.

Accordingly sample for each area was determined according to the following formula:

$$ni = n \times \frac{n_i}{N}$$

where, i = 1, 2, 3, 4

A stratified random sample proportion to size was selected to represent the above geographic areas according to the CAPMS (Annual statistical year book, 2006) as shown in Table 2.

Table 3 demonstrates the frequency distribution of the total sample by governorates and age groups was 35.5% in children aged from 5-7 year and 11 month, 31.2% in children aged from 7-9 year and 11 month and 33.3% in children aged from 9-15 years.

Table 2: Distribution of children age 5-15 years in the population and sample selected by governorates

Governorate	Approximated population size (N)	Sample size (n)
Great Cairo area (Cairo governorate)	1,177,597 child	484 child
Lower Egypt area (Alex and Dakahlia governorates)	871,220 child	358 child
Upper Egypt area (Giza governorate)	281,504 child	116 child
Suez-Canal area (Port-said governorate)	102,688 child	42 child
Total	2,433,009 N	

Descriptive statistics for back ground characteristics

Table 4 demonstrates the frequency distribution of boys and girls in the total sample by governorates was 50.5 and 49.5%, respectively.

Table 5 demonstrates the frequency distribution of children indicated for DCD and those who are probably not DCD in to the total sample was 5.9 and 94.1%, respectively.

Table 6 demonstrates the frequency distribution of sex revealed that the distribution of boys and girls in the DCD sample was 61.7 and 38.3%, respectively.

Table 7 demonstrates the frequency distribution of DCD children according to age groups. While, Table 8 demonstrates the frequency distribution of DCD sample by motor disorder.

Table 9 demonstrates the frequency distribution of preschool nursery attendance among DCD children. Table 10 demonstrates the frequency distribution of practicing sports among DCD sampled children.

As shown in Table 11 there is a relationship between DCD median score and gender since CC = 0.034, but not strong enough to be significant since p = 0.791. While, Table 12 shows no significant difference between gender and child mean score items and age.

Table 13 demonstrates the difference between mean and standard deviation for the three age groups score. While, Table 14 shows no significant difference between age groups in control during movement and general coordination scores, while there was a significant difference between age groups in fine motor handwriting scores.

As shown in Table 15 there is a very weak relationship between DCD median score and pre-school nursery attendance since CC = 0.001.

As shown in Table 16 there is a relationship between DCD median score and practicing sports since CC = 0.129, but not strong enough to be significant since p = 0.313.

DISCUSSION

This work is the first work directed to calculate the prevalence of DCD in Egyptian children. All children participated in this study were assessed by DCDQ' 07

Table 3: Frequency distribution of the total sample by governorates and age groups

	Port said		Alex		Giza		Cairo		Dahlia		Total	
Governorate age groups	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
5-7year and 11month	15	34.9	46	32.2	49	39.8	172	34.8	82	36.9	364	35.5
8-9 year and 11 month	13	30.2	46	32.2	34	27.6	160	32.4	67	30.2	320	31.2
10-15 year	15	34.9	51	35.7	40	32.5	162	32.8	73	32.9	341	33.3
Total	43	100.0	143	100.0	123	100.0	494	100.0	222	100.0	1025	100.0

Table 4: Frequency distribution of the total sample by governorates and gender

	Port said		Alex		Giza		Cairo		Dahlia		Total	
Governorate genders	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Boys	22	51.2	73	51.0	62	50.4	250	50.6	111	50.0	518	50.5
Girls	21	48.8	70	49.0	61	49.6	244	49.4	111	50.0	507	49.5
Total	43	100.0	143	100.0	123	100.0	494	100.0	222	100.0	1025	100.0

Table 5: Frequency distribution of prevalence of DCD total sampled

DCD	Frequency	%
Indication of DCD	60	5.9
Probably not DCD	965	94.1
Total	1025	100.0

DCD: Development coordination disorder

Table 6: Frequency distribution of the DCD sample by gender

	DCD	
Genders	Frequency	%
Boys	37	61.7
Girls	23	38.3
Total	60	100.0

DCD: Development coordination disorder

Table 7: Frequency distribution of DCD children according to age groups

	DCD	
Age groups	Frequency	%
5-7 year and 11month	29	48.3
8-9 year and 11 month	18	30.0
10-15 year	13	21.7
Total	60	100.0

DCD: Development coordination disorder

Table 8: Frequency distribution of DCD sample by motor disorder

Motor disorders	Frequency	%
Control during movement	6	10
Fine motor/handwriting	36	60
General coordination	18	30
Total	60	100

DCD: Development coordination disorder

Table 9: Frequency distribution of preschool nursery attendance among DCD children

	DCD	
Preschool nursery attendance	Frequency	%
Yes	4	6.7
No	56	93.3
Total	60	100.0

