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Review Article

Postural Control in Developmental Coordination Disorder and Typical Children: A Systematic Review

Cristiana Isabel André Mercê[1,2*], Marco António Colaço Branco[1,3], Ana Paula de Lemos Teixeira e Seabra[1], David Paulo Ramalheira Catela[1,2]

[1]Superior School of Sports of Rio Maior (ESDRM), Polytechnic Institute of Santarém (IPSantarém); IPSantarem Research Unit (UI-IPS), Applied Psychology, Portugal

[2]Life Quality Research Centre (CIEQV), Motor Behaviour, Portugal

[3] Laboratory of Biomechanics and Functional Morphology, Interdisciplinary Centre for the Study of Human Performance (CIPER), Faculty of Human Kinetics, University of Lisbon

[*]**Corresponding author:** Cristiana Isabel André Mercê, Superior School of Sports of Rio Maior, Avenida Mário Soares, nº 110 2040-413 Rio Maior, Santarém, Portugal. Tel: +351-243999280; Email: cristianamerce@esdrm.ipsantarem.pt

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Abstract

Developmental Coordination Disorder (DCD) is a motor disorder without neural compromising that affects 6% of school-age children. One of the most prevalent problems is Postural Control (PC) deficit, which affects 73% to 87% of this population . A systematic review was conducted between 24 February 2016 and 3 March 2016 in order to identify the methodologies formerly used in the PC study on DCD children, and the differences determined between them and typical children with the purpose of identifying clues for a suitable intervention. Article references were searched further for additional relevant publications using the electronic databases: PubMed, Science Direct, Scopus, Web of Science, Cochrane and Scielo. The search was performed in English, French, Portuguese and Spanish. 9 articles were retrieved for analysis, being that no articles mentioning nonlinear methods were found. Previous studies suggest that DCD children are more dependent on visual information (VI). In standing condition DCD children revealed to be more variable and oscillate more than typical, especially with increasing difficulty, e.g. without VI or doing tasks simultaneously. In walking balance with no VI, DCD children significantly decreased their step frequency and step length, walking slower. For a more suitable intervention with DCD children we should: consider attentional factors; work on the perception-action link; work on the timing of gastrocnemius contraction and improve this peak force; moreover, increase the limit of stability in backward excursion.

Keywords: Children; DCD; Linear; Nonlinear; Postural control

Abbreviations

AA : Words Articulation Task
AC : Auditory-Choice Reaction Task
AM : Auditory-Memory Task
Ao : Area of Sway
AP : Anterior-Posterior Sway
AV : Auditory-Verbal Reaction Task
BPM : Balance Performance Monitor
CDP : Computerized Dynamic Posturography
COP : Centre of Pressure
DCD : Developmental Coordination Disorder
DCD-BP : Developmental Coordination Disorder with Balance Problems
DSM-MD : Diagnostic and Statistical Manual of Mental Disorders

ES	:	Equilibrium Score
HD	:	High Difficulty
IQ	:	Intelligence Quotient
L	:	Path Length
Lat or LAT	:	Medio-Lateral Sway
LD	:	Low Difficulty
LOS	:	Limit of Stability
MABC	:	Movement Assessment Battery for Children
Oc	:	Counting Task
RC	:	Romberg's Coefficient
PC	:	Postural Control
SOT	:	Sensory Organization Test
TD	:	Typical Development
VI	:	Visual Information

Introduction

The Developmental Coordination Disorder (DCD) is a motor disorder identified and recognized by the Diagnostic and Statistical Manual of Mental Disorders (DSM-MD) [1]. This disorder is expressed early, affecting 6% of school-age children [2,3]. The children with DCD reveal problems in the development of fine or global motor coordination, difficulties in the motor control and learning, and in the acquisition of new motor skills [2]. These difficulties are expressed in many ways, like in a delay of achieving motor milestones, clumsiness, poor balance, difficulties in writing and drawing [4], poor postural control [5], and difficulties in space and temporal organization [6]; affecting the daily life of the children which, consequently, brings more problems and new difficulties like academic delay or social isolation [2,7]. For example, a child who cannot maintain his posture in the chair and simultaneously has difficulties in drawing letters correctly, will be a child that is neither focussed on the lesson nor the teacher but rather on drawing a letter, resulting in academic impairments.

