

Motor characteristics in children with developmental coordination disorder and attention-deficit/hyperactivity disorder: intergroups comparison and predictors

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Abstract

BACKGROUND

Children with Attention-Deficit/Hyperactivity (ADHD) and/or Developmental Coordination Disorder (DCD) show high rates of motor difficulties in daily activities. This study aimed to examine the validity and reliability of the Developmental Coordination Disorder Questionnaire (DCDQ) in identifying motor characteristics in daily activities, differentiating children with ADHD-only, with DCD-only and with ADHD and DCD comorbidity.

METHODS

Thirty-three children with ADHD-only, 30 with DCD-only, 33 with ADHD/DCD, and 35 controls participated to the study. Diagnosis satisfied DSM-5 criteria for ADHD and DCD. The DCDQ was administered to all children; moreover, the association between DCDQ scores and ADHD symptoms, measured by SNAP IV, and motor coordination severity, measured by M-ABC subscales, was examined.

RESULTS

The DCDQ subscale scores were significantly lower in all clinical groups than in controls, but only minimal differences were found between the clinical groups. Principal Component Analysis (PCA) of DCDQ identified five components showing the best adaptability and accounting for 71% of the variance. Both ADHD-only and ADHD/DCD achieved a better performance than DCD-only in the “Motor control in running/jumping”. Conversely, children with DCD-only performed better in “General coordination”. ADHD-only reached better mean scores than ADHD/DCD in “Motor control with the ball” and, than DCD, in “Planning”. Inattention, hyperactivity-impulsivity at SNAP-IV, and balance at M-ABC, represented the main predictors for ADHD-only, ADHD/DCD and DCD-only, respectively.

CONCLUSION

DCDQ may represent a useful measure to detect the different areas of difficulties in children with neurodevelopmental disorders and provides suggestions for identifying distinct altered processes underlying ADHD and DCD, alone or in comorbidity.

Keywords. Attention-Deficit/Hyperactivity disorder; Developmental Coordination disorder; Comorbidity; Developmental Coordination Disorder Questionnaire (DCDQ).

Introduction

Children with attention-deficit/hyperactivity disorder (ADHD) can have difficulties in learning and performing a variety of fine and gross skills that may interfere with their development and adaptation.¹ Approximately 30-50% of children with ADHD present a comorbid developmental coordination disorder (DCD)² characterized by a significant delay in the execution of gross and fine motor skills, characterized by clumsiness or inaccuracy of motor performance.³ In parallel, approximately half of children with DCD show moderate to severe ADHD symptoms.⁴ Even without a formal diagnosis of DCD in children with ADHD, motor problems are found in both fine motor (writing, tying shoelaces, proper use of fork and knife), handwriting (and gross motor abilities (i.e. sports, playing with ball, riding a bicycle). Moreover, it has been reported that children with ADHD may also present impaired skills in handwriting performance⁵, less accuracy in writing, increased spelling errors,⁶ high variability and poorer legibility in production of the letters and/or the spacing between letters and words.^{7,8} Additionally, higher variability, slower reaction time and lesser rhythmicity in playing with a ball or in jumping rope have been reported in children with ADHD.^{9,10} Despite the increasing evidence supporting its validity, DCD has received little attention in the clinic practice for the diagnostic process of ADHD¹¹, and the nature of the relation between ADHD and DCD is not fully clear. In particular, it is unclear whether specific motor difficulties observed among children with ADHD are inherent to ADHD or are mediated by its comorbidity with DCD.¹² As also DCD children show similar problems in fine handwriting^{13,14} and gross motor tasks measured with motor tool, the question is whether the underlying processes are similar to those of ADHD or not. Most studies on motor profiles of ADHD and/or DCD are limited to a comparison with typically developing children; some studies used different standardized measures that do not allow an easy comparison or used different total cut-off scores of the same standardized tool, i.e. <5th centile vs. 6th-14th centile of the Movement Assessment Battery for Children (M-ABC) that did not provide unequivocal evidence of DCD. Moreover, the few comparative studies with distinct clinical samples (i.e. ADHD-only, DCD and ADHD/DCD)^{15,16} did not take into account the possible presence of motor coordination difficulties in daily activities, independent from the motor deficit. Some children with ADHD might present a normal coordination profile, as assessed by specific measures (es. M-ABC), although parents and/or teachers describe many difficulties in daily motor activities. Considering the lack of a clear consensus about the motor difficulties in children with ADHD, some researchers have proposed to combine multiple measures for a more accurate definition of the motor characteristics of these children.^{17,18}

