

Written-Language Disorder Among Children With and Without ADHD in a Population-Based Birth Cohort

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KEY WORDS

attention-deficit/hyperactivity disorder, written-language disorder, reading disability, comorbidity, epidemiology, gender

ABBREVIATIONS

ADHD—attention-deficit/hyperactivity disorder

LD—learning disorder

RD—reading disability

WLD—written-language disorder

DSM-IV—*Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*

CI—confidence interval

HR—hazard ratio

DSM-IV-TR—*Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*

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WHAT'S KNOWN ON THIS SUBJECT: Previous studies have shown that written language among children with attention-deficit/hyperactivity disorder (ADHD) is more impaired compared with children without ADHD. However, population-based epidemiological studies of the comorbidity between written-language disorder (WLD) and ADHD have never been conducted.



WHAT THIS STUDY ADDS: In this population-based birth cohort, ADHD was significantly associated with an increased risk of WLD for both boys and girls. However, the risk of WLD with reading disability associated with ADHD was significantly higher for girls than for boys.

abstract



OBJECTIVE: We determined the incidence of written-language disorder (WLD) among children with and without attention-deficit/hyperactivity disorder (ADHD) in a population-based birth cohort.

METHODS: Subjects included a birth cohort of all children born in 1976–1982 who remained in Rochester, Minnesota, after 5 years of age ($N = 5718$). Information from medical, school, and private tutorial records was abstracted. Cumulative incidences of WLD with or without reading disability (RD), identified with any of 3 formulas, among children with and without ADHD and hazard ratios (HRs) were calculated.

RESULTS: For both genders, the cumulative incidence of WLD by 19 years of age was significantly higher for children with ADHD than for children without ADHD (boys: 64.5% vs 16.5%; girls: 57.0% vs 9.4%). The magnitude of association between ADHD and WLD with RD was significantly higher for girls than for boys (adjusted HR: girls: 9.8; boys: 4.2; $P < .001$). However, this was not true for WLD without RD (adjusted HR: girls: 7.4; boys: 6.6; $P = .64$).

CONCLUSIONS: ADHD is strongly associated with an increased risk of WLD (with or without RD) for both boys and girls. Girls with ADHD are at higher risk of having WLD with RD compared with boys with ADHD, whereas boys and girls are at the same risk of having WLD without RD. *Pediatrics* 2011;128:e605–e612

Attention-deficit/hyperactivity disorder (ADHD), which is characterized by developmentally inappropriate and disabling inattentiveness, impulsivity, and/or hyperactivity, often is accompanied by specific learning disorders (LDs). Because reading disability (RD) accounts for ~80% of all LDs,¹ almost all previous epidemiological studies of LDs have focused on RD, which limits our understanding of the relationship between ADHD and written-language disorder (WLD).

Varying definitions of WLD, including terms such as dysgraphia,² writing problems,³ and writing difficulties,⁴ have been used to describe problems with written language. Although the *International Classification of Diseases, 10th Revision*,⁵ defines WLD as a “specific spelling disorder,” which excludes children who also have RD, the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV)*,⁶ defines WLD as a “disorder of written expression,” without such exclusion criteria. This variability in the definition of WLD has contributed to inconsistent outcomes in studies of the comorbidity between ADHD and WLD.⁷

Children with ADHD may be especially vulnerable to deficits in written language.⁸ For example, deficits in visual-motor integration and motor coordination, which often are observed in ADHD, are to blame for some writing problems.^{9–10} In addition, inefficiencies in working memory, organization, and planning that characterize ADHD can affect the writing process negatively. Preliminary evidence suggests that handwriting quality and written language among children with ADHD are impaired, compared with children without ADHD.^{11–14} High rates of comorbidity between ADHD and WLD have been reported for clinical samples.^{7,15,16} However, population-based

studies on the comorbidity between ADHD and WLD are lacking.

Previously, we reported separately on the epidemiological features of ADHD and WLD in a population-based birth cohort.^{17,18} We also recently completed a study of incidence rates of RD among subjects with ADHD and control subjects, as well as according to gender.¹⁹ In the current study, we evaluated the incidence rates of WLD (with and without RD), according to gender, among children with and without ADHD in the same population-based birth cohort.

