7

Adolescent Academic Outcome of Childhood Attention-Deficit/Hyperactivity Disorder – A Population-Based Study

Kirsten Holmberg
Department of Women and Children Health, Section for Paediatrics, Uppsala University, Sweden

1. Introduction

Children with Attention-deficit/hyperactivity disorder (ADHD) (APA, 1994) or "subthreshold" ADHD (with symptoms not prominent enough to fulfil the diagnostic criteria; i.e., similar but milder ADHD problems) (AAP, 1997) may be at risk of developmental problems (Warner-Rogers et al., 2000) or impairment (e.g., peer rejection) (Hoza, 2007; Scahill et al., 1999). It has been suggested that the research should include examination of the whole range of severity of hyperactivity and inattention symptoms in the population. This may provide further information about the relationship between symptom severity and overall impairment, in order to further evaluate the relative risk of elevated ADHD symptoms (Warner-Rogers et al., 2000).

Children with ADHD or subthreshold ADHD have been found to achieve lower grades at school than their peers (Biederman et al., 1996; Loe & Feldman, 2007). ADHD has been reported to be associated with difficulties in overall cognitive functioning or in specific domains, in reading and mathematics, which are not merely directly associated with low IQ scores (Gillberg et al., 2004; Spencer & Biederman, 2007). Inattention and hyperactivity in young children may be correlated with poor long-term academic achievement (Daley & Birchwood, 2010). Early recognition of ADHD followed by effective interventions has a potential to improve the educational and social outcomes for the affected children (Rasmussen & Gilberg, 2000; Biederman & Faraone. 2005; Jones et al., 2008).

One aim in the present study was to assess if children in a Swedish community sample who show symptoms of inattention, hyperactivity, and impulsivity with or without formal diagnoses of ADHD at 10 years of age also show poor long-term school outcomes. Another aim was to explore what degree of inattentive and hyperactive symptoms during elementary school (age 7 and 10) cause school failure at age 16.

2. Participants and methods

2.1 Study population

This study was based on three data collections in the birth cohort of 1991 in Sigtuna, a municipality in Stockholm County with a total population of approximately 36 000 inhabitants (Figure 1). All schools in the municipality, including special education classes,

participated in the data collection. The special education classes included children with intellectual disabilities or subnormal cognitive abilities ("slow learners"), autistic spectrum disorders or disruptive behaviour. The birth cohort comprised 536 children in 1998 when these children entered first grade at age seven. Data was collected from teachers and parents to 453 of these children (84.5%) in first grade. A second data collection was carried out among all children in fourth grade including children moving into the cohort between first and fourth grade (N=591) in 2001-2002. In wave 2 data was collected from teachers and parents of 92% (n=544) of which 422 children (79% of the entire population born 1991; 204 girls, 218 boys) had participated in grade one. The present study is based on the third wave of data collection completed at age 16 in grade 9 in 2007 when school results were obtained from the national register. Children for whom there was information from three data-sources—the parent and the teacher in grade one or grade four (Conners ratings) and the national register in ninth grade (final grades)—were included in the final study population.

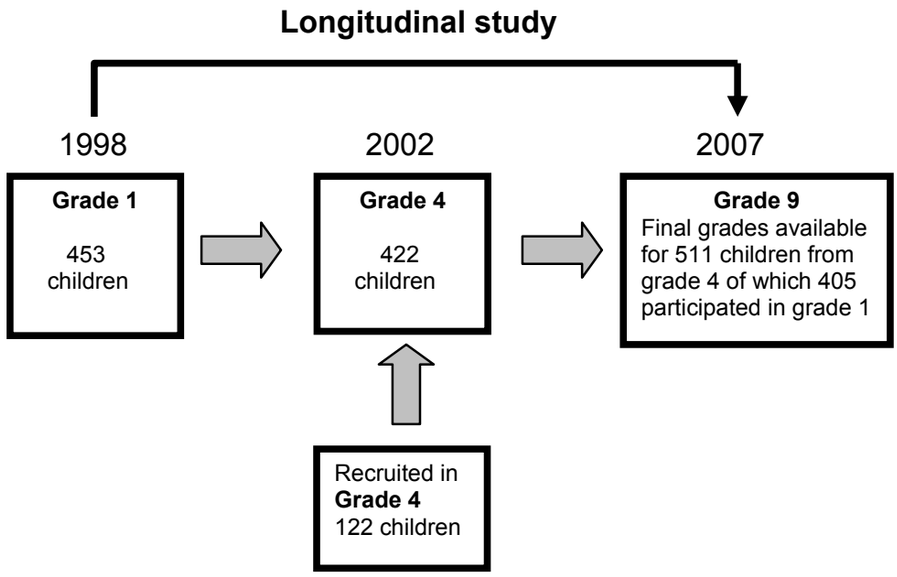


Fig. 1. Study design and participation.

Final grades at age 16 were available for 511 (87%) of the total population (N=591) in grade four. In 33 children participating in grade four no grades were available: 11 children had moved and had not received grades that were traceable in the national register, 4 had retaken one grade and were in eighth grade, 7 had joined a school for the mildly mentally retarded (IQ <71), 1 was already in upper secondary school, and 10 had failed to graduate. Of the total population of 536 first graders studied in 1998, it was possible to obtain grades for 405 (76%) in 2007.

Nonparticipants (i.e., school register data missing) in grade one (n=17) or in grade four (n=33) did not differ from participants by gender, socio-demographic conditions or mean Conners score reported by teacher. Neither was there any difference with respect to clinical ADHD-status in grade four. However, mean parental Conners score was higher in first ($p<0.001$) and fourth grade ($p<0.01$) among nonparticipants.

Ethical approval for the study in first and fourth grade was granted by the Ethics Committee at Karolinska Institutet, Stockholm and the follow-up study was approved by the Regional Ethics Committee in Uppsala.

2.2 Methods

2.2.1 Behavioural screening in first grade

At school entry into first grade the whole population was screened for developmental and behavioural problems by parental report in a questionnaire in connection with the routine health examination.

The questionnaire included the Conners 10-item scale (Conners, 1973; Conners, 1990a), and some questions about the socio-demographic characteristics of the household. The Conners 10-item scale is a commonly used well validated screening instrument for behavioural problems related to hyperactivity/impulsivity and emotional lability (Conners, 1973; Conners, 1990b). This scale consists of ten statements regarding the child's behaviour rated on a 4-point Likert scale, ranging from "0 – not at all true" to "3 – very much true" with a possible total score from 0 to 30 (Conners, 1990a). The scale is obtained from the 10 items constituting the Hyperactivity Index (HI) from the longer versions of the Conners scales (Goyette et al., 1978) and is also known as The Abbreviated Conners Rating Scales for parents (CPRS-HI) and teachers (CTRS-HI) (Conners, 1990a) and as the Abbreviated Symptom Questionnaire-Parent/Teacher (ASQ-P/T) (Conners, 1973; Conners, 1990b). A score of at least 10 has been recommended to identify attention deficits in a Swedish context (Landgren et al., 1996; Kadesjö & Gillberg, 1998), while a score of 15 or higher has been the standard for selecting children with hyperactivity at a level of clinical concern (Jones et al., 2008; Rowe & Rowe, 1997; Ullmann et al., 1985).

The parental version of the screening questionnaire included some questions about the socio-demographic characteristics of the household. The socio-demographic questions included sex of the child, maternal country of birth, and maternal educational level. Educational level was recorded in three categories: 9 years or less of basic education, more than 9 years of basic education but less than 3 years of university education, and 3 or more years of university education. Maternal country of birth was recorded as Sweden, other Nordic countries, other European countries, and the rest of the world.