The Developmental Coordination Disorder Questionnaire (DCDQ) is considered to be a reliable and useful instrument to ascertain the impact of movement organization on functional everyday tasks, at home, at school and at playing (EACD recommendation DCD, 2019).¹⁹

In general, DCDQ has been utilized in studies on children with DCD, but the checklist includes motor activities regularly performed by all the children, is easy and fast to administer, and may provide a complementary motor profile in children with ADHD that do not present a DCD comorbidity.

For all these reasons, we aimed to examine reliability and functionality of the DCDQ in identifying specific motor difficulties in daily activities in children with ADHD (ADHD-only), children with DCD (DCD-only) and children with ADHD and DCD in comorbidity (ADHD/DCD). We also evaluated the association between core ADHD symptoms and M-ABC subscales and the items of the DCDQ.

2. Methods

2.1 Subjects

A total of 138 children (18 girls), aged between 4.7 and 12.1 years, participated in the study; the whole population was composed by three clinical groups and a control group.

2.1.1 Clinical groups

The clinical groups included 103 children (11 girls and 92 boys), with mean age 7.1 years (SD= 1.9; range= 4.7-12 years) enrolled in two Child and Adolescent Neuropsychiatry Outpatient Centers in Rome, Italy. All were medication naïve. Children with abnormal vision or hearing problems, motor disorders (cerebral palsy or other movement limiting conditions such as limbs and feet malformations), cognitive impairment (intelligence quotient, IQ <85) or autistic spectrum disorder (ASD) were excluded.

All children of the clinical groups underwent a) medical history, b) psychiatric interview to parents (K-SADS-PL)²⁰, c) motor assessment (M-ABC) and cognitive evaluation (Wechsler Intelligence Scale for Children, Fourth Edition, WISC-IV 2004).²¹

2.1.2 Control group

The control group included 35 typically developing healthy children of the same age range and gender distribution of the clinical group (seven girls, mean age 8.3 years, SD 1.95, range: 5-12.1), recruited from two public schools in Rome. Children with a history of premature birth or with a certificated diagnosis of cognitive deficit, neurological or psychiatric disorder were excluded.

2.2 Measures

2.2.1 The Developmental Coordination Disorder Questionnaire (DCDQ, Italian version)

The DCDQ is a parent questionnaire for children aged 5 to 15 years. It consists of 15 items on a 5-point Likert scale (1= “Not at all like your child”; 5 = “Extremely like your child”) providing a total score of 15 to 75. The DCDQ items are divided into three subscales: “control during movement,” “fine motor/handwriting” and “general coordination”. For each item, parents are asked to compare the motor performance of their child with that of children of the same age and to rate it on a 5-point Likert scale. Items provide information on how the child, runs, throws, catches, hits a ball, and draws or writes with particular attention to velocity, variability, and precision of the movements. The total score indicates whether the child has “Indication of, or Suspect for DCD” (lower scores), or “probably not DCD” (higher score)” with respect to age (5-7.11 years, 8-9.11 years, and 10-15 years). It is possible to obtain a partial score for each subscale (sub-scores). The psychometric properties of the Italian version of the questionnaire in Italian children achieved satisfactory internal consistency and reliability.²²

