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Attention-Deficit/Hyperactivity Disorder in Children With High IQ: Results from a Population-Based Study

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Abstract

Objective—To compare the characteristics of children with ADHD who have high IQ versus normal and low IQ through long-term follow-up of children with ADHD from a population-based birth cohort.

Methods—Subjects included children with research-identified ADHD (N=379) from a birth cohort (N=5,718). Full scale IQ scores obtained between ages 6 –18 years were used to categorize children into three groups: Low (IQ<80), Normal (80≤IQ<120) and High IQ (IQ≥120). Subjects were retrospectively followed from birth until emigration, death, or high school graduation/ dropout. The groups were compared on demographic characteristics, age at which ADHD case criteria were met, co-morbidities, treatment, and school outcomes.

Results—There were no significant differences among children with high (N=34), normal (N=276) or low IQ (N=21) and ADHD in numerous characteristics, including median age at which ADHD criteria were fulfilled (9.5, 9.7, and 9.8 years); rates of co-morbid learning disorders (85.3%, 78.3%, 76.2%), psychiatric disorders (47.1%, 50.4%, 47.6%), and substance abuse (17.6%, 23.6%, 19.0%); and rates of stimulant treatment (79%, 75%, 90%). In comparison to children with normal or low IQ, those with high IQ had mothers with higher educational levels (e.g., college graduation rates 44.1%, 11.6%, 14.3%), and higher reading achievement (median national percentiles on standardized reading tests 77.0, 42.0, 29.0, p<0.001).

Conclusions—These findings suggest that ADHD is similar among children with high, normal and low IQ, although high IQ may favorably mediate some outcomes such as reading achievement. Diagnosis and treatment of ADHD are important for all children, regardless of cognitive ability.

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Index terms

attention-deficit hyperactivity disorder; giftedness; IQ

Attention-deficit hyperactivity disorder (ADHD) is the most common neurobehavioral disorder seen in children [1,2]. Symptoms may be chronic and continue into adulthood. ADHD is a substantial and costly public health concern [3]. Children with ADHD often have co-morbid psychiatric disorders, learning disabilities, and substance abuse [4,5].

Similar to the general population, children with ADHD may have a broad range of cognitive abilities. Previously, we reported that ADHD is more likely to be present in the context of developmental delay, at the level of borderline-to-mild intellectual disability [6,7]. It has also been reported that children with ADHD tend to have an approximately 9 point lower intelligence quotient (IQ) score than children without the diagnosis [7]. Nevertheless, the literature demonstrates the possibility of having both ADHD and high IQ. Children with a high IQ (full scale IQ greater than 120) are frequently referred to as “gifted”, although the precise definition of giftedness has been surrounded by controversy. According to the Marland Report, giftedness depends on many factors, including age of identification, screening procedures, and tests of creativity [8]. A clear, comprehensive definition of “gifted and talented” is still needed in the literature, as well as an operationalized IQ score requirement to indicate giftedness.

The presence of high IQ within the ADHD population is an area of some controversy. The literature on the topic is primarily comprised of case reports and observations [9–12]. Previous studies have suggested that misdiagnosis of ADHD in gifted children is a legitimate concern. According to Lovecky et. al., misdiagnosis of ADHD can occur in two directions [13]. Gifted children with a lot of energy can be seen as having ADHD, especially those children who receive little or no academic stimulation. Alternatively, some gifted children with ADHD who can concentrate for long periods of time on areas of interest (i.e., hyperfocus) may not be diagnosed with ADHD.

In spite of the possibility of misdiagnosis and the lack of consensus on the definition of giftedness, it appears that ADHD can be a valid diagnosis in children with high IQ. It has been reported that the characteristics of ADHD in children with high IQ mirror those among children with average IQ. Syndromal persistence rates of ADHD have been reported to be similar between high IQ and normal IQ groups [14]. In addition, it has been found that psychiatric comorbidities and functional impairments continued with time and were comparable in the two subgroups (i.e. normal and high IQ) of ADHD cases [15]. The functional impact of ADHD in a child with high IQ may become more evident as the child progresses into later grades in school, perhaps leading to late identification of this ADHD subgroup [14]. In the school setting, it has been observed that gifted children with ADHD may be at risk of underachievement, because they may be frustrated by misinterpretation of their own capabilities and talents [12].

The aim of our study was to add to the existing literature by demonstrating that ADHD is a valid diagnosis in the presence of high IQ by comparing the characteristics of children with ADHD who have high versus normal and low IQ. To our knowledge, this is the first population-based study on high IQ and ADHD. Our hypotheses were as follows: (1) Clinical characteristics of ADHD are similar in all children with low, average and high IQ; (2) Stimulant medication treatment will be initiated at a later age in children with ADHD and high IQ, perhaps owing to the later onset of ADHD-related functional impairment in this

group; and (3) Children with high IQ will have more favorable school outcomes in comparison to other children with ADHD.