The difficulties remain for life, DCD does not simply disappear as time goes by [8]. An early diagnosis accompanied by an early intervention may help to decrease the negative effects of DCD, and provide a better quality of life for these children, and later, in their adult life [9]. Children with DCD are a heterogeneous group, they can reveal just some part of the symptoms and not all simultaneously, e.g., the child can reveal balance problems but no visual and spatial difficulties and vice versa [3]. One of the most prevalent problems is the postural control deficit, which affects 73% to 87% of the DCD children [10]. The postural control is crucial for all daily tasks, so due to the significance it is pertinent to study it in DCD children. If we understand how balance control is performed, and the differences between typical and DCD children in this capacity, we will be able to make a more adjusted intervention with better results.

In recent years, new ways of looking at and interpreting postural control data have been increasing. Previously, only the linear and quantification methods like the COP analysis in sway, path range or coefficient of variation were used. Nowadays the nonlinear methods are emerging and represent a very useful tool, which can provide information on the quality of movement and how the movement is controlled by the system over time [11]. Recently, nonlinear methods have successfully demonstrated sensitivity to small alterations in postural control and to be able to discriminate pathologic from non-pathologic disorders, e.g. detection of infants with cerebral palsy [11-14].

Considering the importance of PC's study in DCD children, which affects their daily living, and bearing in mind the value that linear methods had already proved in the past and also the potential of the recent application of nonlinear methods. It would be of significant importance to review all the methodologies already used in PC's study in DCD to give a holistic view to investigators of what has already been done in this field and, subsequently, what can be improved in future studies. Beyond the methodology, it would be interesting to analyse and synthetize the results found for PC in DCD children and the differences between them and typical, in order to more deeply understand this theme and, if possible, find clues for a more suitable intervention.

Overall, the purpose of this systematic review consists of identifying all the methodologies, linear and nonlinear, that have been used in the PC study in DCD; and also analyse and synthetize the differences that they found between these and typical children. The raised questions were: i) which methods were used to evaluate postural control in children with DCD? ii) which differences were found between the postural control in DCD children and children with typical motor development?

Methods

Search Strategy

A literature searches according to PRISMA guidelines [15] was conducted using the electronic databases PubMed, Science Direct, Scopus, Web of Science, Cochrane and Scielo. These databases were selected as they represent a wide spectrum of disciplines that perform research in DCD [16]. The search was performed between 24 February 2016 and 3 March 2016, all articles presented in the databases in this time frame were scrutinized. Due to the wide range of different terminology to refer postural control, a combined search using the equivalent terms has been chosen; an equivalent term, the acronym and the complete designation for DCD were used. To maximize the spectrum of the search, this was performed in English, French, Portuguese and Spanish using the following key terms in the advanced search: English - ((developmental coordination disorder) or (dyspraxia) or (DCD)) and (postural balance) or (postural sway) or (postural control); French - ((“Développement des troubles de coordination”) or (dyspraxie) or (DCD)) and ((contrôle postural) or (l’équilibre postural) or (balancement postural)); Portuguese - ((“desordem coordenativa do movimento”) or (desordem coordenativa no desenvolvimento) or (DCD) or (dispraxia)) and ((controle postural) or (controlo postural) or (oscilação postural) or (equílibrio postural)); Spanish - ((“Transtorno de la coordinación del desarrollo”) or (dispraxia) or (DCD)) and ((control postural) or (equilibrio postural) or (oscilación postural)).

