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Association Between Childhood Specific Learning Difficulties and School Performance in Adolescents With And Without ADHD Symptoms: A 16-Year Follow-Up

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Abstract

Objective: The authors investigated whether childhood specific learning difficulties (SLDs) predict later school performance in adolescents with ADHD symptoms (ADHDs) and how SLDs associate with educational aspirations. **Method:** In the Northern Finland Birth Cohort 1986 (n = 9,432), data about children were collected using questionnaires for parents and teachers at ages 7 and 8 and for parents and adolescents at ages 15/16. Information on school performance was obtained from a national register. **Results:** The occurrence of SLDs at 8 years was 19.9% (n = 1,198), ADHDs at 15/16 years was 8.0% (n = 530), and comorbid ADHDs and SLDs was 3.0% (n = 179). Having ADHDs but not SLDs or having both was associated with a significantly lower mean value in school grades for theoretical subjects. Adolescents with comorbid ADHDs and SLDs repeated a grade more often, and their educational aspirations were less ambitious than those in other groups. **Conclusion:** ADHDs and SLDs have a negative influence on academic achievements. *(J. of Att. Dis. 2014; 18(1) 61-72)*

Keywords

ADHD, adolescents, specific learning difficulties, SLD, school performance, educational aspirations

According to the International Statistical Classification of Diseases (ICD10, revision in 2011), the basic learning disability is defined to emerge in reading, writing, and/or mathematics, even though the cognitive skills of these children are within normal range. Even though the term can be used for different kinds of difficulties in learning with a different level of seriousness, the terms *learning difficulty* and *learning disability* can be differentiated. According to Carlson (2005), an individual with learning difficulty can learn using conventional teaching techniques, whereas learning disability requires specialized interventions. In accordance with Whiting (2001), in England, learning difficulty and learning disability are used synonymously with intellectual disability, whereas specific learning difficulty (SLD) refers to problems in a single domain of learning, reading, writing, or mathematics. In the present study, we used the term *specific learning difficulties* (SLDs), first, because of the epidemiological sample with mainly questionnaire data and no clinical examination and, second, because the children were just learning reading and writing skills. Third, we had no information whether they were in need of extra tutoring; however, most of them attended mainstream education (98%, Taanila, Ebeling, Kotimaa, Moilanen, & Järvelin, 2004).

Approximately 5% of all public school children are identified as having SLDs (Lyon, 1996), but higher figures have

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been presented. For instance, in a follow-up study from Australia, 36.6% of the primary and secondary school children were identified as having some area of special learning needs in their first school year, and 33.3% were identified 2 years later (McLeod & McKinnon, 2007). Moreover, a large, nationally representative survey of the lifetime prevalence of learning disabilities and special health care needs of children younger than 18 years in the United States indicated the lifetime prevalence to be 9.7%, and depending on the number of definitional criteria (from 1 to 5), the prevalence of learning disabilities ranged from 15.0% to 87.8% (Altarac & Saroha 2007). In Finland, 21.2% of school-aged children were referred to special education because of learning disabilities in the year 2001, and 28% were referred in the year 2004 (Mannerkoski, Heiskala, & Autti, 2006).

Previous research provides strong support for the connection between learning disabilities and ADHD (Beitchman & Young, 1997; Fergusson & Horwood, 1995; Fergusson & Lynskey, 1997; Goldston et al., 2007; Jakobson & Kikas, 2007; Jensen, Martin, & Cantwell, 1997; Rapport, Scanlan, & Denney, 1999; Spira & Fischel, 2005; Yoshimasu et al., 2010). The studies by Mayes and colleagues (Mayes, Calhoun, & Crowell, 2000; Mayes, & Calhoun, 2006) indicated that as many as 70% of the children with ADHD have comorbid learning problems. According to the study by Smith and Adams (2006), parents of children with ADHD and comorbid learning disabilities were more likely to be contacted by a teacher because of their children's behavioral problems than parents of children with only learning disabilities. Comorbidity of these two problems led to significantly poorer academic outcomes than ADHD alone.

Reading disability is common type of learning disability among children with ADHD. For instance, Yoshimasu and colleagues (2010) indicated that the incidence of reading disability was significantly higher among children with ADHD than among those without ADHD (boys: 51% vs. 14.5%, girls: 46.7% vs. 7.7%). Comorbidity between ADHD and reading disability has been presented to range from 20% to 40% (Del'Homme, Kim, Loo, Yang, & Smalley, 2007). In addition, Wigal et al. (2012) reported that stimulant treatment for ADHD improved attention skills and reading rate among those with difficulties in these areas. Difficulties in mathematics among children with ADHD are less studied. However, there is evidence that difficulties in mathematical problem-solving and calculation skills are more common among children with ADHD than those without ADHD (Lucangeli & Cabrele, 2006; Monuteaux, Faraone, Herzig, Navsaria, & Biederman, 2005). Specifically, children with the inattentive type of ADHD have more problems in academic achievement, especially in mathematics, than children with the hyperactive-impulsive type of ADHD (Prior et al., 1999; Spira & Fischel, 2005). Moreover, the study by Marshall, Schafer, O'Donnell, Elliott, and Handwerk (1999) showed that inattention and arithmetic calculation skills have an association and that ADHD can increase the risk for arithmetic difficulties.