DCD: Development coordination disorder

Table 10: Frequency distribution of practicing sports among DCD sampled children

	DCD	
Practicing sports	Frequency	%
Yes	1	1.7
No	59	98.3
Total	60	100.0

Statistical data analysis, DCD: Development coordination disorder

Table 11: Test of relationship between DCD median score and gender

DCD (Median)	<Median	≥Median	Total	Chi square	CC*	p-value	Significance
Gender							
Boys	19	18	37	0.071	0.034	0.791	Not significant
Girls	11	12	23				
Total	30	30	60				

*Contingency coefficient: Interrelation and interactions between two variables, DCD: Development coordination disorder

Table 12: Test of significant difference between gender and child mean score items and age

	Boys N = 37		Girls N = 23		Comparison		
Items	Mean	±SD	Mean	±SD	t-value	p-value	Significance
Age (years)	7.24	2.278	8.30	2.653	1.646	0.105	Not significant
Control during movement (score 30)	15.00	4.082	15.83	4.840	0.709	0.481	Not significant
Fine motor handwriting (score 20)	7.78	3.668	7.65	2.902	0.146	0.885	Not significant
General coordination (score 25)	11.46	3.396	10.96	4.913	0.469	0.641	Not significant
Total (score 75)	34.24	5.423	34.43	5.442	0.133	0.895	Not significant

SD: Standard deviation

Table 13: Test of significant difference between mean and standard deviation for the three age groups motor disorder score

	5-7years, 11 Month (N = 29)		8-9 years, 11 month (N = 18)		10-15 years (N = 13)	
Age groups scores	Mean	SD	Mean	SD	Mean	SD
Control during movement	14.79	2.007	16.56	3.838	14.77	7.758
Fine motor handwriting	6.55	2.443	9.00	2.449	8.62	5.173
General coordination	11.07	1.981	10.56	4.033	12.69	6.626
Total	32.41	4.540	36.11	5.312	36.08	6.130

Table 14: Test of significant difference between the age groups for score

Score	F-test*	Significance	Indication
Control during movement	1.036	0.361	Not significant
Fine motor handwriting	3.838	0.027	Significant*
General coordination	1.144	0.326	Not significant
Total	3.842	0.027	Significant*

*Result of Analysis of Variance (ANOVA)

Table 15: Test for a relationship between DCD median score and pre-school nursery attendance

DCD (Median)	<Median	≥Median	Total	Chi-square	CC*	p-value	Significance
Pre-school nursery attendance							
Yes	2	2	4	0.001	0.001	1.00	Not significant
No	28	28	56				
Total	30	30	60				

*Contingency coefficient: Interrelation and interactions between two variables, DCD: Development coordination disorder

Table 16: Test for a relationship between DCD median score and practicing sports

DCD (Median)	<Median	≥Median	Total	Chi square	CC*	p-value	Significance
Practicing sports							
Playing sports	1	-	1	1.017	0.129	0.313	Not significant
Not playing sports	29	30	59				
Total	30	30	60				

*Contingency coefficient: Interrelation and interactions between two variables, DCD: Development coordination disorder

questionnaire. It is a reliable tool that can be completed by the parents or caregiver. It usually takes about 10-15 min to complete. It consists of 15 items that assess three main factors (control during movement, fine motor and handwriting and

general coordination). The overall sensitivity is 84.6% and the specificity is 70.8% (Wilson *et al*., 2009).

The DCDQ' 07 questionnaire is used to cover a broad range of functional motor skills and the subcategories reflect areas of motor skills known to present difficulties for children with DCD; control during movement (Schoemaker *et al*., 2006), fine motor skills (Sugden, 2006) and general coordination including fatigue and motor imitation skills (Wilson, 2005).

The results of the current showed that the frequency of DCD in Egyptian children age ranged from 5-15 years old was 5.9%. The girls represented 38.3%, while boys represented 61.7%.The statistical analysis also showed that, the frequency of children who were indication of DCD or suspect to DCD according to age were, 48.3 % in children whose ages ranged from 5 years to 7 years 11 months, 30% in children whose ages from 8-9 years 11 months and 21.7% in children whose ages from 10-15 years.

Moreover, the results showed that 10% of DCD children had lower scores in control during movement, 60% in fine motor/handwriting, while 30% had lower scores in general coordination.

The results of the current study come in agreement with Elders *et al*. (2010), who stated that, DCD is considered as one of the most common childhood disorders, with prevalence 5% of the school age children. It also comes in accordance with Sugden and Chambers (2005) who reported that, the prevalence of DCD rates from 6-12%.

Lingam *et al*. (2009), studied the prevalence of DCD in 7 years old children. They reported that, 18 of 1000 7-year-olds have DCD according to strict DSM-IV criteria and that 49 of 1000 7-year-olds have DCD or probable DCD in UK population.