Seven months into the school year, the same questionnaire was completed by the child's main teacher. Information about having an ADHD diagnosis from a physician at school entry was collected from the child's school health records. Results from the developmental screening have been reported in a previous article (Holmberg et al., 2010).

2.2.2 ADHD in fourth grade

The study population was followed up during the academic year 2001–2002 in grade four. The children were screened for ADHD in a two-step procedure which has been described more extensively in previous articles (Holmberg & Hjern, 2006; Holmberg & Hjern, 2008). In the first step, teachers and parents rated the children in a structured questionnaire in connection with a routine health examination. This questionnaire included the Conners 10-item scale, the same scale as in first grade. A cut-off score of at least 10 was used on this scale. The questionnaire also included the executive functions screening scale (EFSS) (Ek et al., 2004), a scale of problems related to concentration and problem solving developed for this study to improve the possibility to identify children with mainly attention problems. A cut-off score of 17 was used on this scale, which has a range of 0 to 51, as to obtain a total of

30% of screen positive children in the study population (Holmberg & Hjern, 2008). Having a score above the cut-off point on at least two of the four ratings made by the teachers and parents was considered screen-positive. Questions about the socio-demographic characteristics of the household were added to the parental version of the screening questionnaire for the children not participating in grade one.

Teachers also rated symptoms of ADHD on the ADHD rating scale—IV (DuPaul et al., 1998) based on the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* (DSM-IV) (APA, 1994) for ADHD as a part of the teacher questionnaire in grade four. This rating scale consists of 18 items (i.e., statements) which correspond to all 18 of the DSM-IV criteria: 9 items indicating inattention; 6 items pertaining to hyperactivity, and 3 items related to impulsivity. The child's behaviour is rated on each item on a 4-point Likert scale, ranging from "0 – not at all true" to "3 – very much true." Scores of 2 or 3 (indicating that a behaviour is present "often" or "very often") on individual items were considered to indicate the presence of ADHD symptoms, thereby creating dichotomised outcome variables for each statement. This scale has been validated (DuPaul et al., 1998; Merell & Tymms, 2001) and is widely used in Sweden for rating of ADHD severity (Diamantopoulou et al., 2005). The scale has demonstrated excellent interrater reliability, also when applied as a standardised interview schedule (Landgren et al., 1996; Thunström, 2002). The total score on each dimension of symptoms was calculated by adding up the scores for each of the 9 inattentive items and the 9 hyperactive/impulsive items.

Each teacher was interviewed by the author (KH) regarding learning and behaviour problems. Information from the teachers was received for all children in the study.

In a second step, 92% (130/141) of the screen-positive children in grade four underwent further clinical diagnostic assessments of ADHD based on the DSM-IV (APA, 1994), by an experienced child neurologist (KH). This evaluation included a clinical interview with structured information from the parents about ADHD symptoms in the home based on DSM-IV (APA. 1994) including the ADHD rating scale—IV (DuPaul et al., 1998), neurological examination of the child, and cognitive assessment according to the WISC III (Wechsler. 1999). The teacher score on the ADHD rating scale—IV was also included in the clinical evaluation.

Based on the clinical assessment, the children were classified into four categories; (1) "pervasive ADHD", children who met DSM-IV criteria for ADHD at home as well as at school; (2) "situational ADHD", children who fulfilled the criteria for ADHD in one setting only, either at home (home only ADHD) or at school (school only ADHD) (Mannuzza, 2002); (3) "subthreshold ADHD", children with four or five criteria for ADHD in one or two settings (AAP, 1997); (4) "no ADHD", all other children, including those who were not selected for clinical assessment.

Ten screen negative children were also clinically assessed and they were all included in the "no ADHD" group. Attention and hyperactivity symptoms in the 11 screen-positive children who did not participate in the clinical examination were assessed by information from parent and teacher questionnaires, teacher interviews, school nurses, and telephone interviews with parents. None of the 11 children who dropped out was judged to have severe behavioural or attention problems and were therefore included in the study population in the "no ADHD" group.

The prevalence of the complete (pervasive) ADHD syndrome in fourth grade was 5.7% (n=29, 2 girls and 27 boys), of which 25 had the combined type according to the DSM-IV criteria (1). Situational ADHD was present in another 6.9% (n=35, 9 girls and 26 boys).

According to the school health records, six boys had been assessed by a multidisciplinary team and received the diagnosis of ADHD at six to seven years of age before starting school. One percent (n=5) of the study population was treated with stimulants in grade four.

2.2.3 School achievement in fourth grade

The teacher questionnaire also included three items about the child's academic achievement in reading, writing and mathematics. The teacher rated the child's difficulties on each item on a 4-point Likert scale, ranging from "0 – not at all true" to "3 – very much true." Scores of 2 or 3 (indicating that a difficulty is present "often" or "very often") on individual items were considered to indicate the presence of learning problems thereby creating dichotomized outcome variables for each subject.

Learning variables	Total (N=511) n (%)	No ADHD (n= 415) n (%)	Subthreshold ADHD (n=32) n (%)	Situational ADHD (n=35) n (%)	Pervasive ADHD (n=29) n (%)
No learning difficulties	417 (82)	363 (87)	22 (5)	17 (4)	15 (4)
Reading or writing difficulties	58 (11)	27 (47)	6 (10)*	14 (24)***	11 (19)***
Mathematics difficulties	65 (13)	38 (58)	6 (9)	12 (19)***	9 (14)***

* $p < 0.05$, *** $p < 0.001$

Table 1. Learning difficulties according to teachers' ratings in children with attention-deficit/hyperactivity disorder (ADHD) in fourth grade.

No children were diagnosed with specific learning disabilities, i. e. dyslexia or dyscalculia at 10 years of age. Teachers reported 18% of fourth graders to have learning difficulties (Table 1). Eleven percent of the children had reading or writing problems while 13% had difficulties in arithmetical skills. These learning problems were strongly associated with situational and pervasive ADHD ($p<0.001$). In addition, reading or writing difficulties tended to be reported more frequent in children with subthreshold ADHD than those without ADHD ($p<0.05$) (Table 1).

2.2.4 School achievement in ninth grade

The Swedish school system is a 9-year compulsory school for children between 7 and 16 years of age. After finishing compulsory school, students receive an admission qualification, calculated from 16 subjects. The grade for each subject is defined as 0, 10, 15 or 20 scores. Therefore, the maximum total grade is 320 scores and is used as instrument of selection when applying to upper secondary school. In order to qualify for further studies in upper secondary school, a student needs to have attained certificate in core subjects: Swedish

language, English and Mathematics. The grading level in each school is under national supervision by the Swedish School Authority through national tests in key subjects. The upper secondary school is divided into a national theoretical programme, giving authorization for university studies, and a national practical programme, leading more directly to work. In 2007, students with a minimum 151 grade point average or higher were admitted to the theoretical program at the local high school. Those with a score of at least 101 and passing grades in core subjects were accepted to the practical program.

In the present study, school grades from the National School Register, which is administered jointly by the Swedish National School Administration and Statistics Sweden, were used to calculate grade point average and qualification for further studies for all students. This register encompasses information on each individual's educational achievement that is grades by subject as well as grade point average. For this study, grades from five subjects were analysed: Swedish, English, Mathematics, History, Physics, Sports education and Music. The first five were analysed as examples of ''theoretical subjects'' and the two latter as ''practical subjects''. The register also encloses national tests results in three core subjects: Swedish, English and Mathematics for all students graduating from the ninth year. The national tests are carried out some weeks before the children graduate. The data from the National School Register are of high quality and summary statistics are published regularly (National School Register, 2010).