2.2.2 *Movement Assessment Battery for Children (M-ABC)*

It is a standardized test that consists of eight items that evaluate fundamental movement skills accommodated for four age ranges designed for use with children aged 4 to 12 years. The items are different for each age range but cover the same type of skills: manual dexterity, ball skills and balance (sub-scales).²³

According to the European Academy for Childhood Disability,²⁴ a total M-ABC score $\leq 5^{\text{th}}$ centile (representing an unequivocal evidence of DCD), and cut-off $\geq 15^{\text{th}}$ centile, (representing a typical motor development), were chosen as criteria to obtain a clear distinction between the groups. Children whose total M-ABC score was in the borderline range (6-14th centiles) were excluded from the study in order to enroll only children with a definite motor impairment or a typical motor development and have a clear distinction between the groups, according to the norms of the test.

The M-ABC test was administered to all children participating to the study (clinical and control group) by an operator trained in child assessment.

2.2.3 *SNAP IV ADHD symptoms checklist*

Parents of the clinical groups completed the SNAP-IV 26-item scale^{25,26}. Items from the *DSM-IV* criteria for ADHD are included for the two subsets of symptoms: Inattention (items 1–9) and Hyperactivity/Impulsivity (items 10–18) and Oppositional Defiance disorder (items 19-26, not utilized in this study), rated on a 4-point scale. This dimensional approach instrument treats the inattention and hyperactivity symptoms as continuous variables, as well as M-ABC and DCDQ scores, the values of which are normally distributed.²⁷ It represents a useful approach to the analysis of the association patterns between severity of symptoms of inattention, hyperactivity and impulsivity with DCDQ scores.

2.3 Procedures

Parents of children of the clinical groups were invited by a physician of the Child and Adolescent Neuropsychiatry Outpatient Centre to participate to the research project; teachers of the participating schools contacted the parents of the control group.

All parents were informed about the aim and scope of the research and signed an informed consent to the study. Regarding the control group, after an explanation by an operator trained in child assessment, who was available for any clarification during the completion of the study, parents were asked to fill out (1) a questionnaire on medical history and development of their child with particular attention to motor and attention-hyperactivity behaviors, and (2) the Italian DCDQ questionnaire.

This research followed the APA ethical standards and was approved by the Ethics Committee of the Department of Social and Developmental Psychology, Sapienza University.

2.4 Group arrangement

Children were included into one of three clinical groups (ADHD-only, DCD-only and ADHD/DCD) based on test results: (1) children were classified as ADHD if they fulfilled ADHD criteria obtained by a psychiatric interview to parents conducted by a child psychiatrist, according to the DSM-5 criteria (K-SADS-PL),²⁰ had a cognitive level within the normal range (IQ >85) and were positive to the ADHD rating Scale adapted for the Italian population (SNAP-IV),^{25,26} (2) children were classified as DCD if they had a cognitive level within the normal range (IQ >85), impaired motor skills requiring motor coordination evaluated by a neurological examination, evaluation of motor development and total score below the 5th centile on the Italian version of the M-ABC, according to the recommendations of the European Academy for Childhood Disability and international classification;^{3,24} (3) children were classified as ADHD/DCD if had both characteristics of ADHD and DCD.

2.5 Statistical Analysis

Between-group comparisons were performed by ANOVA followed by post-hoc LSD tests or by the Kruskal-Wallis (K-W) non-parametric ANOVAs, depending of the distribution of data. No correction for repeated measures was applied, due to the non-independence of the analyzed variables. Cronbach's alpha of 15 items was used to examine the reliability (internal consistency) of the DCDQ. Principal component analysis with Varimax rotation²⁸ was used to study the construct validity of the Italian version of the DCDQ including only clinical groups. Principal component analysis represents the statistical multivariate strategy of choice when aiming to reduce a large number of variables down

to a small set of components.²⁸ By its very nature, principal component analysis is an exploratory and descriptive approach, yielding stable and reliable models if a minimum of approximately 10 subjects per variable is analysed.²⁸ For this aim four different factor extraction techniques were tested (principal components, unweighted least squares, image factoring, and maximum likelihood factoring, followed by varimax rotations). Separate linear regression analyses for each group were conducted for examining the association between inattentive, hyperactive-impulsive SNAP-IV and M-ABC subscales scores (independent variables) and factor scores of each component (dependent variable).