METHODS

Study Setting and Data Sources

According to 1990 Census data, when subjects in this birth cohort were school-aged children, the population of Rochester, Minnesota, was 70 745 individuals (96% white; 72% ≤45 years of age), primarily middle class and resembling the US white population during the time frame relevant to this study.²⁰ The capacity for population-based epidemiological research on WLD and ADHD in Rochester is the result of a unique set of circumstances. First, Rochester is relatively isolated in southeastern Minnesota and, as a result, virtually all medical care is provided locally by Mayo Clinic and Olmsted Medical Center and their 3 affiliated hospitals. Through the Rochester Epidemiology Project, which is characterized by a unique medical record-linkage system for Rochester and Olmsted County residents, all diagnoses and surgical procedures recorded at local affiliated medical facilities are indexed continuously for automated retrieval.^{21,22} The medical records include a detailed history of all medical encounters in the community, including ambulatory medical and social service, hospital, emergency department, and home visits, as well as laboratory, psychiatry, and psychology reports and test results, from birth un-

til the patient no longer resides in the community.

Second, the resources for evaluation and instruction at Minnesota Independent School District 535, the school system for the city of Rochester, are of high quality, and the district has a long tradition of excellent care for children with special needs, including WLD and ADHD. Under a research agreement with Independent School District 535, we obtained permission to access the richly documented cumulative school records of all birth-cohort members registered at any of the 41 public, parochial, or private schools, including those who had moved from the school district, were home-schooled, had died, or had graduated. The cumulative school records consist of all school assessments, reassessments, individualized education programs, and notes related to any type of difficulties in learning, school performance, or behavior, as observed by teachers, parents, school psychologists, social workers, school nurses, physicians, or counselors. Third, under 2 additional research agreements, we also obtained permission to access the resources of the only private community psychiatric practice in the area and the privately owned Reading Center/Dyslexia Institute of Minnesota, the only private tutoring agency in existence in the community during the school years of our birth-cohort members. The study was approved by the institutional review boards of Mayo Clinic and Olmsted Medical Center.

Birth Cohort

Our birth cohort consisted of all children born between January 1, 1976, and December 31, 1982, to mothers residing in the townships in Minnesota Independent School District 535 ($N = 8548$). The target population consisted of 5718 children (2956 boys and 2762 girls) who still lived in Rochester at ≥5

years of age, who were monitored retrospectively from birth until the occurrence of death, emigration, or graduation.^{17,18,23} The steps and resources used for identification and follow-up monitoring of this birth cohort and analysis of the potential influence of migration bias were reported previously.²²

Identification and Case Definition of WLD, RD, and ADHD Incident Cases

Our strategy for identifying all WLD, RD, and ADHD incident cases consisted of several steps, used multiple sources of information, and relied on the recorded histories of symptoms, individual test results, and treatment. Details of these processes were described previously.^{17,18,23} In short, several steps were used to reduce the pool of potential WLD, RD, and ADHD incident cases, starting with cumulative school records for each child in the birth cohort ($N = 5718$). School records were searched for any indication of concerns about learning and/or behavior, and 1961 children were identified with those concerns, as observed and documented by teachers, parents, school psychologists, physicians, social workers, and/or school nurses. Additional work on these 1961 cases consisted of abstracting data from the school and medical records and the records from the 2 other private facilities described above. Of the 1961 children, 1509 (77%) had complete assessment data. The remaining children had learning or behavioral concerns but not to a degree that warranted formal evaluation by medical and/or school personnel.

The following data were abstracted: all individually administered academic achievement and cognitive ability test results and detailed information related to behavioral problems (symptoms, clinical diagnoses of ADHD,