Information about special educational support in grade nine was collected by the author (KH) interviewing all teachers working in special education programs in grade nine.

2.2.5 Statistical analysis

Chi- square, Fisher's exact test, and analysis of variance (ANOVA) were used to examine differences in relationship between ADHD symptoms in grade one and four, learning difficulties in grade four and school outcome variables in ninth grade. Associations of grade point average from the final ninth grade in the Swedish compulsory school system and qualification for upper secondary school with pervasive ADHD status in grade four were tested in linear and logistic regression models, respectively. Individuals with an incomplete course were excluded from the analysis of that particular course. Model 1 was crude while Model 2 was adjusted for sex and maternal education. In Model 3, 4 and 5, we added variables considered as learning difficulties. Results were expressed as B-coefficients with 95% confidence intervals (95% CI) in the linear regression analysis and OR with 95% CI in the logistic regression analysis. All statistical analyses were carried out using the SPSS 17.0 software package for Windows.

3. Results

3.1 Bivariate group outcome comparisons

The socio-demographic characteristics of the children in the study and learning difficulties in grade four by academic outcomes in grade nine are presented in Table 2. The overall mean grade was lower for boys than girls ($p<0.001$). There was no gender difference for being qualified for further studies in upper secondary school. Impaired academic achievement in ninth grade was more common among children from households where the parents had short education compared to households where parents had a university

education (p<0.01) (Table 2). Grade point average was lower and not being qualified for upper secondary school was more frequent among children with previous learning difficulties compared to those with no reported difficulties in grade four (p<0.001) (Table 2).

Children with a at least one Conners score in parental report at age 10 or in teacher's report at age 7 or 10 had lower mean grade and increased prevalence of not qualifying for further studies at age 16 (p<0.001) (Table 3) than children with no reported hyperactivity. The cut-off score of 5 in parental report in first grade was related to impaired educational outcome in grade nine (p<0.01). At least one inattentive or one hyperactive symptom according to teachers' ratings on the ADHD symptom scale in grade four was associated with lower grade at 16 years of age (p<0.001) (Table 3).

Measures	N	Grade point average[1]			Qualified for upper secondary school	Not qualified[2] for upper secondary school
		mean	SD	95% C.I.	n (%)	n (%)
Socio-demographic variables						
Sex						
Boys	268	194.89***	60.32	187.63 – 202.14	234 (87)	34 (13)
Girls	243	213.74	65.49	205.47 – 222.02	218 (90)	25 (10)
Maternal education						
0-9 years	128	174.10***	61.59	163.33 – 184.87	107 (84)	21 (16)**
10-12 years	286	203.27***	60.80	196.19 – 210.35	252 (88)	34 (12)
13 + years	97	244.85	50.34	234.70 – 254.99	93 (96)	4 (4)
Country of birth of mother						
Sweden	397	204.06	64.92	197.65 – 210.46	353 (89)	44 (11)
Other Nordic countries	26	209.42	71.82	180.41 – 238.43	22 (85)	4 (15)
Other European countries	13	228.46	59.81	192.32 – 264.60	12 (92)	1 (8)
Rest of world	75	196.60	52.20	184.59 – 208.61	65 (87)	10 (13)
Learning variables						
No learning difficulties	417	213.68	61.75	207.74 – 219.62	389 (93)	28 (7)
Reading or writing difficulties	58	165.17***	48.77	152.35 – 178.00	41 (71)	17 (29)***
Mathematics difficulties	65	155.08***	51.41	142.34 – 167.81	40 (62)	25 (38)***

[1]Overall grade point average: possible range 0-320.
[2]Not qualified for upper secondary school; i. e. not receiving passing grades in Swedish, English and Mathematics.
** p < 0.01, *** p < 0.001

Table 2. Socio-demographic variables and learning difficulties in fourth grade in relation to school performance in grade nine.

		Grade point average			Qualified for upper secondary school		Not qualified for upper secondary school	
Measures	n	mean	SD	95% C.I.	n	(%)	n	(%)
Grade one	(n=405)				(n=354)		(n=51)	
Conners								
Parent 0	145	209.66	65.64	198.88 – 220.43	129	(89)	16	(11)
Parent 1-30	260	200.12	62.54	192.48 – 207.75	226	(87)	34	(13)
Parent 5-30	99	186.97**	68.01	173.40 – 200.53	82	(83)	17	(17)
Parent 10-30	31	172.58**	71.09	146.51 – 198.65	23	(74)	8	(26)*
Parent 15-30	11	152.27**	59.60	112.23 – 192.31	7	(64)	4	(36)*
Teacher 0	187	217.89	58.97	209.38 – 226.40	173	(92)	14	(8)
Teacher 1-30	218	191.22***	65.23	182.51 – 199.92	182	(84)	36	(16)**
Teacher 5-30	99	173.69***	68.06	160.11 – 187.26	73	(74)	26	(26)***
Teacher 10-30	49	155.82***	64.46	137.30 – 174.33	32	(65)	17	(35)***
Teacher 15-30	27	131.67***	61.75	107.24 – 156.10	14	(52)	13	(48)***
Grade four	(n=511)				(n=450)		(n=61)	
Conners								
Parent 0	165	226.88	60.34	217.60 – 236.15	159	(96)	7	(4)
Parent 1-30	346	192.88***	62.06	186.31 – 199.44	291	(84)	54	(16)***
Parent 5-30	159	178.30***	61.43	168.68 – 187.92	128	(80)	31	(20)***
Parent 10-30	59	155.51***	60.34	139.79 – 171.23	44	(75)	15	(25)***
Parent 15-30	33	150.76***	63.84	128.12 – 173.39	21	(64)	12	(36)***
Teacher 0	244	228.85	60.15	221.27 – 236.44	231	(95)	13	(5)
Teacher 1-30	267	181.01***	57.65	174.07 – 187.96	219	(82)	48	(18)***
Teacher 5-30	130	178.77***	57.61	168.77 – 188.77	103	(79)	27	(21)***
Teacher 10-30	75	166.60***	57.25	153.43 – 179.77	55	(73)	20	(27)***
Teacher 15-30	48	161.04***	51.48	146.09 – 175.99	36	(75)	12	(25)**
Teacher ratings of DSM-IV criteria in grade four	(n=511)				(n=450)		(n=61)	
Inattentive score 0	363	218.56	57.48	212.64 – 224.48	338	(93)	25	(7)
Inattentive score 1-9	148	167.09***	63.02	156.78 – 177.40	112	(76)	36	(24)***
Inattentive score 6-9	47	152.17***	49.02	137.62 – 166.73	32	(68)	15	(32)***
Hyperactivity score 0	416	211.06	62.41	205.04 – 217.07	374	(90)	42	(10)
Hyperactivity score 1-9	95	172.32***	58.57	160.38 – 184.25	76	(80)	19	(20)**
Hyperactivity score 6-9	31	163.55***	41.07	148.48 – 178.61	24	(77)	7	(23)

* $p < 0.5$, ** $p < 0.01$, *** $p < 0.001$

Table 3. Academic outcomes at end of grade nine by childhood ADHD-symptoms in first and fourth grade.

All three ADHD-groups were associated with impaired school outcome (Table 4). Thirty-five percent of children with pervasive ADHD in grade four did not qualify for upper secondary school compared with 8% of those without ADHD ($p<0.001$). The corresponding prevalence for children with subthreshold or situational ADHD was 25% and 26%, respectively. Adolescents with pervasive ADHD in childhood differed from unaffected peers in all educational outcomes except grade in History (Table 4). Situational ADHD showed a similar distribution of low grades at 16 years of age except in the subjects in Swedish, English and Sports education. The subthreshold and the pervasive ADHD group required special educational support in ninth grade more often than the no ADHD or situational ADHD group ($p<0.05$).

