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Balance control in individuals with developmental coordination disorder: A systematic review and meta-analysis.

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Abstract

BACKGROUND. Although it is recognized that the majority of children with developmental coordination disorder (DCD) have balance deficits, comprehensive insights into which balance domains are affected, are still lacking in literature.

RESEARCH QUESTION. To what extent is balance control deficient in individuals with DCD compared to controls?

METHODS. Pubmed, Scopus and Web of Science were systematically searched. Risk of bias was assessed with the Scottish Intercollegiate Guidelines Network checklist for case-control studies. Mean and standard deviations characterizing balance control were extracted to calculate standardized mean differences (SMD) and pooled, if possible, using Review Manager.

RESULTS. The results of 31 studies (1152 individuals with DCD, 1103 typically developing (TD) peers, mean age 10.4 years old) were extracted of which 17 were used for meta-analysis. The mean SMD for the balance subscale of the Movement Assessment Battery for Children was 1.63 (pooled 95%CI =[1.30;1.97]), indicating children with DCD to perform significantly poorer than their TD peers. Force plate studies also revealed that children with DCD present with a larger sway path during bipedal stance with eyes closed (pooled mean SMD=0.55; 95%CI=[0.32;0.78]). Children with DCD tend to have direction-specific limited stability limits and task-independent delayed onset of anticipatory postural adjustments.

INTERPRETATION. Children with DCD perform poorer on different domains of balance compared to TD peers. Future research should focus on comprehensive balance assessment in these children, preferably using a longitudinal design.

Keywords: “postural balance”, “balance control”, “developmental coordination disorder”, “motor skills disorders”

Introduction

Worldwide, Developmental Coordination Disorder (DCD) accounts for 5-6% of school-aged children [1, 2]. These children experience difficulties in acquiring and performing a large set of motor skills, both gross and fine, in such a way that their motor performance is substantially below age-norms [1, 2]. Importantly, these motor control difficulties cannot be explained by intellectual disability, visual impairment or an underlying neurological condition, such as cerebral palsy [1, 2]. The presence of motor delay often persists into adolescence and interferes with participation in physical activities of daily life (ADL) [1, 3].

One of the main motor control problems in children with DCD is deficient balance control [4-6]. Essentially, controlling balance refers to the child's ability to keep or regain the centre of mass within the base of support during activities, ultimately to prevent a fall or a failure of results within an activity. However, consensus exists among researchers in this field that balance control comprises much more than that [7-9]. Children should be able to present different control strategies depending on the context at hand, e.g. reacting to an unexpected external perturbation versus moving voluntarily which produces an expected internal perturbation that needs to be anticipated [7-9]. Movement strategies (ankle, hip or stepping strategy) should be flexibly applied in both static (stable base of support) and dynamic situations (moving base of support) [8]. Children also need to develop the ability to orient themselves in space through perception of gravity, surfaces, and verticality. Children will gradually learn to integrate this incoming sensory information to keep the body balanced [7-9]. Finally, the cognitive processes that allow learning and divided attention are crucial to remain balanced as well [7-9].

The most frequently used task to assess the prevalence of balance deficits in children with DCD is a timed one leg stance task (estimated at 60-87% of all cases) [4-6, 10]. However, this task only measures a very limited aspect of activities or tasks that requires balance control. Unlike standing, the centre of mass during walking or moving between postures is not constantly within the same base of foot support; i.e. it moves synchronically with the changing base of support when moving from one foot or one posture to the next. Keeping balance during walking or changing posture (dynamic balance) requires complex

control of a moving centre of mass. Apart from the type of balance task (static versus dynamic), the environment is also essential for balancing, e.g. walking in the dark (sensory perturbation) on uneven terrain (support surface perturbation) and complex activity demands (dual tasks) can hamper balancing [7, 11]. Currently, the prevalence of deficient balance control in children with DCD might therefore be underestimated. This highlights that an integrated approach for exploring balance control in children with DCD is necessary.

To determine which aspects of balance control are affected directly relates to the conceptual framework used to define it. For example, a perceptual and ecological point of view on motor control has stimulated investigations into the nature of movements during postural and suprapostural tasks, i.e. tasks that require postural control, but have another behavioural goal such as fitting a block through a small opening while standing quietly [12]. This research has led to insights into the task-dependency of coordination dynamics and the development of new measures for postural control [11, 12]. Although ecologically valid, such an approach does not allow for the identification of specific dysfunctional aspects of balance control. In 2009, Horak and colleagues integrated the different aspects of balance control into a conceptual framework consisting of five domains: limits of stability and verticality, anticipatory postural adjustments and transitions, reactive postural responses, sensory orientation, and stability in gait [8]. The domain *limits of stability and verticality* refers to the ability to move the body's centre of mass over its base of support and the extent to which this is possible (limits of stability) as well as the internal representation of gravitational upright (verticality). *Anticipatory postural adjustments and transitions* are active movements of the body's centre of mass in anticipation of a voluntary movement caused by feedforward projections. As a result of slips, trips and pushes, *reactive postural responses* are automatically elicited through short, medium and long proprioceptive feedback loops. *Sensory orientation* is established by integrating sensory information and using it for spatial orientation. The ability to adequately catch a falling body's centre of mass by a changing foot- or base of support is referred to as *stability in gait*. Importantly, these balance domains can be influenced by the presence of *biomechanical constraints* (e.g. muscle strength), i.e. a sixth domain musculoskeletal requisites for balance control. [8]

This conceptual framework has shown to be of use in the assessment of balance control in elderly people, stroke survivors, patients with Parkinson's disease and children with cerebral palsy, allowing researchers and clinicians to obtain a more in-depth understanding of balance deficits in the population of interest [13, 14]. Such a comprehensive and targeted framework is particularly useful to set relevant and specific treatment goals [8]. By mapping the children with DCD's ability to control their balance in accordance with this framework, detailed insights can be gained into the extent to which balance deficits are present in these children.

Although it is recognized that the majority of children with DCD have balance deficits, comprehensive insights into which balance domains are affected, are still lacking in the literature. The aim of this systematic literature review and meta-analysis is therefore to explore balance deficits in individuals with DCD with respect to the different balance domains by comparing their performance to that of typically developing peers and/or groups of individuals with other types of neurodevelopmental disorder. This way, insights can be gained into whether all or specific balance domains are compromised and to what extent, optimising individualised treatment approaches.

Methods

This systematic review is written according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [15] and registered on PROSPERO (CRD42019123177).

Search query and databases

A systematic literature search was conducted in Pubmed, Web of Science and Scopus (last search update August 18th 2020). The search query comprised controlled terminology and free text terms relating to "developmental coordination disorder" and "balance". No date restrictions or filters were applied. The search queries are provided in detail in Appendix 1. After the selection process, the references of included studies were hand searched to identify potentially overlooked citations.

Selection criteria

Relevant studies were identified using predefined selection criteria according to the Population Intervention Comparison Outcome Study Design (PICOS) method:

1 ***Population***: Individuals aged 5 years or older, diagnosed with (probable) DCD using the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) or - 5th edition (DSM-5), or the International Statistical Classification of Diseases and Related Health Problems, 10th edition (ICD-10) criteria were of interest [1]. The specific criteria are presented in Appendix 2. Because of the large overlap between neurodevelopmental disorders, individuals with DCD with and without comorbidity were included. All studies were excluded in which not DCD but another neurodevelopmental disorder was the primary population of interest e.g. Autism spectrum disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), specific language disorders (SLD), developmental dyslexia (DD) and other learning disorders.

2 ***Comparison***: Performance on balance tests of individuals with DCD had to be compared to typically developing (TD) or healthy controls (children or healthy adults) or individuals with other neurodevelopmental disorders without DCD such as ASD, ADHD, dyslexia, specific language disorders, etcetera.

3 ***Outcome***: Balance control had to be measured using a standardized assessment tool for which numeric data (mean and standard deviation/median and interquartile range) were reported. The tests had to be either specific balance tests (e.g. dynamic posturography) or balance subscales of a generic developmental motor scale (e.g. balance subscale of the Movement Assessment Battery for children, 2nd edition – MABC-2). If a generic developmental motor scale was only used as a selection criterion (e.g. MABC Total Impairment Score and balance subscale score below the 5th percentile) and not as an outcome measurement for balance, the study was excluded. This was done to avoid detection bias.

4 ***Study design and publication type***: Original studies written in English, Dutch, French or German, with a case-control design were considered relevant. Conference proceedings/-reports,

editorials, letters, case studies/-series, abstract only, (systematic) reviews and meta-analyses were excluded.

- ***Risk of bias***: Studies that received a rating of low methodological quality based on the Scottish Intercollegiate Guidelines Network (SIGN) [16] assessment were excluded.

The selection criteria were applied by two independent researchers (AT, EV) in the same sequence (population, comparison, outcome and study design) and in two phases (phase 1: title and abstract; phase 2: full text). After each phase, a consensus meeting was held to discuss the results of the article selection. In case of doubt or disagreement in phase 1, articles were screened on full text. In phase 2, a third reviewer's opinion (KK) was decisive. After phase 2, the references of the included studies were screened to ensure no relevant literature was missed. The selection process is presented in Appendix 3.

Risk of bias assessment

The SIGN is a validated checklist for case-control studies and was applied to assess risk of bias in individual studies [16, 17]. The checklist assesses internal validity through selection and assessment bias, confounding factors and the use of statistical analyses and provides an overall quality assessment: **high quality** (++) when the majority of criteria were met, implying little or no risk of bias and results unlikely to be changed by further research (≥9/11 criteria met), as **acceptable quality** (+) when most criteria were met, implying methodological flaws with an associated risk of bias and conclusions may change in the light of further studies (6-8/11 criteria met) and as **low quality** (0) when either most criteria were not met (≤5/11) or significant flaws relating to key aspects of the study design were identified and conclusions likely to change in the light of further studies [16]. Studies were not included in the review as prescribed by the SIGN checklist guidelines in case of: 1) low quality or 2) if the study did not (a) adhere to clear definitions of the source population, (b) comment on how cases were selected, (c) address the influence of confounding factors or (d) provide a statement on psychometrics of the outcome measures or (e) base its main conclusions on primary outcomes [16].

Two independent researchers (CJ, EV) assessed risk of bias and discussed the results in a consensus meeting.

Data-extraction, -synthesis -analysis

After applying the selection criteria and risk of bias assessment, specific data to characterize the study populations, the applied outcome to assess balance control and their results were extracted. First, general population characteristics (number of participants per group, age range, sex distribution, mean values and standard deviation (SD) for age, height, weight and body mass index (BMI)) and specific characteristics for the patient groups (applied criteria for assigning diagnosis, presence of comorbidities) were mapped.

Secondly, numeric values (mean and SD/median and interquartile range (IQR)) for each outcome variable were extracted. Data obtained with *a balance subscale* of a generic motor scale were grouped and analysed, e.g. the MABC(-2). When data were derived from *specific balance tests*, e.g. the sensory organization test, the data were grouped and categorized according to five domains investigating balance control based upon the type of balance task or perturbation under investigation [8]: 1) Stability limits and verticality, 2) Transitions and anticipatory postural adjustments, 3) Reactive balance, 4) Sensory orientation and 5) Stability in gait. Table 1 provides an overview of the tests and their classification according to the balance domains. The domain mapping the biomechanical constraints, such as muscle strength and alignment, was not investigated. Although relevant for this group, this aspect of functioning was beyond the scope of this paper.

For all outcome measures, a standardized mean difference (SMD) was calculated using Hedges' g ($SMD = \frac{\bar{X}_{DCD} - \bar{X}_{CONTROLS}}{SD_{pooled}}$) [18]. Median values were assumed to equate the mean and the IQR was converted to standard deviations (IQRx0.75), using Hillier and Inglis-Jassiem's formula [19]. The SMD values were considered to represent a significant difference if the 95% confidence interval did not include zero [18]. The magnitude of the SMD can be interpreted as follows: small (SMD $\leq$ 0.2), medium (0.2 < SMD < 0.8) or large (SMD $\geq$ 0.8) [18]. If at least two identical outcome variables (e.g. equilibrium score) of the same task (e.g. standing on a moving platform with eyes closed) were available, the numeric data were entered in Review Manager (RevMan 5) to present the individual and the subtotals of the SMD (graphically). The SMD subtotals were estimated with a random effects model. The I^2 statistic

describes the percentage of variation across studies that is due to heterogeneity rather than chance [20]. Higher I^2 values indicate more heterogeneity among individual studies [20].

If multiple publications of the same research group were included, authors were contacted to establish whether the same sample was reported. When confirmed by the authors this was reported, avoiding reporting of duplicate results.

Results

Search results

The search query resulted in 481 unique hits, of which 65 were screened on full text. Finally, 31 studies met all selection criteria [5, 10, 21-51] of which data were extracted. Most studies were excluded in phase 2 (n=18) because they did not fulfil the criteria of the outcome of interest, 10 of which did not report numeric data representing balance control [52-61]. Three studies were excluded because of low methodological quality [39, 40, 62]. The data extracted from 17 studies [10, 21, 23-25, 31-35, 37, 41, 42, 45-48] could be pooled for meta-analyses, because they reported identical outcome variables for the same task. The selection process' flowchart is shown in Appendix 3.

Risk of bias in individual studies

Table 2 provides an overview of the risk of bias assessment. One study was of high quality [24], 30 studies had acceptable quality [5, 10, 21-23, 25-38, 41-51] and three studies were of low quality and had to be rejected [39, 40, 62]. Of the studies of acceptable to high quality, twenty included studies (64.5%) did not report the percentage of recruited children to actually participate in each study group [5, 10, 21, 25, 28, 30-38, 42-44, 48-50], twenty-five included studies (80.6%) did not report confidence intervals [5, 10, 21-23, 25-31, 34, 36-38, 41-47, 49, 50] and none of the studies transparently reported whether they had taken measures to prevent knowledge of the primary exposure influencing case ascertainment (risk for detection bias, nor compared the participants with the non-participants (risk for selection bias).

Population characteristics

All included studies compared balance in individuals with DCD to TD peers. Across the 31 included studies, balance control was assessed in a total of 1152 individuals with DCD (819 males, mean age 10.4 (5.0) years old) and 1103 individuals with TD (733 males, mean age 10.4 (5.2) years old). Thirty studies reported results on children with(out) DCD [5, 10, 21-29, 31-38, 41-51] between age 4 [25] and age 17 [36, 49, 50]. Three studies reported on adults with(out) DCD [30, 36, 49]. Two studies reported data on the same sample [28, 29]. Table 3 provides a description of the samples with respect to sex distribution, age, height, weight and BMI.

The included studies either reported children with a previously confirmed diagnosis of DCD [5, 25, 27-29, 31-35, 38, 43, 44, 48], or children who met the diagnostic criteria of the DSM-IV [37, 41, 42], the DSM-5 [30, 36, 49, 50] or the ICD-10 [23, 45-47]. In two studies children were selected by the physical therapists or physical therapy departments where they received treatment [10, 26] making it assumable that these children received a diagnosis at some point. Specifics on the presence of a confirmed diagnosis and the degree to which the diagnostic criteria were met in the included studies are shown in Appendix 2.

Performance on balance subscales of generic motor scales

Nine studies reported on the balance subscale score of the MABC [10, 21, 23-25, 32, 35, 37, 42], two on the balance subscale score of the MABC-2 [31, 48] and one study on the running speed and agility part of the Bruininks-Oseretsky Test for Motor proficiency (BOT-MP) [21]. Two studies were not considered for data-extraction, because the MABC data were part of the selection criteria, i.e. poor motor and balance performance [27, 45]. For the MABC and MABC-2 balance subscale sufficient data were available to be pooled and analysed.

The overall mean SMD for the MABC balance subscale totalled 1.63 (pooled 95% CI = [1.30;1.97]) for a total of 1004 participants, indicating a large difference with significantly poorer balance in the DCD group, but with a large amount of heterogeneity (I^2=79%) among the included studies (Figure 1).

For the MABC-2 balance subscale the overall mean SMD was -0.95 (pooled 95% CI= [-1.52; -0.39]) accounting for 211 participants. This indicates again, a significant, large difference between groups in favour of the TD children, but also very heterogeneous results among the studies (I^2=70%).