results from teacher/parent questionnaires, and medication treatment). Individuals with clinical diagnoses of severe intellectual disability or full-scale IQ scores of <50 were not included in the study. The manner in which children with LDs should be identified has been debated for decades. Before the Individuals with Disabilities Education Act/PL 94-142 was instituted in Minnesota, remedial classes were viewed as a regular education initiative, much as contemporary Response to Intervention tier II is intended. Such regular education initiatives were not documented. Within the framework of educational assessment, identification practices, and LD eligibility criteria that were in place while our students were in school, discrepancy measures, at varying levels of sophistication, predominated. Therefore, identification of WLD incident cases consisted of applying 3 psychometric criteria. Specifically, for each child designated as having learning/behavioral concerns, all writing achievement and IQ test scores were used to form pairs of cognitive ability and writing performance measures within each calendar year.¹⁸ The earliest date among these pairs, which yielded the discrepancy fulfilling our research criteria, was designated the date of WLD research diagnosis. In each of the following formulas, x represents the study subject's IQ score and y represents the standard score from the writing achievement test. Children classified as having WLD according to the regression formula-Minnesota²⁴ ($y < 17.40 + 0.62x$) had standard scores in writing achievement that were >1.75 SD below the standard score predicted from an individually administered measure of cognitive ability (IQ). In the discrepancy formula approach, differences between age-based standard scores of measures of individually administered intelligence and writing achievement varied according to grade (ie, $x - y \geq$

15, 19, or 23 points for kindergarten to third grade, fourth grade to sixth grade, or seventh grade to 12th grade, respectively). Finally, the low-achievement formula ($x \geq 80$ and $y \leq 90$) represents an alternative method used by other LD researchers to identify WLD cases.²⁵⁻²⁷ In this study, we chose to be inclusive and to consider a child to have a WLD if any of the 3 criteria were fulfilled; this was done because of the controversial issues regarding LD identification. Individual academic reading achievement, cognitive ability test results, and the same 3 psychometric criteria were also applied to identify RD incident cases.²³ We studied these LDs regardless of the presence or absence of any comorbid and/or disadvantaged conditions, to represent the identification, diagnostic, and instructional issues faced daily by professional staff members.

The identification of ADHD incident cases consisted of applying research criteria for ADHD to the 1961 children from our birth cohort who had any recorded behavioral or learning concerns. Cases were defined as research-identified ADHD incident cases if the school and/or medical records included various combinations of the following 3 different categories of information: (1) meeting DSM-IV criteria for ADHD; (2) positive ADHD questionnaire results²⁸; or (3) clinical diagnosis of ADHD documented (Table 1). Research criteria for the age of ADHD onset were defined as the age when the clinical diagnosis was made or, in the absence of a diagnosis, the date of the first positive ADHD-specific questionnaire or the date when DSM-IV research criteria were met. In this manner, a total of 379 ADHD cases were identified. Details of the criteria and the identification process for ADHD incident cases were described earlier.¹⁷

TABLE 1 Research Criteria for ADHD Case Definition¹⁷

Meets DSM-IV Research Criteria for ADHD ^a	ADHD Questionnaire Results	Clinical Diagnosis of ADHD ^b	No. of Subjects	
			Category	Total
+	+	+	170	228
+	+	-	41	
+	-	+	17	151
-	+	+	122	
-	-	+	29	

+ and - indicate the presence or absence, respectively, of a given criterion.

^a All DSM-IV criteria were met, but an age criterion was not used.

^b Clinical diagnosis of ADHD (with or without subtype) was recorded in the medical record.

Subjects Without ADHD

Members of the birth cohort who were still living in Rochester at ≥ 5 years of age, were not identified as having ADHD, and did not have severe intellectual disability were designated subjects without ADHD.

Identification of Specific Writing Difficulties Among Children With WLD

To operationalize the 4 specific writing difficulties described in the DSM-IV Text Revision (DSM-IV-TR)²⁹ (grammatical or punctuation errors within sentences, poor paragraph organization, multiple spelling errors, and excessively poor handwriting), we used information from individualized education program goals for written language and/or specific writing subtest scores of ≤ 90 , both of which were available for a majority of our subjects with research-identified WLD. These specific writing goals (eg, spelling, legibility, and sentence construction) and/or writing subtest scores were then aligned with the 4 specific writing difficulties defined by DSM-IV-TR.¹⁸

Statistical Analyses

Analyses were performed separately for the 2 events of interest, that is, WLD with RD and WLD without RD. Subjects were monitored from birth until migration, death, or graduation. The cumulative incidence of WLD was calculated according to the Kaplan-Meier method. However, because WLD without RD and WLD with RD are competing

risks (ie, an event whose occurrence either precludes the occurrence of the other event or alters the probability of occurrence of the other event), the cumulative incidences of WLD without RD and of WLD with RD were calculated by taking into account this competing risk.³⁰

