



## Activities and participation in children with developmental coordination disorder: A systematic review

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### ARTICLE INFO

#### Article history:

Received 12 April 2010

Received in revised form 5 January 2011

Accepted 16 January 2011

Available online 16 February 2011

#### Keywords:

Developmental Coordination Disorder (DCD)

Activities

Participation

Systematic review

### ABSTRACT

**Purpose:** To systematically review all literature published in peer reviewed journals from January 1995 to July 2008 in order to summarize and describe the activity limitations and participation restrictions of children with developmental coordination disorder (DCD). **Methods:** Multiple databases were systematically searched for articles related to DCD; only descriptive, intervention or qualitative articles were retained. Articles were coded using the International Classification of Function, Disability and Health (ICF) and descriptions of the activity and participation issues of individuals with DCD were identified.

**Results:** Data analysis revealed that, from 371 articles that met inclusion criteria, only 44 (14.4%) presented any data related to activity or participation issues. Information was inconsistent and only 18 articles used published measurement tools. Most frequently cited issues were poor handwriting, difficulties playing ball games, getting dressed and participating in organized sports.

**Conclusion:** Evidence concerning activity and participation issues for children with DCD is limited in both volume and scope. Improved understanding of participation and of activity limitations in children with DCD is essential for clarifying diagnostic criteria, guiding assessment, and making evidence-based decisions regarding intervention. Researchers working with this population should make every effort to measure and consistently report the impact of children's motor impairments on function.

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## 1. Introduction

Developmental coordination disorder (DCD) is considered to be one of the major health problems among school-aged children worldwide (Cairney, Hay, Fought, & Hawes, 2005; Cairney, Hay, Fought, Mandigo, & Flouris, 2005; Cairney, Hay, Fought, Wade, et al., 2005; Green et al., 2005a; Henderson & Henderson, 2002; Polatajko & Cantin, 2006). With prevalence estimates of 5–6% (APA, 2000), DCD is a condition that deserves special attention because of its negative impact on school and daily life tasks. In the past, this condition was known by several names (e.g., dyspraxia, minor neurological dysfunction, minimal brain damage, clumsiness) but, at a consensus meeting in Canada (Polatajko, Fox, & Missiuna, 1995), researchers from different countries recommended use of the term DCD and its diagnostic criteria, as proposed by the DSM-IV (APA, 1994). More recently the Leeds Consensus Statement (Sugden, Chambers, & Utley, 2006) reaffirmed the diagnostic criteria

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elucidated by DSM-IV-TR (APA, 2000), but added a greater emphasis on the identification and assessment of daily living skills that negatively affect the lives of children with DCD.

Children with DCD are characterized by clumsiness and marked impairment in the development of motor coordination. According to current criteria (APA, 2000), this diagnosis is applied to children who present marked impairment in the development of motor coordination that has significant impact on the child's academic achievement or activities of daily living and is not due to any known medical condition. Although the DSM-IV (APA, 2000) as well as the proposed criteria for DSM-V (APA, 2010) specifies that the motor disturbance must interfere significantly with the performance of activities of daily living, many articles focus on examining the body functions of children with DCD (e.g., balance, strength, motor coordination). Little is actually known about difficulties presented by these children on the performance of daily living tasks.

More specific information concerning the pattern of performance on daily skills is necessary to support the emphasis in the diagnostic criteria on the extent to which children's motor impairment impacts their performance at home, in school and in the community (APA, 2000, 2010; Sugden et al., 2006). Moreover, with growing evidence that the motor impairments of children with DCD are difficult to change, therapists and other professionals need evidence on which to base intervention strategies to improve the performance of daily activities and enhance participation (Mandich, Polatajko, Macnab, & Miller, 2001; Wilson, 2005).

The emphasis on functional performance in real life contexts is consistent with current disability models, such as the International Classification of Function, Disability and Health (ICF: WHO 2001). The ICF underscores the need to consider disability not only in terms of impairment in body structures and functions, but to also identify limitations in activity and restrictions in participation in different environments. The ICF terminology (WHO, 2001) will be adopted in this paper and, to be consistent with this classification, daily living skills in children with DCD will be categorized under the broader definition of activities and participation. The objective of this study was to systematically review all literature published in peer reviewed journals from January 1995 to July 2008 and to summarize information concerning the activity and participation difficulties of children with DCD, using the ICF as a classification framework.