Academic variables	Total (N=511) n (%)	No ADHD (n= 415) n (%)	Subthreshold ADHD (n=32) n (%)	Situational ADHD (n=35) n (%)	Pervasive ADHD (n=29) n (%)
Grade point average (mean)	203.86	214.45	164.69***	157.86***	151.03***
Not qualified for upper secondary school	61 (12)	34 (8)	8 (25)**	9 (26)***	10 (35)***
Not qualified for practical programme at upper sec school	28 (6)	14 (3)	3 (9)	7 (20)***	4 (14)**
Not qualified for theoretical programme at upper sec school	86 (17)	49 (12)	11 (34)***	14 (40)***	12 (41)***
Repeated grade (are in grade 8)	24 (5)	11 (3)	4 (13)*	4 (11)*	5 (17)***
Special educational support during grade 9	63 (12)	44 (11)	7 (22)*	5 (14)	7 (24)*
No certificate in					
Swedish	15 (3)	6 (1)	3 (9)*	1 (3)	5 (17)***
English	31 (6)	16 (4)	5 (16)**	4 (11)	6 (21)***
Mathematics	47 (9)	26 (6)	7 (22)***	6 (17)*	8 (28)***
History	30 (6)	18 (4)	4 (13)	5 (14)*	3 (10)
Physics	56 (11)	33 (8)	10 (31)***	7 (20)**	6 (21)**
Sports	32 (6)	18 (4)	6 (19)***	4 (11)	4 (14)*
Music	43 (8)	23 (6)	3 (9)	7 (20)***	10 (35)***

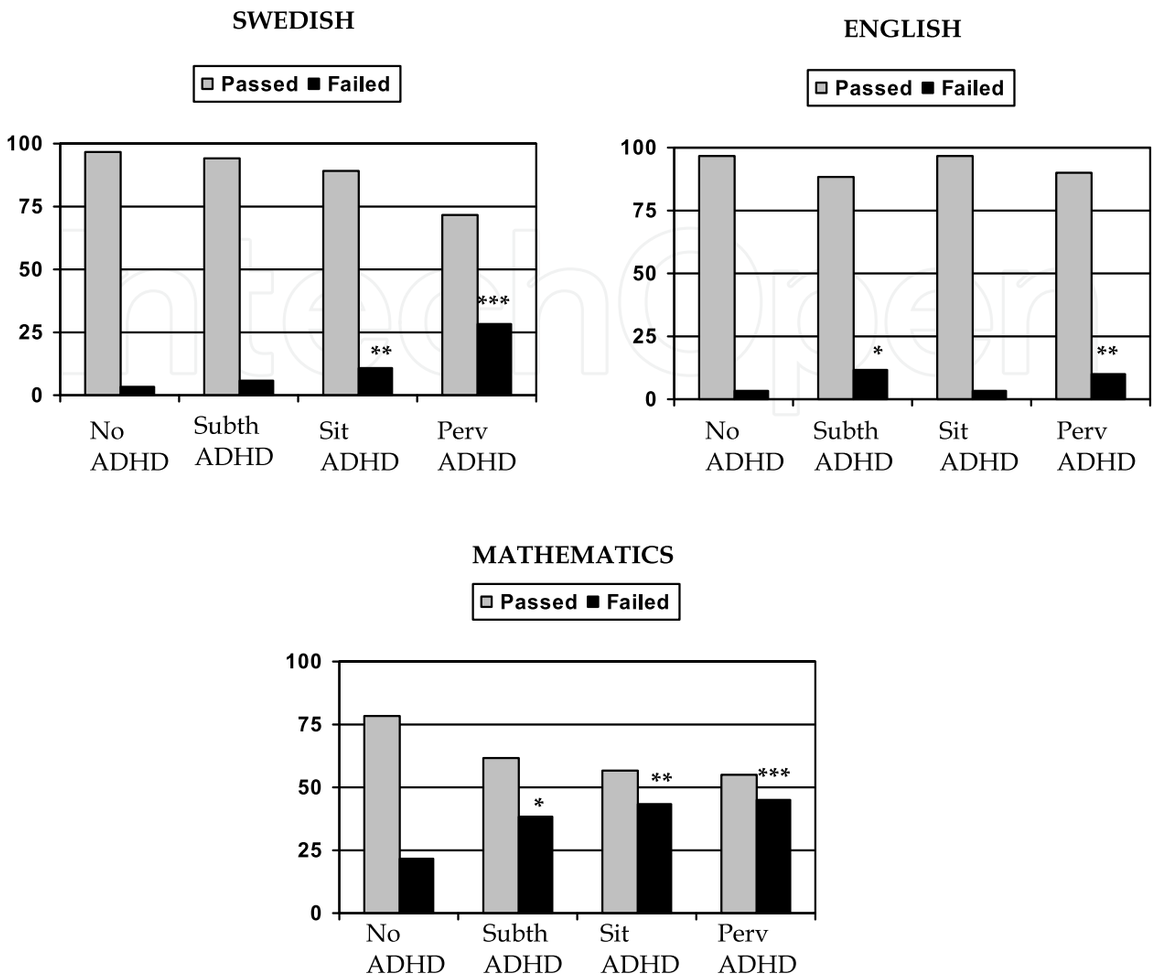
* $p < 0.5$, ** $p < 0.01$, *** $p < 0.001$ ADHD, attention-deficit/hyperactivity disorder

Table 4. Academic outcomes at end of grade nine in children with attention-deficit/hyperactivity disorder (ADHD) in fourth grade.

Figure 2 summarizes the national test results. Children with pervasive ADHD in grade four tended to fail in all three subjects ($p<0.01$ – $p< 0.001$) while those with situational ADHD were unsuccessful in Swedish and mathematics more often than other children ($p<0.01$) (Figure 2). Not passing the English test was more common in subthreshold and pervasive ADHD ($p<0.01$). Subthreshold ADHD was also associated with impaired results in mathematics ($p<0.05$).

3.2 Multivariate outcome prediction

Table 5 presents the linear regression models of mean grade point average and pervasive ADHD. The first model is crude, the second is adjusted for sex and maternal education; model 3 - 5 are also adjusted for reading or writing difficulties, mathematics problems or



* p < 0.5, ** p < 0.01, *** p < 0.001

Fig. 2. National test results in Swedish, English and Mathematics in grade nine in children with attention-deficit/hyperactivity disorder (ADHD) in fourth grade.

both. In model 1, children with pervasive ADHD in grade four had a significantly lower overall mean grade than peers with no ADHD. In all adjusted models, the change in mean grade point average associated with ADHD was less marked, but still significant.

In Table 6 the risk of not being qualified for upper secondary school is presented in 5 models, adjusted for the same variables as in the linear regression analysis (Table 5). Pervasive ADHD at 10 years of age increased the odds of not qualifying for further studies at age 16 in all models (unadjusted odds ratio [OR] of 4.47; 95% confidence interval [CI]: 1.97 – 10.13). This estimate decreased slightly in the adjusted models. Of the socio-demographic covariates, only low maternal education had a significant relationship in model 2, raising the odds of poor school outcome for the child (OR: 1.78; 95% CI: 1.00 – 3.17). When learning difficulties were accounted for in model 3 – 5, the risk figure for pervasive ADHD was attenuated, but still significant. Children with problems learning mathematics in fourth grade had the highest risk of academic failure at end of compulsory school (OR: 6.46; 95% CI: 3.48 – 11.99).