The Cox proportional-hazard model was applied to obtain hazard ratios (HRs) and corresponding 95% confidence intervals (CIs) separately for each of the 2 events (WLD with RD and WLD without RD). In each model, the incidence of the event was regarded as the outcome variable, whereas ADHD case status (incident ADHD cases versus noncases) was regarded as an explanatory variable. Unadjusted and adjusted HRs were calculated. In the

latter case, the children's race (white versus nonwhite), maternal years of education, and maternal age at the birth of the child (all found previously to be significantly different between subjects with ADHD and subjects without ADHD) were included in the model.³¹ Given the overall sample size, the prevalence of ADHD, and the number of events for the 2 outcomes of interest, the study had 80% power to detect a HR of 1.6 for the overall association between ADHD and WLD with RD and a HR of 2.2 for the association between ADHD and WLD without RD. *P* values (2-sided) of $< .05$ were considered statistically significant.

RESULTS

Among the 5718 subjects in the birth cohort, 19 subjects with severe intellectual disability were excluded, which left 5699 subjects for the analysis. A total of 379 children fulfilled the research criteria for ADHD, at a mean \pm SD age of 10.4 ± 3.6 years (median: 9.8 years).

Biological and socioeconomic factors obtained from the birth certificates of children with and without ADHD in the birth cohort are shown in Table 2. Subjects with ADHD were significantly

TABLE 2 Demographic and Perinatal Factors for Children With and Without ADHD

	ADHD (<i>N</i> = 379)	No ADHD (<i>N</i> = 5320)	<i>P</i>
Children			
Boys, <i>n</i> (%)	284 (74.9)	2666 (50.1)	$< .001$
White (6 missing), <i>n</i> (%)	376 (99.2)	5182 (97.5)	.036
Birth weight of < 2500 g (11 missing), <i>n</i> (%)	16 (4.2)	233 (4.4)	.88
Mothers			
Age, mean \pm SD, y	25.9 \pm 4.8	26.6 \pm 4.7	.004
White (6 missing), <i>n</i> (%)	377 (99.5)	5203 (97.9)	.035
Marital status (1 missing), <i>n</i> (%)			.12
Married	345 (91.0)	4953 (93.1)	
Not married	34 (9.0)	366 (6.9)	
Level of education (494 missing), <i>n</i> (%)			.002
< 12 y	29 (8.4)	315 (6.5)	
12 y	138 (40.1)	1662 (34.2)	
13-15 y	116 (33.7)	1594 (32.8)	
≥ 16 y	61 (17.7)	1290 (26.5)	
Pregnancy/labor/delivery			
Pregnancy complications, <i>n</i> (%)	37 (9.8)	432 (8.1)	.26
Labor/delivery complications, <i>n</i> (%)	135 (35.6)	1945 (36.7)	.71
Congenital anomalies, <i>n</i> (%)	5 (1.3)	35 (0.7)	.14

Computerized birth certificate information (for continuous and dichotomous variables) for all birth-cohort children were obtained from the Minnesota Department of Health. Because of the number of missing values (which might not be missing at random), fathers' data were not included.

TABLE 3 Risk of WLD With RD Associated With ADHD, Overall and According to Gender

	N	No. of Cases of WLD With RD by 19 y	Cumulative Incidence of WLD With RD by 19 y, %	HR (95% CI) ^a	
				Unadjusted	Adjusted
Both genders					
ADHD	379	165	45.9	6.23 (5.21–7.46)	5.02 (4.15–6.09) ^b
No ADHD	5320	438	9.6	Reference	Reference
Boys					
ADHD	284	125	46.8	4.61 (3.74–5.69)	4.21 (3.38–5.28) ^c
No ADHD	2666	294	12.9	Reference	Reference
Girls					
ADHD	95	40	43.5	9.20 (6.47–13.07)	9.78 (6.76–14.14) ^c
No ADHD	2654	144	6.3	Reference	Reference

WLD and RD were identified with any of the 3 formulas (regression formula-Minnesota, discrepancy formula, or low-achievement formula); results remained the same when each psychometric formula was evaluated separately.

^a $P < .001$ for all values; $P = .001$ for gender-ADHD interaction in the unadjusted model and $P < .001$ for gender-ADHD interaction in the adjusted model.

^b Adjusted for child's gender, child's race (white versus nonwhite), mother's education level, and mother's age at the birth of the child.