In both cases, this suggests that between studies, children with DCD perform differently on the same balance tasks compared to their TD peers, indicating subclassification is needed.

Running speed and agility (BOT-MP subscale) was significantly poorer in children with DCD compared to TD peers (SMD=-1.44, 95% CI= [-1.87; -1.02] [21].

Performance on specific balance tests

In 26 studies specific balance tests were used [5, 10, 22, 24-34, 36-38, 41-47, 49-51]. Table 1 depicts the investigated domains of balance control and the corresponding tests and outcome variables.

Functional stability limits and verticality

Two studies reported on the functional limits of stability during bipedal stance [5, 42], both using a different method (Table 1). Overall, children with DCD performed similarly to their controls (Appendix 4), except when they had to move towards their backward limits of stability [5]. None of the included studies reported on verticality.

Transitions and anticipatory postural control

Tasks in this domain comprised one leg stance [25, 27, 38, 51], kicking a ball [38], taking the stairs [38] and making rapid goal-directed arm movements [10], which were assessed in five studies. Table 1 depicts the applied outcome measures. None of the available data could be pooled because of differences in applied tasks or outcome measures (Appendix 5). When addressing anticipatory control, postural muscle activation prior to the voluntary movement is of interest. Three studies applied electromyography [10, 38, 51], revealing a trend of deficits in children with DCD during limb movements in the anterior direction. Compared to their TD peers, children with DCD present with slower contractions of the abdominal muscles and faster contractions of the erector spinae during fast arm movements [10], fewer trials comprising preparatory contractions of the tibialis anterior muscle when standing on one leg, kicking a ball and taking stairs [38] and shorter times to the peak contractions of gastrocnemius, tibialis anterior, hamstrings and rectus femoris during the Y-balance test in the anterior direction [51].

Timed one leg stance (item on the MABC) induced large differences when expressed as a standard score [25] in favour of TD children, whereas this is not the case for performance expressed in seconds [27].

Reactive postural control

In two studies reactive control mechanisms were assessed [24, 32]. For this purpose, three different types of tests were applied, summarized in Table 1: the motor control test (neurocom) [24] and by giving the child a push forward when standing quietly [32]. Both methods elicit a similar muscular reaction to maintain the upright position and prevent a fall. As shown in Appendix 6, the results are conflicting: in response to a push, the contractions of hamstring and gastrocnemius were significantly later in children with DCD compared to TD peers, which was not the case when the platform moved unpredictably in the backward direction [24].

Sensory orientation

Sensory orientation was assessed in 11 studies, eight of which data were pooled [31, 33, 34, 37, 42, 45-47] (Figure 2). The data were categorized according to the different sensory conditions, analogous with the composition of the sensory orientation test: 1) standing on firm surface with eyes open [31, 33, 34, 41, 45, 46] (Figure 2.1), 2) standing on firm surface with eyes closed [31, 33, 34, 41, 46, 47] (Figure 2.2), 3) standing on firm surface with a moving visual surround [31, 33, 34] (Figure 2.3), 4) standing on a moving platform with eyes open [31, 33, 34] (Figure 2.4), 5) standing on a moving platform with eyes closed [31, 33, 34] (Figure 2.5), 6) standing on a moving platform with moving visual surround [31, 33, 34] (figure 2.6) and 7) composite scores and sensory ratios [31, 33, 34, 37] (Figure 2.7).

During natural stance with eyes open (Figure 2.1) children with DCD have a significantly larger sway area (pooled SMD=0.35, 95%CI=[0.08;0.62]) [41, 45, 47], sway path (pooled SMD=0.40, 95%CI=[0.16;0.63]) [41, 46, 47] and equilibrium score (pooled SMD=-0.67, 95%CI=[-0.96;-0.37]) [31, 34], but a similar movement strategy (ankle versus hip) (pooled SMD=-0.22, 95%CI=[-0.55;0.11]) [33, 34] compared to TD peers. A strategy score near 100 indicates a full ankle strategy, whereas a score near 0 indicates a full hip strategy. As shown in Figure 2.3, similar findings were reported for standing on firm surface with a moving visual surround. During stance with eyes closed (Figure 2.2) similar results were found as for the eyes open condition, but here also significantly larger strategy scores were

seen in TD children compared to their peers with DCD (pooled SMD=-0.37, 95%CI=[-0.70;-0.04]) [33, 34], indicating children with TD use more ankle strategy than children with DCD.

In the more challenging conditions, where the support surface moves slightly, the same trend is seen for the equilibrium score and the strategy score as when the children stood on firm surface with eyes closed, but the magnitude of the SDM is larger (Figure 2.4, 2.5, 2.6). Thus, children with DCD show a larger amount of postural sway and more hip strategy while maintaining the position compared to TD peers. The relative influence of the sensory conditions (Figure 2.7) was consistently present for the composite score (pooled SMD=-0.80, 95% CI=[-1.08; -0.53]) [31, 34, 37] and all the sensory ratios: the somatosensory ratio (pooled SMD=-0.32, 95% CI=[-0.61;-0.03]), the visual ratio (pooled SMD=-0.54, 95% CI=[-0.78;-0.31]) and the vestibular ratio (pooled SMD=-0.55, 95%CI=[-0.89;-0.20]) [31, 33, 34]. However, all pooled results for the equilibrium score, the strategy score and the sensory ratios should be interpreted cautiously as it is unclear whether the children with DCD of these studies belong to the same sample.

Similar trends were seen for other outcome variables for the amount of postural sway when standing with eyes open or closed on firm surface or on foam (Appendix 7). With increasing task-difficulty, e.g. standing on one leg, children with DCD perform consistently poorer then their TD peers [46, 47].

Stability in gait

In seven studies balance during walking was investigated in four different walking conditions: 1) level walking versus obstacle crossing [28], 2) walking with and without vision [29], walking on treadmill at preferred walking speed [26, 44] and 4) walking on high-density foam sports mats [30, 36, 49, 50]. None of the available data could be pooled due to differences in tasks and/or outcome variables, or when outcome and task were similar, the same samples were reported in different papers (Appendix 8). The results mainly point towards the absence of consistent differences in step-time and centre of mass parameters between groups during walking.

Discussion

The aim of this systematic literature review and meta-analysis was to explore balance deficits in individuals with DCD. All included studies compared DCD individuals' performances to those of TD peers. The main findings of the review are that, compared to TD peers, individuals with DCD: 1) perform significantly poorer on balance subscales, derived from generic motor tests (see Figure 1), 2) tend to have more difficulties in their limits of stability and anticipatory postural adjustments (Appendix 5), 3) have significantly more difficulties to maintain a stable standing position in more complex sensory conditions, e.g. standing on a moving platform with eyes closed (Figure 2, Appendix 7), 4) overall, show similar gait parameters during walking (Appendix 8), and 5) conflicting results were found regarding reactive control (Appendix 6).

Children with DCD present with lower balance subscale scores on the MABC compared to TD peers. Considering the magnitude of the SMD and the proportion of the DCD group which would be below the mean of the control group [18], an SMD of 1.6 would indicate that 94.5% of the DCD group results would be below the TD group mean. Hence, these data suggest that most of the DCD children in the included samples did present with clinically relevant balance problems to some extent (pooled SMD =1.63, 95% CI=[1.30;1.97]). Figure 1 also indicated that heterogeneity in the results was too large. Finding the cause of the heterogeneity is important for making firm conclusions. Heterogeneity can be explained by differences between studies regarding the design, conduct, participants, exposure, outcomes but also the size and direction of the differences [20]. As this review only included studies with the same design, and data of the same outcome measure and metric were pooled, the heterogeneity is probably due to differences in participants across studies inducing imprecision (shown in Figure 1 by larger 95% confidence intervals [10, 23, 25, 37, 42]). The applied criteria for case ascertainment differ largely across studies (Appendix 2). For example, the selection criteria for objectifying the presence of motor performance below expectance regarding chronological age or intelligence vary across studies, e.g. MABC total impairment score below the 5th percentile [21, 23, 32, 35, 42] versus at or below the 15th percentile [10, 24, 25, 37]. Also, as shown in Appendix 2, the impact of the motor difficulties on the school- and/or daily activities (diagnostic criterion B) was not always addressed [10, 23, 25] and

when done, different approaches were used. Looking at the characteristics of the included participants, all children showed similar weight, height and BMI for their age (see Table 2). These factors were therefore not considered. The included age groups, however, differed among studies used in the meta-analyses (Figure 1). Balance is prone to developmental changes [7], but the impairment (Figure 1A) and standard scores (Figure 1B) are corrected for age. Based on the reported population characteristics, the differences across studies cannot be explained.

Although the MABC(-2) can be used to screen for a balance deficit, it does not provide any specifics on which balance domains are compromised. Moreover, the balance subscale comprises voluntary movements in static and dynamic situations, indicating it indirectly assesses anticipatory postural adjustments, and static and dynamic balance. Depending on the version of the MABC and the age band, the test also implements a proprioceptive perturbation during one leg stance. Thus, the MABC balance subscale addresses different domains of balance (i.e. anticipatory postural adjustments, and transitions, sensory orientation and stability in gait), but does not assess them separately. Furthermore, this test does not address other domains such as limits of stability, verticality, reactive postural responses and more complex sensory orientation. The latter might be confounding factors for the heterogenous MABC results.

Interestingly, Figure 2 indicates that sensory orientation is compromised in children with DCD [31, 34, 37, 41, 45-47]. In easier conditions (standing on firm surface with eyes open or a moving visual surround), children with DCD present with more sway, but use similar movement strategies, i.e. ankle strategy, than their TD peers. In more difficult conditions (moving platform, Figure 2.4-2.6), however, the differences become more pronounced and children with DCD start to use more hip strategy than their TD peers, though in both groups the ankle strategy also remains present [31, 33, 34]. This moving platform serves as an unpredictable base of support, which elicits small reactive postural responses to maintain the position as shown by the hip and ankle strategy. Perhaps, the difficulties in these specific sensory organization test conditions (see Figure 2) might rather be a result of deficient postural reactions than difficulties in sensory integration or reweighting. Indeed, as a result to a forward push, children with DCD also tend to need more time to reach a maximal contraction and a larger peak contraction of

the Hamstrings and Gastrocnemius muscles to counteract the perturbation and remain standing [32]. This confirms that children with DCD have trouble showing adequate reactive responses, but this should be interpreted with caution due to the conflicting results regarding the muscle onset latencies following a push versus a moving platform, shown in Appendix 6 [24, 32]. Furthermore, the results on the equilibrium and strategy score [31, 33, 34] should be interpreted cautiously as well. The three studies reporting these data are from the same authors. Based on the description of the sample and the age range it is unclear whether the children are part of the same sample. If this would be the case, the subtotals are no longer valid and the differences between DCD and TD children should be interpreted at the level of the individual studies.

Other authors measured postural sway during one leg stance with eyes open or eyes closed instead of using the sensory organization test paradigm (Appendix 7). When DCD children stand on one leg, they present with more sway than their TD peers both with eyes open and eyes closed [46, 47]. Although one leg stance was intended in the studies to decrease the base of support and therefore make the condition proprioceptively more difficult, inducing a sensory perturbation [46, 47], one leg stance has also been used to investigate anticipatory postural adjustments [38, 51] (Appendix 5). During quiet one leg stance, children with DCD have fewer trials with anticipatory onset of the tibialis anterior muscle [38]. Indeed, Kane and colleagues (2012) also showed that children with DCD have less adequate trunk muscle contractions [39]. The anticipatory postural adjustments are not only disturbed during quiet one leg stance, but also when taking stairs or kicking a ball or to prepare for rapid goal-directed arm movements [10, 38, 39], and therefore seem to be deficient regardless of the task at hand. It could therefore be that the sensory problems by the children with DCD exhibited in the more difficult tasks are also influenced by their deficient anticipatory control.

Thus, both *reactive and anticipatory balance mechanisms* seem to be disturbed in children with DCD compared to TD peers. The deficiency in these mechanisms can be related to the internal modelling deficit in children with DCD [1]. The anticipatory postural adjustments relate to the extent to which a motor plan is built up and thus relates to both experience and learning. In literature, DCD is often described as a motor learning disorder [1, 63], which explains the inefficient anticipatory postural

adjustments and the associated difficulties in executing voluntary movements that require a large amount of balance control. Next to the motor plan, constant online monitoring of the movement execution is performed through the sensory input received from the body and environment. By comparing the online input to the existing motor plan in the cerebellum, errors can be adjusted for. However, the feedback-based control is slower compared to the predictive control [1]. In the easier situations, such as exploring the limits of stability in anterior and lateral direction (Appendix 4) or during stance on stable ground with eyes open (Appendix 7), children with DCD are able to adequately adjust for the errors using this slower feedback-based control (Appendix 4, 7), but not in the more difficult tasks that required more anticipatory control as well as more complex sensory integration (Appendix 5, 6 and 7). This is in line with the internal modelling deficit hypothesis for DCD [1]. The anticipatory postural adjustment deficiencies also seem to be direction-specific. All investigated tasks required limb movements in the anterior direction, i.e. arm elevation [10], lifting a leg, kicking a ball, taking stairs [38], Y-balance in the anterior direction [51], requiring control over centre of mass in the opposite direction. Indeed, children with DCD seem to have limited limits of stability in the backward direction [5]. However, whether the reduced backward stability limits are a result of deficient anticipatory postural adjustments or the increasing difficulty level of the task at hand (swaying anteriorly as far as possible is easier than backward) still needs to be determined.

In general, whether the selective motor control through anticipatory postural adjustments, sensory integration processing and/or limits of stability are affected and how they influence one another in children with DCD needs to be determined in future research. To disentangle the origin of the balance deficits these children experience, functional brain imaging (e.g. functional near-infrared spectroscopy) during balance tasks is required.

This review clearly shows that a more comprehensive approach is necessary to obtain a better understanding of which balance domains are affected in children with DCD and whether they are interrelated. Although children with DCD seem to be at risk for deficiencies in several balance domains, these results are merely a compilation of individual studies, all investigating a different balance domain. Future research on performances in the different balance domains in these children could be useful to

explain the heterogeneity in children with DCD, endorsing the need for subclassification based on a balance profile [6]. Secondly, it could disentangle whether the different domains are interrelated and provide clear implications for their assessment. Finally, longitudinal follow-up of performances in these balance domains in children with DCD could provide valuable information about its developmental course. Even though none of the included studies had a longitudinal design, which would allow determination of the developmental course of balance control in these children, some studies investigated different age groups in both children with DCD and their TD controls [41, 42]. It may be expected that children with DCD perform similarly than younger TD children. However, this developmental delay [42] could not be confirmed. We did, however, find deviating results compared to literature on development of balance control. By the age of six, anticipatory postural adjustments before voluntary arm movements during standing quietly are essentially mature in TD children [7]. Johnston and colleagues (2002) showed that in 8- to 10-year-olds, up to 99% of the children with DCD had delayed muscle contractions performing a rapid goal-directed arm movement, that were below the mean contraction time of TD peers, of the ipsilateral internal oblique muscles (mean SMD=3.18, 95%CI=[2.44; 3.92]) and the contralateral rectus abdominis (mean SMD=3.25, 95%CI=[2.50; 4.00]) [10]. To determine the developmental course of balance control in children with DCD, longitudinal research is necessary.

Not only insights into the developmental course of balance control in children with DCD are lacking, the extent to which the balance problems transfer into adulthood are underexposed. This information is crucial to determine the disorders' long-term impact on overall functioning and deserves attention in future research.

Study strengths and limitations

When interpreting the results of this first study on different balance aspects in individuals with DCD, some strengths and limitations should be considered. All relevant studies seem to be identified by searching three complementary databases as hand searching did not reveal any additional relevant references. With the current methodology we aimed to perform meta-analyses to assess a common result on pooled data of published studies. As such, published studies that reported numeric values of balance

test performances were included. This, however, resulted in the exclusion of 12 studies, which focused on relevant aspects of balance control but did not provide numeric values.

