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Increase in impaired motor coordination in six-year-old German children between 1990 and 2007

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ABSTRACT

Aim: To evaluate changes in prevalence of impaired motor coordination among 6-year-olds of a geographically defined area in Germany between the years 1990 and 2007.

Methods: Data from the obligatory school entrance examinations in the German state of North Rhine Westphalia between the years 1990 and 2007 were used. The number of children assessed per year varied from 81 517 to 124 086. The classification of impaired motor coordination was based on the combination of standardized screening and physicians' clinical impression of need of treatment. Logistic regression modelling was performed to evaluate the changes in prevalence of impaired motor coordination.

Results: Between 1990 and 2007, the prevalence of impaired motor coordination rose from 2.5% to 8.9% in boys and from 0.8% to 3.6% in girls. As the standard error of these percentages is below 0.15%, the changes are highly statistically significant.

Conclusion: The prevalence of impaired motor coordination tripled during the last decades in North Rhine Westphalia. This may imply that the prevalence of Developmental Coordination Disorder also increased. Factors that may explain the increasing prevalence include the increase in surviving preterm infants, increasing parental age at child birth, maternal and child obesity and decreasing child mobility.

INTRODUCTION

Gradually, the awareness of the impact of mild motor problems on children's daily activities is growing. Nowadays, mild motor problems are generally described in terms of the DSM-IV classification Developmental Coordination Disorder (DCD), which uses four criteria to define the disorder. In short, these denote the presence of impairments of motor function, which cannot be explained by the child's age, intelligence or evident neurological pathology. Children who suffer from DCD may experience problems in the following areas: body functions and structures (e.g. movement, sensory and cognitive functions, emotional and affective functions, speech), everyday activities (e.g. independence, academic achievement), participation in school, in the community and in their environment generally. The criteria for DCD are debated, but recently Blank et al. (1) reported European recommendations based on comprehensive analyses and consensus discussions of the various criteria for definition and assessment of DCD.

The prevalence of DCD in the literature varies from two (2) to 39% (3). The 39% was based on a group of 69 6–7-year-olds tested with the Körper-Koordinationstest für Kinder (3), the 2% on an epidemiological study of over 7000 7-year-olds from the general population with normal intelligence in the United Kingdom, using the Movement-ABC-test battery with very strict criteria (2). Generally, the prevalence among school-aged children is estimated to be around 5–6% (4). This means that DCD affects everyday life of a considerable number of children, a situation that is sometimes underappreciated by professionals working in health care and education (5, 6).

A recent study indicated that motor development during the last two decades is less optimal than it was previously (7). If so, this could result in an increasing prevalence of DCD. Hadders-Algra (8) suggested that this may indeed be the case. The school entrance assessment data in North Rhine Westphalia (NRW) between 1990 and 2007 allowed

Key notes

- The prevalence of impaired motor coordination in 6-year-olds of a geographically defined area in Germany tripled between 1990 and 2007.
- Boys had impaired motor coordination three times more often than girls.
- The rise in impaired motor coordination was stronger in boys than in girls.

us to explore whether the prevalence of motor problems increased over the years. School entrance assessments are obligatory examinations in Germany. This provided a unique opportunity for the study of changes in the prevalence of motor impairment.

PATIENTS AND METHODS

We used the school entrance assessment data of children in NRW during the years 1990–2007 in which children usually are assessed shortly before their sixth birthday. NRW is a German federal state with a large proportion of urban residents and highly developed industry, but it also includes a rural population. It has circa 18 million inhabitants.

The average age of children at school entrance assessment has been decreasing, in part because it has become easier for children to attend school at a younger age. In 1996, the average age of assessed children was 6 years and 3 months, and in 2008, it was 5 years eleven months (9). Data are not available for the other years of the study.