^c Adjusted for child's race (white versus nonwhite), mother's education level, and mother's age at the birth of the child.

TABLE 4 Risk of WLD Without RD Associated With ADHD, Overall and According to Gender

	N	No. of Cases of WLD Without RD by 19 y	Cumulative Incidence of WLD Without RD by 19 y, %	HR (95% CI) ^a	
				Unadjusted	Adjusted
Both genders					
ADHD	379	58	16.6	7.90 (5.81–10.73)	6.80 (4.87–9.48) ^b
No ADHD	5320	145	3.3	Reference	Reference
Boys					
ADHD	284	46	17.7	7.81 (5.41–11.28)	6.62 (4.46–9.81) ^c
No ADHD	2666	78	3.6	Reference	Reference
Girls					
ADHD	95	12	13.5	6.67 (3.60–12.35)	7.37 (3.95–13.75) ^c
No ADHD	2654	67	3.1	Reference	Reference

WLD and RD were identified with any of the 3 formulas (regression formula-Minnesota, discrepancy formula, or low-achievement formula); results remained the same when each psychometric formula was evaluated separately.

^a $P < .001$ for all values; $P = .74$ for gender-ADHD interaction in the unadjusted model and $P = .64$ for gender-ADHD interaction in the adjusted model.

^b Adjusted for child's gender, child's race (white versus nonwhite), mother's education level, and mother's age at the birth of the child.

^c Adjusted for child's race (white versus nonwhite), mother's education level, and mother's age at the birth of the child.

more likely to be male ($P < .001$), to be white ($P = .036$), to have mothers with fewer years of education ($P = .002$), and to have younger mothers at birth ($P = .004$), compared with subjects without ADHD. There were no statistically significant differences regarding perinatal factors between subjects with and without ADHD.

Among the 5699 subjects, 806 met ≥ 1 of the 3 psychometric formula criteria for WLD. Of those 806 subjects, 603 also met ≥ 1 of the 3 criteria for RD, which yielded 203 subjects with WLD without RD (Tables 3 and 4). The median age at which a subject first met the WLD cri-

teria was older for children with WLD without RD than for those with WLD with RD (11.3 vs 8.2 years; $P < .001$). For both genders, the cumulative incidence of WLD by 19 years of age was significantly higher for children with ADHD than for those without ADHD (boys: 64.5% vs 16.5%; girls: 57.0% vs 9.4%; $P < .001$).

Table 3 shows the risk of WLD with RD associated with ADHD, separately for boys and girls. ADHD was significantly associated with an increased risk of WLD with RD for both boys and girls. However, the magnitude of increased risk for WLD associated with ADHD was

greater for girls than for boys (adjusted HR: girls: 9.8; boys: 4.2), as shown by a significant gender-ADHD interaction with respect to the incidence of WLD ($P < .001$ for adjusted model).

Furthermore, ADHD was significantly associated with an increased risk of WLD without RD for both boys and girls. However, the gender difference observed in the model described above for increased risk for WLD associated with ADHD disappeared. The ADHD/non-ADHD HRs were similar for the 2 genders (6.6 for boys and 7.4 for girls), without any significant gender-ADHD interactions ($P = .64$ for adjusted model) (Table 4).

We studied specific writing difficulties among children with WLD and ADHD. Girls tended to have a single specific writing difficulty, whereas boys were more likely to have multiple writing difficulties ($P = 0.003$). Figures 1 and 2 present the distributions of specific difficulties in writing among children with WLD with RD or WLD without RD, according to ADHD status and gender. Among boys with WLD without RD, the proportion with any combination of the 4 DSM-IV-TR–described difficulties in writing tended to be higher for boys with ADHD (86%) than for boys without ADHD (67%; $P = .07$) (Fig 2). Such differences were not observed for children with WLD with RD (Fig 1).