Using the SIGN checklist for assessing methodological quality is a strength of this study. The checklist allows the identification of poorly designed studies and demands to reject them from the review, leaving only studies of at least acceptable quality. All but one [24] of the included studies are of acceptable methodological quality, implicating that the conclusions may change in the light of further studies. Especially since research on each specific balance domain is limited or when several studies were available, they all used different tests and/or (types of) outcomes, it is likely that conclusions might change. The risk of bias assessment revealed that most studies might have been exposed to selection bias as shown by the lacking reporting on percentage of participating cases and controls, as well as comparisons between participants and non-participants. Whether outcome bias occurred in the included studies is unclear as this was poorly reported in the majority of the studies.

The applied tests and outcome measures were very diverse, complicating comparison between studies. Especially for the sensory orientation domain and the stability in gait domain, several different parameters were used to investigate differences in performances between groups. The MABC(-2) balance subscale results showed that the included TD children outperformed their DCD peers. These are measures at activity level, in contrast to the outcome measures used to describe performances in the balance domains, that are situated at function level. Children with DCD are known for their limitations in daily activities. Perhaps if the balance domains would be assessed with an outcome measure at activity level such as the Kids BESTest [64], currently being psychometrically assessed in children with cerebral palsy [14], similar magnitude in differences between children with DCD and their TD peers might be obtained as for the MABC(-2) balance subscales. Such an approach therefore deserves attention in future research.

Although the conceptual framework by Horak et al. (2009) provides a broad overview of different components of balance control and the degree to which they have been investigated in children with DCD, this framework comprises several – still – hypothetical assumptions on posture and postural control. Even though agreement exists that postural control is not one system that merely builds on equilibrium reflexes, its neural basis has not yet been unravelled [65]. For example, the neural circuits

used to establish automatic postural reactions, that are seen as a response to external perturbations, remain to be determined. These reactions are assumed to be established through short, medium and long proprioceptive feedback loops, based on empirical studies in patients with sensory neuropathy, multiple sclerosis, Parkinson's disease and cerebellar ataxia [8]. The short and medium latency reactions likely depend on spinal cord and brainstem circuits, whereas the Supplemental Motor Area is thought to influence the release and timing of the long latency component of postural reactions [66]. A recent systematic review and meta-analysis in healthy adults has shown that the cerebellum and Supplemental Motor Area are activated during simulated stance tasks with surface translation or visual field motion [65]. The activation of the cerebellum likely reflects the sensory processing that is needed to ensure the response adequacy [65], whereas activation of the Supplemental Motor Area seems to confirm its influential role. Furthermore, the cerebellum is also related to the automatization of posture and movement, and has therefore been suggested to play a crucial role in the motor learning deficit in children with DCD. To address automatization, the dual-task paradigm can be applied, e.g. a comparison between a postural and a suprapostural task [11]. The framework used in this study does not account for cognitive aspects of postural control. Although its importance is recognized [8], this is a limitation and should be addressed in future research. Nevertheless, new insights into brain activity while actually performing (supra)postural tasks are needed to understand the neural basis of balance control and will thereby also provide clarity about whether its concept is covered by this theoretical model.

Finally, this review has strongly focused on well-known outcome measures such as the muscle onset latencies or spatial centre of pressure outcomes. However, it should be noted that alternative measures have been proposed recently but these have not yet found their way to the DCD community. For example, Haddad et al. (2010) proposed the use of postural time-to-contact to provide insights into balance during suprapostural tasks [12]. Future work on balance in DCD could benefit from incorporating these new measures with ecological tasks.

Conclusion

In summary, different balance domains may be affected in children with DCD. However, the magnitude of the difference in performance between DCD and TD children seems to depend upon both the applied

test and outcome variable. None of the existing studies investigated the entire construct of balance within one group, making it difficult to determine whether the test and outcome are causing the diverging results, or that the heterogeneity of the DCD disorder is accountable for these differences. Current knowledge suggests that children with DCD have deficient anticipatory control and sensory orientation, that becomes more pronounced when tasks become more difficult. More detailed insights into whether different balance domains are compromised can help us understand the nature of the heterogeneity of DCD. This may then provide a rationale for subclassifying the children, ultimately to enhance targeted and individualized task-oriented training.

Declarations of interest

None to declare.

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Figures

Figure 1: Performance on the balance subscale of the Movement Assessment Battery for Children for individual studies and overall across studies.

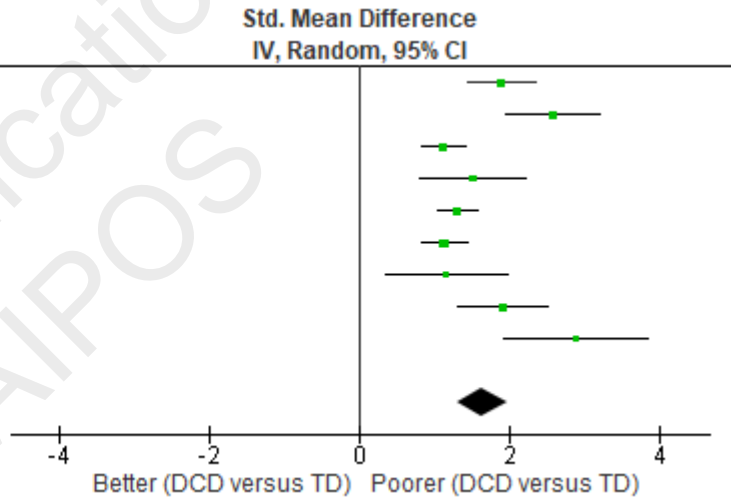
Figure 2: Standardized mean differences (DCD versus TD children) in sensory orientation during quiet stance (Domain 5).

Figure 1: Performance on the balance subscale of the Movement Assessment Battery for Children for individual studies and overall across studies (comparing children with DCD with TD).

A. Impairment scores on the balance subscale of the Movement Assessment Battery for Children (MABC)

Study or Subgroup	DCD Mean	DCD SD	DCD Total	Controls Mean	Controls SD	Controls Total	Weight	Std. Mean Difference IV, Random, 95% CI
Asonitou et al. 2012	7.03	3.8	54	1.43	1.72	54	12.2%	1.89 [1.43, 2.34]
Chen et al. 2012	5.95	1.6	38	2.17	1.3	38	10.4%	2.57 [1.95, 3.18]
Cheng et al. 2018	3.75	4.17	120	0.28	0.59	100	14.2%	1.11 [0.83, 1.40]
Cherng et al. 2007	6.6	3.1	20	2.7	1.8	20	9.3%	1.51 [0.80, 2.22]
Fong et al. 2015	2.72	2.14	130	0.47	1.09	117	14.3%	1.30 [1.03, 1.58]
Fong et al. 2016	2.72	2.64	86	0.47	1.18	99	13.9%	1.12 [0.81, 1.43]
Grove & Lazarus 2007	5.4	4.4	14	1.4	1.8	14	8.3%	1.16 [0.35, 1.96]
Johnston et al. 2002	5.6	3.1	32	1	1.3	32	10.6%	1.91 [1.31, 2.51]
Przysucha et al. 2008	8.47	2.58	17	1.77	1.97	19	6.9%	2.88 [1.92, 3.84]
Total (95% CI)			**511**			**493**	**100.0%**	**1.63 [1.30, 1.97]**

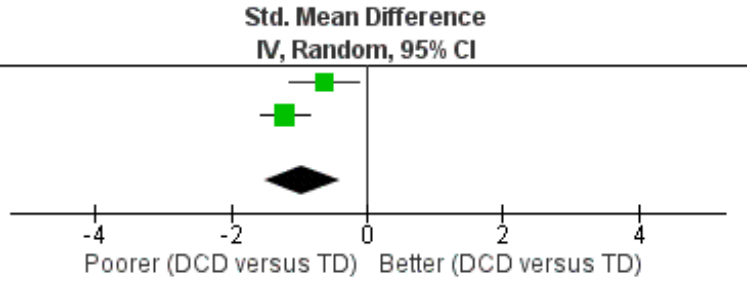
Heterogeneity: Tau² = 0.19; Chi² = 37.91, df = 8 (P < 0.00001); I² = 79%
Test for overall effect: Z = 9.47 (P < 0.00001)



B. Standard scores on the balance subscale of the Movement Assessment Battery for Children 2nd edition (MABC-2)

Study or Subgroup	DCD Mean	DCD SD	DCD Total	Controls Mean	Controls SD	Controls Total	Weight	Std. Mean Difference IV, Random, 95% CI
Tsang et al. 2012	28.2	7.07	33	31.8	3.4	30	44.8%	-0.63 [-1.14, -0.12]
Fong et al. 2011	7.23	3.09	81	10.7	2.53	67	55.2%	-1.21 [-1.56, -0.86]
Total (95% CI)			**114**			**97**	**100.0%**	**-0.95 [-1.52, -0.39]**

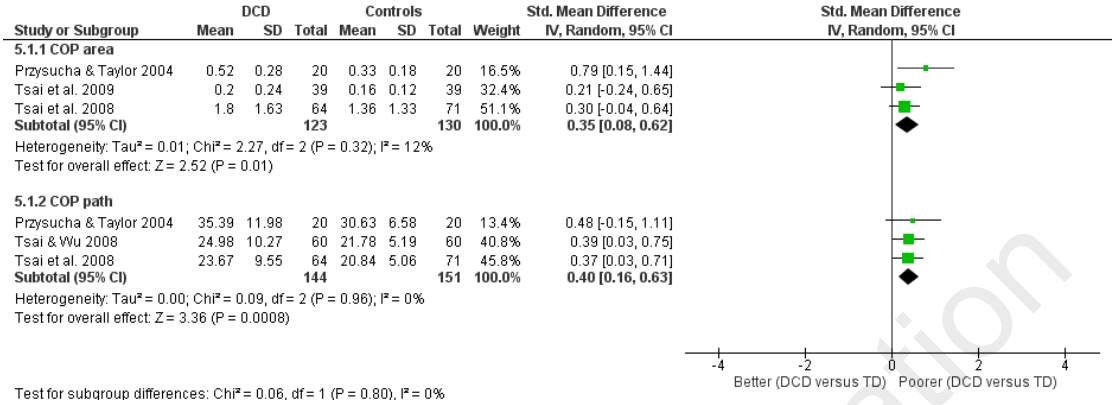
Heterogeneity: Tau² = 0.12; Chi² = 3.38, df = 1 (P = 0.07); I² = 70%
Test for overall effect: Z = 3.30 (P = 0.0010)

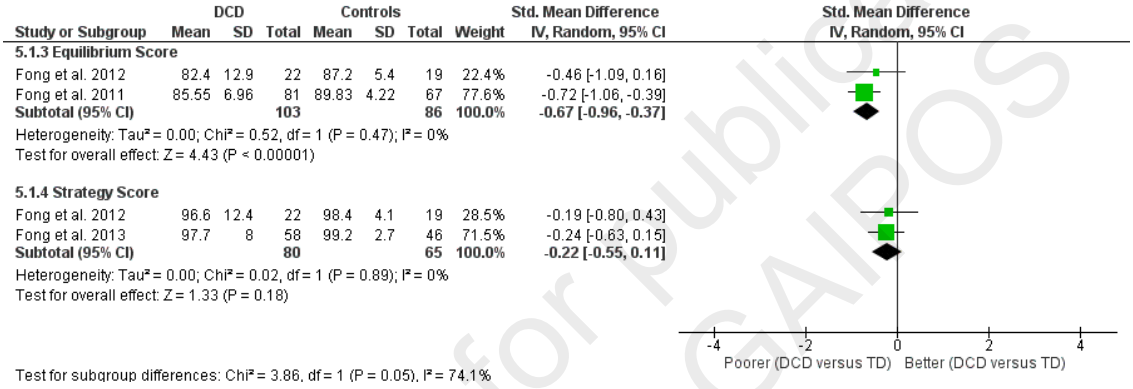


Legend: *MABC*: Mean impairment scores are presented. The impairment score is the sum of the scores on the three balance tasks and varies between 0 and 15 points. Lower scores indicate better performance (i.e. less impairment).
MABC-2: Standard scores are presented. Tsang et al. (2012) reported the component score for the balance subscale, whereas Fong et al. (2011) reported an overall standard score for the entire balance subscale (normative data: mean = 10, standard deviation = 3). SD: standard deviation; 95% CI: 95% confidence interval. Higher scores indicate better performance.

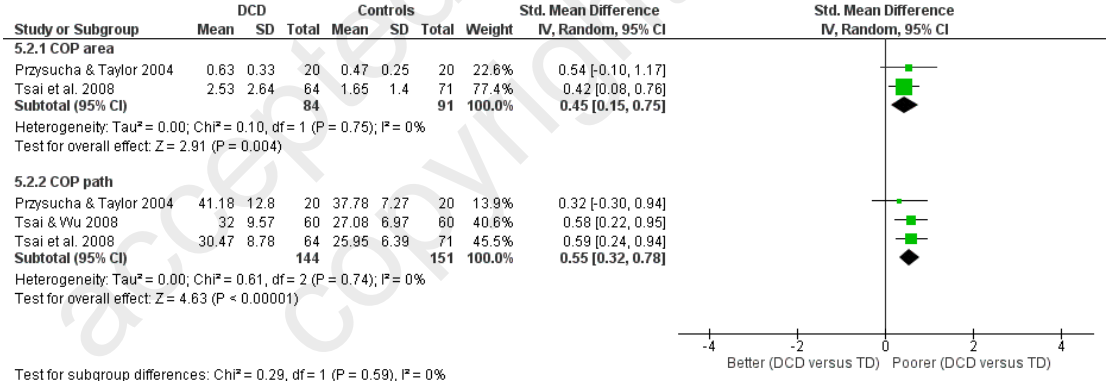
Figure 2: Standardized mean differences (DCD versus TDC in sensory orientation during quiet stance (Domain 5)

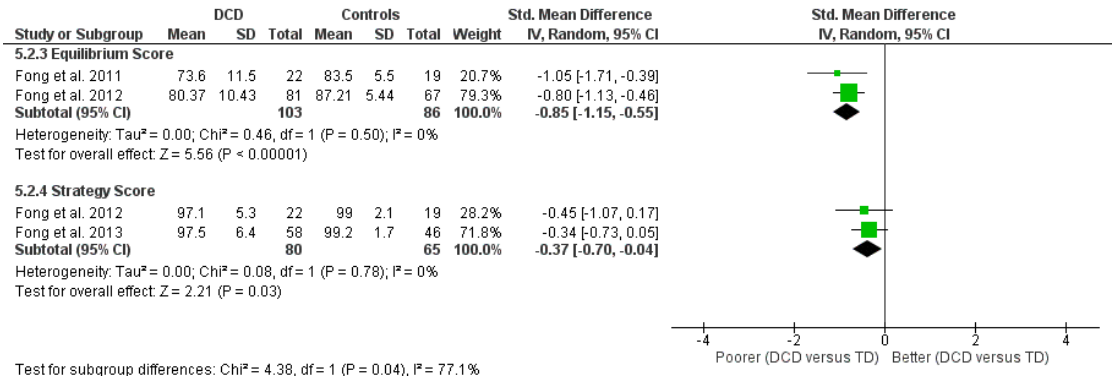
1. Standing on firm surface ground with eyes open