This comes in accordance with other studies which have shown that, DCD is becoming extremely common motor disorder, that 6% of the world population is affected. It has been suggested that, in each classroom there is a child with DCD (Gibbs *et al*., 2007; APA, 2000).

More studies were conducted in some countries to calculate the prevalence of DCD showed that DCD estimates higher range from 2-19%. Such as, studies in Netherlands and Germany showed a 7.7% in children from 4-13 years (Jongmans *et al*., 1996) and in Switzerland 7.3% (Kadesjo and Gillberg, 1999). Lingam *et al*. (2009) have investigated the prevalence of DCD on 6,990 children in England aged 7 years. The results showed that, the rate was 1.7% children with probable DCD and 4.9% in situation of risk. Moreover, Tsiotra *et al*. (2006) studied the incidence in Canada and Greece. They reported extremely different values, 8 and 19%, respectively. Valentini *et al*. (2012), reported that19.9% of children in South Brazil presented probable DCD and 16.8% were at risk of DCD.

Our results showed a higher percentage (48.3%) of DCD in younger children compared to typically developing children. These results are opposite to the opinion of Cairney *et al*. (2010) who studied the participation trajectories in children with and without coordination difficulties at age of 9-12 years old. They reported that a persistent activity deficit between children with DCD and typically developing children. This deficit appears in both organized and free-play activities.

Our results are opposite to the opinion of Wall (2004), who noted, the skill demands for play increase with age as the active play becomes more complex, which suggests that the practical difficulties in children with DCD become more serious with time as the child grows up.

The results of the current study could be attributed to many factors. First, it is possible that movement difficulties are increasingly dependent on adaptation and compensations. In other words, older children with coordination difficulties choose to engage in activities where a high degree of motor skill is not crucial or begin to prefer individual activities.

Second, we must also take into account the psychological, social and financial factors related to believes about the value of physical activity. There are many differences in the perceived social value of physical activity may, however, also pose problems for studies such as the present one. For instance, we found that 98.30% of children suspected to DCD do not practice any sports. Moreover the higher percentage of DCD in younger ages could also be attributed to that 93.30% of children suspected to DCD do not attend to preschool nursery.

Finally, we can also attribute these results to that; we studied the prevalence of DCD in Egyptian population from 5-15 years old. There is shortage of literature studies about the prevalence of DCD covering this age. The previous studied were performed in limited age ranges. There was higher prevalence of DCD 38.3% among girls, while boys represented 61.7%, which is inconsistent with the world estimates of higher prevalence of the disorder in boys (APA., 2000). This could be attributed to the hypothesis that, sex differences may account for differences in participation between males and females with DCD (Cairney *et al*., 2010).

This also comes in agreement with Kimm *et al*. (2005), who stated that, boys and girls show different value of time and free play that males and females place on physical activity and sports. Also there is difference between boys and girls regarding the interest and participation in physical activity and in the social value that they place on being active.

This comes in agreement with Cairney *et al*. (2010) who stated that, boys seem to be more physically active than girls. This is due to social and self-conception factors. They reported that girls show little participation in physical activities over time. On the other hand, boys with DCD in fact appear not to decrease their level of participation over time. Therefore, the motor disorders increase over time in boys.

Another important factor is that, girls are motivated to participate in simple activities such as drawing and playing with dolls, while boys engage in more vigorous games, such as contact sports. That is why girls have limited opportunities to development of basic motor skill (Brazelton and Sparrow, 2002).

Boys and girls show different levels of participation in physical activity and have developmentally different activity experiences. In addition must consider the psychological and social factors related to beliefs about the value of physical activity. This comes in accordance with Kimm *et al*. (2005) reported that, girls tend to be inactive through late childhood and adolescence compared to boys.

Our work revealed that, children with DCD show problems in different aspect of physical performance including control during movement (10%), fine motor and handwriting (60%) and general coordination (30%).

This comes in accordance with Forseth and Sigmundsson (2003) and Cherng *et al*. (2007) who stated that, children with DCD usually experience variable degree of motor coordination impairment, running, jumping and stair climbing, to fine motor skills like buttoning and inability to use scissors. Handwriting and also the children's poor balance are noticeable at younger ages and are the first motor disorders that are reported by the parents and teachers.

The coordination difficulty in children with DCD may arise in three levels. Level 1 which is the most basic level in which there is difficulty when moving a single degree of freedom (e.g., turning the head); second level, difficulty when coordinating two or more degrees of freedom (e.g., moving the head and the arm) and finally the third level, difficulty when coordinating with objects in the environment (e.g., reaching out to grasp an object they also reported that, children with DCD had difficulties simply sitting upright and maintaining balance while carrying out the task (Elders *et al*., 2010).