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria for this systematic review were similar to another review on the topic of DCD [16], consequently, were discussed and defined by all authors. As inclusion criteria the authors only considered studies that: i) had been published in peer reviewed journals; ii) had had a DCD group evaluated by a standardized assessment of motor skills to diagnose a probable DCD, such as, Movement Assessment Battery for Children 1 or 2 [17,18] and/or Bruininks Test of Motor Proficiency-2 [19]; iii) had a control group with typical development; iv) had used, at least, one nonlinear measurement/method to analyze postural control; v) incorporated children until 10 years old, this age limit was defined based on the final stage of third infancy, where children developed expertise and a combination of motor skills. The exclusion criteria were the following: i) not reviewed by pairs; ii) books or chapters; iii) studies of qualitative nature; iv) studies in which the DCD group has violated the DSM-IV criteria for this disorder, such as children with an identifiable neurological disorder, an IQ (intelligence quotient) score outside the normal range or children with any (gross) physical or sensory impairment.

Identification of Eligible Articles

After completing the search in the different languages, 1 302 records were identified (English- 834, French- 116, Portuguese- 27, Spanish- 325), which were reduced to 598 after removing duplicates. Subsequently, the title reading was carried out, where 67 potentially relevant articles were identified. This marked decrease of potential articles, from 598 to 67, was the result of a combined search with the terms “postural control” that retrieved articles including other disorder like CP, autism or Asperger in which we had no interest.

Based on the abstract reading 34 articles were excluded: 8 for not being an article reviewed by pairs, 2 for being a systematic review, 2 for not including a DCD group, 8 due to the absence of postural control’s analyses, and 14 for not corresponding to the age group selected. After a full reading a further 24 articles were excluded: 3 for not using a standard instrument to access DCD, 14 for violating DSM-IV, and 7 for not corresponding to the age group selected. In the end just 9 articles were considered for the present systematic review, all of which included linear methods with no reference whatsoever to nonlinear methods, details can be found in (Figure 1). After screening each eligible paper, the following data were extracted: sample size, mean and standard deviation of sample’ age, tasks, tools, outcome variables, results and conclusions.

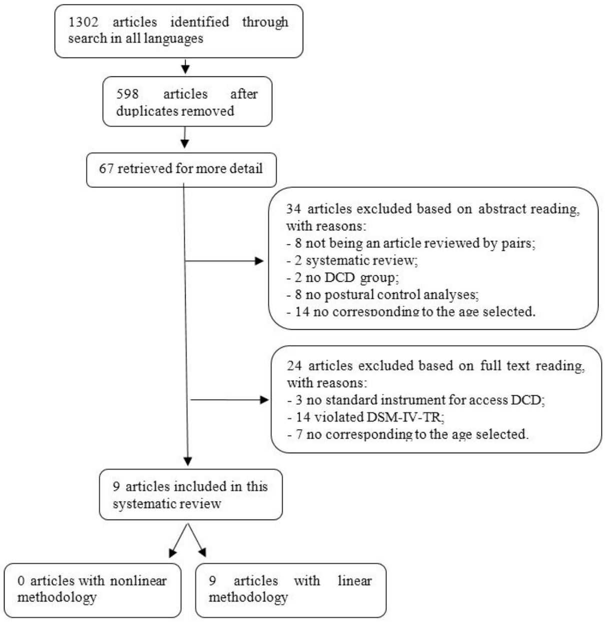

Figure 1: Search strategy flow chart.

Results

The data retrieved from the eligible studies are presented in (Table 1) for sample, age, tasks and tools, and in (Table 2) for outcome variables, principle results and conclusions. All studies incorporated a DCD and a control group, the sample sizes across the DCD group ranged from 12 to 130, and in control group from 12 to 117. All studies reported the mean age and standard deviation. With regard to the tools and outcome variables, all studies used biomechanical instruments including force platforms [20]; three-dimensional video record [21]; a balance performance monitor [22,23]; a magnetic tracking system [24,25]; a computerized dynamic system [26,27]; electromyography, accelerometer and dynamometer [28]. All studies performed kinematic analysis and only one also included kinetic analysis [28]. In almost all studies the tasks changed to standing position, except in one which analysed walking [21]. In 3 studies an additional task was performed besides standing [23-25]. No study was found using nonlinear methodology.