Statistical significance was set at a nominal two-tail $p < 0.05$, unless otherwise specified. Statistical analyses were performed using SPSS software release 18.0.

3. Results

At the end of the assessments, the groups were composed by 33 children with ADHD (mean age 7.8 years; SD: 1.9; range: 5-11.4 years), 30 with DCD-only (mean age 8.4 years; SD: 2.3; range: 4.7-12 years) and 33 with ADHD/DCD (mean age 7.7; SD:1.7; range: 5-12 years). Four children with ADHD and three with DCD that showed M-ABC total score between the 6th and 14th centiles were excluded. In the control group, no children reported a clinical history of poor motor performance or marked delays in achieving developmental motor milestones, or a M-ABC with total score $\leq 15^{\text{th}}$ centile, and they did not report symptoms suspicious for ADHD.

The four groups did not differ for age ($F=1.190$; $df=127$; $p=0.316$) or gender ($\chi^2(3)=4.864$, $p=0.182$). Table 1 summarizes the sample composition, the demographic characteristics and descriptive statistics for each clinical group and the control group.

Quantitative analysis of SNAP-IV revealed that children with ADHD/DCD showed a higher frequency of inattentive symptoms and more hyperactivity and/or impulsivity compared to children with ADHD-only, while children with DCD-only showed the lowest scores in both core ADHD symptoms.

The descriptive statistics (mean \pm SD) and the ANOVA results for DCDQ and M-ABC are reported in Table 2. All clinical groups significantly differed from controls in DCDQ and ADHD-only showed better scores in motor control compared to DCD-only and ADHD/DCD groups. As expected, DCD-only and ADHD/DCD displayed more severe pattern of motor impairment in M-ABC, compared to ADHD-only and controls, in particular in manual and balance abilities, respectively (Table 2).

Since Cronbach's alpha of 15 items was high for all clinical groups: ADHD-only 0.908; ADHD/DCD 0.858; DCD only 0.812, such as item-total correlation coefficients, we decided to perform further PCA analyses in order to improve its psychometric properties for a better differentiation among

clinical groups. A five factor PCA followed by Varimax rotation with Kaiser normalization²⁸ showed the best adaptability and accounted for 72% of the variance (Table 3). The five components are labelled (1) “*control during movement: with the ball*”, (2) “*control during movement: running and jumping*”, (3) “*fine motor handwriting*”, (4) “*planning*” and (5) “*general coordination*”. PCA showed that the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.81 (Bartlett’s test of sphericity $p < 0.0001$), demonstrating these data as suitable for PCA.

To dissect the underpinnings of this component model, we analyzed the distribution of factor scores in the three clinical groups using a parametric ANOVA. The highest discriminatory power is evident for components 2 “*control during movement: running and jumping*” ($p = 0.021$) and 5 “*general coordination*” ($p = 0.022$). Post-hoc LSD comparisons showed that ADHD-only performed significantly better than ADHD/DCD in “*control during movement: with the ball*” ($p = 0.036$) and from DCD-only in “*planning*” ($p = 0.041$), while ADHD only and ADHD/DCD children performed significantly better than DCD-only children in “*control during movement: running and jumping*” ($p = 0.007$ and $p = 0.046$, respectively). Conversely, the two clinical groups with ADHD showed significantly decreased performance in “*general coordination*” compared to DCD-only children (ADHD-only $p = 0.010$; ADHD/DCD $p = 0.023$). The component 3 “*fine motor handwriting*” was not different between the three groups.