METHODS

Study Setting

Rochester, Minnesota is located 90 miles southeast of Minneapolis-St. Paul. Previously, we have retrospectively defined and identified all incident cases of ADHD in a population-based birth cohort consisting of all children born between 1976–1982 to mothers residing in Independent School District #535 and who remained in the community until the age of school entry. This study employed the unique resources of the Rochester Epidemiology Project (REP), through which we had access to the complete medical records for all members of this birth cohort, encompassing records from the Mayo Clinic, Olmsted Medical Center, and the community's few private medical practices [16]. A contractual research agreement granted us permission to access the cumulative school records for every child in the 1976–1982 birth cohort[17]. The school records are comprehensive and include yearly report cards, absenteeism data, results of all standardized tests, and graduation status of the child.

Identification of ADHD cases

Previously, we published a detailed description of the process for identification of the 5718 members of the birth cohort who remained in Rochester at least until the age of school entry [2]. In order to identify ADHD cases, we employed a five-step process. The first four steps were used to screen the records for potential cases of ADHD, whereas in the fifth, research criteria were applied to all potential ADHD candidates. In the first step, school records for all 5718 children were reviewed, regardless of whether the child had any specific clinical diagnoses. After this preliminary step, a team of trained abstractors collected additional information from school and medical records, including symptoms of ADHD as specified in the DSM-IV, results from teacher and parent ADHD questionnaires, and clinical diagnoses of ADHD. The third step comprised a search of the computerized index of medical diagnoses of the Mayo Clinic and Olmsted Medical Center for children who had received any diagnosis including or related to ADHD. Subsequently, we looked at the records of children who had received care at the only other private community provider of psychiatric care in operation during the years relevant to the study. Finally, in the fifth step, explicit research criteria were applied to identify ADHD incident cases among the 1344 possible cases identified in the preceding four steps [2]. Research-identified incident cases of ADHD were defined by a model combining DSM-IV criteria, ADHD-specific questionnaires, and clinical diagnoses (Table 1). The exclusion criteria specified in DSM-IV were followed: the subjects could not be identified as an ADHD case if they had a diagnosis of pervasive developmental disorder, severe mental retardation (IQ<50, N=19), schizophrenia, or a psychotic disorder. The analyses reported herein are based on these research-identified ADHD incidence cases.

ADHD comorbidities, treatments, and outcomes

Substance abuse was defined as documented abuse before 18 years of age. In a previous report, we detailed the process of abstracting this and the following information from both medical and school records [4]. The medical records were also reviewed for documentation of diagnoses of major psychiatric disorders prior to 18 years of age. For the current study, psychiatric disorders (i.e. mood anxiety, adjustment, disruptive, personality, and eating disorders) are presented as one category. Additionally, a learning disability was determined by applying two discrepancy formulas and one low achievement formula to scores from all

individually administered IQ and achievement tests for math, reading and written language documented in the school and medical records [18,19] .

Detailed information about treatment with stimulant medications was also abstracted from medical and school records for all members of the birth cohort[20]. This included the age of onset and duration of treatment.

In this study, school outcomes include four objective measures: reading achievement, grade retention, school dropout, and receipt of an Individual Education Program (IEP) Plan. In a prior study, we described the methods for abstracting these measures of academic achievement and school performance [5,21]. Reading achievement was assessed using the last available California Achievement Test (CAT) reading score for each subject. It should be noted that these scores were available for virtually every member of the birth cohort. Grade retention was defined as having to repeat one or more grades. Subjects were categorized as school dropouts if they were known to have dropped out of school prior to high school graduation. The IEPs were categorized as emotional/behavior disturbance (EBD) or non-EBD (this would include services for a documented, specified learning disability according to state and federal guidelines in effect at the time).

Individual IQ Testing

Information from the complete medical, psychological, and school records was collected to identify all children who had completed an individually administered intellectual assessment between 6 and 18 years of age. IQ scores were primarily from the full scale score of the Wechsler Intelligence Scales for Children, Revised and Third Editions. Academic achievement scores were primarily from the Woodcock-Johnson Tests of Achievement. Children were categorized into three groups: (1) low IQ (IQ<80), (2) normal IQ (80≤IQ<120) and (3) high IQ (IQ≥120). For those children who had completed more than one individually administered test of intellectual ability between 6 and 18 years of age, at least one full scale IQ score ≥120 was the criterion required to place the child into the high IQ category. If the last available full scale IQ score between the ages of 6 and 18 was <80, the child was assigned to the low IQ category. Finally, children with no IQ score >120 and whose last available IQ score between ages 6 and 18 was between 80 and 120 were considered to have normal IQ.