2. Standing on firm surface ground with eyes closed

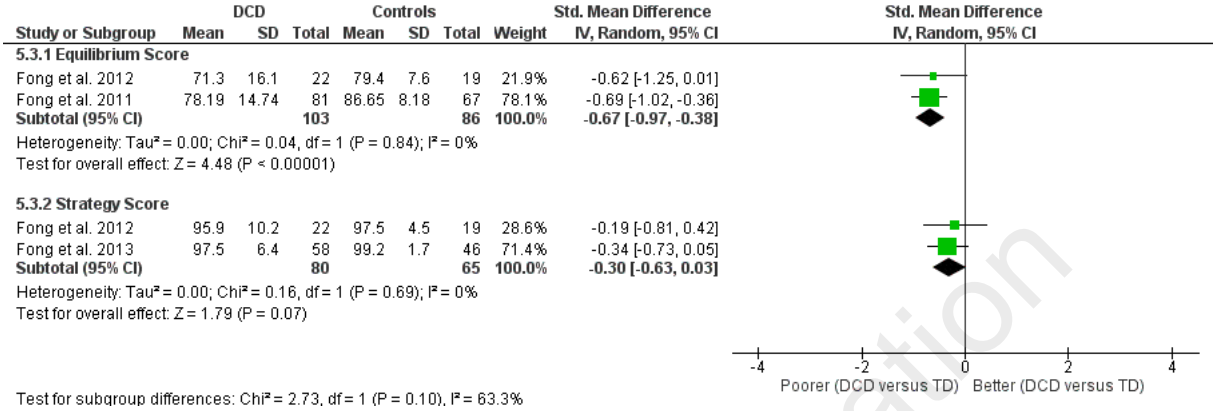




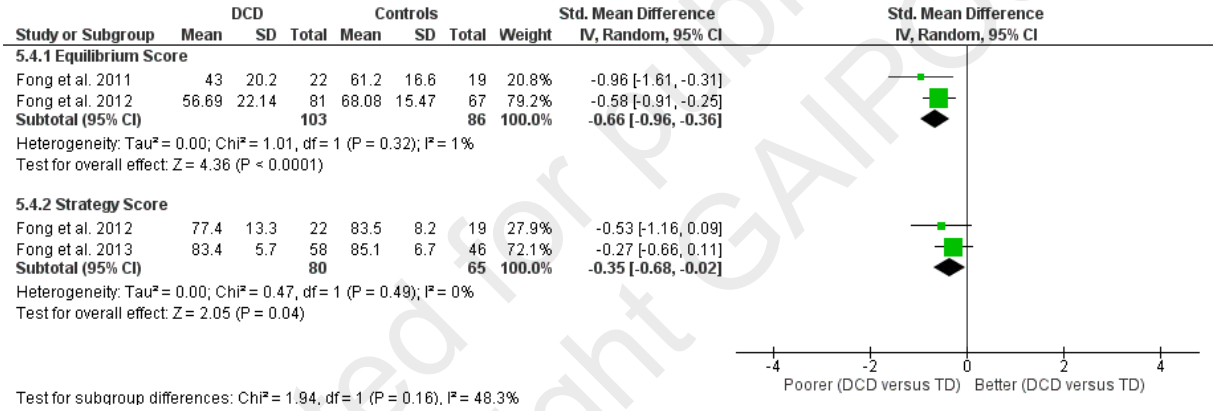
Legend: COP area: the total area of the COP excursion, higher values indicate more instability; COP path: the total path of the COP excursion, higher values indicate more instability; Equilibrium score: higher scores represent more stability (no sway); Strategy score: scores near 100 indicate full ankle strategy and scores near 0 full hip strategy. SD: standard deviation; 95% CI: 95% confidence interval

Figure 2: Standardized mean differences (DCD versus TDC in sensory orientation during quiet stance (Domain 5) - continued

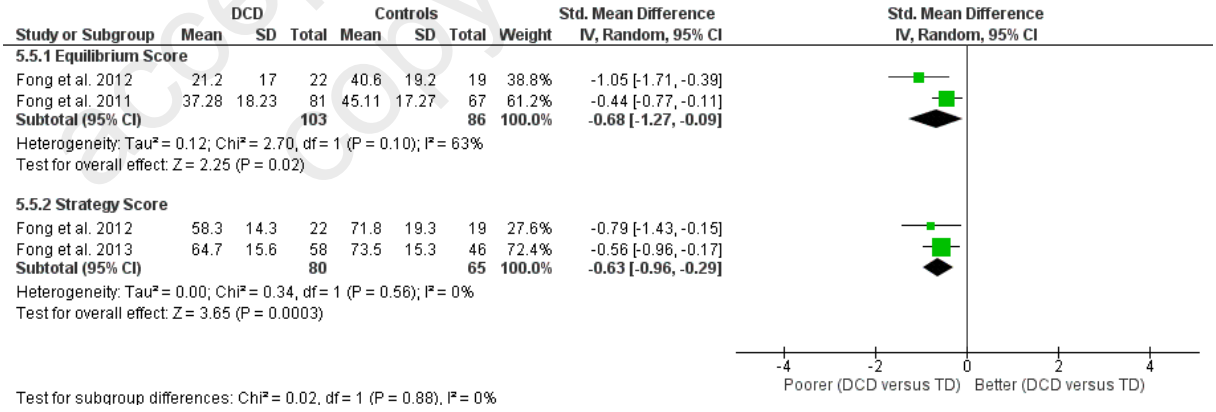
3. Standing on firm surface ground with moving visual surround



4. Standing on a moving platform with eyes open



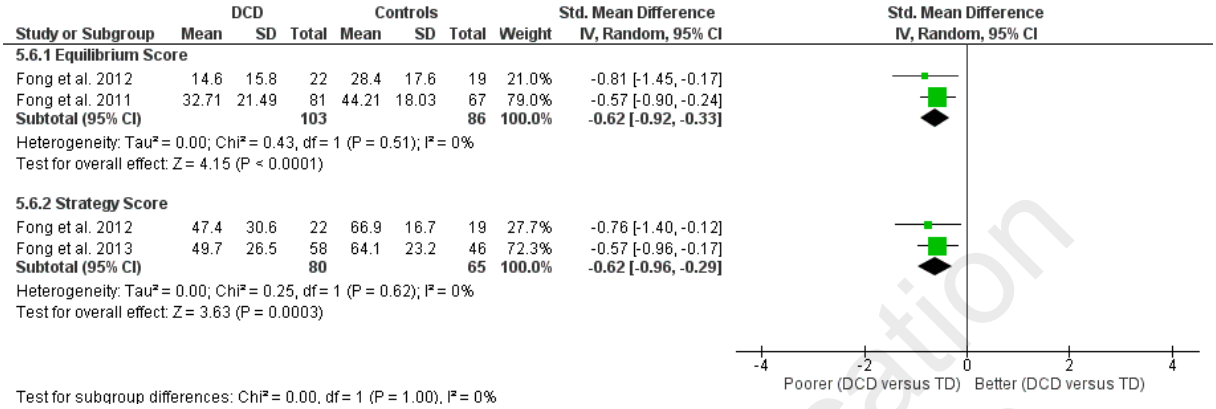
5. Standing on a moving platform with eyes closed



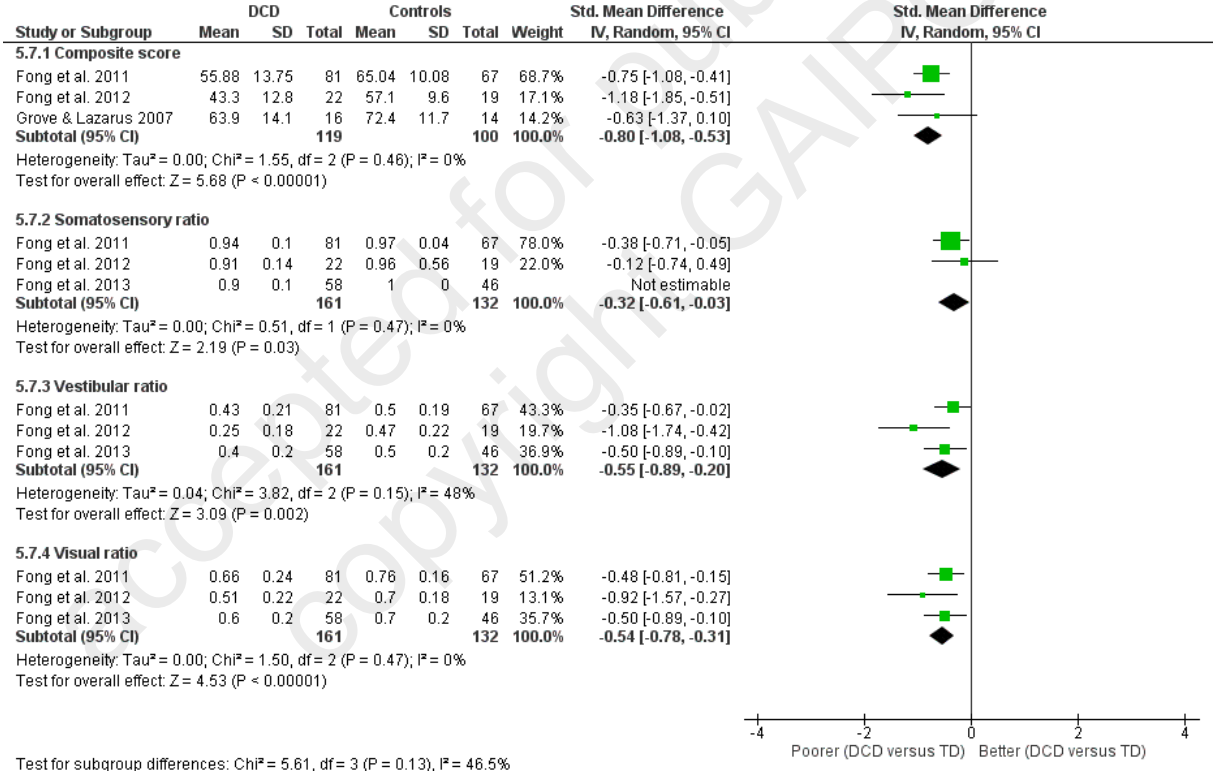
Legend: Equilibrium score: higher scores represent more stability (no sway); Strategy score: scores near 100 indicate full ankle strategy and scores near 0 full hip strategy. SD: standard deviation; 95% CI: 95% confidence interval

Figure 2: Standardized mean differences (DCD versus TDC in sensory orientation during quiet stance (Domain 5) – continued

6. Standing on a moving platform with moving visual surround



7. Composite scores and sensory ratios



Legend: Equilibrium score: higher scores represent more stability (no sway); Strategy score: scores near 100 indicate full ankle strategy and scores near 0 full hip strategy. Composite score: the mean equilibrium score for the six sensory conditions; Somatosensory ratio: scores near a ratio of 1 indicated a superior ability to use the somatosensory input to maintain balance; Vestibular ratio: scores near a ratio of 1 indicated a superior ability to use the vestibular input to maintain balance; Visual ratio: scores near a ratio of 1 indicated a superior ability to use the visual input to maintain balance; SD: standard deviation; 95% CI: 95% confidence interval.

Tables

Table 1: Definitions of the domains of balance control and the applied methodology for their assessment

Table 2: Risk of bias assessment of individual studies – consensus scores

Table 3: General description of the samples included in the individual studies.

Table 1: Definitions of the domains of balance control and the applied methodology for their assessment

Domain	Definitions by Horak et al. 2009 [8]	Applied tests/tasks in the included studies	Applied outcome variables in the included studies
Stability limits and verticality	The **"Limits of stability"** refer to the ability to move the body's centre of mass over its BOS and the extent to which this is possible, i.e. how far it can be moved towards the edges of the BOS. **"Verticality"** is the representations of gravitational upright.	Neurocom - Limits of Stability test in forward, backward, right and left direction AMTI force platform – moving forward, backward, left, right as far as possible Not applied in the included literature	Reaction time (s), movement velocity (°/s), maximum excursions (%), end point excursions (%), directional control (%) [5] Anterior sway, posterior sway, COP_area, COP_AP, COP_ML, COP_path [42]
Transitions and anticipatory postural adjustments	The **"anticipatory postural adjustments"** are active movements of the body's centre of mass in anticipation of a voluntary movement, i.e. a postural transition from one body position to another.	One Leg Stance One Leg Stance in the Y-balance protocol One Leg Stance, kicking a ball, take stairs Rapid goal-directed arm movements	Static balance score (combination of (non-)dominant leg) – MABC [25, 27] EMG – muscle peak root mean square (%) and time to peak (ms) [51] EMG – trials with anticipatory onset of the ipsilateral tibialis anterior (%) [38] EMG – muscle onset latencies (ms) of the ipsilateral and contralateral internal oblique, external oblique, rectus abdominis and erector spinae muscles [10]
Reactive postural responses	Through short, medium and long proprioceptive feedback loops, automatic postural responses or "**reactive postural responses**" are elicited to prevent slips, trips and pushes.	Neurocom – Motor Control Test for forward and backward platform translation Reaction to a forward push during quiet stance	EMG – muscle onset latencies (ms) of the gastrocnemius, hamstrings, tiabialis anterior, rectus femoris muscles. Motor Control latency scores (ms) and composite scores. [24] EMG – muscle onset latencies (ms), peak force (kg) and time to peak force (s) for gastrocnemius and hamstrings muscles. [32]
Sensory Orientation	"**Sensory orientation**" results from the integration of sensory information for spatial orientation inducing an increased body sway during stance when sensory information is altered.	Neurocom – Sensory Orientation Test conditions (all conditions) AMTI force platform – bipedal stance (F)EO, (F)EC One Leg Stance with EO or EC	Equilibrium Score [31, 34], Strategy Score [33, 34]. COP_AP (rambling/trembling) (cm) [41, 43], COP_area (cm²) [41, 47], COP_ML (rambling/trembling) (cm) [41, 43, 47] , COP_path (cm) [41, 46, 47], sway velocity (°/s) [27], Romberg Coefficients [41, 45], COP_RMS_AP (cm) [22]. COP_area (cm²), COP_path (cm) for the (non-)dominant leg. [46, 47]
Stability in gait	"**Stability in gait**" comprises the ability to adequately catch a falling body's centre of mass by a changing base of – or foot support.	Level walking with vision Walking in the dark (no vision) Obstacle crossing (low and high) Walking on high-density foam surface Walking on treadmill at preferred speed	double support (s or %), Step width ratio, Stride length (mm), stride time (s), stride velocity (m/s) [28, 29] Double support (%), Double support time (ms), Medio-lateral excursion (mm), Step width ration (%), Stride length (mm), Stride time (ms), Support (%), Support time (ms), Swing (%), Swing time (ms) [29] double support (s) [28], Lead clearance height (m), lead step length (m), lead swing (s), Step width 1 (m), Step width 2 (m), Stride length (m), stride time (s), stride velocity (m/s), Trail clearance height trail (m), trail swing (s), trial step length (m) COM_acceleration and COM_velocity AP, ML and vertical direction (mean and variability measures) [30, 49, 50], double support (%) [30, 36, 50], Normalised step width, step length, stride time (mean and variability measures), velocity (m/s) [30, 36, 50] Absolute step width (mm), Cadence (steps/ min), Index of walking performance, Normalised step width, Stride length (mm) [26], COM_acceleration_RMS in AP/ML/vertical direction (m/s²)

Legend: (F)EO: (Foam) Eyes Open; (F)EC: (Foam) Eyes Closed; BOS: Base of Support; COP: Centre of pressure; COM: Centre of Mass; AP: Anteroposterior; ML: mediolateral; MABC: movement Assessment Battery for Children; EMG: electromyography; RMS: Root mean square.