Feder and Majnemer (2007) have reported that, DCD children experience also deficit in perceptual skills which in turn causes delay in the development of fine motor skills. That is usually manifested with difficulties in the education process and academic achievement.

Previous literature reported that, children with DCD manifest motor deficits in virtually every motor domain, such as deficits in gross-motor (i.e., balance, gait) (Deconinck *et al*., 2006; Geuze, 2005) and fine-motor skills (Rodger *et al*., 2003; Smits-Engelsman *et al*., 2001). It is also suggested that they tend to move more slowly than their typically developing peers. This is reflected on the child performance of daily living skills like dressing, personal hygiene and eating (Mandich *et al*., 2003; Missiuna *et al*., 2007; Rosenblum, 2006; Schoemaker *et al*., 2008).

Independence in maintenance activities of daily living is also a common problem in children with DCD compared to their typically developing peers. This is usually seen in different levels of performance from running and jumping to hand writing. Children with DCD are believed to have motor coordination disorders that has a direct impact on activities of daily living academic achievement (Rodger *et al*., 2003; Polatajko and Cantin, 2005; Rosenblum, 2006; Missiuna *et al*., 2007).

Movement disorders are not the only problems that are seen in children with DCD. They usually experience psychological problems such as low self-esteem, anxiety and depression (Piek *et al*., 2008; Missiuna *et al*., 2006). Cairney *et al*. (2010) have reported that, children with DCD are at risk for development of obesity and coronary vascular disease due to inactivity and low physical performance.

Zoia *et al*. (2006) stated that, although deviations in motor development may start early in life, coordination disorders are usually not diagnosed before age 5. These deviations range widely from gross motor activities such as running, jumping and stair climbing, to fine motor skills like buttoning, using scissors and handwriting (Forseth and Sigmundsson, 2003; Cherng *et al*., 2007). Balance problems and difficulties in maintaining postural control are the first symptoms reported in DCD population (Mackenzie *et al*., 2008). Shumway-Cook and Woollacott (2001) have reported that, visual, somato-sensory and vestibular inputs as well as their integration to reference the self within the environment are essential for maintaining balance.

Central nervous system receives different sensory inputs as a combination of the three senses provides accurate or enough information for balance control purpose under all sensory conditions. Therefore, central nervous system compares and integrates all the incoming inputs in order to maintain balance (sensory organization or sensory integration). Therefore, balance disorders in children with DCD may be either due to a deficit in the effectiveness of an individual's sensory system or to a deficit in sensory organization (Cherng *et al*., 2007).

Disorders in postural control and balance possess a challenge to the child with DCD. The main complain of parents of children with DCD is that, these children experience

pervasive activity restrictions at home and in school (Stephenson and Chesson, 2008; Mandich *et al*., 2003; Missiuna *et al*., 2007).

Rodger *et al*. (2003) stated that, children with DCD have below average self-care functions abilities in skills such as, putting toothpaste on a toothbrush, using a hairbrush, performing self-hygiene activities, dressing, using cutlery and tying shoelaces.

Missiuna *et al*. (2007) and Rodger *et al*. (2003) stated that, children with DCD have poor performance in activities of daily living. This negatively influences their physical fitness,health, self-esteem, social adjustment and academic problems. Academic problems may range from poor handwriting to poor organizational skills as well as poor manipulation skills.

Wang *et al*. (2009) reported that, children with DCD participate less in social and leisure activities. This could be attributed to that, they expend much more energy than normally developing children and are often fatigued easily. They tend to participate less in physical activities at school as well as less positive social interaction with their classmates; e.g., children with DCD spend more playground time in isolation than their peers.

The high prevalence of cases of DCD proved to be worrying, especially considering the limited resources available in Egypt for compensatory and preventive care for these children. The results regarding difficulties in manual dexterity emphasize the need to identify this disorder before children enter school, so that they are provided with specific treatment.

In short, the present results suggest the following interventional goals; Improving fine motor skills in children with DCD and at risk of DCD before entering school, keeping interventional continuity throughout the school years, so that these difficulties will not worsen and providing opportunities, particularly in schools, for girls to develop ball skills. It should also be emphasized, the clear need for future investments in different scientific areas, for the better understanding of the heterogeneous nature of DCD and its underlying mechanisms.

Study strengths and limitations: Our study had a number of strengths. First, our study is longitudinal and included a large number of children. Second, we were able to examine and adjust for several potential confounding factors in the analysis. Third, we excluded children with neuromuscular and musculoskeletal diseases that have an impact on the prevalence of DCD.

There are also several limitations in our study. First, children probable for DCD in our study had not confirmed clinical diagnoses. Second, children with a low DCDQ'07 score were probable cases.

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