Despite broad research on this area, few studies used epidemiological samples or longitudinal design. Our earlier study (Taanila, Yliherva, Kaakinen, Moilanen, & Ebeling, 2011) from the Northern Finland Birth Cohort 1986 (NFBC 1986) indicated that at the age of 8, the cross-sectional association between learning difficulties and behavioral problems was clear. In the present study, we examined whether this association still exists when the children are 15/16 years old and, if so, in what way it associates with the school performance and future educational plans. The specific aim was to investigate whether childhood SLDs predict later poor school performance (assessed as school grades and their mean values, grade repetition) of adolescents with and without ADHD symptoms, and how SLDs affect their educational aspirations.

Method

Study Population

Our sample is based on an unselected, general population from the NFBC 1986. The original study population consists of 9,432 live-born children, whose expected date of birth fell between July 1, 1985, and June 30, 1986 (Järvelin, Hartikainen-Sorri, & Rantakallio, 1993). All the mothers living in the two northernmost provinces of Finland, Oulu and Lapland, were recruited. At the time of the first follow-up, when the children were 7 and 8 years old, 99% (n = 9,357) of them were alive (Taanila et al., 2004). The second follow-up study was started in 2001, when the adolescents were 15/16 years old. At this phase, 99% (n = 9,340) of the adolescents were alive, and the residence was known for 9,215 adolescents. Data collection is described in Figure 1.

The ethical committee of Northern Ostrobotnia Hospital District approved the study. Written informed consents were obtained from the parents and from the adolescents in the second follow-up study.

Procedure and Measures

The First Follow-Up at the Ages of 7 and 8

The assessment of the learning difficulties and family background factors. Data collection started before the children's birth, and after the newborn phase, the first follow-up study was carried out when the children were 7 and 8 years old. In the first stage, in the autumn of the children's first school year, information on their growth, development, and health; school and family type; and social situation was gathered from the parents using a postal questionnaire (response rate n = 8,416; 90%). In the second stage, in the spring of the children's first school year, the teachers screened children's possible learning difficulties (response rate n = 8,525;