DISCUSSION

Population-based, nonreferred samples of boys and girls with ADHD and WLD are of critical importance for increasing our understanding of the natural history of the comorbidity between ADHD and WLD. Sufficient attention has not been given to the epidemiological aspects of WLD without RD, partly because of the high rates of comorbidity between RD and WLD and the later onset of WLD without RD, compared with RD (data not shown). The core of this epidemiological study is

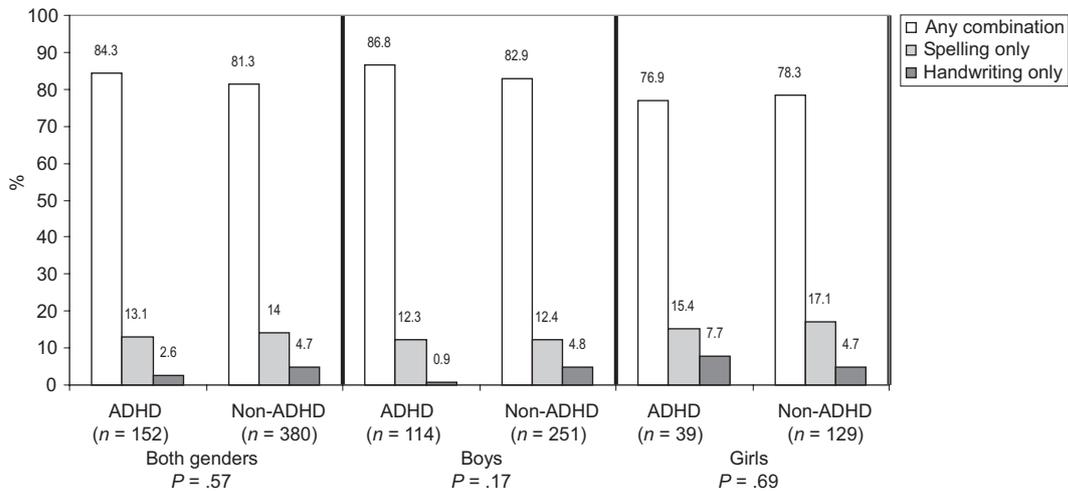


FIGURE 1

Distribution of DSM-IV-TR-specific WLD difficulties, with or without ADHD, according to gender among WLD with RD incident cases. WLD and RD were identified with any of the 3 formulas (regression formula-Minnesota, discrepancy formula, or low-achievement formula). Subjects with “any combination” had any combination of the 4 DSM-IV-TR-described difficulties, that is, grammatical errors, poor paragraph organization, multiple spelling errors, or excessively poor handwriting, but not spelling errors only or excessively poor handwriting only. Subjects without classifiable writing difficulties were excluded. Fisher’s exact test was used to compare the distributions of the specific writing difficulties between children with versus without ADHD.

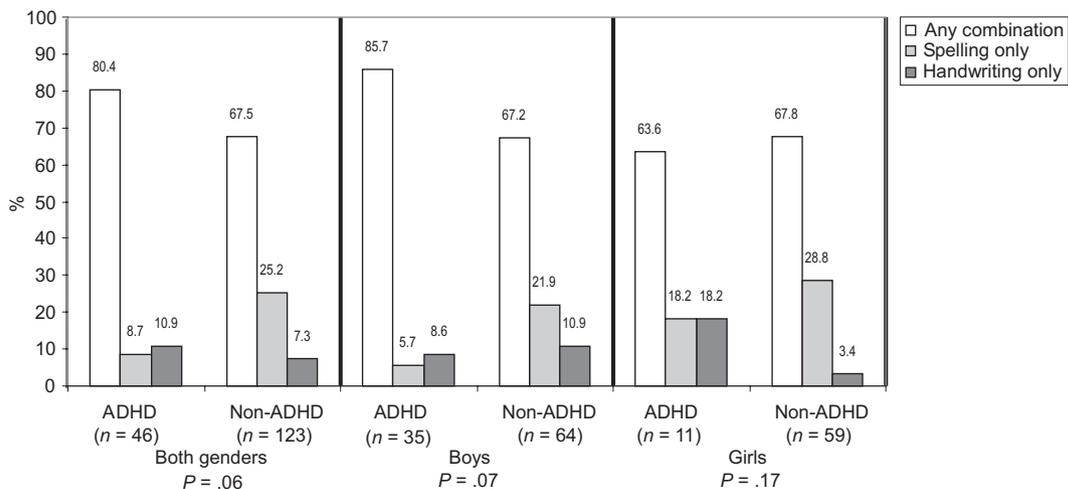


FIGURE 2

Distribution of DSM-IV-TR-specific WLD difficulties, with or without ADHD, according to gender among WLD without RD incident cases. WLD and RD were identified with any of the 3 formulas (regression formula-Minnesota, discrepancy formula, or low-achievement formula). Subjects with “any combination” had any combination of the 4 DSM-IV-TR-described difficulties, that is, grammatical errors, poor paragraph organization, multiple spelling errors, or excessively poor handwriting, but not spelling errors only or excessively poor handwriting only. Subjects without classifiable writing difficulties were excluded. Fisher’s exact test was used to compare the distributions of the specific writing difficulties between children with versus without ADHD.