	Model 1 GPA (95% CI)	Model 2 GPA (95% CI)	Model 3 GPA (95% CI)	Model 4 GPA (95% CI)	Model 5 GPA (95% CI)
Pervasive ADHD	-56.00 (-79.36 – -32.64)	-47.99 (-70.87 – -25.11)	-39.92 (-62.87 – -16.98)	-38.19 (-60.40 – -15.97)	-35.71 (-58.11 – -13.31)
No ADHD	0	0	0	0	0
Sex: male	-	-12.96 (-23.56 – -2.35)	-10.53 (-21.06 – .01)	-13.58 (-23.78– -3.37)	-12.47 (-22.75 – -2.18)
Sex: female	-	0	0	0	0
Maternal education: low	-	-38.17 (-50.16 – -26.19)	-37.23 (-49.10 – -25.43)	-36.39 (-47.93– -24.85)	-36.18 (-47.71 – 24.65)
Maternal education: high	-	0	0	0	0
Reading or writing difficulties	-	-	-32.56 (-49.17 – -15.95)	-	-14.02 (-31.57 – 3.53)
No reading or writing difficulties	-	-	0	-	0
Mathematics difficulties	-	-	-	-47.71 (-64.84 – -34.58)	-44.63 (-61.02 – -28.24)
No mathematics difficulties	-	-	-	0	0
R^2 for model	.042	.122	.147	.188	.192

Model 1 is crude. ADHD, attention-deficit/hyperactivity disorder
Model 2 is adjusted for sex and maternal education.
Model 3, as Model 2 additionally adjusted for difficulties in reading or writing in grade 4.
Model 4, as Model 2 additionally adjusted for difficulties in mathematics in grade 4.
Model 5, as Model 2 additionally adjusted for difficulties in reading, writing and mathematics in grade 4.
CI, confidence interval.

Table 5. Linear regression of pervasive ADHD and mean grade point average (GPA) (N=511).

4. Discussion

4.1 Discussion of results

4.1.1 ADHD symptoms

This population-based study demonstrates that symptoms of inattention at age 7 and 10 as well as clinically diagnosed subtreshold ADHD and ADHD in 10-year-olds are associated with lower grade point average at the age of 16 and not being qualified for upper secondary school. Both levels of childhood ADHD are correlated to grade retention and not passing national tests in core subjects in grade nine. There appears to be a gradient relationship

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Pervasive ADHD	4.47 (1.97 – 10.13)	4.40 (1.86 – 10.42)	3.38 (1.38 – 8.30)	3.29 (1.30 – 8.28)	3.11 (1.22 – 7.93)
No ADHD	1	1	1	1	1
Sex: male	-	.99 (.56 – 1.75)	.89 (.49 – 1.59)	1.04 (.57 – 1.89)	.99 (.54 – 1.82)
Sex: female	-	1	1	1	1
Maternal education: low	-	1.78 (1.00 – 3.17)	1.72 (.96 – 3.08)	1.73 (.95 – 3.17)	1.72 (.95 – 3.16)
Maternal education: high	-	1	1	1	1
Reading or writing difficulties	-	-	3.10 (1.56 – 6.16)	-	1.44 (.65 – 3.18)
No reading or writing difficulties	-	-	1	-	1
Mathematics difficulties	-	-	-	6.46 (3.48 – 11.99)	5.66 (2.86 – 11.20)
No mathematics difficulties	-	-	-	1	1
R^2 for model	.021	.028	.046	.087	.088

Model 1 is crude. ADHD, attention-deficit/hyperactivity disorder
Model 2 is adjusted for sex and maternal education.
Model 3 is adjusted for sex, maternal education and reading or writing difficulties in grade 4.
Model 4 is adjusted for sex, maternal education and mathematics difficulties in grade 4.
Model 5 is adjusted for sex, maternal education and difficulties in reading, writing and mathematics in grade 4.
CI, confidence interval.

Table 6. Logistic regression of pervasive ADHD in the fourth grade and not being qualified for upper secondary school (N=511).

between the number of symptoms and the frequency of subsequent adverse outcome. The risk of not being qualified for further studies after ninth grade is about three times higher in children diagnosed with pervasive ADHD than in other children. Children with learning difficulties according to teacher's reports at age 10, also have increased risk of academic underachievement. Low mathematical ability is a strong predictor of educational underachievement in 16-year-olds and moderates the effect of ADHD on school outcome although the association remains significant.

Our results replicate findings of Bussing et al. that childhood ADHD and subthreshold ADHD herald significant risks for lower educational achievement in adolescence (Bussing et al., 2010). In contrast to the previous study carried out in the US, both subthreshold and pervasive ADHD were associated with increased grade retention despite both groups receiving special educational support in ninth grade more often than children with no

ADHD (Table 4). This may reflect the possibility for children absent of a full ADHD diagnosis to qualify for special school services in the Swedish educational system. However, despite receiving extra academic support, , overall mean grade tended to be lower in in pervasive ADHD compared to children with subthreshold status and the prevalence of retaking one grade did not differ essentially between the subgroups (Table 4). Further studies with more detailed information about the remedial educational services both in special and general education classroom settings are warranted.

Inattentive/hyperactive symptoms in grade one and grade four defined as positive ratings on Conners Parent or Teacher Rating scales were associated with low grade point average and increased risk of not being qualified for upper secondary school. The cut-off level of at least one Conners score was related to negative school outcome (Table 3) in contrast to a threshold of 10 which is recommended to identify attention deficits in a Swedish context (Landgren et al., 1996; Kadesjö & Gillberg, 1998). Teacher's assessment on the ADHD rating scale—IV revealed that at least one inattentive or at least one hyperactive symptom according to the DSM-IV criteria at age 10 was correlated to not being qualified for further studies and a lower overall mean grade at age 16 (Table 3). Inattentiveness tended to result in slightly lower outcome results than hyperactivity. As for the Conners instrument the cut-off level on the DSM-IV symptom scale associated with underachievement at end of compulsory school was lower than the score of =>6 usually applied for identifying ADHD in epidemiological studies (Merell & Tymms, 2010). These results indicate that children with less behaviour problems than those at risk of developing clinically ADHD may also need specific educational attention. However, young children are frequently observed to be active and impulsive and this does not necessarily mean that they are not learning. According to previous research, the inattention element of ADHD appears to be the most important factor associated with underachievement in reading and mathematics (Diamantopoulou et al., 2007; Merell & Tymms, 2010). Further analyses in the present study population have revealed that Conners item 4 and 6 reflecting attention problems and Inattentive item 5 according to the DSM-IV criteria are the strongest predictors of poor school outcome (Holmberg & Bölte, 2011). These findings are in line with results from a longitudinal study by Breslau et al. demonstrating that symptoms of inattention at age 6 predict math and reading achievement at 17 years of age (Breslau et al., 2009).

Attention problems are likely to negatively influence children's academic achievement beginning in the early grades (Merrell & Tymms, 2001, Barbaresi et al., 2007). Students who have difficulties focusing on classroom activities or completing homework assignments because of their attention problems are likely to be less efficient learners compared with their classmates without attention problems. Inefficient learning in the early grades may limit students' ability to acquire basic skills that are necessary for developing higher level math and reading skills (Breslau et al., 2009). Learning problems in lower grades may cause additional inattentive behaviour and thereby further complicate the situation in school for students as they advance to the higher curricular demands of the later grades. In the longitudinal study by Barbaresi et al. following school-age children with ADHD into late adolescence, it was evident that the cumulative incidence of absenteeism and grade retention both increased as the children progressed from elementary school through high school (Barbaresi et al., 2007).