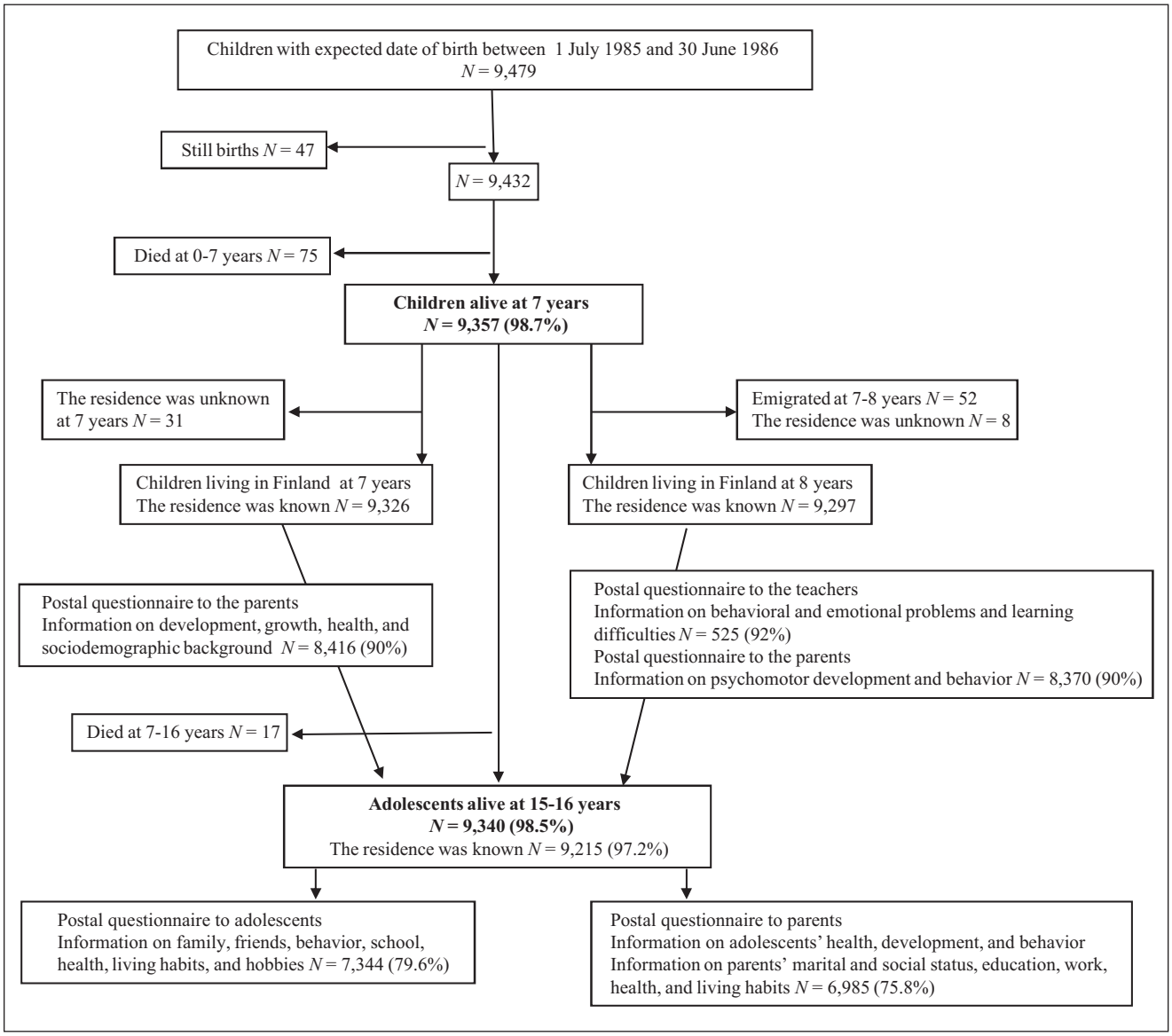

Figure 1. Data collection until the age of 16 years in the Northern Finland 1986 Birth Cohort.

92%). Most of the children (98%) were attending mainstream education (Taanila et al., 2004).

The teachers assessed children's learning difficulties by answering the following questions: "Has the child got difficulties in learning to read/to write/mathematics? (1) Yes, (2) No." If the teacher responded affirmatively to whether the child presented with learning difficulties in reading, spelling, or mathematics, the child was considered to have difficulties in the specific area. In our analyses, the child was considered to have SLDs in general if she or he had them in any of the three areas.

Information on the socioeconomic status (SES) of the family, family type, and parents' education from the parents' 7-year questionnaire was used as background factors. Family type was classified into four subgroups: intact family, divorced family, reconstructed family, and single-parent family. Family SES was also classified into four groups: professional, skilled worker, unskilled worker, and farmer. Parents' education was classified into primary (less than 10 years of education), secondary (10-12 years of education), and tertiary level (more than 12 years of education).

The Second Follow-Up at the Age of 15/16

The assessment of ADHD symptoms and school performance. The data of ADHD symptoms were collected at the age of 15/16 as a part of a larger data collection. Adolescents and parents received a postal questionnaire. Parents assessed adolescents' behavior, and adolescents reported

their educational aspirations and whether they had grade repetitions. Eighty percent (n = 7,344) of the adolescents and 76% (n = 6,985) of the parents returned the questionnaire.

In their postal questionnaire, the parents assessed ADHD symptoms of their offspring using the Strengths and Weakness of ADHD Symptoms and Normal Behavior (SWAN) Scale (Swanson et al., 2001). We used the 18-item ADHD scale based on 18 ADHD symptoms described in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994). These symptoms are translated into statements and are rated with scores of 3, 2, and 1 (describing problems); 0 (average behavior); and −1, −2, and −3 (describing strengths). The ratings can be summed up into summary scores. The Inattention (Statements 1-9), Hyperactive-Impulsive (Statements 10-18), and Combined (Statements 1-18) subscales were used. We used the 95th percentile of distribution of scores on the ADHD scale as a cutoff point to define adolescents with ADHD symptoms. The 95% cutoff values for the subscales were 0.625, 0.125, and 0.277, respectively. In our study, the adolescent had ADHD symptoms if one of these cutoff values was exceeded. This screening procedure has been described in detail elsewhere (Smalley et al., 2007).

Information on adolescents' school performance (teacher-assigned school grades from 4 to 10 where 4 indicates failing a subject and 10 indicates excellent performance) in the final year of comprehensive school was obtained from the national application register. Finnish three-level education system includes comprehensive school between ages 7 and 16, general upper secondary school and vocational qualifications between ages 17 and 19, and tertiary level including polytechnic, college, or university education. In addition to mainstream education, special schools with adjusted syllabus for those with special needs are available in basic and secondary levels. Compulsory education ends after comprehensive school, but all adolescents are advised to apply to general upper secondary education. All applications and preferences for upper secondary education are stored in the national register, including data on school grades and their mean scores. These data were extracted until 2006. Information on the grade repetition and the adolescents' educational aspirations was obtained from the postal questionnaire filled in by the adolescents.

Our final study population consisted of those who had information on childhood learning difficulties, valid answers to the SWAN questionnaire (maximum of one item missing out of the 18 items), and information on school performance and educational aspirations, and those whose parents had given permission to use the data (n = 6,034). The numbers in the tables vary because of missing data. After combining the information from the follow-up studies, we divided the adolescents into four subgroups: those who had comorbid ADHD symptoms and SLDs (+ADHDs, +SLDs), those who had only ADHD symptoms (+ADHDs, −SLDs), those who had only SLDs (−ADHDs, +SLDs) and those who had neither ADHD symptoms nor SLDs (−ADHDs, −SLDs).