The pattern of association between factorial scores, derived from each component, and inattentive-hyperactive symptoms, showed: 1) a negative association between “*control during movement: jumping and running*” and the component “*general coordination*” factors with inattentive symptoms among ADHD-only; 2) a negative association with the “*control during movement: with the ball*” and “*planning*” and a positive correlation with the “*control during movement: jumping and running*” factor scores with hyperactivity symptoms among the ADHD/DCD group; 3) a positive association between the “*planning*” factor scores and hyperactive-impulsive symptoms was found among DCD-only children (Table 4).

With regard to M-ABC scores subscales, we found a negative association between manual skills and “*control during movement: running and jumping*” factor scores in ADHD-only; a positive association between the component “*general coordination*” factor scores and manual skills in ADHD/DCD children; and a negative association between “*control during movement: jumping and running*” and balance skills in DCD-only children (Table 4).

4. Discussion

The main aims of this study were to examine the utility of DCDQ in identifying motor functioning in daily activities that better differentiated ADHD-only, DCD-only and ADHD/DCD groups and to

characterize the influence of ADHD symptoms and of motor difficulties on specific DCDQ motor abilities. At a general analysis, all clinical groups showed worse skills in motor activities when compared to typically developing children and small differences between the clinical groups. Thus, the first evidence of our study is that children with ADHD-only present skill challenges in daily activities captured by DCDQ, even if they do not fulfil the DSM-5 criteria for DCD.^{29,30} According with Ghanizadeh et al.³¹ although the internal reliability of the DCDQ was high for the full scale, factor analysis indicated that the fit with original factor structure of the DCDQ was poor for the clinical ADHD population. PCA to 5 components improved the psychometric properties and provided distinct items that better discriminate the clinical groups. Moreover, the strong associations between item scores of each component with both SNAP-IV inattentive or hyperactive-impulsive and M-ABC subscales scores gave interesting information about risk factors of specific motor activities in each clinical group, suggesting considerations about the underlying mechanisms.

At a detailed exam of each PCA component, the DCD-only group showed worse performance when compared to both ADHD groups for “*control during movement: jumping and running*”. Among children with DCD, M-ABC balance represented the predictor that better explained the worse performance in these activities. Instead, attention and manual skills in ADHD-only and hyperactivity/impulsivity deficit in ADHD/DCD represented the predictors in these clinical groups. Balance skills demand the integration of multiple sensory,^{32,33} proprioceptive,³⁴ kinesthetic information for postural control³⁵ that, consistently with our findings, are reported to be significantly impaired among DCD only. Deficit in balance also delays the time of automatization and speed and motor control of these performances, and this impairment reflects in slow learning of new complex motor skills such as in sports, less enjoyment and engagement in participation.³⁶ In contrast, higher inattentive symptoms and manual dexterity were risk factors for lower motor jumping and running abilities in ADHD-only, according with studies on this topic reporting difficulties in motor timing linked to attention in tasks that require variation of velocity and rhythmicity and hand-foot movement coordination in children with ADHD.^{9,37} Higher hyperactive-impulsive symptoms scores in ADHD/DCD were positively associated to higher scores in these motor abilities. Pitcher et al.³⁸ did not report any difference among ADHD hyperactive-impulsive when compared to typically developing children in motor jumping and running abilities, while ADHD-Inattentive reported higher difficulties. Although we did not study specific subtypes but total scores of inattention and hyperactive-impulsive symptoms, it is presumable that higher hyperactive-impulsive scores in ADHD-DCD, represent a protective factor for these specific motor abilities.

Conversely, hyperactivity-impulsive played a risk factor for ADHD/DCD in “*control during the movement: with the ball*” factor, where this clinical group reported worse performance compared to ADHD-only.