Table 2: Risk of bias assessment of individual studies – consensus score

Authors	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	1.11	2.1
Asonitou et al. 2012	+	+	+	NR	-	+	+	?	+	+	-	A
Chen et al. 2012	+	+	+	DCD: 15%, TDC: 15%	-	+	+	?	+	+	-	A
Chen et al. 2016	+	+	+	DCD: 5%, TDC: 5%	-	+	+	?	+	+	-	A
Cheng et al. 2018	+	+	+	DCD: 44%, TDC: 36%	-	+	+	?	+	+	+	H
Cherng et al. 2007	+	+	+	NR	-	+	+	?	+	+	-	A
Deconinck et al. 2006A	+	+	?	DCD: NR, TDC: 4%	-	+	?	?	+	+	-	A
Deconinck et al. 2006B	+	+	-	DCD: NR, TDC: 3%	-	+	+	-	+	+	-	A
Deconinck et al. 2008	+	+	?	DCD: NR, TDC: 3%	-	+	+	?	+	+	-	A
Deconinck et al. 2010	+	+	?	NR	-	+	+	?	+	+	-	A
Du et al. 2015	+	+	+	NR	-	+	+	?	+	+	-	A
Fong et al. 2011	+	+	+	NR	-	+	+	?	+	+	-	A
Fong et al. 2012	+	+	+	NR	-	+	+	?	+	+	-	A
Fong et al. 2013	+	+	+	NR	-	+	+	?	+	+	+	A
Fong et al. 2015	+	+	+	NR	-	+	+	?	+	+	+	A
Fong et al. 2016A	+	+	+	NR	-	+	+	?	+	+	+	A
Fong et al. 2016B	+	+	+	NR	-	+	+	?	+	+	-	A
Ganapathy & Monisha 2019	+	+	+	DCD: 20%, TDC: 20%	-	?	?	?	?	+	-	R
Gentle et al. 2016	+	+	-	NR	-	+	+	?	+	+	-	A
Grove & Lazarus 2007	+	+	+	NR	-	+	+	?	+	+	-	A
Johnston et al. 2012	+	+	+	NR	-	+	+	?	+	+	-	A
Kane & Barden 2012	+	-	-	NR	-	+	+	?	+	+	-	R
Kane & Barden 2014	+	?	+	NR	-	+	+	?	+	+	-	A
Miller et al. 2018	+	-	+	NR	-	+	-	?	+	+	-	R
Przysucha & Taylor 2004	+	+	+	DCD: 38%, TDC: 38%	-	+	+	?	+	+	-	A
Przysucha et al. 2008	+	+	+	NR	-	+	+	?	+	+	-	A
Speedtsberg et al. 2017	+	?	+	NR	-	+	+	?	+	+	-	A
Speedtsberg et al. 2018	+	?	+	NR	-	+	+	?	+	+	-	A
Tsai & Wu 2008	+	+	+	DCD: 83%, TDC: 10%	-	+	+	?	+	+	-	A
Tsai et al. 2008	+	+	+	DCD: 29%, TDC: 33%	-	+	+	-	+	+	-	A
Tsai et al. 2009	+	+	+	DCD: 67%, TDC: 10%	-	+	+	-	+	-	-	A
Tsang et al. 2012	+	+	+	NR	-	+	+	?	+	+	+	A
Wilmut et al. 2016	+	?	+	NR	-	+	+	?	+	+	-	A
Wilmut & Barnett 2017	+	?	+	NR	-	+	+	?	+	+	-	A
Yam & Fong 2018	+	+	+	DCD: 24%, TDC: 26%	-	+	+	?	+	?	+	A

Legend: **1.1** The study addresses an appropriate and clearly focused question; **1.2** The cases and controls are taken from comparable populations; **1.3** The same exclusion criteria are used for both cases and controls; **1.4** What percentage (%) of each group (cases and controls) participated in the study?; **1.5** Comparison is made between participants and non-participants to establish their similarities or differences; **1.6** Cases are clearly defined and differentiated from controls; **1.7** It is clearly established that controls are non-cases; **1.8** Measures will have been taken to prevent knowledge of primary exposure influencing case ascertainment; **1.9** Exposure status is measured in a standard, valid and reliable way; **1.10** The main potential confounders are identified and taken into account in the design and analysis; **1.11** Confidence intervals are provided; **2.1** How well was the study done to minimise the risk of bias or confounding?. "**+**" yes, the study does this; "**?**" can't say whether the study does this ; "**-**" no, the study does not do this; **NR**: not reported; **DCD**: Developmental Coordination Disorder; **TDC**: typically developing children; **H**: High Quality, **A**: Acceptable quality; **R**: Reject.

Table 3: General description of the samples included in the individual studies

	Individuals with DCD										Control groups									
	Total	Boys	Age (years)		Height (cm)		Weight (kg)		BMI (kg/m²)		Total	Boys		Age (years)		Height (cm)		Weight (kg)		BMI (kg/m²)	
	(N)	(%)	*mean*	*SD*	*mean*	*SD*	*mean*	*SD*	*mean*	*SD*	(N)	(%)	Group	*mean*	*SD*	*mean*	*SD*	*mean*	*SD*	*mean*	*SD*
Asonitou et al. 2012 [21]	54	66.6	5.5	0.2							54	68.5	TD	5.6	0.2						
Chen & Tsai 2016 [22]	30	60.0	11.87	0.5	147.21	8.82	49.0	9.5			30	46.7	TD	11.7	0.5	148.29	9.33	46.8	8.1		
Chen et al. 2012 [23]	38	55.3	9.4	0.5	139.11	6.66	37.9	11.3			38	55.3	TD	9.2	0.4	140.11	6.40	38.1	9.3		
Cheng et al. 2018 [24]	120	82.5	7.4	1.3	124.16	8.94	26.1	7.2	16.7	2.7	100	79.0	TD	6.7	1.1	120.39	8.54	23.3	5.9	15.9	2.3
Cherng et al. 2007 [25]	20	80.0	5.5	0.9	113.20	7.30	21.5	4.5			20	80.0	TD	5.4	0.9	112.20	6.50	20.3	3.1		
Deconinck et al. 2006A [29]*																					
Deconinck et al. 2010 [28]*	12	83.3	7.8	0.5	126.80	4.93	25.6	4.4			12	83.3	TD	7.7	0.6	127.50	6.13	25.6	3.4		
Deconinck et al. 2006B [26]	10	90.0	7.4	0.9	128.00	7.00	25.3	4.1			10	90.0	TD	7.5	0.85	131.00	5.10	28.0	4.4		
Deconinck et al. 2008 [27]	10	100.0	7.7	0.8	129.00	7.00	25.7	4.1			10	100.0	TD	7.6	0.9	132.00	4.00	28.5	4.6		
Du et al. 2015 [30]	15	60.0	25.3								15	60.0	TD	25.4							
Fong et al. 2011 [31]	81	77.7	8.1	1.5	130.53	11.87	33.1	11.6	18.9	3.7	67	71.6	TD	8.3	1.6	129.87	10.41	30.3	8.7	17.65	3.0
Fong et al. 2012 [34]	22	72.7	7.5	1.4	124.80	10.40	27.4	8.4			19	68.4	TD	6.9	1.1	121.30	11.90	29.3	12.6		
Fong et al. 2013 [33]	58	84.5	7.6	1.2	126.60	10.20	27.8	8.5	16.9	2.7	46	73.9	TD	8.0	1.8	128.40	14.70	30.0	7.7	18.1	3.6
Fong et al. 2015 [32]	130	68.5	7.7	1.4	123.50	10.60	25.2	7.9	16.1	2.5	117	63.2	TD	7.4	1.3	123.40	9.50	24.5	6.4	15.7	3.2
Fong et al. 2016A [35]	86	75.6	7.9	1.7	125.00	11.50	26.6	8.8	16.6	2.7	99	74.7	TD	7.4	1.6	122.60	10.30	24.0	6.4	15.6	3.2
Fong et al. 2016B [5]	30	76.7	7.7	1.5	123.70	11.50	26.0	9.2	16.5	2.8	20	55.0	TD	7.9	1.6	125.80	8.50	24.0	4.5	15.2	2.4
Gentle et al. 2016 [36]	12	83.3	10.3	1.3							12	83.3	TD	10.3	1.3						
	12	75.0	16.2	1.3							12	75.0	TD	16.0	1.7						
	11	63.6	24.2	5.1							11	63.6	TD	27.6	5.0						
Grove & Lazarus 2007 [37]	16		9.5	1.8							14		TD	9.8	2.0						
Johnston et al. 2002 [10]	32	68.8	9.3	0.9	137.8	7.3	35.1	8.2			32	46.9	TD	9.3	0.9	138.4	12	35.5	13.9		
Kane & Barden 2014 [38]	11	81.8	11.1	2.1							11	81.8	TD	10.9	2.5						
Przysucha & Taylor 2004 [41]	20	100.0	8.6	2.1							20	100.0	TD	8.5	2.00						
Przysucha et al. 2008 [42]	9	100.0	7	0.9	128.1	7.9					10	100.0	TD	6.9	0.7	125.8	9.2				
	8	100.0	10.5	1.5	146.7	10.5					9	100.0	TD	10.7	1.2	147.4	9.1				
Speedtsberg et al. 2017 [43]	9	77.8	9.0	0.5	139.9	2.5	33.1	2.3			10	70.0	TD	9.1	0.4	141.1	3.0	33.7	1.8		
Speedtsberg et al. 2018 [44]	8	75.0	8.8	1.5	139.5	8.1	33.6	7.3			10	70.0	TD	9.1	1.4	141.1	3.0	33.7	1.8		
Tsai et al. 2008 [47]	64	46.9	10.1	0.3							71	46.5	TD	10.3	0.2						
Tsai & Wu 2008 [46]	60	50.0	10.1	0.3							60	29	TD	10.1	0.4						
Tsai et al. 2009 [45]	39	59.0	9.7	0.4	137.4	6.7	36.9	11.2	19.2	4.7	39	48.3	TD	9.6	0.2	136.4	6.2	34.7	8.4	18.5	3.8
Tsang et al. 2012 [48]	33	81.8	7.8	1.4	127.7	10.7	30.1	10.7	17.9	3.5	30	80.0	TD	7.6	1.1	127.5	8.7	29.6	7.9	17.9	3.0
Wilmut & Barnett 2017 [49]	15	60.0	25.4								15	60.0	TD	23.3							
Wilmut & Barnett 2017 [49]**	15	73.3	14.9								15	73.3	TD	14.6							
Wilmut et al. 2016 [50]**	14	85.7	9.3								14	85.7	TD	9.3							
Yam & Fong 2019 [51]	48	77.0	8.0	1.1	126.8	9.9	26.0	7.2	15.9	2.8	51	62.7	TD	7.8	1.1	126.5	7.8	25.5	6.5	15.7	2.3
TOTAL	**1152**	**72.1**	**10.4**								**1103**	**67.3**		**10.4**							

Legend: TD: typical development; N: number of participants; SD: standard deviation; *identical samples; **identical samples

Appendices

Appendix 1: Details on the search queries used in the different databases

Appendix 2: Overview of the diagnostic criteria applied to the included children with DCD

Appendix 3: Flowchart of the selection process

Appendix 4: Raw data and standardized mean differences for task performances in the domain “stability limits and verticality” (Domain 2)

Appendix 5: Raw data and standardized mean differences for task performances in the domain “transitions and anticipatory postural adjustments” (Domain 3)

Appendix 6: Raw data and standardized mean differences for task performances in the domain “Reactive postural reactions” (Domain 4)

Appendix 7: Raw data and standardized mean differences for task performances in the domain “Sensory orientation” (Domain 5)

Appendix 8: Raw data and standardized mean differences for task performances in the domain “Stability in gait” (Domain 6)

Appendices – Supplementary files for online-only publication

Appendix 1: Details on the search queries used in the different databases

Pubmed

("Developmental coordination disorder"[TIAB] OR “clumsy child syndrome”[TIAB] OR “minimal brain damage”[TIAB] OR “developmental dyspraxia”[TIAB] OR “sensory integration dysfunction”[TIAB] OR “motor perception dysfunction”[TIAB] OR "DCD"[TIAB] OR "dyspraxia"[TIAB] OR "Motor Skills Disorders"[Mesh] OR "developmental coordination disorders"[TIAB]) AND ("postural balance"[Mesh] OR "postural control"[TIAB] OR “balance control”[TIAB] OR posturography[TIAB] OR "postural sway"[TIAB] OR posture[Mesh] OR postures[TIAB] OR equilibrium[TIAB]). N=273 hits; August 18th 2020.

Web of Science

TS=(("Developmental coordination disorder" OR “clumsy child syndrome” OR “minimal brain damage” OR “developmental dyspraxia” OR “sensory integration dysfunction” OR “motor perception dysfunction” OR "DCD" OR "dyspraxia" OR "developmental coordination disorders") AND ("postural balance" OR "postural control" OR posturography OR "postural sway" OR posture OR postures OR equilibrium)) OR TI=(("Developmental coordination disorder" OR “clumsy child syndrome” OR “minimal brain damage” OR “developmental dyspraxia” OR “sensory integration dysfunction” OR “motor perception dysfunction” OR "DCD" OR "dyspraxia" OR "developmental coordination disorders") AND ("postural balance" OR "postural control" OR “balance control” OR posturography OR "postural sway" OR posture OR postures OR equilibrium)). N=169 hits; August 18th 2020.

Scopus

(TITLE-ABS-KEY("developmental coordination disorder") OR TITLE-ABS-KEY("clumsy child syndrome") OR TITLE-ABS-KEY("minimal brain damage") OR TITLE-ABS-KEY("developmental dyspraxia") OR TITLE-ABS-KEY("sensory integration dysfunction") OR TITLE-ABS-KEY("motor perception dysfunction") OR TITLE-ABS-KEY("DCD") OR INDEXTERMS("motor skills disorders")

OR TITLE-ABS-KEY("developmental coordination disorders")) AND (TITLE-ABS-KEY("postural control") OR INDEXTERMS("postural balance") OR TITLE-ABS-KEY(“balance control”) OR TITLE-ABS-KEY(posturography) OR TITLE-ABS-KEY("postural sway") OR INDEXTERMS(posture) OR TITLE-ABS-KEY(postures) OR TITLE-ABS-KEY(equilibrium)). N=375 hits; August 18th 2020.

Appendix 2: Overview of the diagnostic criteria applied to the included children with DCD

Authors	**Formal diagnosis**	**DSM-IV criteria**			
		Criterion A: motor performance is below expectance regarding chronological age or intelligence	**Criterion B:** the motor difficulties significantly impact school- and/or daily activities	**Criterion C:** the motor difficulties cannot be explained by a medical condition or pervasive developmental disorder	**Criterion D:** in case of intellectual disability, the motor difficulties are more severe than typically seen in this group
Asonitou et al. 2012 [21]	Not reported	TIS ≤ P5 (MABC)	subjectively screened by a teacher	No physical, emotional or behavioural disability; no history of paediatrician-determined pre- or existing developmental disorder	No intellectual disability (IQ ≥ 70)
Chen & Tsai 2016 [22]	Not reported	TIS ≤ P5 (MABC)	≥ 95% MABC Checklist	No medical conditions (parental report)	No intellectual disability (Kaufmann Brief Intelligence Test, 2nd edition >80 and no other medical conditions
Cherng et al. 2007 [25]	Yes	TIS ≤ 15% (MABC)		medical condition controlled by physician	
Deconinck et al. 2006A [29]	Yes	TIS < P15 (MABC)			Normal primary schools + IQ ≥ 85 (WISC revised)
Deconinck et al. 2006B [26]	Deducible*	TIS < P15 and balance subscale > P15 (MABC)		No neurological or neuromuscular dysfunctions	"mentally healthy"
Deconinck et al. 2008 [27]	Yes	TIS < P15 (MABC)		No neurological, behavioural or pervasive disorders	No intellectual disability (IQ > 80)
Deconinck et al. 2010 [28]	Yes	TIS < P15 (MABC)		No neurological, behavioural or psychological disorders	Normal intellectual capacities diagnosed by a neuro-paediatrician
Fong et al. 2011 [31]	Yes			No formal diagnoses of neurological, emotional or other movement disorders	Regular education framework
Fong et al. 2012 [34]	Yes	gross motor composite score < 42 (BOT-MP)	interference with the child's ADL and academic performance (parent report)	No neurological impairments	Normal intelligence
Fong et al. 2013 [33]	Yes	Standard Score ≤ 42 (BOT-MP)		No neurological or other movement disorders	No intellectual impairment determined by child psychologist or assessment centre
Fong et al. 2015 [32]	Yes	TIS < P5 (MABC) AND/OR Gross motor composite score ≤ 42 (BOTMP)	DCD-Q	No neurological or other movement disorders	Regular education framework
Fong et al. 2016A [35]	Yes	TIS < P5 (MABC) AND/OR Gross motor composite score ≤ 42 (BOTMP)	DCD-Q	No emotional, cognitive, behavioural, neurological, or other movement disorder	Mainstream primary school an able to follow instructions
Fong et al. 2016B [5]	Yes	TIS < P5 (MABC)	DCD-Q	No emotional, cognitive, behavioural, neurological, or other movement disorder	Mainstream primary school an able to follow instructions
Grove & Lazarus 2007 [37]	Not reported	TIS < P15 (MABC)	interference with the child's ADL and academic performance (parent report)	No neurological impairments	Verbal-IQ > 80
Johnston et al. 2002 [10]	Deducible*	TIS < P15 (MABC)		No neurological, neuromuscular or pervasive developmental disorders	No intellectual disabilities
Kane & Barden 2014 [38]	Yes	TIS ≤ P15 (MABC)	DCD-Q		
Przysucha & Taylor 2004 [41]	Not reported	TIS ≤ P5 (MABC)	Motor Behavior Checklist by teachers	No neurological diagnoses	Normal intelligence
Przysucha et al. 2008 [42]	Not reported	TIS ≤ P5 (MABC)	Motor Behavior Checklist by teachers	No neurological diagnoses	Normal intelligence
Speedtsberg et al. 2017 [43]	Yes	Total score < P15 (MABC-2)			
Tsang et al. 2012 [48]	Yes			No diagnosis of emotional, endocrine, neurological, or other movement disorders	No intellectual disability

Legend: *If children were recruited via physical therapists or diagnostic- or rehabilitation centres where they received therapy for DCD, a formal diagnosis of DCD was assumed. DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, 4th edition; TIS: Total Impairment Scale; MABC(-2): Movement Assessment Battery for Children (2nd edition); BOT-MP: Bruininks-Oseretsky Test of Motor Proficiency; P: percentile; DCD-Q: Developmental Coordination Disorder Questionnaire; WISC: Wechsler Intelligence Scale for Children.