Statistical Analyses. Pearson's chi-square test was used to study the gender differences in frequencies of SLDs and ADHDs as well as the association of background factors and SLDs and ADHDs. For small frequencies, we used Fisher's exact test instead of Pearson's chi-square test. Frequencies, percentages, and p values are reported. Univariate and multivariate linear, logistic, and multinomial logistic regression analyses were performed to study the unadjusted and adjusted associations of the variables. The analyses were stratified by gender and for all. Covariates included in the multivariate analyses were family type, family SES, mother's education, and father's education, and in the analyses for all, we also adjusted for gender. Betas, their standard errors (*SE*), odds ratios (OR), and their 95% confidence intervals (CI) are reported. SPSS version 15.0 for Windows and SAS version 9.1 were used for statistical analyses.

Results

In the study population, the occurrence of SLDs at 8 years was 19.9% (n = 1,198), and the reporting of ADHD symptoms at 15/16 years was 8.0% (n = 530). The occurrence of SLDs was 24.5% (n = 734) among boys and 15.3% (n = 464, $p < .0001$) among girls at 8 year. ADHD symptoms were more common among boys at 10.4% (n = 346) than girls at 5.6% (n = 184, $p < .0001$) at 15/16 years. Comorbid ADHDs and SLDs (+ADHDs, +SLDs) existed in 3.0% of the study population (n = 179). The comorbidity was 4.5% (n = 136) among boys and 1.4% (n = 43, $p < .0001$) among girls at 15/16 years (Table 1).

The association between background factors at 8 years and comorbid ADHDs and SLDs (+ADHD, +SLDs) at 15/16 years is presented in Table 2. Reconstructed family type, low SES of the family, and parents' low level of education seemed to increase the risk of having ADHD symptoms and learning difficulties.

Table 3 presents the distribution of the adolescents in the different school types at the ages 15 and 16 years. Most of the adolescents attended comprehensive school, but a small proportion had moved up to the upper secondary school (due to the age distribution). However, among the adolescents with comorbid ADHDs and SLDs (+ADHDs, +SLDs), as much as 18.3% reported to attend vocational and 8.5% special school compared with the group without problems (−ADHDs, −SLDs) where the figures were 7.2% for vocational and 0.3% for special school. Twelve percent of boys and 11% of girls with comorbid ADHDs and SLDs (+ADHDs, +LDs) had repeated a grade (not shown in the

Table 1. Numbers and Proportions of Teacher-Reported LDs in 8-Year-Old Children and ADHDs in 15/16-Year-Old Adolescents and Their Different Combinations.

	Boys	Girls	All	
ADHDs and LDs	*n* (%)	*n* (%)	*n* (%)	*p* value[a]
LDs at 8 years (*n* = 6,034; 3,001 boys; and 3,033 girls)	734 (24.5)	464 (15.3)	1,198 (19.9)	<.0001
ADHDs at 15/16 years (*n* = 6,622; boys 3,314; and 3,308 girls)	346 (10.4)	184 (5.6)	530 (8.0)	<.0001
−ADHDs, −LDs	2,102 (70.0)	2,455 (80.9)	4,557 (75.5)	
−ADHDs, +LDs	598 (19.9)	421 (13.9)	1,019 (16.9)	
+ADHDs, −LDs	165 (5.5)	114 (3.8)	279 (4.6)	
+ADHDs, +LDs	136 (4.5)	43 (1.4)	179 (3.0)	<.0001

Note: LDs = learning difficulties; ADHDs = ADHD symptoms; −ADHDs, −LDs = no ADHD symptoms, no learning difficulties; −ADHDs, +LDs = no ADHD symptoms, have learning difficulties; +ADHDs, −LDs = have ADHD symptoms, no learning difficulties; +ADHDs, +LDs = have ADHD symptoms, have learning difficulties.
[a]*p* value is from the chi-squire test for gender differences (Fisher's exact test for frequencies).

Table 2. The Association Between Background Factors at 8 Years and ADHD Symptoms With Learning Difficulties (+ADHDs, +LDs) at 15/16 Years of Age.

	Boys			Girls			All		
	Total	+ADHDs, +LDs		Total	+ADHDs, +LDs		Total	+ADHDs, +LDs	
	N	*n* (%)	*p* value[a]	*n*	*n* (%)	*p* value[a]	*n*	*n* (%)	*p* value[a]
Family type									
Intact	2,503	99 (4.0)		2,472	33 (1.3)		4,975	132 (2.7)	
Divorced	168	12 (7.1)		157	3 (1.9)		325	15 (4.6)	
Reconstructed	157	14 (8.9)		190	5 (2.6)		347	19 (5.5)	
Single	23	—	.005	48	—	.389	71	—	.002
Family SES									
Professionals	1,212	36 (3.0)		1,179	9 (0.8)		2,391	45 (1.9)	
Skilled workers	1,181	67 (5.7)		1,212	23 (1.9)		2,393	90 (3.8)	
Unskilled workers	202	10 (5.0)		206	7 (3.4)		408	17 (4.2)	
Farmers	225	13 (5.8)	.010	220	3 (1.4)	.010	445	16 (3.6)	<.001
Mother's education									
Basic	428	25 (5.8)		442	9 (2.0)		870	34 (3.9)	
Secondary	1,612	82 (5.1)		1,502	22 (1.5)		3,114	104 (3.3)	
Tertiary	801	17 (2.1)	.001	916	10 (1.1)	.386	1,717	27 (1.6)	<.001
Father's education									
Basic	645	46 (7.1)		612	9 (1.5)		1,257	55 (4.4)	
Secondary	1,619	68 (4.2)		1,659	26 (1.6)		3,278	94 (2.9)	
Tertiary	531	8 (1.5)	<.001	520	4 (0.8)	.395	1,051	12 (1.1)	<.001