Studies reported that ADHD are less accurate than typically developing children in timing phases of tracking and hitting the ball.³⁹ Lower accuracy of motor timing has been suggested to be linked to impulsivity and to inhibitory control deficit mainly in ADHD/DCD⁴⁰ in the preparation of a response, in stopping an in-progress response, and to manage the interference.⁴¹ Discordant results relative to protective and risk function of hyperactive-impulsive predictor in jumping-running and ball motor abilities could be due to different mechanisms involved in two motor tasks; this consideration is supported also by their collocation in two distinct factors of the PCA analysis.

As expected, both groups with ADHD reported higher deficit vs. DCD-only in the items of “general coordination” maintaining the sitting position or moving clumsy. These findings support the critical under-regulation of physical movement control closely linked to core symptoms of ADHD as a distinctive marker of this condition. Among ADHD-only, inattention resulted to be a predictive factor for lower abilities in the “*general coordination*” component, at the same time we found a positive association between manual M-ABC abilities and high motor abilities for this DCDQ factor in ADHD-DCD, which seems to be counterintuitive. In support of the latter, Pitcher et al. 2002 reported that poor force and slower reaction time in fine motor ability of ADHD/DCD were due to the association with DCD. Since M-ABC manual dexterity items measure the time of execution of the performance whereas DCDQ general coordination items regard the postural and dynamic organization of the body, it is presumable that slower reaction time, although negatively impacting on M-ABC manual dexterity evaluation, promoted a better motor self-control of skills linked to the general coordination in ADHD-DCD.

We did not find any predictor in DCD-only children. It is presumable that multiple mechanisms crossing different M-ABC motor skills could interact for this result.

Despite a common impairment in all clinical groups in “fine motor handwriting”, between-group significant differences or specific risk predictors were not observed. Among ADHD, most studies suggested a difficulty in parameterizing movements in a consistent way⁴² because of fluctuations of visual attention invalidating the stability of the stroke within motor patterns²⁹ or deficit in divided attention between the visual and motor tasks.^{43,44} Among DCD-only children, an altered strength pressure and more airtime movement and erasements or overwritten letters were suggested to supply information about perceptual aspect of the motor act to form the letter within organized motor patterns, despite of correct height and size of the letter.⁴⁵ Based on the above literature, the lack of

predictor factors could be due to involved processes, not intercepted by the core ADHD symptoms nor by specific motor deficit.

ADHD-only resulted to better perform in motor abilities that required planning tasks compared to DCD-only and ADHD-DCD. Low planning motor abilities reported in all clinical groups, were hypothesized to be dependent on a deficit in precision planning of motor time, as an outcome of working memory in ADHD-only,^{46,47} whereas in DCD-only and ADHD/DCD children, seems due to a deficit of perceptual organization and motor programming.^{23,48} In both ADHD/DCD and DCD-only we found a strong association between “planning” and hyperactive-impulsive symptom scores, but while higher scores were related to lower planning DCDQ scores in ADHD-DCD, they resulted to show a positive association with planning skills among DCD. To date, the role of ADHD symptoms in DCD has not been delineated and since the hyperactive-impulsive symptoms in DCD-only had subclinical values, this finding could be considered as a suggestion to investigate on this topic.

Finally, some limitations must be acknowledged. First, the sample sizes were relatively small; thus, this study must be considered as a preliminary contribution to this topic. Second, we did not take into account the eventual presence of comorbidities, such as dysgraphia, that should contribute to better define different profiles and the nature of motor problems underlying the handwriting difficulties. Third, we have considered only parents, although they resulted to be a reliable source of information; however, using both parents and teachers as informers should allow a greater accuracy of the results.

Conclusion

With the current model, DCDQ represents a sensible instrument to use in the assessment of children with ADHD and DCD in order to identify different severity in the impairment of specific daily motor activities, with and without reciprocal comorbidity. Moreover, specific ADHD symptoms or M-ABC subscales predictors of distinct motor daily DCDQ abilities, are consistent with different altered mechanisms reported in the literature and characterizing clinical groups.

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Authors' contributions

Each author made a substantive intellectual contribution to the study.

