Are Impaired Childhood Motor Skills a Risk Factor for Adolescent Anxiety? Results From the 1958 U.K. Birth Cohort and the National Child Development Study

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Objective: Neurodevelopmental impairments have been associated with early-onset schizophrenia, early-onset bipolar disorder, and childhood-onset affective disorder. The authors investigated whether delayed childhood motor skills predicted persistent anxiety in adolescence among 6,850 subjects from a national 1958 U.K. birth cohort.

Method: This historic cohort study used data from the National Child Development Study that was collected when its subjects were 7, 11, and 16 years old.

Results: Boys with poor motor skills had more than threefold the odds of maternally rated anxiety at the ages of 11 and 16, but no effect was observed for girls.

Conclusions: Childhood motor impairment was strongly associated with persistent anxiety among male, but not among female, adolescents. The effect modification by sex was greater than expected, as was the effect size for boys. Both findings warrant replication and further examination.

(Am J Psychiatry 2002; 159:1044–1046)

Neurodevelopmental impairments, including delayed or incomplete attainment of motor milestones, have been identified as risk factors for subsequent development of mental disorders (1–3). In a recent British survey of 10,000 5–15-year-olds (4), 35% of the children with coordination difficulties met criteria for a mental disorder, compared to 10% of all children and 37% of epileptic children. We tested the hypothesis that motor impairments in childhood are associated with a twofold or greater increase in the odds of experiencing persistent anxiety in late childhood and adolescence.

Method

Our sample stemmed from the National Child Development Study (5), an ongoing prospective longitudinal cohort study of all those living in Great Britain who were born between March 3 and 9, 1958. Written informed consent was obtained from the parents for all measurements in the first three sweeps. For the main analysis, a risk set was created containing all 6,850 subjects for whom there were complete data available on relevant variables.

Five measures of motor skills were used to define motor impairment:

1. Not walking by age 18 months, according to parents (0=no, 1=yes).
2. Poor hand control at age 7.
3. Rated "clumsy" at age 7.
4. Poor hand control at age 11.
5. Poor coordination at age 11.

Variables 2–5 were rated by classroom teachers who traditionally supervise 7- and 11-year-olds in physical education classes in British primary schools. Variables 2–5 were scored 0 ("doesn't apply"), 0.5 ("applies"), 1 ("certainly applies"). Subjects who had a summary score of 2 or above were rated as having motor impairment, also referred to as being "exposed."

Cohort members were defined as meeting criteria for persistent anxiety if their mothers had responded "yes, frequently" to the question, "Does your child worry about many things?" when the child was 11 years old and "certainly applies" to the statement, "Your child often worries about things," when the cohort was 16 years old. All subjects without motor impairment in the risk set served as comparison subjects.

Data were available on sex, father's social class, birth weight, and "seeming frequently miserable," in the mother's opinion, at ages 11 and 16 years—an indicator of depressive symptoms. Because reliable data on the prevalence of early-onset psychosis were not available for the cohort, the only way to adjust for this potential confounder was to correct for "any history of contact with a specialist for an emotional problem by the age of 16."

Using the risk set in Mantel-Haenszel and logistic regression analyses ensured that nested logistic regression models contained an identical number of observations. Power calculations demonstrated that if 5% of the comparison subjects were exposed and the ratio between the subjects with persistent anxiety and the comparison subjects was 1:20 (9.5% of the subjects with persistent anxiety exposed), 260 subjects with persistent anxiety and 5,200 comparison subjects would be required to achieve at least 80% power to detect an odds ratio of 2.0 or above at a significance level of 5%.

Results

The target sample for sweep 3, when the subjects were 16 years old, numbered 16,915. Some measures were completed on sweep 3 for 14,761 (87.3%) of the subjects. Overall, 11,551 subjects had been rated on all five exposure variables in sweeps 1, 2, and 3, of whom 659 (5.7%) met our criteria for motor impairment. Among the risk set, 368 (5.4%) of 6,850 subjects met the criteria for motor impairment. Boys and girls were disproportionately affected by motor impairment: approximately one (8.1%) in 12 boys but only approximately one (3.2%) in 30 girls in the cohort was exposed. Similarly, 7.7% (269 of 3,479) of the boys and 2.9% (99 of 3,371) of the girls in the risk set met the criteria for motor impairment.