4.1.2 Learning difficulties

Our findings confirm that ADHD and learning difficulties, especially in mathematics, are risk factors for poor school achievement. There is evidence showing that coexisting learning disabilities predicts further impaired academic outcomes for children with ADHD (Frazier et al., 2007; Bussing et al., 2010). When adjusting for ADHD and learning difficulties as predictors in regression analyses, it was evident that ADHD still had significant impact on academic outcome variables (Table 5 and 6). However, risk of coexisting attention and learning difficulties was not evaluated due to insufficient sample size.

4.1.3 Medication

Whether stimulant medication in children and adolescents improves school performance or not has been discussed (Loe & Feldman. 2007; Barnard et al., 2010). Stimulant medication alone seems not to eliminate academic achievement deficits of ADHD, but may moderate the long-term academic outcome (Powers et al., 2008). The use of medication in our study population was low, only 1% of children diagnosed with ADHD were treated with stimulants at age 10. The prevalence of medical treatment may have increased to some extent during secondary school years, but this would probably not have had any major impact on the total result.

4.1.4 Cognitive performance

Low school grades may also imply lower IQ. Children with ADHD show significant decreases in estimated full-scale IQ compared with controls but score on average within the normal range (Biederman et al., 1996; Gillberg et al., 2004, Daley & Birchwood, 2010). However, research that demonstrate the link between ADHD and academic underachievement have controlled for intelligence (Diamantopoulou et al., 2007) suggesting that individuals with ADHD perform academically at a lower level than would be predicted by their IQ. In a previous study in our cohort we have reported that children with ADHD performed better in the cognitive tests in connection with the clinical evaluation in fourth grade (according to age and gender-related norms for Swedish school children) than they did in terms of academic performance in grade nine (Ek et al., 2010). This result confirms the previous Swedish study by Diamantopoulou et al. indicating that children with ADHD underachieve academically in relation to their optimal cognitive capacity (Diamantopoulou et al., 2007).

4.1.5 Early recognition of childhood ADHD symptoms

Our results stress the importance of early recognition of childhood ADHD and its subthreshold and situational presentations with or without coexisting reading, writing or mathematics difficulties. Young children with less prevalent symptoms of inattention may also be at risk of educational underachievement. Considering evidence that attention problems influence children's academic achievement negatively already in early grades, it may be of importance to start intervention during primary school to promote basic skills necessary for higher education. Early intervention may also prevent negative interaction with peers and teachers to evolve thereby reducing the increased risk of health complaints and increased risk of bullying behaviour in children with ADHD (Holmberg & Hjern, 2006; Holmberg & Hjern, 2008).

4.1.5.1 Screening

Several different strategies may be considered in such interventions. In order to identify children at risk, screening at school entry has been recommended as part of school health surveillance for early detection of developmental or behavioural problems (Hall & Elliman, 2003; Swedish National Board of Health and Welfare, 2004). This may be the first step in secondary prevention in terms of social and educational support. Validated rating scales, such as a behaviour rating scale based on DSM-IV criteria may be applied (Merrell & Tymms, 2001; Holmberg, 2009). Teachers have been reported to underestimate ADHD symptoms and consider failure to persist in a task to be a sign of lack of interest, learning disability or family problems rather than inattention (Schachar & Tannock, 2006). Involving teachers in screening may be a way to increase their awareness of ADHD symptoms (Merell & Tymms, 2001; Holmberg, 2009), to discuss factors affecting the child's educational achievements and enhance the communication between teachers and the school health team. However, previous longitudinal studies of the developmental and behavioural screening of pre-schoolers and first graders in our cohort have demonstrated that the screening has low predictive values (15% – 50%) in relation to ADHD and school problems (Holmberg, 2009; Holmberg et al., 2010, Holmberg & Bölte, 2011). One reason for low efficiency of screening in young children may be that the behaviour of an individual child is influenced by many different factors that change over time. Changing family, teacher and peer relationships and increased demands on the child's intellectual capacity in the classroom in close interaction with the maturing brain create a dynamic context for the child's behaviour over time (Holmberg & Hjern, 2008). If screening for inattention and hyperactivity is carried out at the population level, it might be supplemented by a short clinical interview built into the routine school health programme. Such an approach may be more cost-effective and merit further evaluation (Holmberg, 2009).

4.1.5.2 Early intervention

In the present study, about half of the children were reported to have at least one Conners score according to teachers in grade one or four and 29% of fourth graders had at least one inattentive score on the ADHD rating scale—IV in teacher's reports (Table 3). These results suggest that interventions should target all children, not only those with pronounced disruptive or inattentive behaviour. Several different strategies may be considered in such interventions. Interventions may target the family, the school situation or the child himself. Family-focused parent support programme with some evidence based support have been developed for children with ADHD symptoms in first grade (Jones et al., 2008; Sonuga-Barke et al., 2001). These programmes usually target all children with disruptive behaviour, not exclusively ADHD. Positive benefits from parent training, however, must be carefully balanced against the potential negative consequences of stigma associated with mislabeling. School focused interventions may include specific academic intervention strategies. Environmental modifications being offered to all students such as improvements in instruction/teaching methods, teaching materials, curriculum design, school physical designs, and leadership may also benefit children with ADHD-symptoms (Loe & Feldman, 2007). In addition, school may offer child focused interventions including behaviour management training, skill-based interventions (Breslau et al., 2009), emotional support and easy access to medication when indicated.

4.1.5.3 Multi-disciplinary collaboration

Converging evidence regarding the importance of early childhood attention problems in predicting later school performance suggests that these problems should be a focus of concern across the multiple disciplines that address child health and well-being (Breslau et al., 2009). Early intervention services need to be supplemented with an effective strategy for identifying and supporting children who develop ADHD—or other neuropsychiatric disabilities that may interfere with learning—in the classroom when these problems arise. Such a strategy calls for close collaboration and communication between educators, who meet the children in the classroom every day, and the school health team (Holmberg et al., 2010). Children with school-related problems associated with ADHD require proper evaluation and treatment to prevent further impairment. Close collaboration between teachers and the school health team requires sufficient resources—both in terms of competence and finances—and may be an important ingredient in public health strategy for ADHD.

4.2 Limitations

Can the results of this study be generalized to all children with ADHD? Sigtuna is a medium-sized municipality with a population with a slightly more disadvantaged socioeconomic situation than the country as a whole, in terms of education, single parent household and the immigrant proportion of the population according to the Register of the Total Population and the Swedish Education Register. Thus, considering the higher rates of ADHD in families with low socioeconomic status (Swedish National Board of Health and Welfare, 2009) somewhat higher rates of ADHD compared with the national average should be expected in this study population. The school system is similar to the systems in most Swedish communities, with a preponderance of community-run schools with mainstream teaching methods. According to the National School Register (National School Register, 2010), 86.8% of children (n=4384) leaving compulsory school in grade nine in Sigtuna June 2007 were qualified for further studies and the mean grade point average was 203.3, compared to 89.1% (N=935 869) and 207.3, respectively, in the whole country. Thus, the associations between ADHD and impaired academic outcome reported in this study may be over-estimated compared to other societal contexts in Sweden.

Educational systems and school demands, mental health use and stimulant medication as well as the prevalence of ADHD varies considerably between countries. This suggests that the results of this study may, to a certain extent, be specific for Swedish schoolchildren.

Children being screen positive for ADHD-symptoms in grade four (and ten screen negative) were assessed by the clinician. The Conners 10-item scale has been validated in previous population-based studies in Sweden (Landgren et al., 1996; Kadesjö & Gillberg, 1998). The EFSS-scale has not been validated and we have no information about the sensitivity of this instrument which is a potential weakness in our study-design. Some children with ADHD may not have been correctly identified in fourth grade. Since the screening by questionnaires in grade four was completed by interviews of all teachers about ADHD-symptoms, it is unlikely that children with significant problems were not identified.