Maria Grazia Melegari: conceptualization and study design; data analysis, data collection and interpretation; preparation and revision of the manuscript.

Oliviero Bruni: conceptualization, data interpretation; revision of the manuscript.

Robert Sacco: data analysis, data interpretation; revision of the manuscript.

Anna Costa: data collection and interpretation; revision of the manuscript.

Claudia Russo: data analysis, data interpretation; revision of the manuscript.

Raffaele Ferri: revision of the manuscript; approved the final manuscript as submitted.

Barbara Caravale: conceptualization and study design; data collection and interpretation; revision of the manuscript.

All Authors read and approved the final version of the manuscript.

Table 1. Descriptive statistics (age, gender, % of suspect DCD, ADHD subtypes)

		ADHD ^a N=33(%)	ADHD/DCD ^b N=33(%)	DCD ^c N=30(%)	Controls ^d N=35(%)	χ^2	<i>p</i>
Gender	<i>Boys</i>	31 (93.9)	31 (93.9)	25 (83.3)	28 (80)	4.864	0.182
	<i>Girls</i>	2 (6.1)	2 (6.1)	5 (16.7)	7 (20)		
Indication of, or suspect for DCD		20 (60.6)	27 (81.8)	29 (96.7)	5 (14.3)	54.558	0.001
ADHD subtype*	<i>Inattentive</i>	21 (63.6)	10 (30.3)			7.758	0.02
	<i>Hyperactive</i>	6 (15.2)	7 (21.2)				
	<i>Combined</i>	7 (21.2)	16 (48.5)				
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	F	p
Age		7.70 (1.9)	7.39 (1.7)	8.20 (2.2)	8.23(1.9)	1.19	0.316
Total M-ABC		5.20 (2.6) ^{b,c}	20.24 (5.0) ^{a,d}	20.58 (4.6) ^{a,d}	6.13(3.4) ^{b,c}	146.56	0.001
Total DCDQ		47.73 (13.9) ^d	42.52 (9.5) ^d	41.23 (7.9) ^d	62.71(8.6) ^{a,b,c}	31.05	0.001
Mean ADHD Total score*	<i>Inattentive</i>	17.03 (4.1)	20.65 (3.7)	8 (2.7)		9.80	0.03
	<i>Hyperactive</i>	13.14 (5.6)	19.6 (4.3)	6.2 (4.3)		18.88	0.00

*based on SNAP-IV cut-off

Table 2. Descriptive statistics of DCDQ and M-ABC sub-dimensions and differences among groups (ANOVA)

Variables	ADHD ^a	ADHD/DCD ^b	DCD ^c	CONTROLS ^d	F	<i>p</i>
Motor Control	21.64(5.96) ^{b,c,d}	17.91(4.20) ^{a,d}	17 (3.57) ^{a,d}	24.74(4.14) ^{a,b,c}	20.100	.001
Fine motor/handwriting	12.45(4.22) ^d	10.52(3.34) ^d	10.17 (3.37) ^d	17.06(2.70) ^{a,b,c}	28.600	.001
General Coordination	15.48(4.68) ^d	13.88(3.86) ^d	14.07 (2.75) ^d	20.91(3.43) ^{a,b,c}	26.107	.001
Manual abilities	3.21(2.72) ^{b,c}	9.39(3.24) ^{a,d}	7.42 (3.64) ^{a,d}	2.49(2.35) ^{b,c}	40.687	.001
Ball Skills	.773(1.04) ^{b,c}	4.29(2.14) ^{a,d}	4.58 (2.40) ^{a,d}	.871(1.66) ^{b,c}	40.782	.001
Balance	1.24(1.64) ^{b,c}	6.65(2.76) ^{a,d}	8.23 (3.12) ^{a,d}	2.53(2.21) ^{b,c}	57.419	.001

Note. Groups that result significantly different at LSD test (p,001).