Authors	Sample	Age	Tasks	Tools
Przysucha & Taylor (2004) [20]	20 DCD boys 20 TD boys	8.6±2.1 8.5±2	i) Standing quiet with eyes open; ii) idem in eyes closed	1 AMTI force platform
Deconinck et al. (2006) [21]	12 DCD 12 TD	7.8±0.52 7.7±0.56	i) Walk at their preferred speed with lighting; ii) same in dark. The order conditions were randomized	8 Three-dimensional ProReflex cameras recording at 240 Hz
Tsai et al. (2008) [22]	64 DCD-BP 71 TD	10.1±0.3 10.3±0.2	With and without vision standing still 30'' on: i) dominant leg, ii) non-dominant leg and iii) both legs. First eyes open and then closed during both the two-leg and one-leg stances	Balance performance monitor (BPM) composed by a feedback unit and a set of force platforms, recording at 100 Hz
Tsai, Pan, Cherng & Wu (2009) [23]	39 DCD-BP 39 TD	9.7±0.4 9.6±0.2	i) For 30'' just standing; ii) idem doing five dual-tasks: Oral Counting task (OC), Auditory-Verbal reaction task (AV), auditory-choice reaction task (AC), Auditory-Memory task (AM) and words articulation task (AA); iii) Standing with eyes closed	Balance Performance Monitor, 100 Hz
Chen, Tsai, Stoffregen, & Wade (2011) [25]	32 DCD 32 TD	9.4±0.5 9.21±0.42	While standing do a visual task of signal detection in a monitor: i) Low Difficulty (LD); ii) High Difficulty (HD). The order conditions were randomized	Magnetic tracking system, 60 Hz
Chen, Tsai, Stoffregen, & Wade (2012) [24]	38 DCD 38 TD	9.37±0.49 9.21±0.41	While standing do a digital memory task at two levels: i) Low Difficulty (LD); ii) High Difficulty (HD). The order conditions were randomized	Magnetic tracking system (no reference of recording frequency)
Fong et al. (2012) [27]	22 DCD 19 TD	7.5±1.4 6.9±1.1	Just be standing for: i) eyes open, fixed support; ii) eyes closed, fixed support; iii) sway-referenced vision, fixed support; iv) eyes open, sway-referenced support; v) eyes closed, sway-referenced support; vi) sway-referenced vision and sway-referenced support	Computerized dynamic posturography machine to perform a Sensory Organization Test (SOT)
Fong et al. (2015) [28]	130 DCD 117 TD	7.7±1.4 7.4±1.3	Standing with: i) eyes closed; ii) idem with an unexpected perturbation; iii) voluntarily contracting their leg muscles as hard and as fast as possible.	Electromyography; accelerometer; dynamometer; Lafayette Manual Muscle Test System
Fong et al. (2016) [26]	30 DCD 20 TD	7.7±1.5 7.9±1.6	Standing at force platform without moving their feet and watching their COP projection in a visor, children should redirect their COP by redistribute their weight in the feet to reach target positions that were randomly selected	Computerized dynamic posturography to perform limit of stability test (LOS)

Table 1: Studies included in the review listed by sample, age, tasks and tools.