## 2. Materials and methods

The systematic search strategy used in this review began with re-examination of the 319 articles included by Magalhaes, Missiuna, and Wong (2006) in a study reviewing the terminology used for children with DCD. The articles in the 2006 review had been published in peer-reviewed journals from January 1995 to December 2005. The search strategy used by Magalhaes and colleagues was extended to include additional articles that met the initial criteria and had been published between January 2006 and July 2008.

### 2.1. Search strategy

A systematic literature search was conducted using seven electronic databases: Medline; Psych Info; CINAHL; HEALTHSTAR; ERIC; EMBASE and SocioFile. Keywords used to perform the literature search included terms commonly used by researchers and service providers working with children with DCD: clumsy; clumsiness; developmental coordination disorder (DCD); incoordination; motor-impairment; motor skills disorder; minimal brain dysfunction; minor neurological dysfunction; motor delay; perceptual motor difficulties; dyspraxia; dysgraphia; developmental right hemisphere syndrome; movement disorders; non-verbal learning disability; sensory integration; sensory integrative dysfunction; sensorimotor difficulties; physically awkward; and psychomotor disorders. Articles dating from January 1995 to July 2008 were considered for inclusion. In addition to the electronic search, a manual search was completed in order to ensure that the search was exhaustive and not subject to search bias.

### 2.2. Criteria used to select studies to review

The following procedures were applied. Step one: the title and abstract of each article identified by the search were reviewed to determine the study described assessment and/or intervention of children or adults with motor coordination problems. As an initial inclusion/exclusion criteria, studies involving children who had commonly co-occurring conditions, such as attention deficit hyperactivity disorder (ADHD), were included but only if the article clearly described motor functions. Articles, books, chapter, theses, dissertations, abstracts, letters to the editor and commentaries written in other languages than English were excluded. Step two: criteria were applied to exclude review articles, meta-analyses and all articles in which: (a) the data were obtained from a source other than individuals with DCD or parents of a child with DCD; (b) the participants had co-occurring medical conditions which precluded the diagnosis of DCD (e.g., cerebral palsy); (c) the participants' motor coordination problems were attributed to preterm birth; and (d) the inclusion criteria reported was not specific enough to determine whether the sample included children with other medical conditions.

### 2.3. The coding process

Step three: the articles located in step two were coded by two raters according to the ICF (WHO, 2001) as reporting data about: (a) body functions and (b) activity and participation. Any disagreements were discussed and consensus was achieved.

On the basis of the ICF definitions (WHO, 2001), articles referring to the assessment of strength, movement patterns, balance, muscle tone, cognition, attention and visual perception were coded as body function. According to the ICF (WHO, 2001), activity is the execution of tasks and actions by an individual, the definition is broad and includes tasks such as walking, throwing and catching a ball, picking up small objects or writing, which are common in standardized motor assessments. Based on this definition, articles whose main source of data came from motor assessments such as the Movement ABC (Henderson & Sugden, 1992) or the Bruininks Ozeretsky Test of Motor Proficiency (Bruininks, 1978) were coded as activity, as defined by the capacity qualifier. Participation is defined as involvement in real life situations (WHO, 2001), which includes self-care, as well as involvement in play, sports and classroom tasks. Articles were coded as activity and/or participation according to the definitions listed in the ICF (WHO, 2001). Although the ICF does not specify separate codes for activity and participation, in this article, descriptions based on standardized assessments were coded as activity and performance in real life situations as participation. It was possible for an article to be coded in more than one category.

*Step four:* articles identified as measuring activity or participation, or both, were further coded. Two researchers read each article and independently completed a table that included information about the research design, the number and age of the participants, the criteria used to identify DCD, the measurement tools utilized, the variables or specific activity and participation issues described in the article. Other relevant issues that were frequently documented within the literature were also coded, if they provided additional information.