Note: +ADHDs, +LDs = have ADHD symptoms, have learning difficulties; SES = socioeconomic status.
[a]*p* value is from the chi-squire test for gender differences (Fisher's exact test for frequencies).

table). The difference was statistically significant compared with other groups (+ADHDs, −SLDs, boys 4.2%, girls 2.8%; −ADHDs, +SLDs, boys 7.7%, girls 4.0%; −ADHDs, −SLDs boys 0.4%, girls 0.5%).

Results of the linear regression analysis for school performance of the boys and girls (Table 4) indicated that having ADHD symptoms but not learning difficulties (+ADHDs, −SLDs) or having both (+ADHDs, +SLDs) was associated with a statistically significantly lower mean value of school grades for the theoretical subjects. Table 5 shows teacher-reported school grades for Finnish and mathematics. In all the problem combinations, the adolescents were more likely to have school grades below average, and the probability to have school Grades 9 or 10 was extremely small. For girls, comorbid ADHDs and SLDs (+ADHDs, +SLDs) seemed to cause great difficulties in Finnish (OR =

Table 3. Distribution of the Adolescents in the Different School Forms at the Ages of 15/16 Years.

	School form				
	Comprehensive	Upper secondary	Vocational	Special	Elsewhere[a]
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Boys					
−ADHDs, −LDs	1,339 (69.6)	344 (17.9)	186 (9.7)	8 (0.4)	43 (2.2)
−ADHDs, +LDs	328 (62.2)	64 (12.1)	99 (18.8)	21 (4.0)	15 (2.8)
+ADHDs, −LDs	107 (76.4)	10 (7.1)	14 (10.0)	3 (2.1)	6 (4.3)
+ADHDs, +LDs	72 (61.5)	6 (5.1)	25 (21.4)	10 (8.5)	4 (3.4)
Girls					
−ADHDs, −LDs	1,662 (70.7)	495 (21.1)	123 (5.2)	6 (0.3)	64 (2.7)
−ADHDs, +LDs	271 (68.6)	57 (14.4)	47 (11.9)	7 (1.8)	11 (2.8)
+ADHDs, −LDs	74 (71.2)	10 (9.6)	10 (9.6)	5 (4.8)	5 (4.8)
+ADHDs, +LDs	26 (72.2)	2 (5.6)	3 (8.3)	3 (8.3)	2 (5.6)
All					
−ADHDs, −LDs	3,001 (70.2)	839 (19.6)	309 (7.2)	14 (0.3)	107 (2.5)
−ADHDs, +LDs	599 (65.0)	121 (13.1)	146 (15.8)	28 (3.0)	26 (2.8)
+ADHDs, −LDs	181 (74.2)	20 (8.2)	24 (9.8)	8 (3.3)	11 (4.5)
+ADHDs, +LDs	98 (64.1)	8 (5.2)	28 (18.3)	13 (8.5)	6 (3.9)

Note: −ADHDs, −LDs = no ADHD symptoms, no learning difficulties; +ADHDs, −LDs = have ADHD symptoms, no learning difficulties; −ADHDs, +LDs = no ADHD symptoms, have learning difficulties; +ADHDs, +LDs = have ADHD symptoms, have learning difficulties.
[a]These adolescents have finished the school; they were working or were unemployed.

Table 4. Linear Regression Results for School Performance (Presented as a Mean Value of School Grades in Theoretical Subjects[a]) Predicted by Childhood Learning Difficulties (LDs) Among Adolescents With and Without ADHD Symptoms.

			Unadjusted		Adjusted[b]	
	n	Mean of school grades in theoretical subjects (*SD*)	β (*SE*)	*p* value	β (*SE*)	*p* value
Boys						
–ADHDs, –LDs	2,084	7.6 (1.0)	ref.		ref.	
–ADHDs, +LDs	589	6.9 (1.0)	–0.69 (0.05)	<.0001	–0.60 (0.05)	<.0001
+ADHDs, –LDs	159	6.6 (0.9)	–0.98 (0.08)	<.0001	–0.88 (0.08)	<.0001
+ADHDs, +LDs	123	6.3 (0.9)	–1.30 (0.09)	<.0001	–1.15 (0.09)	<.0001
Girls						
–ADHDs, –LDs	2,430	8.2 (1.0)	ref.		ref.	
–ADHDs, +LDs	407	7.3 (0.9)	–0.88 (0.05)	<.0001	–0.72 (0.05)	<.0001
+ADHDs, –LDs	110	7.1 (1.0)	–1.05 (0.09)	<0.0001	–1.01 (0.09)	<.0001
+ADHDs, +LDs	37	6.6 (0.5)	–1.60 (0.16)	<.0001	–1.48 (0.16)	<.0001
All						
–ADHDs, –LDs	4,514	7.9 (1.0)	ref.		ref.	
–ADHDs, +LDs	996	7.1 (1.0)	–0.84 (0.04)	<.0001	–0.65 (0.04)	<.0001
+ADHDs, –LDs	269	6.8 (1.0)	–1.08 (0.06)	<.0001	–0.94 (0.06)	<.0001
+ADHDs, +LDs	160	6.4 (0.9)	–1.54 (0.08)	<.0001	–1.24 (0.08)	<.0001