The medical school entrance assessments are a part of the school entrance procedures. They are obligatory prior to school entry. This means that the large majority of almost 6-year-olds are included in the assessment, only children with special needs, that is, children with an evident mental or physical handicapping disorder, are assessed separately. The school entrance assessment evaluates the child's physical abilities, including its motor abilities. In most districts, the assessment of motor abilities follows the standardized Bielefelder model of the public health service [Landesinstitut des öffentlichen Gesundsheitsdienstes (LÖGD)]. Since 1990, the number of participating districts has been growing steadily. In 2006, only four of the 54 NRW districts did not use the Bielefelder model. This study only used data from the 'Bielefelder model' districts. For the years 2001–2007, this means that 81% of all children starting school in NRW were included in the study. Similar data on the percentage of children included in the study prior to 2001 were not available.

Assessment

The Bielefelder model is a standardized set of diagnostic procedures evaluating body proportions, body function, behaviour and the presence of specific impairments (10). All findings are recorded with an additional remark whether they require treatment, treatment is in progress, treatment is not or is no longer needed, no treatment is possible, further examination is required. It is also noted whether activity is significantly impaired.

From 1990 to 2003, the motor assessment in the Bielefelder model consisted of five tests: standing on one leg, hopping on one leg, diadochokinesis, sequential finger-thumb opposition, drawing a line (between two parallel lines at 1.5 cm distance). The criteria to pass the respective tests were (i) being able to stand on each leg for at least 7-sec without touching the floor with the other leg (three attempts are allowed), (ii) being able to hop at least nine consecutive times on each leg, (iii) both hands are able to produce movements with two turns per second, (iv) in each hand, the thumb is able to touch – with a fully opened hand – the tips of the second through fifth finger and (v) the line must be drawn without deviating from the intended direction and without tremor (11). Motor development was considered impaired when at least one of the criteria was not met. Whether treatment was indicated was based on further testing (11). After 2003, the motor assessment part of the school entry assessment was reduced to a single test, that is, the lateral jumps test, which consists of quick, repeated jumps from left to right and back using both legs simultaneously. The number of jumps within ten seconds on a mat with a central dividing line is counted. Eight or more jumps indicate a good performance, seven jumps a borderline performance and less than seven are considered as an indication of coordination disorder (12). The reduction in five tests to one test was justified by the finding that the lateral jumps were the MOT 4–6 [Motor Function Test for 4- to 6-year-olds (13)] item that correlated best with the total score of the MOT 4–6. The psychomotor properties of the set of test items have not been assessed as such, but it is known from other assessments that such items can be assessed reliably (14–16).

In this study, children were classified as having impaired motor coordination when they fulfilled two criteria: (i) they failed on motor testing, that is, prior to 2003, those who met the criteria of one of the five tests, and from 2003 onwards, those who achieved less than seven jumps and (ii) were considered to be in need of therapy.

Data analysis

To evaluate changes in prevalence of impaired motor coordination, we analysed the data by logistic regression analysis. Impaired motor coordination was the binary outcome, and time, gender and a binary indicator of the post-2003 period were, together with their interactions, the explanatory variables.

RESULTS

Table 1 and Fig. 1 present the data on prevalence of impaired motor coordination. Between 1990 and 2003, the prevalence of impaired motor coordination rose from 2.5% to 8.6% in boys and from 0.8% to 3.2% in girls. Between 2004 and 2007, the prevalence in boys varied from 7.8% to 8.9% and from 3.2% to 3.6% in girls. As the standard error of these prevalence does not exceed 0.15%, the differences are highly statistically significant. Apart from confirming this, the logistic regression analysis also revealed that both the prevalence and its increase are higher for boys than for girls and that the diagnostic change had a more pronounced effect in boys than in girls. Table 2 presents the estimated logistic model, and Fig. 1 shows the estimated curves for boys and girls. Figure 1 suggests that the prevalence increase was mostly realized between 1995 and 2000, especially in boys. We, however, did not pursue this aspect by further refining the model.