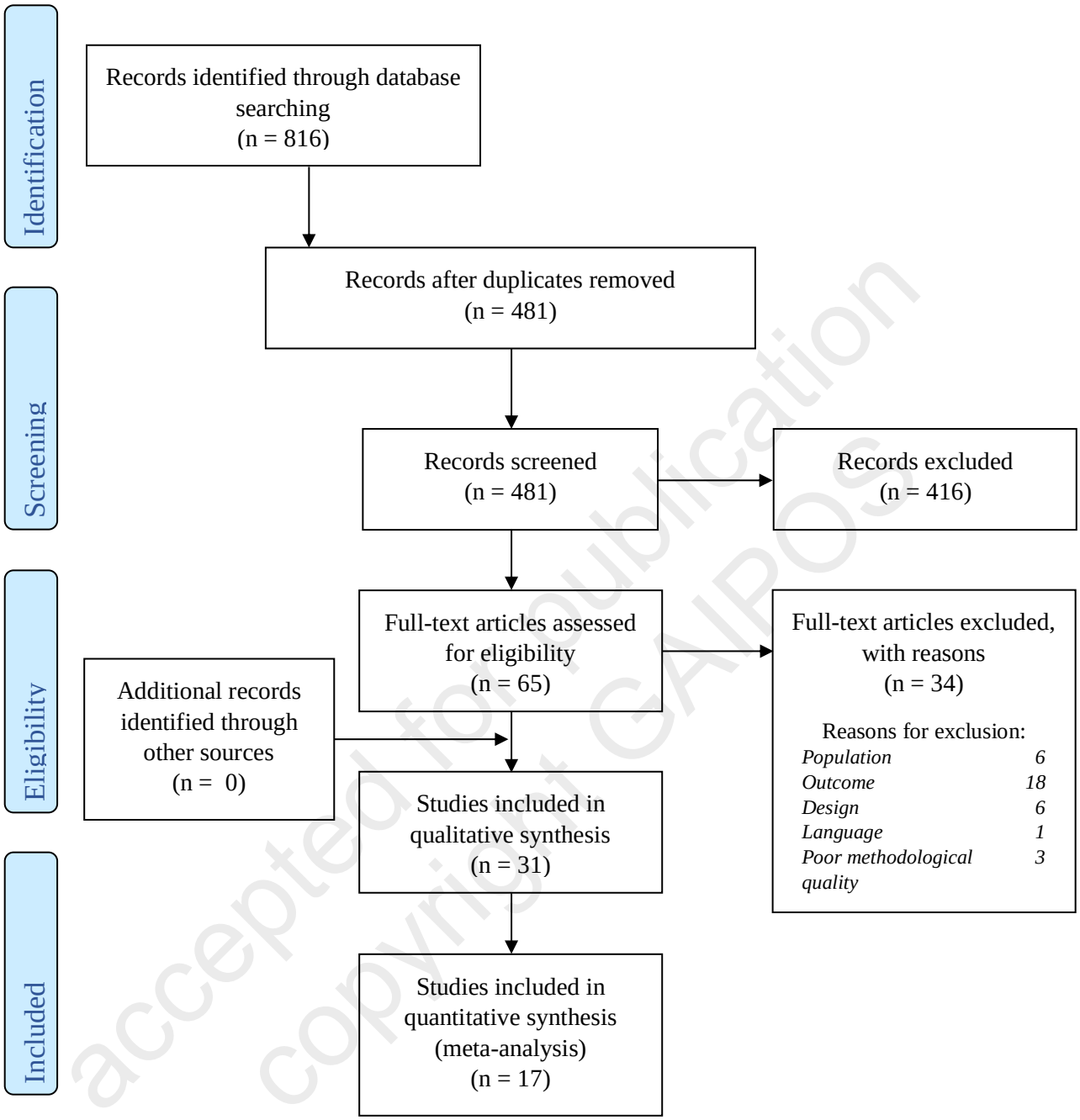
Author	Formal diagnosis	DSM-5 criteria			
		Criterion A: motor performance is below expectance regarding chronological age or intelligence	**Criterion B:** the motor difficulties significantly impact school- and/or daily activities	**Criterion C:** early onset of symptoms	**Criterion D:** intellectual disability or other neurological conditions cannot better explain the motor difficulties
Cheng et al. 2018 [24]	Yes	TIS ≤ 15% (MABC)	DCD-Q		Mainstream school, IQ within normal range
Du et al. 2015 [30]	Not reported	Total score < P5 (MABC-2) AND Total score < P18 (BOT-2 Brief)	Adult Developmental Coordination Disorder/Dyspraxia Checklist + telephone interview	Onset of the motor difficulties was during childhood (self- or parent report)	Difficulties were not due to a known intellectual disability or neurological impairment (self-/parent report)
Gentle et al. 2016 [36]	Not reported	Total score < P5 (MABC-2) AND Total score < P18 (BOT-2 Brief)	Adult Developmental Coordination Disorder/Dyspraxia Checklist + telephone interview	Onset of the motor difficulties was during childhood (self- or parent report)	Difficulties were not due to a known intellectual disability or neurological impairment (self-/parent report)
Speedtsberg et al. 2018 [44]	Yes	Total Score < P15 (MABC-2)			
Wilmut et al. 2016 [50]	Not reported	Total score < P16 (MABC-2)	MABC-2 checklist and DCD-Q and telephone interview	Onset in early childhood (parent report)	Difficulties were not due to a known intellectual disability or neurological impairment (parent report)
Wilmut & Barnett 2017 [49]	Not reported	Total score < P16 (MABC-2) AND Total score < P18 (BOT-2 Brief)	MABC-2 checklist and DCD-Q and telephone interview (parents) OR Adult Developmental Coordination Disorder/Dyspraxia Checklist + telephone interview (self-report for adults)	Onset of the motor difficulties was during childhood (self- or parent report)	Difficulties were not due to a known intellectual disability or neurological impairment (self-/parent report)
Yam & Fong 2019 [51]	Not reported	Total Score ≤ P15 (MABC-2)	DCD-Q	Onset in early childhood (parent report)	No neurological impairment, no intellectual disability (parent report)

Legend: *If children were recruited via physical therapists or diagnostic- or rehabilitation centres where they received therapy for DCD, a formal diagnosis of DCD was assumed. DSM-5: Diagnostic and Statistical Manual of Mental Disorders, 5th edition; TIS: Total Impairment Scale; MABC(-2): Movement Assessment Battery for Children (2nd edition); BOT-2: Bruininks-Oseretsky Test of Motor Proficiency 2nd edition; P: percentile; DCD-Q: Developmental Coordination Disorder Questionnaire.

Author	Formal diagnosis	ICD-10 criteria		
		A serious impairment in the development of motor coordination	Not solely explicable in terms of general intellectual retardation	Not solely explicable in terms of general of any neurological disorder
Chen et al. 2012 [23]	Not reported	TIS < P5 (MABC)	No specific neurological disorders (parental report)	IQ within normal range (WISC 3rd edition)
Tsai et al. 2008 [47]	Not reported	TIS ≤ P5 (MABC) and balance subscore ≤ P5 (MABC)	No overt neurological disorders	IQ > 69
Tsai & Wu 2008 [46]	Not reported	TIS ≤ P5 (MABC) and balance subscore ≤ P15 (MABC)	No signs of neurological damage	IQ > 69
Tsai et al. 2009 [45]	Not reported	TIS ≤ P5 (MABC) and balance subscore ≤ P5 (MABC)	No neurological disorders	IQ ≥ 80

Legend: *If children were recruited via physical therapists or diagnostic- or rehabilitation centres where they received therapy for DCD, a formal diagnosis of DCD was assumed. ICD-10: the International Statistical Classification of Diseases and Related Health Problems, 10th edition; TIS: Total Impairment Scale; MABC(-2): Movement Assessment Battery for Children (2nd edition); P: percentile; DCD-Q: Developmental Coordination Disorder Questionnaire.

Appendix 3: Flowchart of the selection process



Appendix 4: Raw data and standardized mean differences for task performances in the domain "stability limits and verticality" (Domain 2)

Test	Outcome Variable		Children with DCD			TD controls			SMD (Hedges' g)	
		Age group	N	Mean	SD	N	Mean	SD	Mean	95% CI
LOS - Forward [5]	Reaction time (s)	6-10y	30	0.92	0.47	20	0.94	0.31	-0.01	[-0.57; 0.56]
	COP_velocity (°/s)			4.92	2.56		4.67	2.00	0.04	[-0.53; 0.61]
	COP_maximum excursions (%)			97.97	12.89		94.60	11.49	0.21	[-0.36; 0.78]
	COP_end point excursions (%) -			67.10	28.67		80.50	20.09	-0.53	[-1.11; 0.04]
	COP_directional control (%)			78.97	16.44		81.70	9.14	-0.16	[-0.73; 0.41]
LOS - Backward [5]	Reaction time (s)	6-10y	30	0.61	0.31	20	0.71	0.31	-0.05	[-0.61; 0.52]
	COP_velocity (°/s)			4.29	2.20		3.31	1.85	0.17	[-0.40; 0.73]
	COP_maximum excursions (%)			**67.63**	**22.81**		**87.15**	**20.63**	**-0.83**	**[-1.42; -0.24]**
	COP_end point excursions (%)			**59.63**	**25.62**		**46.20**	**18.04**	**0.57**	**[0.00; 1.15]**
	COP_directional control (%)			49.13	23.95		58.95	19.19	-0.42	[-0.99; 0.15]
LOS – Right [5]	Reaction time (s)	6-10y	30	0.83	0.36	20	0.68	0.26	0.06	[-0.50; 0.63]
	COP_velocity (°/s)			6.02	2.68		6.61	2.56	-0.09	[-0.66; 0.48]
	COP_maximum excursions (%)			100.07	11.60		97.60	13.36	0.15	[-0.41; 0.72]
	COP_end point excursions (%)			77.53	29.52		77.80	21.04	-0.01	[-0.58; 0.56]
	COP_directional control (%)			99.00	125.13		74.85	8.55	0.55	[-0.02; 1.13]
LOS – Left [5]	Reaction time (s) - Left direction	6-10y	30	0.77	0.31	20	0.82	0.26	-0.02	[-0.59; 0.54]
	COP_velocity (°/s)			6.35	2.86		6.17	2.65	0.03	[-0.54; 0.59]
	COP_maximum excursions (%)			95.17	16.08		134.65	179.81	-0.31	[-0.88; 0.26]
	COP_end point excursions (%)			80.73	25.51		78.00	14.08	0.12	[-0.44; 0.69]
	COP_directional control (%)			74.83	13.32		79.50	10.88	-0.29	[-0.86; 0.28]
LOS[42]	COP_AREA (cm^2)	6-12y	17	8.75	4.26	19	12.93	5.32	-0.59	[-1.26; 0.08]
	COP_AP (cm)			7.56	1.37		9.09	1.57	-0.43	[-1.09; 0.24]
	COP_PATH (cm)			10.05	4.95		14.89	5.94	-0.63	[-1.30; 0.04]
	COP_ML (cm)			8.37	1.69		8.96	1.41	-0.15	[-0.81; 0.50]
	movement time (s)			2.30	0.75		2.70	0.75	-0.16	[-0.81; 0.50]
	peak velocity during movement (s)			0.95	0.12		0.52	0.11	0.42	[-0.24; 1.09]
	peak frequency (Hz)			1.40	0.34		1.00	0.26	0.23	[-0.42; 0.89]

Legend: LOS: limits of stability test; COP: Centre of Pressure; AP: anteroposterior; ML: mediolateral; TD: typical development; N: number of participants; SD: standard deviation; y: years old. Bold values indicate the 95% confidence interval does not include zero.

Appendix 5: Raw data and standardized mean differences for task performances in the domain "transitions and anticipatory postural adjustments" (Domain 3)

Test	Outcome Variable	Age group	Children with DCD			TD Controls			SMD (Hedges' g)	
			N	Mean	SD	N	Mean	SD	Mean	95% CI
OLS (MABC item) [25, 27]	Standard score [25]	4-6y	20	**2.9**	**1.4**	20	**0.30**	**0.40**	**2.53**	**[1.69; 3.36]**
	Seconds [27]	6-8y	10	33.30	5.80	10	35.90	4.60	-0.50	[-1.39; 0.39]
rapid goal-directed arm movements [10]	EMG - muscle onset latencies (ms) – I IO	8-10y	32	**55**	**57**	32	**-84**	**24**	**3.18**	**[2.44; 3.92]**
	EMG - muscle onset latencies (ms) – C IO			**-25**	**44**		**-58**	**26**	**0.91**	**[0.40; 1.43]**
	EMG - muscle onset latencies (ms) – C EO			**90**	**67**		**-34**	**42**	**2.22**	**[1.59; 2.84]**
	EMG - muscle onset latencies (ms) – C RA			**173**	**99**		**-70**	**37**	**3.25**	**[2.50; 4.00]**
	EMG - muscle onset latencies (ms) – C ES			**-33**	**40**		**-8**	**31**	**-0.70**	**[-1.20; -0.19]**
OLS, kick ball, take stairs [38]	EMG - trials with anticipatory onset (%) – I TibA	7-14y	11	**77**	**18**	11	**91**	**9.0**	**-0.98**	**[-1.87; -0.10]**
Y-balance test in anterior direction [51]	EMG - muscle peak rms (%) - RF	6-9y	48	69.72	62.1	51	60.42	45.88	0.17	[-0.22; 0.57]
	EMG - muscle peak rms (%) - BF			70.73	43.27		69.63	35.1	0.03	[-0.37; 0.42]
	EMG - muscle peak rms (%) - TibA			101.58	58.29		105.59	73.44	-0.06	[-0.45; 0.33]
	EMG - muscle peak rms (%) - G			195.96	136.91		151.91	116.26	0.35	[-0.05; 0.74]
Y-balance test in posteromedial direction [51]	EMG - muscle peak rms (%) - RF			65.32	56.59		73.19	47.56	-0.15	[-0.55; 0.24]
	EMG - muscle peak rms (%) - BF			54.14	32		60.31	39.25	-0.17	[-0.57; 0.22]
	EMG - muscle peak rms (%) - TibA			107.76	72.82		113.35	78.63	-0.07	[-0.47; 0.32]
	EMG - muscle peak rms (%) - G			**170.00**	**129.22**		**123.65**	**72.08**	**0.44**	**[0.04; 0.84]**
Y-balance test in posterolateral direction [51]	EMG - muscle peak rms (%) - RF			80.11	69.34		79.72	56.21	0.01	[-0.39; 0.40]
	EMG - muscle peak rms (%) - BF			60.97	36.22		63.7	67.02	-0.05	[-0.44; 0.34]
	EMG - muscle peak rms (%) - TibA			123.99	73.19		120.9	78.33	0.04	[-0.35; 0.43]
	EMG - muscle peak rms (%) - G			194.19	131.75		144.91	121.71	0.39	[-0.01; 0.79]
Y-balance test in anterior direction [51]	EMG - time to peak (ms) - RF			**3.38**	**2.09**		**4.67**	**3.48**	**-0.45**	**[-0.85; -0.05]**
	EMG - time to peak (ms) - BF			**2.78**	**2.07**		**4.4**	**3.67**	**-0.54**	**[-0.95; -0.14]**
	EMG - time to peak (ms) - TibA			**2.68**	**1.93**		**3.96**	**3.33**	**-0.47**	**[-0.87; -0.07]**
	EMG - time to peak (ms) - G			**3.06**	**1.99**		**4.21**	**2.82**	**-0.47**	**[-0.87; -0.07]**
Y-balance test in posteromedial direction [51]	EMG - time to peak (ms) - RF			3.59	2.71		3.64	2.47	-0.02	[-0.41; 0.37]
	EMG - time to peak (ms) - BF			4.22	2.86		3.91	2.43	0.12	[-0.28; 0.51]
	EMG - time to peak (ms) - TibA			3.32	2.95		4.1	2.2	-0.30	[-0.70; 0.10]
	EMG - time to peak (ms) - G			3.17	2.3		3.79	2.62	-0.25	[-0.65; 0.35]
Y-balance test in posterolateral direction [51]	EMG - time to peak (ms) - RF			3.43	2.68		4.35	3.53	-0.29	[-0.69; 0.10]
	EMG - time to peak (ms) - BF			4.11	2.66		4.25	3.69	-0.04	[-0.44; 0.35]
	EMG - time to peak (ms) - TibA			2.74	2.46		3.75	2.62	-0.40	[-0.80; 0.00]
	EMG - time to peak (ms) - G			2.93	2.46		3.78	2.72	-0.33	[-0.72; 0.07]