Note: –ADHDs, –LDs = no ADHD symptoms, no learning difficulties; –ADHDs, +LDs = no ADHD symptoms, have learning difficulties; +ADHDs, –LDs = have ADHD symptoms, no learning difficulties; +ADHDs, +LDs = have ADHD symptoms, have learning difficulties.
[a]Theoretical subjects: Finnish language, foreign languages, mathematics, history and civics, religion, biology, chemistry, physics, geography.
[b]Adjusted for family type, family socioeconomic status, mother's education, and father's education and in the analyses for all additionally adjusted for gender.

Table 5. Multinomial Logistic Regression Results for School Grades Predicted by Childhood Learning Difficulties (LDs) Among Adolescents With and Without ADHD Symptoms.

		Finnish					Mathematics			
		Unadjusted		Adjusted[a]			Unadjusted		Adjusted[a]	
		School grades[b]	School grades[b]	School grades[b]	School grades[b]		School grades[b]	School grades[b]	School grades[b]	School grades[b]
		Low (n = 830) vs. moderate (n = 3,278)	High (n = 1,847) vs. moderate (n = 3,278)	Low vs. moderate	High vs. moderate		Low (n = 1,359) vs. moderate (n = 2,828)	High (n = 1,766) vs. moderate (n = 2,828)	Low vs. moderate	High vs. moderate
	n	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	n	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Boys										
−ADHDs, −LDs	2,081	ref.	ref.	ref.	ref.	2,079	ref.	ref.	ref.	ref.
−ADHDs, +LDs	588	2.31 [1.87, 2.84]	0.27 [0.18, 0.40]	2.08 [1.66, 2.62]	0.28 [0.19, 0.43]	588	2.52 [2.05, 3.11]	0.46 [0.35, 0.60]	2.43 [1.94, 3.05]	0.46 [0.35, 0.62]
+ADHDs, −LDs	161	3.51 [2.52, 4.91]	0.16 [0.06, 0.44]	3.52 [2.43, 5.11]	0.19 [0.07, 0.54]	161	2.91 [2.07, 4.09]	0.23 [0.12, 0.44]	2.79 [1.91, 4.08]	0.27 [0.14, 0.51]
+ADHDs, +LDs	127	5.40 [3.72, 7.84]	—	5.06 [3.37, 7.60]	—	127	4.78 [3.23, 7.08]	0.21 [0.09, 0.49]	4.61 [3.01, 7.07]	0.23 [0.09, 0.59]
Girls										
−ADHDs, −LDs	2,435	ref.	ref.	ref.	ref.	2,435	ref.	ref.	ref.	ref.
−ADHDs, +LDs	414	2.88 [1.87, 4.46]	0.27 [0.21, 0.35]	2.44 [1.48, 4.04]	0.32 [0.25, 0.42]	414	2.52 [1.98, 3.20]	0.22 [0.16, 0.32]	2.36 [1.81, 3.09]	0.27 [0.19, 0.40]
+ADHDs, −LDs	107	2.55 [1.25, 5.21]	0.15 [0.09, 0.27]	2.84 [1.32, 6.09]	0.15 [0.08, 0.27]	107	3.65 [2.40, 5.55]	0.29 [0.15, 0.56]	3.91 [2.48, 6.16]	0.33 [0.17, 0.65]
+ADHDs, +LDs	42	9.71 [4.76, 19.84]	0.03 [0.00, 0.22]	10.40 [4.81, 22.51]	0.04 [0.01, 0.26]	42	9.13 [4.62, 18.04]	—	9.24 [4.48, 19.07]	—
All										
−ADHDs, −LDs	4,516	ref.	ref.	ref.	ref.	4,514	ref.	ref.	ref.	ref.
−ADHDs, +LDs	1,002	2.39 [1.99, 2.86]	0.27 [0.22, 0.33]	2.15 [1.75, 2.64]	0.31 [0.25, 0.39]	1,002	2.59 [2.21, 3.03]	0.34 [0.27, 0.42]	2.39 [2.01, 2.84]	0.38 [0.30, 0.47]
+ADHDs, −LDs	268	3.14 [2.37, 4.16]	0.16 [0.10, 0.27]	3.34 [2.40, 4.63]	0.16 [0.10, 0.27]	268	3.30 [2.54, 4.30]	0.25 [0.16, 0.40]	3.15 [2.36, 4.22]	0.29 [0.18, 0.47]
+ADHDs, +LDs	169	6.55 [4.75, 9.03]	0.02 [0.00, 0.13]	5.93 [4.10, 8.57]	0.02 [0.00, 0.17]	169	6.14 [4.39, 8.60]	0.15 [0.06, 0.35]	5.44 [3.78, 7.84]	0.16 [0.06, 0.40]

Note: −ADHDs, −LDs = no ADHD symptoms, no learning difficulties; −ADHDs, +LDs = no ADHD symptoms, have learning difficulties; + ADHDs, −LDs = have ADHD symptoms, no learning difficulties; +ADHDs, +LDs = Have ADHD symptoms, have learning difficulties.