Altogether, 332 subjects with persistent anxiety at the ages of 11 and 16 (3.4%) were identified among 9,888 subjects (95% confidence interval [CI]=3.0–3.7). The proportion of subjects with persistent anxiety in the risk set was 3.5% (N=241) (95% CI=3.1–4.0), with a female-to-male ratio of 1.43:1.

A significant multiplicative interaction between sex and motor impairment was present both in the overall sample and in the risk set (likelihood ratio test: χ^2=7.85, df=1, p=0.005). As shown in Table 1, the boys with poor motor skills had an adjusted odds ratio of 3.29 for persistent anxiety (95% CI=2.0–5.4) (likelihood ratio test: χ^2=18.29, df=1, p<0.001), with correction for social class, birth weight, depressive symptoms, and contact with mental health services by age 16, while no effect was observed for girls (adjusted odds ratio=0.95, 95% CI=0.3–2.7) (likelihood ratio test: χ^2=0.01, df=1, p=0.92).

For the boys, a nested logistic regression model supported a linear trend for the effect of childhood motor impairment on subsequent persistent anxiety. The adjusted odds ratio was an increase in motor impairment of 1.38 per unit increase in motor impairment score (95% CI=1.1–1.7) (range=0–5) compared to baseline impairment (likelihood ratio test: χ^2=8.83, df=1, p=0.003). For girls, a comparable model did not support a linear trend (odds ratio=1.15 per unit increase in motor impairment, 95% CI=0.9–1.5) (likelihood ratio test: χ^2=1.22, df=1, p=0.27). These results remained robust, with slightly higher point estimates, when contact with psychiatric services and depressive symptoms were removed from multivariate models in order to examine more generally the relationship between motor skills and persistent anxiety.

TABLE 1. Relation of Persistent Anxiety Among 11- and 16-Year-Old Subjects to Childhood Motor Impairment

Sex and Childhood Motor Status	Number of Subjects		Anxious Subjects as Percent of Total	Odds of Persistent Anxiety	
	With Anxiety	Comparison		Odds Ratio[a]	95% CI
Boys					
Impaired	26	243	9.67	3.29	2.0–5.4
Not impaired	76	3,134	2.37		
Girls					
Impaired	4	95	4.04	0.95	0.3–2.7
Not impaired	135	3,137	4.13		

[a] Multiple logistic regression adjusted for social class, birth weight, depressive symptoms at ages 11 and 16 years, and contact with mental health specialists for emotional problems by age 16 to correct for early-onset psychosis, if present. Contact with mental health specialists by age 16 was the only moderately strong confounder, while depressive symptoms, birth weight, and social class gave rise to minor confounding only.

Discussion

The use of prospectively collected birth cohort data enabled us to examine links longitudinally between two clusters of symptoms that are usually regarded as unrelated—namely, motor skills and persistent anxiety.

One would expect parental errors of recall to be independent of the presence of subsequent anxiety symptoms in later childhood and adolescence. Classroom teachers and parents were, obviously, blind to the hypotheses of this study. Hence, misclassification of exposure was most likely to be of a nondifferential nature. This would obscure any observed association between motor impairment and persistent anxiety.

The outcome "persistent anxiety" was based on two consecutive scores of maternally rated anxiety. The questions used were simple and hard to misinterpret by the mothers. Misclassification of outcome in either direction would have acted to dilute any observed association, provided that such errors were independent of motor impairment status, as one would expect.

Selection bias cannot be excluded as accounting for the findings. However, the unadjusted odds ratio for the main effect for boys, based on five ordinal categories of motor impairment, was lower in the risk set than in the entire sample from the National Child Development Study, which argues against selection bias in the risk set giving rise to spurious results for boys. The significant heterogeneity of effect by sex and the large effect size for boys are also not easy to reconcile with the presence of such a bias.

Our arbitrary definition of motor impairment might raise concern about the internal validity of the findings. The main effect of the binary exposure variable was strongly supported by tests for trend and nested logistic regression models, which indicated a linear dose-response relationship between ordinal categories of motor impairment and persistent anxiety for boys. It is therefore unlikely that any attributable risk was confined to a subgroup among the boys in the cohort. Although we conclude that these results require replication, potential causal pathways should be considered. These would have to account for the significant effect modification observed by sex.

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The authors thank the data archive of the University of Essex, Colchester, U.K., and the Institute of Education, London, for permitting their use of the National Child Development Study data set and Professor Anthony H. Mann for discussion and comments.

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