Authors	Outcome Variables	Results	Conclusions
Przysucha & Taylor (2004) [20]	Kinematic COP analysis in: Anterior-Posterior (AP) sway, lateral (Lat) sway, path length (L), area of sway (Ao). Romberg's quotient.	No significant difference between groups in LAT or L. Boys with DCD demonstrated a higher AP sway ($p < .01$) and Ao ($p < .03$). Romberg's quotient indicated that boys with DCD did not over-rely on visual information	Boys with DCD are able to compensate as effectively as TD for the loss of visual input while maintaining quiet stance.
Deconinck et al. (2006) [21]	Kinematic Spatiotemporal gait variables: stride length, stride frequency, stride velocity, support time, swing time, double support time.	With light the gait pattern was similar between groups. In dark, step frequency and step length were decreased in the DCD children, with significantly slower walking ($p<0.001$). Velocity and the medio-lateral excursion of COP tended to increase in DCD	The study suggest that DCD are more dependent on visual information than TD for the maintenance of balance and the control of velocity during walking.
Tsai et al. (2008) [22]	Kinematic COP analysis in: sway area, total path length. Romberg's quotient.	In all conditions DCD-BP children demonstrated greater total path length and sway area than TD. DCD-BP showed significantly larger maximum COP excursions, especially with closed eyes. Romberg's coefficient indicated that DCD-BP did not over-rely on visual information	Static balance abilities of children with DCD-BP were significantly worse, especially when standing with eyes closed, than for TD (significant lower sway area and total path).
Tsai, Pan, Cherng & Wu (2009) [23]	Kinematic Sway area of COP. Variation index. Romberg coefficient.	No significant differences in single task or dual-task balancing between groups. For intra-group comparisons no significant differences in TD for dual task in relation to baseline. DCD-BP increase significantly their sway path in OC, AV and AM ($p=00.3$, $p=0.011$, $p=0.041$ respectively). Romberg coefficient suggested that DCD-BP did not over-rely on visual information	The study suggests that children with DCD-BP were more cognitively dependant and may have an automatization deficit.
Chen, Tsai, Stoffregen, & Wade (2011) [25]	Kinematic Positional variability (standard deviation of position) for: head and torso, anteroposterior and mediolateral direction.	DCD group exhibited a significant higher positional variability than the TD group for head and torso motion in all conditions ($p<0.05$). Both groups modulated their postural activity in response to difficulty variations. The effect of visual task (HD vs. LD) on postural activity differed for TD and DCD groups. TD reduced postural motion in the HD while DCD increased	The study suggests a weakened perception-action link in children with DCD as they seem less able to reduce postural control to benefit signal detection performance.
Chen, Tsai, Stoffregen, & Wade (2012) [24]	Kinematic Positional variability (standard deviation of position) for: head and torso, anteroposterior and mediolateral direction.	DCD exhibited significantly larger postural motion ($p<0.05$) than TD. TD modulated their sway in response to variations in task difficulty, they significantly reduced postural motion in the HD ($p<0.05$) compared LD, DCD did not	The study suggests that the postural responses of DCD differ from TD while engaging in a memory task with various difficulty levels. Also suggest that DCD had a reduced ability to modulate postural motion when engaged in cognitive activity.
Fong et al. (2012) [27]	Kinematic Equilibrium Score (ES) for AP direction. Composite ES (considering ES in all the six conditions). Somatosensory, visual and vestibular ratio.	DCD had lower composite ES ($p < .001$), visual ratios ($p = .005$) and vestibular ratios ($p = .002$) than TD. DCD had lower motor strategy scores (swayed more on their hips) than the normal children when forced to depend on vestibular cues alone to balance ($p < .05$)	DCD had deficits in standing balance control in conditions that included reduced or conflicting sensory signals. The visual and vestibular systems tended to be more involved in balance deficits than somatosensory. DCD children tended to use hip strategy excessively when forced to rely primarily on vestibular signals to maintain postural stability.

Fong et al. (2015) [28]	Kinematic and kinetic Hamstring and gastrocnemius: muscle activation latencies, muscle peak force, time to peak force.	DCD had longer hamstring and gastrocnemius muscle activation latencies (P<0.001) and lower isometric peak forces (P<0.001). Gastrocnemius peak force explained 5.7% (P=0.003) and 8.5% (P=0.001) of the variance of MABC balance sub score and ball skills sub score respectively. Gastrocnemius muscle activation latency explained 11.4% (P<0.001) of the variance in the MABC ball skills sub score.	DCD had delayed leg muscle activation and lower isometric peak forces. Gastrocnemius peak force was associated with balance and ball skills performances, whereas timing of gastrocnemius muscle activation was a determinant of ball skill performance in the DCD population. Improving the timing of gastrocnemius muscle activation and strengthening should be included in the rehabilitation treatments to improve postural control.
Fong et al. (2016) [26]	Kinematic LOS in standing reaction time. Movement velocity. Maximum excursion. End point excursion. Directional control. Self-reported fall incidents in the previous week.	DCD had shorter LOS maximum excursion in the backward direction compared to the control group (p = 0.003). This was associated with a higher number of falls in daily life (p = 0.001). DCD had direction-specific postural control impairment, specifically, diminished LOS in the backward direction.	Improving LOS should be factored into rehabilitation treatment for children with DCD.