[a]Adjusted for family type, family socioeconomic status, mother's education, and father's education and in the analyses for all additionally adjusted for gender.

[b]School grades: Low = 4, 5, 6; Moderate = 7, 8; High = 9, 10. In Finland, school grades range from 4 to 10, defined as: 4 = *rejected*, 5-6 = *poor*, 7-8 = *satisfactory*, 9-10 = *excellent*.

Table 6. The Plans for Future Education in the Ages of 15/16 Years.

	Vocational qualification		Upper secondary school and vocational qualification		Upper secondary school, but no polytechnic, college, or university		Upper secondary school and polytechnic, college, or university	
	n (%)	*p* value[a]	*n* (%)	*p* value[a]	*n* (%)	*p* value[a]	*n* (%)	*p* value[a]
Boys								
−ADHDs, −LDs	502 (26.0)		144 (7.4)		72 (3.7)		753 (39.0)	
−ADHDs, +LDs	256 (48.0)		28 (5.3)		17 (3.2)		94 (17.6)	
+ADHDs, −LDs	60 (41.4)		12 (8.3)		3 (2.1)		22 (15.2)	
+ADHDs, +LDs	59 (50.4)	<.001	4 (3.4)	.122	3 (2.6)	.653	6 (5.1)	<.001
Girls								
−ADHDs, −LDs	377 (16.0)		194 (8.2)		86 (3.7)		1,153 (49.0)	
−ADHDs, +LDs	131 (32.7)		29 (7.2)		14 (3.5)		104 (25.9)	
+ADHDs, −LDs	36 (34.3)		6 (5.7)		2 (1.9)		18 (17.1)	
+ADHDs, +LDs	13 (34.2)	<.001	2 (5.3)	.651	—	.727	3 (7.9)	<.001
All								
−ADHDs, −LDs	879 (20.5)		338 (7.9)		158 (3.7)		1,906 (44.4)	
−ADHDs, +LDs	387 (41.4)		57 (6.1)		31 (3.3)		198 (21.2)	
+ADHDs, −LDs	96 (38.4)		18 (7.2)		5 (2.0)		40 (16.0)	
+ADHDs, +LDs	72 (46.5)	<.001	6 (3.9)	.089	3 (1.9)	.346	9 (5.8)	<.001

Note: −ADHDs, −LDs = no ADHD symptoms, no learning difficulties; +ADHDs, −LDs = have ADHD symptoms, no learning difficulties; −ADHDs, +LDs = no ADHD symptoms, have learning difficulties; +ADHDs, +LDs = have ADHD symptoms, have learning difficulties.
[a]*p* value is from the chi-squire test for gender differences (Fisher's exact test for frequencies).

10.40, 95% CI = [4.81, 22.51]) and in mathematics (OR = 9.24, 95% CI = [4.48, 19.07]). Our findings indicated that the association of poor school performance was stronger with ADHD symptoms than with learning difficulties, although it is worth noting that the confidence intervals of the estimates overlapped.

The adolescents were also asked about their plans for future education (Table 6). The adolescents with comorbid ADHDs and SLDs (+ADHDs, +SLDs) were planning to aim for a vocational qualification (46.5%) more often than those in other groups. Conversely, the adolescents without problems (−ADHDs, −SLDs) planned to go to polytechnic, college, or university (44.4%) more often than did adolescents with problems (+ADHDs, +SLDs; 5.8%).

Discussion

The purpose of our study was to find out whether the childhood SLDs predict poor school performance in adolescents with and without ADHD symptoms in the large community-based NFBC 1986. Having ADHDs but not SLDs or having both was associated with a significantly lower mean value in school grades for theoretical subjects. Adolescents with comorbid ADHDs and SLDs repeated a grade more often, and their educational aspirations were less ambitious than those in other groups.

The connection between ADHD symptoms and learning difficulties seems to be strong and was associated with problems in studying Finnish (school grades low vs. moderate, OR = 5.93, 95% CI = [4.10, 8.57]) and mathematics (school grades low vs. moderate, OR = 5.44, 95% CI = [3.78, 7.84]). Also, the mean value of school grades for theoretical subjects was lower in boys and girls with ADHD symptoms and learning difficulties compared with the adolescents in other groups. Comorbid ADHDs and SLDs increased the risk for grade repetition and had an effect on adolescents' future plans regarding education. Adolescents with ADHD and/or SLDs did not plan to pursue higher level education as often as adolescents without these problems. However, an interesting finding was that having ADHD symptoms only caused more underachievement in Finnish and mathematics than having SLDs only (a mean value of theoretical subjects 6.8 and 7.1). The difference was statistically significant.