*Step five:* a list of daily activities, adapted from Appendix A of the Canadian Occupational Performance Measure (COPM) (Law et al., 2005), was used to code and categorize activities and participation. Finally, the data that had been coded were grouped according to themes and content areas. Descriptive data analysis was completed by counting the number of articles that reported each specific issue.

### 3. Results

From January 1995 to June 2008, 476 published articles were located that were about children or adults with DCD. Fig. 1 outlines the data gathering and elimination process.

Following the exclusion of 165 articles that did not comply with the inclusion criteria, 311 were retained. Of these, 255 (81.99%) described body function and measured issues solely at the impairment level. Of the 56 (18.01%) articles that included data about 'activity' and/or 'participation' 12 articles were further excluded: two were case descriptions, nine articles included heterogeneous samples, and one was vague. Of the 311 articles that reported data about individuals with DCD, only 44 (14.15%) presented specific information regarding the performance of activities or participation issue. Thirty four of these were quantitative studies (23 descriptive and 11 intervention), and 10 used qualitative methods.

These articles presented data on a wide variety of issues related to activities and participation and it was not always easy to code them according to ICF categories. Ongoing discussion and agreement between two coders was used to refine the final criteria. When data were coded for activity and participation, the following themes were identified: limitations in performance of classroom tasks; play and/or sports; activities of daily living and social skills. Two other areas were reported in several studies: speech and language issues, and psychological issues related to life satisfaction and feelings associated with motor awkwardness. Although social and psychological issues are classified in the ICF under body function (WHO, 2001), these categories were included in the final analysis because concepts of perceived efficacy about participation in physical activities (social), motivation and perception of quality of life (psychological) are issues that reflect the impact of children's motor challenges. A complete list of articles reviewed is available in Appendix A.<sup>1</sup>

The most frequent activity limitations and participation restrictions reported in the studies were participation in play-related activities (Table 1). Difficulties riding a bicycle or tricycle, rollerblading, using playground equipment, jumping rope and participating in free play were reported in 32 (72.72%) articles. Twenty-four (54.54%) articles reported children with DCD having problems with running, jumping, skiing, swimming and having limited participation in organized sports. Poor performance on ball games was reported in 19 (43.18%) articles. Problems with written expression and difficulty participating in classroom tasks was the second most important issue, reported in 31 (70.45%) articles. Poor handwriting, the most prevalent limitation, was reported in 23 (52.27%) articles and difficulties using hands to do classroom related tasks reported in 20 (45.45%) articles. Limited ability to perform self-care tasks was reported in 21 (47.72%) articles, with specific references to problems with dressing, reported in 14 (31.81%) and difficulty using cutlery and feeding independently, reported in 12 (27.27%). Seven articles (15.55%) referred to difficulties in language and speech which interfered with the child's participation; 11 (24.44%) articles reported poor social skills and a tendency for loneliness and exclusion by peers. Finally, nine articles (20.45%) measured children feelings of inadequacy or poor quality of life related to motor awkwardness.

Although several activity and participation issues were examined in the articles, it is interesting to note that these data were almost always collected by therapist observation or by parent and teacher report. Standardized measures of activities of daily living were used in only six articles (Bayona, McDougall, Tucker, Nichols, & Mandich, 2006; Dunford, Missiuna, Street, & Sibert, 2005; Green et al., 2005b; Rodger, Watter, Marinac, Woodyat, & Ziviani, 2007; Rodger et al., 2003; Taylor, Fayed, & Mandich, 2007). Standardized measures of handwriting were used in five (Bernie & Rodger, 2004; Klein et al., 2008; Rodger et al., 2003; Schoemaker, Niemeijer, Reynders, & Smits-Engelsman 2003; Tseng, Howe, Chuang, & Hsieh, 2007) and

<sup>1</sup> Tables with the content of each article are available at: <http://www.canchild.ca/en/>.