Legend: OLS: One Leg Stance; EMG: electromyography; I: ipsilateral; C: contralateral; IO: internal oblique muscle; EO: external oblique muscle; RA: rectus abdominis muscle; ES: erector spinae muscle; TA: transverse abdominal muscle; TibA: tibialis anterior muscle; RF: rectus femoris muscle; BF: biceps femoris muscle; G: gastrocnemius muscle; N: number of participants; SD: standard deviation; y: years old. Bold values indicate the 95% confidence interval does not include zero.

Appendix 6: Raw data and standardized mean differences for task performances in the domain "Reactive postural reactions" (Domain 4)

Perturbation during bipedal stance	Outcome Variable	Age group	Children with DCD			TD controls			SMD (Hedges' g)	
			N	Mean	SD	N	Mean	SD	Mean	95% CI
Moving platform (B) [24]	EMG – muscle onset latencies (ms) – G	6-9y	120	103.82	37.88	100	102.01	47.37	0.04	[-0.22; 0.31]
Push forward [32]	EMG – muscle onset latencies (ms) – G	6-10y	130	**76.63**	**26.49**	117	**56.91**	**23.03**	**0.79**	**[0.54; 1.05]**
	EMG – Peak force (kg) – G			**4.83**	**1.47**		**6.42**	**2.19**	**-0.85**	**[-1.11; -0.59]**
	EMG – Time to peak force (s) – G			2.28	0.58		2.27	0.49	0.02	[-0.23; 0.27]
Moving platform (B) [24]	EMG - muscle onset latencies (ms) – H	6-9y	120	123.04	57.09	100	123.59	58.77	-0.01	[-0.27; 0.26]
Push forward [32]	EMG - muscle onset latencies (ms) – H	6-10y	130	**89.88**	**42.91**	117	**70.62**	**23.84**	**0.55**	**[0.30; 0.81]**
	EMG – Peak force (kg) – H			**5.9**	**2.3**		**7.75**	**1.65**	**-0.92**	**[-1.19; -0.66]**
	EMG – Time to peak force (s) – H			**2.17**	**0.47**		**2.04**	**0.55**	**0.25**	**[0.00; 0.50]**
Moving platform (B) [24]	Motor control test latency scores (ms)	6-9y	120	**118.67**	**45.37**	100	**103.84**	**54.86**	**0.29**	**[0.03; 0.56]**
Moving platform (B&F) [24]	Motor control test latency scores (ms)	6-9y	120	82.69	68.4	100	88.6	68.22	-0.09	[-0.35; 0.18]
Moving platform (F) [24]	Motor control test latency scores (ms)	6-9y	120	**138.85**	**51.6**	100	**151.11**	**34.28**	**-0.28**	**[-0.55; -0.01]**
	EMG – muscle onset latencies (ms) – RF			151.29	44.12		148.42	39.25	0.07	[-0.20; 0.33]
	EMG – muscle onset latencies (ms) – TibA			131.66	35.55		130.22	36.34	0.04	[-0.23; 0.31]

Legend: B: backward; F: forward; G: Gastrocnemius; H: Hasmtrings; RF: Rectus Femoris; TibA: Tibialis Anterior; N: number of participants; SD: standard deviation; y: years old. Bold values indicate the 95% confidence interval does not include zero.

Appendix 7: Raw data and standardized mean differences for task performances in the domain "Sensory orientation" (Domain 5)

Task	Outcome Variable	Age group	Children with DCD			TD controls			SMD (Hedges' g)	
			N	Mean	SD	N	Mean	SD	Mean	95% CI
Bipedal stance (RQ) [41, 45]	COP_AP (cm) [41]	6-10y	20	125.61	41.64	20	133.45	46.15	-0.18	[-0.80; 0.44]
	COP_path (cm) [41]			117.75	16.83		124.81	17.74	-0.41	[-1.03; 0.22]
	COP_ML (cm) [41]			104.11	23.18		129.69	58.82	-0.57	[-1.20; 0.06]
	COP_area (cm²) [41]			127.89	44.43		157.24	69.61	-0.50	[-1.13; 0.13]
	COP_area (mm²) [45]	9-10y	39	200.21	391.62	39	219.9	283.18	-0.06	[-0.50; 0.39]
Bipedal stance EO [22, 27, 41, 43]	COP_rms_AP (cm) [22]	11-12y	30	**0.75**	**0.07**	30	**0.65**	**0.10**	**1.18**	**[0.64; 1.73]**
	sway velocity (°/S) [27]	6-8y	10	**0.61**	**0.25**	10	**0.38**	**0.15**	**1.12**	**[0.17; 2.06]**
	COP_ML (cm) [41]	6-10y	20	2.12	0.74	20	1.9	0.7	0.31	[-0.32; 0.93]
	COP_AP (cm) [41]			**2.14**	**0.68**		**1.66**	**0.52**	**0.79**	**[0.15; 1.44]**
	COP_ML rambling [43]	8-9y	9	6.23	1.2	10	4.96	2.3	0.69	[-0.23; 1.62]
	COP_ML trembling [43]			**1.65**	**0.37**		**0.74**	**0.1**	**3.36**	**[1.96; 4.75]**
	COP_AP rambling [43]			6.08	1.7		5.02	2.4	0.51	[-0.41; 1.42]
	COP_AP trembling [43]			**1.4**	**0.34**		**0.8**	**0.16**	**2.26**	**[1.11; 3.41]**
Bipedal stance FEO [27]	sway velocity (°/S)	6-8y	10	**1.23**	**0.3**	10	**0.72**	**0.2**	**2.00**	**[0.93; 3.07]**
Bipedal stance with light touch [22]	COP_rms_AP reduction (cm)	11-12y	30	**0.14**	**0.06**	30	**0.19**	**0.10**	**-0.66**	**[-1.18; -0.14]**
OLS EO – dominant leg [46, 47]	COP_area (cm²) [47]	9-10y	64	2.23	1.46	71	1.78	1.97	0.26	[-0.08; 0.60]
	COP_path (cm) [46, 47]			**32.00**	**11.75**		**26.95**	**12.60**	**0.41**	**[0.07; 0.76]**
		9-10y	60	**33.17**	**12.35**	60	**28.03**	**13.66**	**0.39**	**[0.03; 0.76]**
OLS EO – non-dominant leg [46, 47]	COP_area (cm²) [47]	9-10y	64	**2.86**	**2.01**	71	**1.91**	**1.34**	**0.56**	**[0.21; 0.90]**
	COP_path (cm) [46, 47]			**37.13**	**13.75**		**29.74**	**10.12**	**0.61**	**[0.27; 0.96]**
		9-10y	60	**38.93**	**14.54**	60	**29.99**	**10.36**	**0.71**	**[0.34; 1.08]**
Bipedal stance EC [27, 41]	COP_AP (cm) [41]	6-10y	20	**2.47**	**0.62**	20	**2.04**	**0.63**	**0.69**	**[0.05; 1.33]**
	COP_ML (cm) [41]			2.20	0.81		2.06	0.8	0.17	[-0.45; 0.79]
	sway velocity (°/S) [27]	6-8y	10	**1.02**	**0.35**	10	**0.49**	**0.19**	**1.88**	**[0.83; 2.93]**
Bipedal stance FEC [27]	sway velocity (°/S)	6-8y	10	2.52	0.73	10	2.03	0.52	0.77	[-0.14; 1.68]
OLS EC – dominant leg [46, 47]	COP_area (cm²) [47]	9-10y	64	**5.55**	**4.22**	71	**3.50**	**2.96**	**0.56**	**[0.22; 0.91]**
	COP_path (cm) [46, 47]			**57.92**	**23.77**		**43.96**	**19.07**	**0.65**	**[0.30; 0.99]**
		9-10y	60	**60.44**	**24.65**	60	**45.19**	**19.56**	**0.69**	**[0.32; 1.05]**
OLS EC – non-dominant leg [46, 47]	COP_area (cm²) [47]	9-10y	64	**6.64**	**4.61**	71	**4.47**	**2.67**	**0.58**	**[0.23; 0.92]**
	COP_path (cm) [46, 47]			**61.07**	**24.64**		**50.59**	**17.91**	**0.49**	**[0.14; 0.83]**
		9-10y	60	**63.09**	**25.54**	60	**50.28**	**16.99**	**0.59**	**[0.23; 0.96]**

Legend: (F)EO: (foam) eyes open; (F)EC: (foam) eyes closed; RQ = EC/EO; COP: centre of pressure; AP: anteroposterior direction; ML: mediolateral direction; OLS: one leg stance; N: number of participants; SD: standard deviation; y: years old. Bold values indicate the 95% confidence interval does not include zero.

Appendix 8: Raw data and standardized mean differences for task performances in the domain "Stability in gait" (Domain 6)

Task	Outcome Variable	Age group	Children with DCD			TD controls			SMD (Hedges' g)	
			N	Mean	SD	N	Mean	SD	Mean	95% CI
MABC [25]	Dynamic balance score	4-6y	20	**3.7**	**2.3**	20	**0.1**	**0.2**	**2.21**	**[1.42; 2.99]**
Level walking [28]	Double support (s)	7-9y	12	0.19	0.03	12	0.17	0.02	0.71	[-0.11; 1.54]
	Lead clearance height (m)			0.03	0.00		0.025	0.002	0.00	[-0.80; 0.80]
	Lead step length (m)			0.54	0.05		0.56	0.05	-0.33	[-1.13; 0.48]
	Lead swing (s)			0.33	0.02		0.34	0.03	-0.38	[-1.19; 0.42]
	Step width 1 (m)			0.15	0.03		0.148	0.022	0.11	[-0.69; 0.91]
	Step width 2 (m)			0.16	0.02		0.151	0.019	0.19	[-0.61; 0.99]
	Stride length (m)			1.07	0.09		1.10	0.09	-0.31	[-1.12; 0.49]
	Stride time (s)			0.84	0.08		0.84	0.05	-0.03	[-0.83; 0.77]
	Stride velocity (m/s)			1.29	0.95		1.32	0.13	-0.04	[-0.84; 0.76]
	Trail clearance height trail (m)			0.03	0.00		0.025	0.002	0.00	[-0.80; 0.80]
	Trail swing (s)			0.32	0.03		0.33	0.02	-0.50	[-1.31; 0.32]
	Trail step length (m)			0.53	0.05		0.54	0.05	-0.22	[-1.02; 0.58]
Obstacle crossing (5% height) [28]	Approach distance (m)	7-9y	12	0.43	0.06	12	0.395	0.037	0.77	[-0.06; 1.60]
	Clearance distance (m)			0.18	0.04		0.207	0.053	-0.64	[-1.47; 0.18]
	Double support (s)			0.20	0.05		0.18	0.04	0.41	[-0.40; 1.21]
	Lead clearance height (m)			0.13	0.05		0.12	0.04	0.23	[-0.58; 1.03]
	Lead step length (m)			0.61	0.07		0.61	0.06	0.05	[-0.75; 0.85]
	Lead swing (s)			**0.48**	**0.10**		**0.42**	**0.04**	**0.88**	**[0.04; 1.72]**
	Step width 1 (m)			0.17	0.03		0.159	0.026	0.45	[-0.36; 1.26]
	Step width 2 (m)			0.16	0.03		0.159	0.02	0.04	[-0.76; 0.84]
	Stride length (m)			1.07	0.11		1.12	0.12	-0.42	[-1.23; 0.38]
	Stride time (s)			1.11	0.18		1.04	0.10	0.51	[-0.30; 1.32]
	Stride velocity (m/s)			0.99	0.16		1.09	0.11	-0.77	[-1.59; 0.06]
	Trail clearance height trail (m)			0.19	0.04		0.189	0.05	-0.07	[-0.87; 0.73]
	Trail swing (s)			0.43	0.05		0.44	0.04	-0.26	[-1.07; 0.54]
	Trial step length (m)			0.46	0.07		0.51	0.07	-0.74	[-1.57; 0.09]
Obstacle crossing (30% height) [28]	Approach distance (m)	7-9y	12	0.40	0.08	12	0.416	0.063	-0.27	[-1.08; 0.53]
	Clearance distance (m)			0.19	0.03		0.203	0.037	-0.48	[-1.29; 0.33]
	Double support (s)			0.20	0.05		0.19	0.04	0.21	[-0.59; 1.01]
	Lead clearance height (m)			0.14	0.04		0.117	0.036	0.66	[-0.16; 1.49]
	Lead step length (m)			0.64	0.09		0.63	0.07	0.17	[-0.63; 0.98]
	Lead swing (s)			**0.55**	**0.08**		**0.48**	**0.04**	**1.07**	**[0.21; 1.92]**
	Step width 1 (m)			0.14	0.01		0.148	0.018	-0.37	[-1.18; 0.43]
	Step width 2 (m)			0.17	0.03		0.152	0.023	0.65	[-0.17; 1.47]
	Stride length (m)			1.02	0.14		1.10	0.13	-0.56	[-1.38; 0.25]
	Stride time (s)			1.24	0.16		1.19	0.11	0.39	[-0.42; 1.19]
	Stride velocity (m/s)			0.89	0.13		0.94	0.18	-0.31	[-1.11; 0.50]
	Trail clearance height trail (m)			0.21	0.05		0.216	0.048	-0.18	[-0.98; 0.63]
	Trail swing (s)			0.49	0.06		0.52	0.06	-0.46	[-1.27; 0.35]
	Trial step length (m)			0.44	0.06		0.47	0.06	-0.53	[-1.34; 0.29]
Walking with vision [29]	Double support (%)	7-9y	12	**11.40**	**1.30**	12	**9.90**	**1.30**	**1.15**	**[0.29; 2.02]**
	Double support time (ms)			**96.00**	**16.20**		**83.00**	**12.30**	**0.90**	**[0.06; 1.74]**
	Medio-lateral excursion (mm)			33.00	7.80		36.00	6.40	-0.42	[-1.23; 0.39]
	Step width ration (%)			71.30	13.80		72.40	13.20	-0.08	[-0.88; 0.72]
	Stride length (mm)			1072.00	92.80		1097.00	83.60	-0.28	[-1.09; 0.52]
	Stride time (ms)			837.00	75.70		843.00	48.60	-0.09	[-0.89; 0.71]
	Support (%)			61.60	1.69		60.60	1.36	0.65	[-0.17; 1.47]
	Support time (ms)			516.00	52.30		511.00	37.00	0.11	[-0.69; 0.91]
	Swing (%)			38.40	1.58		39.50	1.28	-0.77	[-1.59; 0.06]
	Swing time (ms)			321.00	27.80		333.00	16.60	-0.52	[-1.34; 0.29]
Walking in dark [29]	Double support (%)	7-9y		**13.2**	**1.75**	12	**10**	**1.38**	**2.03**	**[1.05; 3.02]**
	Double support time (ms)			**119**	**23.5**		**84**	**15.1**	**1.77**	**[0.83; 2.72]**
	Medio-lateral excursion (mm)			40	9.8		34	5.6	0.75	[-0.08; 1.58]
	Step width ration (%)			70.7	9.3		72.1	13.6	-0.12	[-0.92; 0.68]
	Stride length (mm)			**972**	**85.5**		**1061**	**79.1**	**-1.08**	**[-1.94; -0.22]**
	Stride time (ms)			897	92.5		840	64	0.72	[-0.11; 1.54]
	Single support (%)			**62.7**	**2.01**		**60.3**	**1.72**	**1.28**	**[0.40; 2.16]**
	Single support time (ms)			**563**	**65.9**		**507**	**43.1**	**1.01**	**[0.16; 1.86]**
	Swing (%)			**37.3**	**2.01**		**39.3**	**1.32**	**-1.18**	**[-2.04; -0.31]**
	Swing time (ms)			334	34.5		330	21.7	0.14	[-0.66; 0.94]
walking on treadmill at preferred speed [26, 44]	Absolute step width (mm) [26]	6-8y	10	146	15.6	10	141	15.5	0.32	[-0.56; 1.20]
	Cadence (steps/ min) [26]			**146**	**16.4**		**128**	**16.9**	**1.08**	**[0.14; 2.02]**
	Index of walking performance [26]			**4.36**	**3.148**		**1.28**	**0.743**	**1.35**	**[0.38; 2.32]**
	Normalised step width [26]			0.63	0.097		0.57	0.086	0.65	[-0.25; 1.55]
	Stride length (mm) [26]			**711**	**84.5**		**799**	**101**	**-0.95**	**[-1.87; -0.02]**
	Walking speed (m/s) [44]	7-10y	8	**0.92**	**0.06**	10	**1.06**	**0.06**	**-2.33**	**[-3.54; -1.13]**