Table 1 Prevalence of impaired motor coordination from 1990 to 2007

Year of assessment	Total of all assessed boys	Boys with impaired motor coordination	Boys with impaired motor coordination in (%)	Total of all assessed girls	Girls with impaired motor coordination	Girls with impaired motor coordination in (%)	Total of all assessed boys and girls	Boys and girls with impaired motor coordination	Boys and girls with impaired motor coordination in (%)
1990	42 268	1053	2.5	39 249	297	0.8	81 517	1350	1.6
1991	50 527	1680	3.3	47 615	483	1	98 142	2163	2.2
1992	56 343	1938	3.4	53 191	543	1	109 534	2481	2.2
1993	65 836	2266	3.4	61 968	711	1.2	127 804	2977	2.3
1994	55 396	1823	3.3	52 907	548	1	108 303	2371	2.2
1995	56 495	1964	3.5	53 748	635	1.2	110 243	2599	2.4
1996	48 900	2012	4.1	46 055	558	1.2	94 955	2570	2.6
1997	52 806	2667	5.1	50 509	838	1.7	103 315	3505	3.4
1998	47 728	2563	5.4	45 475	883	1.9	93 203	3446	3.6
1999	51 153	3192	6.2	48 534	1006	2.1	99 687	4198	4.2
2000	45 198	3530	7.8	42 422	1072	2.5	87 620	4602	5.2
2001	40 469	3305	8.2	38 355	1133	3	78 824	4438	5.6
2002	39 556	3246	8.2	37 303	1040	2.8	76 859	4286	5.5
2003	35 849	3076	8.6	33 878	1076	3.2	69 727	4152	5.9
2004	44 490	3491	7.8	42 265	1358	3.2	86 755	4849	5.5
2005	54 942	4530	8.2	51 323	1724	3.4	106 265	6254	5.8
2006	64 059	5939	9.3	60 027	2277	3.8	124 086	8216	6.6
2007	61 900	5537	8.5	58 135	2096	3.6	120 035	7633	6

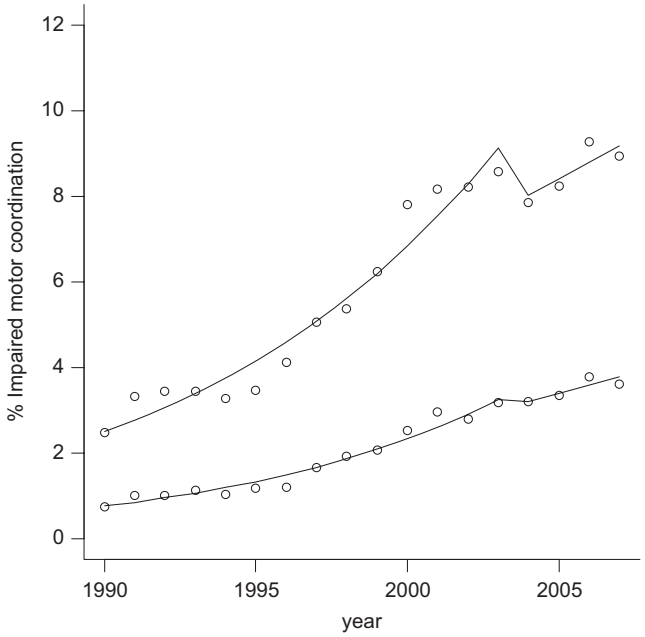

Figure 1 Prevalence of motor impairment in boys and girls. Circles indicate the prevalence of motor impairment, the curves reflect the changes over time indicated by logistic regression analysis. Upper curve: changes in boys, lower curve: changes in girls.

Table 2 Results of the logistic regression analysis

Variable	Estimated regression coefficient	Standard Error	p-Value
Intercept	−213	2.91	
Year	0.105	0.001456	<0.001
Sex*	−18.6	5.79	0.001
Diagnostic Change	112	12.0	<0.001
Interactions			
Year × Sex	0.00873	0.0029	0.003
Year × dc†	−0.0559	0.0060	<0.001
Sex × dc†	0.115	0.0293	<0.001

*Sex: 0 = boys, 1 = girls.
†dc = diagnostic change: 0 = before 2004, 1 = after 2003.