The method of data collection is the greatest strength of this study. Data about learning and/or behaviour problems in 2002 were collected within the school health system and used

in connection with health visits to the school nurses and physicians. This explains the extraordinarily high participation rate of parents and teachers. Using the national register of final grades minimised the attrition rate since all schools in Sweden report to this register. We could retrieve grades for 41 children who had moved out of the study-population between first and second data collection. Another strength of the study is the use of multiple informants where data on behaviour is provided by both teachers and parents, data on socio-economic conditions by parents, and data on school results from national register.

Our sample is too small to allow for any conclusions to be drawn about gender differences in ADHD, whether girls with ADHD graduated from compulsory school with better academic results than boys with ADHD. Interaction effects of ADHD and learning difficulties on the outcome variables were not analysed due to the insufficient sample size.

5. Conclusions

This population-based study demonstrates a connection between mild as well as more severe ADHD-symptoms in young schoolchildren (age 7 and 10) and academic underachievement at 16 years of age. Schoolchildren with behavioural problems of inattention, hyperactivity and impulsivity but not reaching diagnostic threshold may nevertheless be at risk of impaired academic progress. The results suggest that subthreshold and situational ADHD deserve the same clinical attention and psychosocial treatment as pervasive ADHD to prevent further impairment. Children with learning problems, especially mathematics difficulties, in middle school with or without ADHD seem to be especially at risk of school failure. Close collaboration between health and educational personnel is required to identify and support children with attention and learning problems. A multi-disciplinary approach with integrated services may prevent further impairment. This needs to be further explored in large, prospective, longitudinal, and community-based studies. Future research on childhood ADHD symptoms and learning difficulties in larger populations with longer follow-up periods may reveal whether elevated ADHD symptoms only have the same impact on adverse outcome as coexisting problems. Finally, additional research is required to determine which pharmacologic, behavioural, and educational interventions can improve academic outcomes of children with ADHD.

6. Acknowledgements

We wish to thank Professor Anders Hjern of CHESS, the Centre for Health Equity Studies at Stockholm University, for supervising the design and execution of the study, ethical application and for valuable assistance to gain access to data from the national register. Financial support for this study has been provided by The Swedish Society of Medicine, the First of May Flower Annual Campaign, the Samariten Foundation and the Foundation Claes Groschinskys Memory. We thank the school authorities of Sigtuna, the school nurses, and the teachers, without whose assistance the study could not have been completed.

7. References

American Academy of Pediatrics (1997). *Diagnostic and Statistical Manual of Mental Disorders for Primary Care*. American Academy of Pediatrics, Washington DC, US.

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders,* 4 ed. American Psychiatric Association, Washington DC, US.

Barbaresi, W.J., Katusic, S.K., Robert, C., Colligan, R.C., Weaver, A.L. & Jacobsen, S.J. (2007). Long-Term School Outcomes for Children with Attention-Deficit/Hyperactivity Disorder: A Population-Based Perspective. *J Dev Behav Pediatr,* Vol.28(No.4), pp 265–73.

Barnard, L., Stevens, T., To, Y.M., Lan, W.Y. & Mulsow, M. (2010). The Importance of ADHD Subtype Classification for Educational Applications of *DSM-V. J Atten Disord*, Vol.13(No.6), 573–83. E pub 2009 Apr 16.

Biederman, J., Faraone, S., Milberger, S., et al. (1996). A prospective 4-year follow-up study of attention-deficit hyperactivity and related disorders. *Arch Gen Psychiatry*, Vol.53(No.5), pp 437–446.

Biederman, J. & Faraone, S.V. (2005). Attention-deficit hyperactivity disorder. *Lancet,* Vol.366(No.9481), pp. 237-248.

Breslau, J., Miller, E., Breslau, N., Bohnert, K.., Lucia, V. & Schweitzer J. (2009). The Impact of Early Behavior Disturbances on Academic Achievement in High School. *Pediatrics,* Vol.123(6), pp 1472-6.

Bussing, R., Mason, D.M., Bell, L., Porter, P. & Garvan, C. (2010). Adolescent outcome of childhood attention-deficit/hyperactivity disorder in a diverse community sample. *J Am Acad Child Adolesc Psychiatry,* Vol.49(No.6), pp 595-605. Epub 2010 May 1.

Conners, C.K. (1973). Rating scales for use in drug studies with children. *Psychopharmacology Bulletin* (Special issue, Pharmacotherapy of Children), pp. 24–29.

Conners, C.K. (1990a) *Manual for Conners Rating Scales*. Multi-Health Systems, Toronto, Canada.

Conners, C.K. (1990b). *Conners Abbreviated Symptom Questionnaire: Parent Version, Teacher Version Manual*. Multi-Health Systems, Toronto, Canada.

Daley, D. & Birchwood, J. (2010). ADHD and academic performance: why does ADHD impact on academic performance and what can be done to support ADHD children in the classroom? *Child Health Care Develop* Vol.36(No.4),pp 455-64. E pub 2010 Jan 13.

Diamantopoulou, S., Henricsson, L. & Rydell, A.M. (2005). ADHD symptoms and peer relations of children in a community sample: Examining associated problems, self-perceptions, and gender differences. *International Journal of Behavioral Development* Vol.29:388-398.

Diamantopoulou, S., Rydell, A., Thorell, L. B. & Bohlin, G. (2007). Impact of executive functioning and symptoms of attention deficit hyperactivity disorder on children's peer relations and school performance. *Developmental Neuropsychology*, Vol.32, pp 521–42.

DuPaul, G., Power, T., Anastopoulos, A. & Reid, R. (1998). *ADHD rating scale - IV. Checklists, norms, and clinical interpretation.* Guildford Press. New York, USA.

Ek, U., Holmberg, K., de Geer, L., Swärd, C. & Fernell, E. (2004). Behavioural and learning problems in schoolchildren related to cognitive test data. *Acta Paediatrica*, Vol.93(No.7), pp. 976- 981.

Ek, U., Westerlund, J., Holmberg, K. & Fernell, E. (2010). Academic performance in adolescents with ADHD and other behavioural and learning problems – a

population-based longitudinal study. *Acta Paediatrica,*Vol.100(No.3),pp 402-6, Epub 2010 Nov 5.

Frazier, T.W., Youngstrom, E.A., Glutting, J.J. & Watkins, M.W. (2007). ADHD and achievement: meta-analysis of the child, adolescent, and adult literatures and a concomitant study with college students. *J Learn Disabil.* Vol.40: pp 49–65.

Gillberg, C., Gillberg, I.C., Rasmussen, P., Kadesjö, B., Söderström, H., Råstam, M., Johnson, M., Rothenberger, A. & Niklasson, L. (2004). Co-existing disorders in ADHD – implications for diagnosis and intervention. *Eur Child Adolesc Psychiatry*, Vol.13 Suppl 1:pp I80-92.

Goyette, C.H., Conners, C.K. & Ulrich, R.F. (1978). Normative data on revised Conners Parent and Teacher Rating Scales. *J Abnorm Child Psychol*, Vol.6(No.2), pp. 221-36.

Hall, D. & Elliman, D. (Eds) (2003) *Health for All Children*, (4th ed), Oxford University Press, Oxford, UK.

Holmberg, K. & Hjern, A. (2006). Health complaints in children with attention-deficit/hyperactivity Disorder. *Acta Paediatrica*, Vol.95(No.6), pp. 664-70.

Holmberg, K. & Hjern, A. (2008). Bullying and ADHD in 10 year-olds in a Swedish community. *Dev Med Child Neurol,* Vol.50(No.2), pp. 134-138, Epub 2007 Dec 19.