the population-based birth cohort from which carefully defined, research-identified ADHD and WLD incident cases were drawn. This is the first epidemiological study to evaluate the comorbidity of ADHD and WLD in the general population. We found a strong association between WLD and ADHD; among children with ADHD, the cumulative incidences of WLD were 64.5%

for boys and 57.0% for girls. In contrast, among children without ADHD, the cumulative incidences of WLD were 16.5% for boys and 9.4% for girls.

We reported previously that boys in this birth cohort were 2 to 3 times more likely than girls to have ADHD, RD, and WLD.^{17,18,23,28} In this study, however, we found that, among children with

ADHD, the incidence of WLD was significantly higher for both boys and girls. For children with ADHD, the risks of WLD without RD were similar for boys and girls. However, the risk of WLD with RD was significantly higher for girls. Shaywitz et al^{32,33} demonstrated, by using functional MRI, that, during phonologic tasks, brain activation in male subjects is lateralized to the left infe-

rior frontal gyrus. In female subjects, the pattern of activation is more diffuse, involving both the left and right inferior frontal gyri. This diffuse pattern may allow female subjects to compensate for deficits in phonologic processing that cannot be overcome in male subjects. This may explain the decreased incidence of phonologically based LDs (RD and WLD) among girls that we demonstrated previously.^{18,23} In contrast, our current data indicate that the presence of ADHD may affect adversely the ability of female subjects to compensate for deficits in phonologic processing.

To understand better the associations between ADHD and WLD, we studied specific difficulties in writing skills (ie, grammar, punctuation, organization, spelling, and handwriting quality) (Figs 1 and 2). For both boys and girls with WLD with RD, the specific types of writing problems did not differ between children with or without ADHD. However, among boys with WLD without RD, the writing problems tended to be more complex for boys with ADHD. Re et al¹¹ also identified difficulties in writing involving spelling and written language expression among children with ADHD but, in that small, school-based study, comorbid RD and gender differences were not evaluated. In another school-based study, Adi-Japha et al¹² reported that spelling errors and writing deficits among children with ADHD without RD stemmed primarily from nonlinguistic deficits, such as impairments in kinematic motor production. Because the characteristics of

writing ability are inherently complex,^{12,34} standardized measures of writing ability among children with ADHD are needed for better understanding of their specific handwriting difficulties.¹³

Several limitations should be considered. First, because this investigation was a retrospective cohort study, determining the precise age of onset of ADHD and WLD in our sample was not possible. Rather, we determined the age at which our research criteria for WLD and ADHD were fulfilled. It is also possible that some incident cases of WLD or ADHD were not identified, because no screening measures were performed for every child in this birth cohort. However, it should be emphasized that a systematic, multistage process, multiple, independent, complementary sources of data, research criteria, and formulas were used to identify incident cases. Although Rochester is comparable to the US population (median age: 31.6 vs 32.8 years; median household income: \$35 789 vs \$30 056; male: 48.5% vs 48.7%), the proportion of white subjects in the population is higher in Rochester than in the United States (95% vs 81%), which may limit generalization of these results to other populations.²⁰ However, a homogeneous population minimizes confounding effects of ethnicity and race.

CONCLUSIONS

Our results show that ADHD is associated with a significantly increased risk of WLD in boys and girls regardless of

comorbid RD. However, the magnitude of the risk of WLD with RD associated with ADHD is significantly higher for girls than for boys. There are similar levels of risk for WLD without RD associated with ADHD for boys and girls. Among boys with WLD without RD, those with ADHD tended to have multiple writing difficulties, compared with boys without ADHD.

The American Academy of Pediatrics recommends that evaluations of children with suspected ADHD include assessment for coexisting conditions.³⁵ Our data indicate that clinicians should give serious consideration to thorough psychoeducational evaluations for WLD among all children with ADHD.

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