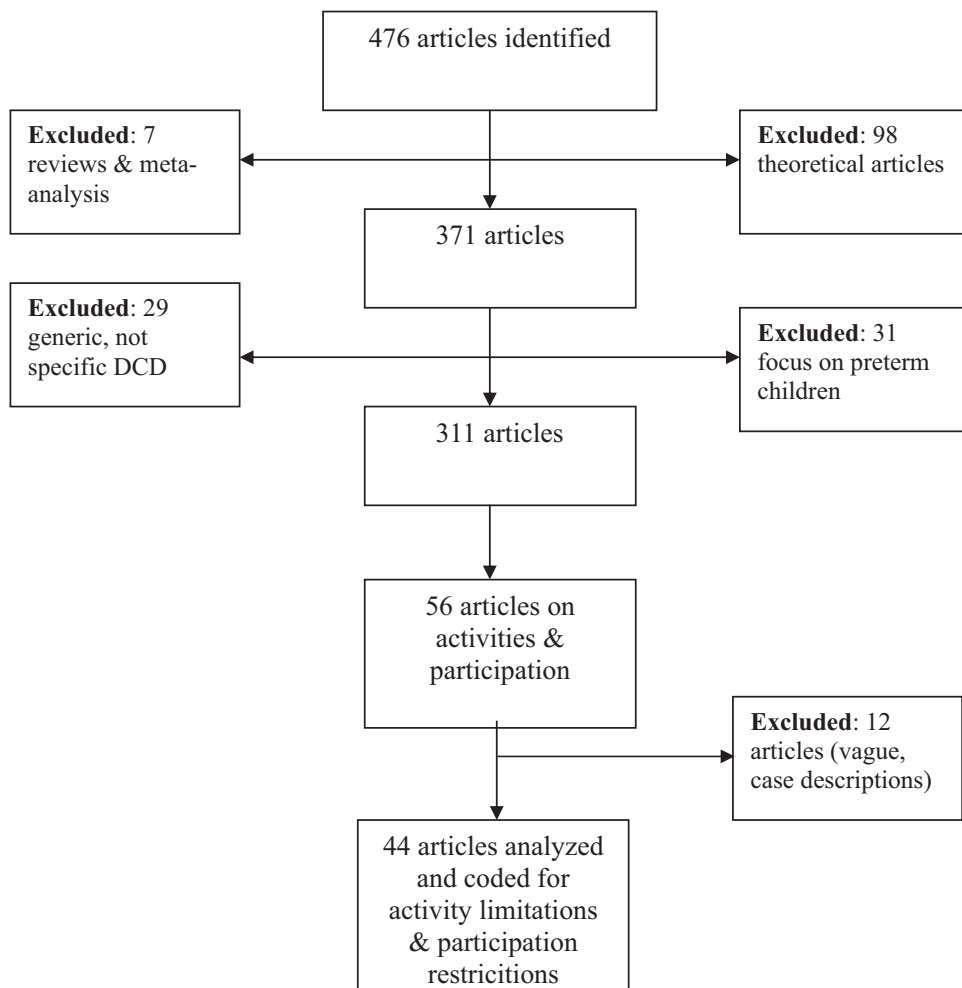


Fig. 1. The data collection process.

**Table 1**  
Articles documenting difficulties related to activity or participation.

Categories of activity/participation	Number of articles/percentage (n = 44)
Play	32 (72.72%)
Classroom activities	31 (70.45%)
Sports – gross motor activities	24 (54.54%)
Activities of daily living	21 (47.72%)
Social skills	29 (65.90%)
Psychological issues	09 (20.45%)
Speech and language issues	07 (15.90%)

measures of participation were used in two (Cairney, Hay, Faught, Mandigo, et al., 2005; Cairney, Hay, Faught, Wade, et al., 2005).

#### 4. Discussion

Despite the exponential increase in the number of articles published in the past two decades, and the fact that DCD diagnostic criteria have become more recognized (Magalhaes et al., 2006), only 14% of the articles published in this field have examined issues related to daily activity and participation. The majority of published literature focuses on the body structure/function impairments of children with DCD. When data on activity and participation are included, they are more often gathered secondarily to the measurement of body function and not as the focal point of the research. Despite the fact

that diagnosis of DCD requires comprehensive consideration of the impact of the motor impairment on academic achievement and activities of daily living, only 44% of the articles that reported activity limitations reported data concerning either school performance ( $n = 32$ ) or activities of daily living ( $n = 21$ ).