Table 2: Principles outcome variables, results and conclusions from the studies included in the review.

Visual Information

The importance of visual information to PC in DCD was approached in 5 out of the 9 studies, which incorporated tasks with and without visual information [20-23,27].

In 3 studies the Romberg's Coefficient was performed (RC), this may provide a simple clinical description of the degree of dependence on visual input in balance maintenance, calculated by ((eyes closed/eyes open) x 100%) when RC is larger than 100%, this indicates more sway with eyes closed than open. In all of the 3 studies, and although they found RC's values to be higher than 100%, it was considered that the coefficient didn´t indicate that DCD children over-rely on visual information due to the absence of significant differences [20,22,23]. Przysuvha and Taylor [20] even concluded that DCD boys are able to compensate the loss of visual information in quiet standing balance as effectively as typical boys. However, these findings differ from other authors, Deconinck and their colleges [21] suggested that DCD children are more dependent on visual information than typical for maintaining balance in walking; Tsai, Pan, Cherng and Wu [23] found that DCD did not perform as well as typical in maintaining balance, especially with the absence of visual information; also Fong and their colleges [27] reported that visual system tended to be more involved in balance deficits in DCD children.

Kinematic Analysis

Relating to the kinematic variables the DCD children seem to be more variable and to oscillate more than typical. Boys with DCD revealed a significantly higher sway in AP direction ($p<0.01$) and in the total area of sway ($p<0.03$) than typical boys in just standing still, with higher values with no visual information [20]. Again in just standing still on both legs, dominant and non-dominant leg, DCD children had greater total path length and sway area than TD, and also revealed a significantly larger excursion of COP especially with eyes closed [22]. While doing a memory task with low and high difficulty DCD children always revealed a significantly higher positional variability in head and torso than TD ($p<0.05$) [24]. The same had occurred during a visual detection task with low and high difficulty, once again DCD children had a significantly higher positional variability to head and torso under all conditions ($p<0.05$), being that long TD in high difficulty decreased their sway DCD increased [25]. Analysing posture during cognitive tasks DCD children tended to oscillate more, and this difference was significant during an oral-counting task ($p=0.03$), auditory-verbal reaction ($p=0.011$) and auditory-memory task ($p=0.041$). This increased oscillation is even more notorious in the hips, DCD children tended to use hip strategy excessively, swayed more ($p<0.05$), when forced to rely on vestibular signals [27].

When we leave the standing analysis, and look at walking balance, DCD children had a similar pattern to TD with lighting, showing a slightly longer support phase. But in a harder task, walking in the dark, these children decreased their step frequency and step length substantially ($0<0.001$) walking significantly slower [21].

Kinetic Analysis

Along with a longer hamstring and gastrocnemius activation latencies ($p<0.001$), DCD children also revealed a lower isometric peak forces for these muscles (p<0.001) [28]. This low peak force of gastrocnemius explained 5.7% (P=0.003) and 8.5% (P=0.001) of the variance of MABC balance score and ball skills score respectively. While Gastrocnemius muscle activation latency explained 11.4% (P<0.001) of the variance in the MABC ball skills score.

Discussion

The purpose of the present systematic review consisted on reviewing all the methodologies already used in PC's study in DCD; and analysing and synthetizing the results and differences between DCD and typical children in these studies, in order to more deeply understand this theme and find clues for a more suitable intervention.

Despite there being few studies, just 9, all of which have used biomechanical instruments, we found diversity in the methodology. Force platforms, three-dimensional video recording, balance performance monitor, magnetic tracking system and computerized dynamic posturography were used to access the COP's participants, so as to study their postural control. Besides the COP analysis, we also found limit of stability tests, and equilibrium scores through the sensory organization tests, electromyography, accelerometer and dynamometry. We can accept that it is possible to study postural control with a broad and varied methodology.