According to many studies, the co-occurrence of ADHDs and SLDs often associates with poor academic performance (Barry, Lyman, & Klinger, 2002; Jakobson & Kikas, 2007; Taanila, Hurtig, Miettunen, Ebeling, & Moilanen, 2009). Rates of comorbidity range from 10% to 92% (Mayes & Calhoun 2006; Mayes et al., 2000; Voeller, 2004), and reading disabilities seems to be the most common (Del'Homme et al., 2007; Lucangeli & Cabrele, 2006). The high variation

of the results can be explained by different formation of the data and different measurements used (Altarac & Saroha, 2007). In our study, comorbid prevalence of ADHDs and SLDs was only 3.0%. One explanation for this low percentage may be due to the study population, which was a wide unselected birth cohort, whereas most of the previous studies were based on smaller study populations with clinically referred children or adolescents or children with one or more diagnoses (e.g., Brook & Boaz, 2005; Hastings, Beck, Daley, & Hill, 2005). Furthermore, when comparing the prevalence figures of reading disabilities between countries, we must take into consideration the ease of literacy acquisition in different languages (Seymour, Aro, & Erskine, 2003). For instance, Finnish language has systematic letter-sound correspondence making learning to read easier among Finnish-speaking children than learning to read English is among English-speaking children. This makes it more difficult to compare studies based on different languages concerning this subject.

Family background factors have also been indicated to have strong connection with ADHD symptoms (Rydell, 2010; Taanila et al., 2004), learning difficulties (Zafiriadis et al., 2005), and school performance (Guerrero, Hishinuma, Andrade, Nishimura, & Cunanan, 2006). Our study showed that the adolescents with comorbid ADHDs and SLDs lived more often in a reconstructed family, or with parents who had basic level education.

In the present study, the adolescents were 15 to 16 years of age, and they were going through the midadolescence, which impacts their attitudes about school attendance and school performance. This phase has been regarded as a period of crisis characterized by profound change in the process of development into adulthood. It is a time of mental turmoil, and even though there are studies that indicate that the majority of adolescents actually go through this stage successfully, without any major problems and reporting a level of relative well-being, there are also studies showing contrary results (Arnett 1999; Newman et al., 1996). Our earlier study (Taanila et al., 2009) on psychosocial well-being of the adolescents in this birth cohort indicated that many negative factors affect the life and functioning of the adolescents with ADHD symptoms compared with those without ADHD. For instance, those with ADHD symptoms reported that they did not like going to school over 5 times more commonly than those without symptoms, which surely has an effect on their school performance. It is also possible that adolescents with ADHDs and SLDs are underachievers because of the negative feedback they receive in school due to behavioral and educational problems.

Strengths and Weaknesses

The present study is based on a large unselected population cohort, which provides a high degree of reliability of the findings. Also, the time interval of about 8 years is long enough to show the consequences of childhood learning difficulties. In addition, an important strength is that we have official information on adolescents' school performance (school grades) from the national application register for upper secondary education reported by the teachers.

One of the weaknesses in this study is that we could obtain only teachers' assessment of children's SLDs instead of several informants (e.g., parents). In addition, at the time of evaluation, children were finishing their first school year, and thus, it may have been too early to differentiate late maturing children from those with real learning difficulties. However, teachers are typically responsible for comparing and reporting children's classroom difficulties, which makes their perspective more objective than that of parents. According to the earlier studies, teachers seem to be good informants in evaluating children's SLDs (e.g., Avchen, Scott, & Mason, 2001; Mannerkoski et al., 2006), even though it has been reported that teachers may overestimate children's problems (Ahonen & Lyytinen, 1998). Also, several factors like preconceptions and stereotypes affect teachers' assessments (Bakker & Bosman, 2006; Sideridis, Antoniou, & Padeliadu, 2008). Furthermore, the screening instrument for SLDs was also a weakness. In many studies concerning SLDs with smaller sample sizes, issues such as IQ, neuropsychological measures, and early history of language development have been taken into account. It was not possible to include those factors in the present study because of its epidemiological nature.

Correspondingly, only parents assessed current ADHD symptoms of their adolescents at the age of 15/16 using the SWAN Scale. Although the SWAN Scale has been indicated to be suitable to use in a general population (Hay, Bennett, Levy, Sergeant, & Swanson, 2007; Polderman et al., 2007; Swanson et al., 2001), the timing of the data collection may create bias. It is difficult to know whether the parents reported true ADHD symptoms or normal adolescents' turmoil. However, Faraone, Monuteaux, Biederman, Cohen, and Mick (1993) reported that maternal reports of ADHD symptoms of their offspring are not biased.

Conclusion

We conclude that ADHDs and SLDs may have significant effects on adolescents' school performance and their educational plans for the future. Comorbid ADHDs and SLDs, particularly, have a strong negative influence on student performance at school. Therefore, these problems should be recognized and diagnosed as early as possible. Special support should be given to children with ADHDs and/or SLDs, because working under a normal schedule can be frustrating to these children. Even though the background of a child's learning difficulties or behavioral problems may be genetic or neurological, managing environmental factors can either hinder or promote the outbreak and intensity of problems. As for children's learning difficulties, the earlier the symptoms are identified, the better are the possibilities

to treat them successfully with remedial instruction or other educational interventions, thereby preventing their unfavorable effect in later life.

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