Few articles used standardized measures to determine limitations in activities of daily living or handwriting and only two articles used specific measures of participation. Data on activity and participation was scattered and difficult to code, perhaps because some of the articles were published prior to 2001 when these concepts were not yet widespread. However, consistent with the ICF (WHO, 2001) and current diagnostic criteria (APA, 2000, 2010; Sugden et al., 2006) that stress the need to gather evidence regarding the impact of motor impairment on daily living skills, future studies on DCD should use objective measures of activity and participation, at home and school, as an inclusion criteria, along with the traditional motor measures.

Of the articles that reported activity limitations, most reported findings concerning handwriting ( $n = 23$ ), ball skills ( $n = 19$ ) and dressing ( $n = 14$ ). Very few articles reported information about children's participation in organized group activities, other than sports ( $n = 12$ ), highlighting the need to increase the scope of activities examined. A few articles focused specifically on participation ( $n = 10$ ) and some measured personal factors such as the children's feelings of inadequacy, social skills, perceptions of loneliness and exclusion by peers, or quality of life related to motor awkwardness ( $n = 11$ ). Seven (15%) articles cited language difficulties, which are known to commonly co-occur with DCD, as an impediment to a child's social participation. No articles addressed or measured environmental supports/factors that might encourage participation. Studies on family life style, number of children, characteristics of the neighborhood as well as the pattern of daily activities are needed to shed light on the heterogeneous presentation and variation in the outcomes of children with DCD (Visser, 2003).

Literature concerning activity and participation issues of children with DCD is limited in both volume and scope. Information is even more scarce concerning adults, as only one descriptive (Cantell, Smyth, & Ahonen, 2003) and two qualitative (Fitzpatrick & Watkinson, 2003; Missiuna, Moll, King, Stewart, & Macdonald, 2008) articles were located. Other than a few short follow up intervention studies and qualitative, but retrospective, data, all other information concerning activity and participation has been collected within cross-sectional studies; longitudinal data is needed to monitor changes in patterns of activity and participation, providing a better understanding of the experiences of individuals with DCD.

Most individuals with DCD are cognitively competent and are able to provide information about their own abilities and limitations; however, data in nearly all studies came from external observations or from interviews with parents. Studies combining observation with the perspective of individuals with DCD would add relevant information to understand the complexity of skills needed for participation in different contexts. Finally, the relationship between motor, language, and social skill impairments and their impact on activity limitations and restrictions in participation needs further examination.

#### 4.1. Limitations

This study has limitations as it was difficult to code for activity and participation because the definitions in the ICF are not very clear (WHO, 2001) and many articles did not provide adequate descriptions of children's performance difficulties. Some articles with relevant information may have been excluded due to our strict inclusion criteria (e.g., literature on preterm children was excluded). We also had to make some inferences; for example, we inferred that tasks selected as therapy goals were activities in which children's performance were below age expectations. Since the search was restricted to articles published in English, the activity and participation issues reported here may not be universal. Information is needed, particularly from countries other than Europe and North America who are currently publishing most of the literature in this field.

## 5. Conclusion

Research literature that provides data on the activity and participation of individuals with DCD is presently limited. Typically this information is only included as a secondary focus within articles that are focused on impairments in children's body structure and function. Improved understanding of the participation of children with DCD in everyday activities is essential to support diagnostic criteria and to guide intervention. Expanding the age range of participants in research studies into the adolescent and adult years as well as conducting longitudinal studies would add needed information on the impact of DCD across the lifespan. Future publications would benefit from the use of standardized measures to gather data as well as from strategies to investigate the participants' perspectives and relevant environmental factors. Clinical decisions about intervention strategies for children with DCD and relevant outcomes concerning activities and participation need to be based upon empirical evidence.

## Acknowledgements

Livia Magalhaes receives support for research activities from The Brazilian Nacional Council of Research (CNPq). Cheryl Missiuna holds a Rehabilitation Scientist career award from the Ontario Ministry of Health and Long Term Care and the Ontario Neurotrauma Foundation.

## Appendix A. Reference list of articles included in the analysis

### A.1. Descriptive Studies

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