Table 3. Results related the five factors Principal Component Analysis (PCA)

	Control during movement: with ball	Control during movement: running jumping	Fine motor handwriting	Planning	General coordination
Throws ball	0.793	0.283	0.262	0.070	0.086
Catches ball	0.700	0.281	0.079	0.240	0.003
Hits ball / birdie	0.674	0.181	0.380	0.256	0.053
Jumps over	0.298	0.702	0.026	0.245	0.123
Runs	0.186	0.769	0.104	0.276	0.037
Plans activity	0.171	0.347	-0.014	0.776	0.017
Writes fast	0.154	0.115	0.725	0.485	-0.027
Writes legibly	0.190	0.190	0.847	0.121	-0.035
Effort and pressure cuts	0.301	0.097	0.797	-0.108	0.238
Likes sports	0.266	0.086	0.365	0.643	0.147
Learning new skills	0.163	0.789	0.190	0.062	0.138
Quick and competent	0.515	0.591	0.242	-0.088	0.058
“Bull in shop”	0.715	0.139	0.138	0.132	0.161
Does not fatigue	0.249	0.013	-0.003	0.253	0.760
	-0.026	0.208	0.111	0.105	0.829

Extraction method: principal components analysis. Rotation Method: Varimax with normalization Kaiser (convergence for rotation performed in 6 iterations).

Table 4. Regression analyses: association between ADHD SNAP-IV and ABC-M skills scores with 5 components

Independent Variables	control during movement: with the ball β (p)	control during movement: Running-jumping β (p)	Fine motor handwriting β (p)	Planning β (p)	General coordination β (p)
<i>Inattentive symptoms</i>					
ADHD	-0.110 (0.534)	-0.423 (0.016)	0.097 (0.595)	-0.273 (0.126)	-0.342 (0.048)
ADHD-DCD	0.032 (0.852)	0.035 (0.842)	-0.111 (0.581)	0.207 (0.247)	-0.162 (0.420)
DCD	0.548 (0.065)	0.205 (0.504)	0.300 (0.332)	0.223 (0.348)	0.347 (0.258)
<i>Hyperactive/impulsive</i>					
ADHD	-0.276 (0.124)	0.113 (0.498)	0.119 (0.516)	0.184 (0.298)	-0.227 (0.181)
ADHD-DCD	-0.546 (0.003)	0.486 (0.010)	0.089 (0.657)	-0.502 (0.008)	0.050 (0.803)
DCD	-0.272 (0.341)	0.044 (0.895)	-0.237 (0.439)	0.501 (0.045)	-0.205 (0.499)
<i>Manual skill</i>					
ADHD	-0.153 (0.438)	-0.400 (0.047)	0.174 (0.397)	-0.155 (0.457)	-0.129 (0.529)
ADHD-DCD	-0.289 (0.164)	-0.224 (0.301)	0.170 (0.391)	-0.099 (0.640)	0.426 (0.031)
DCD	-0.108 (0.608)	-0.189 (0.287)	0.241 (0.239)	-0.002 (0.991)	-0.240 (0.248)
<i>Ball skills</i>					
ADHD	-0.368 (0.055)	-0.091 (0.620)	-0.130 (0.502)	-0.114 (0.562)	-0.165 (0.396)
ADHD-DCD	-0.244 (0.178)	-0.038 (0.841)	0.105 (0.543)	-0.132 (0.478)	-0.136 (0.413)
DCD	0.298 (0.178)	-0.330 (0.080)	-0.354 (0.100)	-0.297 (0.182)	-0.223 (0.299)
<i>Balance skills</i>					
ADHD	0.015 (0.939)	-0.289 (0.146)	0.234 (0.257)	0.005 (0.980)	-0.160 (0.437)
ADHD-DCD	-0.044 (0.829)	0.154 (0.475)	0.334 (0.098)	-0.192 (0.366)	0.090 (0.633)
DCD	0.038 (0.859)	-0.558 (0.004)	-0.288 (0.165)	-0.201 (0.350)	-0.220 (0.292)

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