Unfortunately, considering the present systematic review, until now, the nonlinear methods were not yet applied in studies of postural control in DCD, so we cannot synthesize and analyze information about those particular studies. The nonlinear methods like approximated entropy or Lyapunov exponent have been used in the study and diagnosis of developmental delay in infants and children with several disorders, like cerebral palsy [12], and proved to be able to supply additional information to linear methods. Considering that the first goal of this systematic review consisted of reviewing the methodology already used in PC's study in DCD, in order to gather information on what investigators can improve in future. Our suggestion consists of supporting linear and nonlinear methods, as already done in CP [12], using, if possible, a triangulation method. It is possible that this new nonlinear technology, allied to other linear that has already proved to be reliable and valuable, in future we can find more information to better understand this theme.

The second purpose, was to synthetize and analyse information, looking at the linear data and for all studies including the fact that visual information in balance control of DCD children is still unclear, among the 5 studies that approached this theme 1 did not present a conclusion or suggestion [23], another suggested that boys with DCD can compensate effectively the absence of visual information as typical [20], and 3 studies suggested a greater dependency on visual information in DCD children [21,22,27]. It seems possible that DCD children are more dependent on visual information.

In a general, DCD children appear to be more variable and oscillate more in a standing condition especially when the task becomes more difficult, e.g. loss of visual information [20,22] or doing tasks simultaneously [23-25]. This increasing oscillation when the task difficulty increases in DCD is not fully proved, when we leave the standing analysis and look at walking balance DCD walking in the dark significantly decreased their step frequency and step length (0<0.001) walking slower [21]. Despite several studies having noted a higher oscillation in DCD, these children had a shorter limit of stability in backward direction (p=0.003) which was related to a higher number of falls [26].

Analysing the conclusions and suggestions of all studies included in the present review, it was possible to identify some clues for intervention with DCD children. Some studies suggested that DCD were more cognitively dependant and may have an automatization deficit, which means that the intervention should take into account attentional factors [23,24]. Other studies reported a deficit in standing balance with reduced or conflicting sensory signals, and also suggested a weakness in the perception-action link [25,27]. This should be another field to explore in the intervention, the child is not a system closed on itself, it is rather a dynamic system which, consequently, is influenced by the environment. If the child has problems accessing and incorporating the information available, the cycles of perception-action, he/she will have problems in using it to maintain its posture and/or fulfil a task.

It was also found that the late timing of contraction and the lesser peak force of the gastrocnemius muscle are related to a higher incidence of falls in DCD children [28]. Besides that, the limit of stability in backward excursion of DCD children is significantly lesser [26]. All of these aspects should be addressed in physical therapy in order to improve balance control in these children.

Conclusion

According to the present systematic review, nonlinear methods have not yet been applied to postural control's studies in DCD. Considering their applicability and value already proved in studies with CP [12], for future studies our suggestion is to ally linear and nonlinear methods, using a triangulation method if possible. All studies incorporated in this review used linear methodology with some different approaches. It was found COP analysis, limit of stability tests, equilibrium scores, electromyography, accelerometer and dynamometry, all using biomechanical instruments. We can accept that it is possible to study postural control with a broader and varied methodology.

The importance of visual information in PC of DCD children is still unclear, it seems possible that DCD children are more dependent on visual information [21,22,27]. In general, DCD children seem to be more variable and oscillate more in a standing condition especially when the task becomes more difficult, e.g. loss of visual information [20,22] or performing tasks simultaneously [23-25]. However, when walking balance in the dark was analysed, DCD children decreased their step frequency and step length significantly, walking slower [21].

According to the studies analysed we can identify some clues for a more suitable intervention with DCD children: take into account attentional factors [23,24]; work on the perception-action link [25,27] bearing in mind that the child is a dynamic system which is influenced by the environment, and needs this information to maintain its posture and/or perform a task; work on the late timing of gastrocnemius contraction compared to TD, and also improve its peak force [28]; increase the limit of stability in backward excursion which is significantly less [26].

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