DISCUSSION

The present study indicates that, in the period 1990–2007, the prevalence of impaired motor coordination in North Rhine Westphalia rose from 1.6% to 6.2%. The findings correspond to previous suggestions that, during the last years, physical capabilities of school age children gradually declined (8, 15). Opper et al. indicated that the deterioration in children's physical abilities and full body coordination occurred particularly in children living in cities (15). Others also addressed the question whether the prevalence of impaired motor coordination in Germany increased over the years (16, 17). In addition, Raczek (18) reported that the prevalence of motor impairment in Polish children aged 8–18 year increased between 1965 and 1995, which was attributed to a general decrease in motor activity in children and adolescents. But the review study of Bös (19) indicated that the data available in the literature were too heterogeneous to support a firm conclusion on changes in prevalence of impaired motor coordination. A similar conclusion was reached by Starker (20).

Various factors may play a role in the increase in the prevalence of impaired motor coordination. Firstly, the increase may be related to the increased survival of preterm infants without major disabilities but with minor developmental disorders over the years (21). Secondly, parental age at childbirth and the prevalence of maternal obesity have increased over the years. Both factors are associated with subfertility (22), which in turn has been associated with less optimal neurological condition (23). Thirdly, the prevalence of obesity in children has doubled between 1984 and 1999 (24). Obesity has been associated with impaired motor coordination, even though the direction of the association is a matter of debate (25, 26). Fourthly, poverty has also been increasing in Germany over the last two decades (27) and is a well-known risk factor for nonoptimal development (28). Fifthly, children move less than they did twenty years ago due to changes in environment and society (29, 30). The latter is, for instance, reflected by the large increase in the consumption of new media in the period between 1990 and 2007. Children who consume an excessive amount of media are more obese and less mobile (31). Finally, the 4-month decrease in testing age between 1990 and 2007 may have attributed to the rise in children classified as having impaired motor coordination.

Our data indicated that impaired motor coordination occurred about three times as often in boys as in girls (32). In addition, we found that the increase was more pronounced in boys than in girls. It is well known that boys more often are diagnosed with neurodevelopmental disorders such as DCD and ADHD (32, 33). It has been suggested that also the prevalence of ADHD has increased recently (34). The two developmental disorders ADHD and DCD are highly correlated (35). Therefore, it is conceivable that the gender-specific increase in impaired motor coordination in our study is mediated by the time-related increase in ADHD. Alternatively, it is also possible that increases in the prevalence of ADHD and DCD both are brought about by the multifactorial mix of factors discussed above.

The study has several limitations. Firstly, it does not cover all 6-year-olds in the region and the percentage covered increased over the years. Nevertheless, the districts included in the study have the same social background as the districts not included, suggesting that the data may be considered as representative for NRW. Secondly, the children's motor capacity was screened and not assessed comprehensively, and the label 'impaired motor coordination' was also based on the clinical point of view of the medical doctor in charge of the assessment. This means that our label 'impaired motor coordination' is not synonymous to the diagnosis DCD. For the latter, the criteria specified in the recent recommendations on DCD (1) should be fulfilled. The latter includes the use of an appropriate, valid, reliable, appropriately norm-referenced, standardized motor test, such as the Movement ABC-II. Thirdly, the criteria for motor impairment changed during the study period. Prior to the change, both gross and fine motor skills were assessed, and after the change, only gross motor skill was evaluated. It is conceivable that the decrease in children's physical activity over time especially affected the development of gross motor skills and less that of fine motor skills. Even though most children with DCD exhibit problems in both gross and fine motor abilities, it is possible that the restriction of the assessment to gross motor problems only exaggerated the prevalence of motor impairments in general. Nevertheless, the logistic regression model indicated that prevalence indeed changed over time, that is, also within the two time periods and in particular during the first period when the assessment included the evaluation of both gross and fine motor skills. The strengths of the study are its large sample sizes covering all social strata and its time span of 18 years.

In conclusion, our study suggests that the prevalence of impaired motor coordination tripled over the last twenty years. Most likely, the rise in the prevalence has a multifactorial origin, in which an increase in parental age at childbirth, increases in the prevalence of preterm birth and obesity and diminishing opportunities for outdoor play may play a role. Future studies need to address the question whether a similar steep rise occurred in the prevalence of DCD.

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