Legend: MABC: Movement Assessment Battery for Children; N: number of participants; SD: standard deviation; y: years old. Bold values indicate the 95% confidence interval does not include zero.

Appendix 8: Raw data and standardized mean differences for task performances in the domain "Stability in gait" (Domain 6) – continued

Task	Outcome Variable	Age group	Children with DCD			TD Children			SMD (Hedges' g)	
			N	Mean	SD	N	Mean	SD	Mean	95% CI
walking on treadmill at preferred speed	COM RMS AP acceleration (m/s²) [44]	7-10y	8	0.17	0.11	10	0.15	0.04	0.24	[-0.69; 1.17]
	COM RMS ML acceleration (m/s²) [44]			0.16	0.03		0.15	0.04	0.28	[-0.65; 1.22]
	COM RMS V acceleration (m/s²) [44]			0.19	0.04		0.21	0.05	-0.44	[-1.38; 0.50]
	COM normalised RMS AP acceleration [44]			0.5	0.17		0.51	0.1	-0.07	[-1.00; 0.86]
	COM normalised RMS ML acceleration [44]			0.54	0.14		0.5	0.07	0.36	[-0.58; 1.30]
	COM normalised RMS V acceleration [44]			0.63	0.1		0.69	0.08	-0.66	[-1.62; 0.29]
walking on high-density foam sports mats walkway [30, 36, 49, 50]	COM AP acceleration (m/s²) [30]	Adults	15	1.45	0.24	15	1.55	0.30	-0.37	[-1.09; 0.35]
	COM normalised AP acceleration [49, 50]	7-11y [49]	14	3.56	1.82	14	3.74	1.45	-0.11	[-0.85; 0.63]
		12-17y [49]	15	1.73	0.40	15	2.27	1.70	-0.44	[-1.16; 0.29]
		Adults [49]	15	2.00	0.75	15	2.42	0.74	-0.56	[-1.29; 0.17]
		7-12y [50]	14	3.728	2.64	14	2.559	0.39	0.62	[-0.14; 1.38]
		12-17y [50]	15	1.495	0.19	15	1.521	0.28	-0.11	[-0.82; 0.61]
	COM_AP acceleration variability (m/s²) [30]	Adults	15	0.20	0.08	15	0.21	0.11	-0.10	[-0.82; 0.61]
	COM normalised AP acceleration variability [50]	7-12y	14	0.642	0.34	14	0.497	0.21	0.51	[-0.24; 1.27]
		12-17y	15	0.233	0.11	15	0.217	0.08	0.17	[-0.55; 0.88]
	COM ML acceleration (m/s²) [30]	Adults	15	1.51	0.42	15	1.42	0.48	0.20	[-0.52; 0.92]
	COM normalised ML acceleration [49]	7-11y	14	**2.75**	**0.82**	14	**2.15**	**0.44**	**0.91**	**[0.13; 1.69]**
		12-17y	15	1.83	0.42	15	1.69	0.50	0.30	[-0.42; 1.02]
		Adults	15	1.77	0.56	15	1.78	0.54	-0.02	[-0.73; 0.70]
	COM normalised ML acceleration [50]	7-12y	14	3.195	1.89	14	2.259	0.48	0.68	[-0.08; 1.44]
		12-17y	15	1.595	0.46	15	1.427	0.39	0.39	[-0.33; 1.12]
	COM acceleration ML variability (m/s²) [30]	Adults	15	0.31	0.17	15	0.22	0.09	0.66	[-0.07; 1.40]
	COM normalised ML acceleration variability [50]	7-12y	14	**0.784**	**0.36**	14	**0.545**	**0.19**	**0.83**	**[0.06; 1.60]**
		12-17y	15	0.295	0.08	15	0.276	0.1	0.21	[-0.51; 0.93]
	COM V acceleration (m/s²) [30]	Adults	15	2.56	0.52	15	2.51	0.62	0.09	[-0.63; 0.80]
	COM normalised V acceleration [49, 50]	7-11y [49]	14	3.71	1.15	14	3.88	0.94	-0.16	[-0.90; 0.58]
		12-17y [49]	15	2.36	0.64	15	2.59	0.87	-0.30	[-1.02; 0.42]
		Adults [49]	15	2.38	0.63	15	2.66	0.54	-0.48	[-1.20; 0.25]
		7-12y [50]	14	5.473	2.78	14	4.38	1.16	0.51	[-0.24; 1.27]
		12-17y [50]	15	2.412	0.77	15	2.643	0.62	-0.33	[-1.05; 0.39]
	COM acceleration V variability (m/s²) [30]	Adults	15	**0.35**	**0.12**	15	**0.23**	**0.06**	**1.26**	**[0.48; 2.05]**
	COM normalised V acceleration variability [50]	7-12y	14	0.947	0.24	14	0.786	0.3	0.59	[-0.16; 1.35]
		12-17y	15	0.339	0.12	15	0.309	0.1	0.27	[-0.45; 0.99]
	COM AP velocity (m/s) [30]	Adults	15	1.35	0.12	15	1.37	0.17	-0.14	[-0.85; 0.58]
	COM normalised AP velocity [49, 50]	7-11y [49]	14	1.82	0.79	14	1.61	0.25	0.36	[-0.39; 1.11]
		12-17y [49]	15	1.40	0.46	15	1.29	0.10	0.33	[-0.39; 1.05]
		Adults [49]	15	1.31	0.16	15	1.43	0.18	-0.70	[-1.44; 0.03]
		7-12y [50]	14	2.345	0.81	14	1.998	0.19	0.59	[-0.17; 1.35]
		12-17y [50]	15	1.342	0.2	15	1.38	0.15	-0.21	[-0.93; 0.50]
	COM AP velocity variability (m/s) [30]	Adults	15	**0.07**	**0.02**	15	**0.05**	**0.02**	**1.00**	**[0.24; 1.76]**
	COM normalised AP velocity variability [50]	7-12y	14	0.187	0.08	14	0.142	0.1	0.50	[-0.26; 1.25]
		12-17y	15	0.067	0.03	15	0.057	0.02	0.39	[-0.33; 1.11]
	COM ML velocity (m/s) [30]	Adults	15	0.13	0.04	15	0.11	0.03	0.57	[-0.16; 1.30]
	COM normalised ML velocity [49, 50]	7-11y [49]	14	0.27	0.08	14	0.23	0.04	0.63	[-0.13; 1.39]
		12-17y [49]	15	0.19	0.05	15	0.17	0.04	0.44	[-0.28; 1.17]
		Adults [49]	15	0.13	0.05	15	0.12	0.03	0.24	[-0.48; 0.96]
		7-12y [50]	14	0.203	0.09	14	0.163	0.02	0.61	[-0.14; 1.37]
		12-17y [50]	15	**0.118**	**0.03**	15	**0.099**	**0.02**	**0.75**	**[0.01; 1.49]**
	COM_ML velocity variability (m/s) [30]	Adults	15	**0.03**	**0.01**	15	**0.02**	**0.01**	**1.00**	**[0.24; 1.76]**
	COM normalised ML velocity variability [50]	7-12y	14	0.07	0.03	14	0.059	0.01	0.49	[-0.26; 1.24]
		12-17y	15	0.03	0.01	15	0.023	0.01	0.70	[-0.04; 1.44]
	COM V velocity (m/s²) [30]	Adults	15	0.21	0.04	15	0.19	0.04	0.50	[-0.23; 1.23]
	COM normalised V velocity [49, 50]	7-11y [49]	14	0.25	0.13	14	0.23	0.06	0.20	[-0.55; 0.94]
		12-17y [49]	15	0.17	0.05	15	0.17	0.04	-0.02	[-0.74; 0.69]
		Adults [49]	15	0.17	0.05	15	0.19	0.03	-0.49	[-1.21; 0.24]
		7-12y [50]	14	0.351	0.14	14	0.306	0.08	0.39	[-0.35; 1.14]
		12-17y [50]	15	0.196	0.06	15	0.206	0.05	-0.18	[-0.90; 0.54]

Legend: N: number of participants; SD: standard deviation; y: years old. Bold values indicate the 95% confidence interval does not include zero. COM: Centre of mass; ML: mediolateral direction; AP: anteroposterior direction; RMS: root mean square;

Appendix 8: Raw data and standardized mean differences for task performances in the domain "Stability in gait" (Domain 6) – continued

Task	Outcome Variable	Age group	Children with DCD			TD Children			SMD (Hedges' g)	
			N	Mean	SD	N	Mean	SD	Mean	95% CI
walking on high-density foam sports mats walkway [30, 36, 49, 50]	COM V velocity variability (m/s²) [30]	Adults	15	**0.03**	**0.01**	15	**0.02**	**0.01**	**1.00**	**[0.24; 1.76]**
	COM normalised V velocity variability [50]	7-12y	14	0.064	0.03	14	0.054	0.02	0.39	[-0.37;1.14]
		12-17y	15	0.025	0.01	15	0.021	0.01	0.40	[-0.32; 1.12]
	Double support (%) [30, 36, 50]	Adults [30]	15	13.09	1.64	15	13.56	2.16	-0.25	[-0.96; 0.47]
		7-12y [50]	14	11.8	1.14	14	12.1	0.33	-0.36	[-1.10; 0.39]
		12-17y [50]	15	12.3	1.61	15	12.2	1.24	0.07	[-0.65; 0.79]
		8-12y [36]	12	15.65	3.05	12	15.05	1.39	0.25	[-0.55; 1.06]
		13-17y [36]	12	17.67	4.46	12	15.80	2.19	0.53	[-0.28; 1.35]
		Adults [36]	11	16.74	5.66	11	16.04	1.13	0.17	[-0.67; 1.01]
	Double support variability (%) [30, 50]	Adults [30]	15	**1.29**	**0.20**	15	**1.01**	**0.17**	**1.51**	**[0.70; 2.32]**
		7-12y [50]	14	1.7	0.34	14	1.43	0.49	0.64	[-0.12; 1.40]
		12-17y [50]	15	**1.43**	**0.17**	15	**1.14**	**0.23**	**1.43**	**[0.63; 2.24]**
	Normalised step length [50]	7-12y	14	0.6	0.1	14	0.64	0.08	-0.44	[-1.19; 0.31]
		12-17y	15	0.54	0.1	15	0.6	0.11	-0.57	[-1.30; 0.16]
	Normalised step length variability [30, 50]	Adults [30]	15	0.03	0.02	15	0.02	0.01	0.63	[-0.10; 1.37]
		7-12y [50]	14	0.05	0.01	14	0.05	0.03	0.00	[-0.74; 0.74]
		12-17y [50]	15	0.03	0.02	15	0.03	0.01	0.00	[-0.72; 0.72]
	Step length ratio [30]	Adults	15	0.56	0.07	15	0.55	0.05	0.16	[-0.55; 0.88]
	Normalised step width [36, 50]	8-12y [36]	12	0.83	0.17	12	0.92	0.12	-0.61	[-1.43; 0.21]
		13-17y [36]	12	0.63	0.17	12	0.68	0.13	-0.33	[-1.14; 0.48]
		Adults [36]	11	0.66	0.20	11	0.75	0.13	-0.53	[-1.38; 0.32]
		7-12y [50]	14	0.7	0.09	14	0.67	0.07	0.37	[-0.38; 1.12]
		12-17y [50]	15	**0.64**	**0.09**	15	**0.55**	**0.11**	**0.90**	**[0.14; 1.65]**
	Normalised step width variability [30, 50]	Adults [30]	15	**0.11**	**0.03**	15	**0.09**	**0.02**	**0.78**	**[0.04; 1.53]**
		7-12y [50]	14	0.18	0.06	14	0.16	0.03	0.42	[-0.33; 1.17]
		12-17y [50]	15	0.13	0.04	15	0.11	0.03	0.57	[-0.16; 1.30]
	Step width ratio [30]	Adults	15	0.56	0.08	15	0.59	0.09	-0.35	[-1.07; 0.37]
	Percentage of trials with path deviation (%) [49]	7-11y	14	96.00	11.00	14	95.00	10.00	0.10	[-0.65; 0.84]
		12-17y	15	96.00	8.00	15	99.00	4.00	-0.47	[-1.20; 0.25]
		Adults	15	96.00	10.00	15	94.00	16.00	0.15	[-0.57; 0.87]
	Stride time (s) [30, 50]	Adults [30]	15	0.93	0.06	15	0.89	0.06	0.67	[-0.07; 1.40]
		7-12y [50]	14	0.74	0.15	14	0.81	0.05	-0.63	[-1.38; 0.13]
		12-17y [50]	15	0.9	0.05	15	0.91	0.04	-0.22	[-0.94; 0.50]
	Stride time variability (s) [30, 50]	Adults [30]	15	**0.02**	**0.01**	15	**0.01**	**0.01**	**1.00**	**[0.24; 1.76]**
		7-12y [50]	14	0.03	0.02	14	0.02	0.01	0.63	[-0.13; 1.39]
		12-17y [50]	15	**0.02**	**0.01**	15	**0.01**	**0.01**	**1.00**	**[0.24; 1.76]**
	Velocity (m/s) [36]	8-12y	12	0.99	0.20	12	1.05	0.17	-0.32	[-1.13; 0.48]
		13-17y	12	1.06	0.22	12	1.12	0.12	-0.34	[-1.14; 0.47]
		Adults	11	1.06	0.17	11	1.10	0.18	-0.23	[-1.07; 0.61]

Legend: V: vertical; N: number of participants; SD: standard deviation; y: years old. Bold values indicate the 95% confidence interval does not include zero.