Holmberg K. (2009). *Health complaints, bullying and predictors of attention-deficit/hyperactivity disorder (ADHD) in 10-year-olds in a Swedish community* [dissertation], University of Uppsala, Uppsala, Sweden.

Holmberg, K., Sundelin, C. & Hjern, A. (2010). Routine developmental screening at 5.5 and 7 years of age is not an efficient predictor of attention-deficit/hyperactivity disorder at age 10. *Acta Paediatrica*,Vol. 99(No.1), pp. 112-120. Epub 2009 Sep 17.

Holmberg, K., & Bölte, S. (2011). Symptoms of ADHD at age 7 and 10 predict academic outcome at age 16. *Proceedings of the European Academy of Childhood Disability 23rd Annual meeting*, 8-11 June, 2011, Rome, Italy. Dev Med Child Neurol 2011 June;53(Suppl s3):60. Epub 2011 May 19.

Hoza, B. (2007). Peer functioning in children with ADHD. *J Pediatr Psychol* Vol.32, pp 655-63.

Jones, K., Daley, D., Hutchings, J., Bywater, T. & Eames, C. (2008). Efficacy of the Incredible Years Programme as an early intervention for children with conduct problems and ADHD: long-term follow-up. *Child: care, health and development*, Vol.34(No.3), pp. 380-90.

Kadesjö, B. & Gillberg, C. (1998). Attention deficit and clumsiness in Swedish 7-year-old children. *Dev Med Child Neurol*, Vol.40(No.12), pp. 796-804.

Landgren, M., Pettersson, R., Kjellman, B. and Gillberg, C. (1996). ADHD, DAMP and other neurodevelopmental/psychiatric disorders in 6-year-old children: epidemiology and co-morbidity. *Dev Med Child Neurol*, Vol.38(No.10), pp. 891-906.

Loe, IM. & Feldman, HM. (2007). Academic and educational outcomes of children with ADHD. *J Pediatr Psychol,* Vol.32(No.6), pp 643-54. Epub 2007 Jun 14. Review.

Mannuzza, S., Klein, R.G. & Moulton, J.L. 3rd (2002). Young adult outcome of children with "situational" hyperactivity: a prospective, controlled follow-up study. *J Abnorm Child Psychol* Vol.30:191-8.

Merrell, C. & Tymms, P. B. (2001). Innatention, hyperactivity and impulsiveness: their impact on academic achievement and progress. *Br J Edu Psychol*, Vol.71, pp 43–56.

National School Register (2010) (10 August 2011, date last accessed). URL: www.skolverket.se. The Swedish National Agency for Education, Stockholm, Sweden.

Powers, R.L., David J. Marks, D.J., Miller, C.J., Newcorn, J.H. & Halperin, J.M. (2008). Stimulant Treatment in Children with Attention-Deficit/Hyperactivity Disorder Moderates Adolescent Academic Outcome. *J Child Adolesc Psychopharmac,* Vol.18(No.5), pp 449-59.

Rasmussen, P. & Gillberg, C. (2000). Natural outcome of ADHD with developmental coordination disorder at age 22 years: a controlled, longitudinal, community- based study. *J Am Acad Child Adolesc Psychiatry*, Vol.39(No.11):1424-31.

Rowe, K.S. & Rowe, K.J. (1997).Norms for Parental Ratings on Conners' Abbreviated Parent-Teacher Questionnaire: Implications for the Design of Behavioral Rating Inventories and Analyses of Data Derived from Them. *J Abnormal Child Psychol*, Vol.25, pp. 425-451.

Scahill, L., Schwab-Stone, M., Merikangas, K.R., Leckman, J.F., Zhang, H. & Kasl, S. (1999). Psychosocial and clinical correlates of ADHD in a community sample of school-age children. *J Am Acad Child Adolesc Psychiatry* Vol.38:976-84.

Schachar, R. & Tannock, R. (2006). Syndromes of Hyperactivity and Attention Deficit. In: *Child and Adolescent Psychiatry,* (4th ed) (eds M. Rutter, E. and E. Taylor), pp. 399-418. Blackwell Science Ltd; Oxford, UK.

Sonuga-Barke, E.J., Daley, D., Thompson, M., Laver-Bradbury, C. & Weeks, A. (2001). Parent-based therapies for preschool attention-deficit/hyperactivity disorder: a randomized, controlled trial with a community sample. *J Am Acad Child Adolesc Psychiatry*, Vol.40(No.4), pp. 402-408.

Spencer, T.J., Biederman, J. & Mick, E. (2007): Attention-deficit/hyperactivity disorder: diagnosis, lifespan, comorbidities, and neurobiology. *J Pediatr Psychol* Vol.32(No.6), pp 631-42.

Swedish National Board of Health and Welfare (2004). *Socialstyrelsens riktlinjer för skolhälsovården. Rekommendationer för planering/tillsyn/metodutveckling*. [Manual for School Health Services]. Socialstyrelsen, Stockholm, Sweden, (in Swedish).

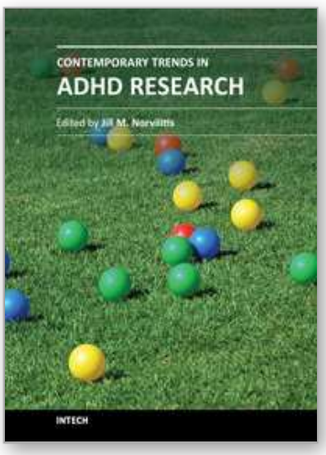
Swedish National Board of Health and Welfare (2009). Folkhälsorapporten. [Health in Sweden - The National Public Health Report 2005]. Socialstyrelsen, Stockholm, Sweden (in Swedish).

Thunström, M. (2002): Severe sleep problems in infancy associated with subsequent development of attention-deficit/hyperactivity disorder at 5.5 years of age. *Acta Paediatr* Vol.91, pp 584-92.

Ullmann, R.K., Sleator, E.K. & Sprague, R.L. (1985). A change of mind: the Conners abbreviated rating scales reconsidered. *J Abnorm Child Psychol*, Vol.13(No.4), pp. 553-565.

Warner-Rogers, J., Taylor, A., Taylor, E. & Sandberg, S. (2000). Inattentive behavior in childhood: epidemiology and implications for development. *J Learn Disabil* Vol.33, pp 520-36.

Wechsler D. (1999). *Wechsler intelligence scale for children* (3rd ed), Revised Psychological Corporation, New York, US.



Contemporary Trends in ADHD Research
Edited by Dr. Jill M. Norvilitis

ISBN 978-953-307-858-8
Hard cover, 196 pages
Publisher InTech
Published online 15, February, 2012
Published in print edition February, 2012

With many children and adults affected by Attention Deficit Hyperactivity Disorder, researchers strive to understand the underpinnings of ADHD and associated factors on both a basic and applied level. The goal of this volume is to explore some of the broad array of research in the field of ADHD. The 12 chapters cover a variety of topics as varied as postural control, endocrine dysfunction, juvenile justice, and academic outcomes. These chapters will provide valuable insights for students reading about ADHD for the first time, researchers wishing to learn about the latest advances, and practitioners seeking new insight in the field.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:

Kirsten Holmberg (2012). Adolescent Academic Outcome of Childhood Attention-Deficit/Hyperactivity Disorder – A Population-Based Study, Contemporary Trends in ADHD Research, Dr. Jill M. Norvilitis (Ed.), ISBN: 978-953-307-858-8, InTech, Available from: http://www.intechopen.com/books/contemporary-trends-in-adhd-research/adolescent-academic-outcome-of-childhood-attention-deficit-hyperactivity-disorder-a-population-based

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen