Research in Developmental Disabilities 34 (2013) 3084–3091

Contents lists available at SciVerse ScienceDirect

Research in Developmental Disabilities

Is severity of motor coordination difficulties related to co-morbidity in children at risk for developmental coordination disorder?

Marina M. Schoemaker [a,*], Raghu Lingam [b,e], Marian J. Jongmans [c,d], Marieke J.G. van Heuvelen [a], Alan Emond [b]

[a] University of Groningen, University Medical Centre Groningen, Centre for Human Movement Sciences, PO Box 30,001, 9700 RB Groningen, The Netherlands
[b] Centre for Child and Adolescent Health, School of Social and Community Medicine, University of Bristol, Oakfield House, Oakfield Grove, Bristol BS8 2BN, United Kingdom
[c] Department of Neonatology, Wilhelmina Children's Hospital, University Medical Centre Utrecht, 3508 AB Utrecht, The Netherlands
[d] Department of Special Education, Faculty of Social Sciences, Utrecht University, PO Box 80,140, 3508 TC Utrecht, The Netherlands
[e] Child Health Intervention Research Group, Department of Population Health, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, United Kingdom

ARTICLE INFO

Article history:
Received 28 February 2013
Received in revised form 20 June 2013
Accepted 21 June 2013
Available online

Keywords:
Developmental coordination disorder
Co-morbidity
ADL
Academic skills
Attention
Social skills
ALSPAC

ABSTRACT

Aim of the study was to investigate whether 7–9 year old children with severe motor difficulties are more at risk of additional difficulties in activities in daily living, academic skills, attention and social skills than children with moderate motor difficulties. Children ($N = 6959$) from a population based cohort, the Avon Longitudinal Study of Parents and Children (ALSPAC), were divided into three groups based on their scores on the ALSPAC Coordination Test at age 7: control children (scores above 15th centile; $N = 5719$ [82.1%]); children with moderate (between 5th and 15th centile; $N = 951$ [13.7%]); and children with severe motor difficulties (below 5th centile $N = 289$ [4.2%]). Children with neurological disorders or an IQ < 70 were excluded. Logistic regression was used to compare children with moderate and severe motor coordination difficulties with each other and with control children regarding their risk of co-morbidity defined as significant ($<$10th centile) difficulties with activities of daily living (ADL); academic skills (reading, spelling and handwriting); attention; social skills (social cognition and nonverbal skills). Children with severe motor difficulties demonstrated a higher risk of difficulties in ADL, handwriting, attention, reading, and social cognition than children with moderate motor difficulties, who in turn had a higher risk of difficulties than control children in five out of seven domains. Screening and intervention of co-morbid problems is recommended for children with both moderate and severe motor difficulties.

* Corresponding author at: University Medical Center Groningen, Sector F, Center for Human Movement Sciences, PO Box 196, 9700 AD Groningen, The Netherlands. Tel.: +31 50 363 2651; fax: +31 50 363 3150.
E-mail addresses: m.m.schoemaker@umcg.nl (M.M. Schoemaker), Raghu.Lingam@lshtm.ac.uk (R. Lingam), m.j.jongmans@uu.nl (M.J. Jongmans), m.j.g.van.heuvelen@umcg.nl (Marieke J.G. van Heuvelen), alan.emond@bristol.ac.uk (A. Emond).

0891-4222/$ – see front matter © 2013 Published by Elsevier Ltd.
http://dx.doi.org/10.1016/j.ridd.2013.06.028

1. Introduction

According to the four diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders (*DSM-IV-TR*) (American Psychiatric Association, 2000), a child with developmental coordination disorder (DCD) has a significant impairment in the development of motor coordination substantially below that expected given a person's chronological age (criterion A); these motor problems significantly interfere with academic achievement or activities of daily living (ADL; criterion B); in the absence of a medical condition (criterion C); and the motor problems are not explainable by severe learning difficulties (criterion D). All four criteria have to be met to be diagnosed with DCD.

It is apparent that criteria A and B leave room for interpretation. It is commonly accepted that a norm-referenced test of motor performance should be administered to assess whether criterion A has been met. However, there is discussion regarding which cut-off score is most appropriate and different authors have suggested both the 5th and the 15th centile (Chambers, Sugden, and Sinani, 2005; Geuze, Jongmans, Schoemaker, and Smits-Engelsman, 2001; Henderson and Barnett, 1998; Larkin and Rose, 2005; Magalhaes, Missiuna, and Wong, 2006; Wilson, Kaplan, Crawford, and Campbell, 2000). In 2006, a group of professionals from a wide range of disciplines reached consensus about the criteria to classify children as having DCD and the 5th percentile was recommended as cut-off criterion for criterion A in the subsequent consensus statement (Sugden, 2006).

However, recently a Clinical Practice Guideline (CPG) for DCD was composed after a systematic review of the literature, initiated by the European Academy of Childhood Disability (EACD). According to the recommendations in the CPG, the 15th percentile should be used as a cut-off. Many children with moderate DCD would be missed if using the 5th centile due to the limited sensitivity of motor tests currently used (Blank, Smits-Engelsman, Polatajko, and Wilson, 2012). The decision for a particular cut-off criterion will be more empirically grounded if it is supported by research findings about differences evident on motor and behavioral measures between children performing below the 5th (children with severe motor difficulties) versus those scoring between the 5th and 15th percentile (children with moderate motor difficulties) on a motor coordination test. However, few studies address this issue.

To fill this gap, differences between children with severe and moderate motor coordination difficulties were examined using data of the Avon Longitudinal Study of Parents and Children (ALSPAC). This is a large population-based study and has information about motor coordination of children collected at 7 years of age, as well as information about functional areas (ADL, attention, academic and social skills) known to be affected in children at risk for DCD (Alloway, 2007; Chen, Tseng, Hu, and Cermak, 2009; Dewey, Kaplan, Crawford, and Wilson, 2002; Missiuna, Gaines, DeLaat, Egan, and Soucie, 2008; Schoemaker and Kalverboer, 1994). Using the same data set, Lingam et al. (2010) recently demonstrated that children with probable DCD (defined as those with motor coordination scores below the 15th centile on a motor test (who in addition had functional difficulties in ADL or handwriting and no associated neurological difficulty) had an increased risk of difficulties in attention, short-term memory, academic and social skills compared to control children without coordination difficulties. The aim of the present study is to investigate whether children with severe motor difficulties have an increased risk of difficulties in four functional areas (ADL, attention, academic skills [reading, spelling and handwriting], and social skills) compared to children with moderate motor difficulties and to clarify to what extent both groups differ from control children. To this end, the group with motor coordination scores below the 15th centile will be split into two groups, one with severe motor difficulties (scores below the 5th centile on a motor test) and one with moderate motor difficulties (scores between the 5th and 15th centile on a motor test). The influence of possible confounding factors (such as IQ) will be accounted for.

2. Materials and methods

2.1. Participants

ALSPAC is a prospective population-based birth cohort study designed to investigate the interaction of environment and genotype on the health and development of children. The study investigators invited all pregnant women in the geographically defined area of Avon, southwest England, with an expected date of delivery between April 1, 1991 and December 31, 1992 to take part. The study contains data on 14,062 live births of which 13,988 children were still alive at 1 year of age. Mothers of infants in the ALSPAC were broadly representative of the rest of the United Kingdom at the 1991 census, although the percentage of non-white mothers was somewhat lower (2%) compared with mothers across the whole of the United Kingdom (7.6%). See Table 1 for the demographics of the sample. Details of study recruitment, retention, and data collection have been described elsewhere (Boyd et al., 2012). Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees.

The ALSPAC Coordination Test, derived from subtests of the Movement Assessment Battery for Children (MABC) and standardized within the ALSPAC cohort, was used to assess the motor coordination of children from ALSPAC aged 7–8 years (Henderson and Sugden, 1992). The test was conducted in large, purpose built clinic rooms that were specifically used by the study. The session lasted 20 minutes and was conducted by trained ALSPAC examiners. Parents accompanied children but were not allowed to help them. Examiners came from an array of backgrounds but had specific, standardized training. In total there were 19 ALSPAC examiners. Reliability of test administration was maintained by regular supervision and on-going training. The examiners were trained with input from two of the current study authors M.J. and A.E. both experienced clinicians. Motor coordination tests consisted of the placing pegs (manual dexterity), throwing bean bag (ball skills) and