Statistical Analysis

Comparisons between the three IQ subgroups were evaluated based on the chi-square test for categorical variables and the non-parametric Kruskal-Wallis test for continuous variables. The association between IQ group and dropping out of school (yes vs. no) was summarized using the odds ratio (OR) and corresponding 95% confidence interval (CI) estimated by fitting a logistic regression model. The cumulative incidence of grade retention was estimated using the Kaplan-Meier method, taking into account the varying length of enrollment in the school district. For subjects who had been retained a grade, the duration of follow-up was calculated from birth to the date of retention. For all remaining subjects who were never retained, the duration of follow-up was calculated from birth to the date of their last follow-up (i.e., emigrated, dropped out, or graduated). The association between IQ subgroup and grade retention was summarized using the hazard ratio (HR) and corresponding 95% confidence interval estimated by fitting a Cox proportional hazards model. All calculated p-values were two-sided and p-values less than 0.05 were considered statistically significant.

RESULTS

Among the 379 ADHD cases, 370 (97.6%) attended school in the district and granted permission for their records to be included in this study. Among these 370 subjects, 331 (89.5%) had documented full scale IQ scores available in their school and/or medical records from tests that had been administered between ages 6 and 18 years. Based on these scores, 34 subjects were in the High IQ Group, 276 in the Normal IQ Group and 21 in the Low IQ Group. The groups were similar in the median age at which they fulfilled research criteria for ADHD (9.5, 9.7 and 9.8 years respectively), the presence of a co-morbid learning disorder (85.3%, 78.3% and 76.2% respectively), the presence of a co-morbid psychiatric disorder (47.1%, 50.4% and 47.6% respectively), and presence of co-morbid substance abuse (17.6%, 23.6% and 19.0% respectively (Table 2). However, the groups differed in level of maternal education (higher for the High IQ Group).

Rates of stimulant medication treatment (79.4%, 75.0% and 90.5%) as well as age at onset and duration of stimulant treatment were similar among the three groups (Table 3).

The groups did differ significantly in academic achievement in reading, with the High IQ Group significantly outperforming the other two groups (mean national percentile reading scores 74.6, 42.5 and 26.9 respectively, Table 4). ADHD children with Low and Normal IQ were three times more likely to dropout of school than their High IQ ADHD peers (Low IQ group: OR 3.0, 95% CI 0.6–14.4; Normal IQ group: OR 3.0, 95% CI 0.9–10.3). In addition, ADHD cases with Low IQ were 2.2 times (95% CI 0.6–8.1) more likely to be retained in a grade than ADHD cases with High IQ. ADHD cases with Normal IQ were 1.8 times (95% CI 0.6–4.9) more likely to be retained a grade than high IQ ADHD children. However, the differences in the rates of grade retention or school dropout across the three groups were not statistically significant. There was also a non-significant trend for those with High IQ to be less likely to have received special education services through an Individual Education Program plan (Table 4).

DISCUSSION

Studies of population-based, non-clinically referred samples of children with ADHD are necessary to further the understanding of the diagnosis, treatment, and outcomes of this neurodevelopmental disorder. This unique study included information from medical and school records of all subjects in the birth cohort. This comprehensive information allowed us to report on the occurrence of psychiatric disorders, substance abuse, and school problems for all ADHD cases in the birth cohort. Subjects were followed longitudinally from childhood through adolescence. To our knowledge, this is the first epidemiologic study to present data on children with ADHD across the spectrum of cognitive ability.

In our study, we used the results of individually administered IQ tests to place the ADHD cases into High, Normal, or Low IQ subgroups. Any tests completed after age six and before age eighteen years were taken into consideration. The medical and school records contained extensive information about individualized testing, especially for ADHD cases. Of the 370 ADHD incident cases who were included in this study, 331 had at least one full-scale IQ score. Many subjects from the birth cohort had more than one individualized IQ test administered. According to the Marland Report, the greatest impact on IQ from environmental factors generally takes place between the ages of one and five. After age six, IQ tests could thus be considered a more accurate measure of intelligence [8]. We therefore placed our subjects in the three IQ groups based on IQ measures obtained after age 6 years. It should also be noted that on tests of intelligence and achievement, gifted children with

ADHD show a greater degree of inter and intra test variability in comparison to children without ADHD [13].

The results of this study suggest that children with ADHD, regardless of their place along the IQ spectrum, have similar presentations and outcomes. This includes the age at which children met research diagnostic criteria, as well as rates of co-morbid conditions including learning disabilities, psychiatric disorders, and substance abuse. Our findings are comparable to those of Antshel et. al., who reported that children with high IQ and ADHD showed cognitive, psychiatric, and behavioral features consistent with the diagnosis of ADHD in children with average IQ [14].

Stimulant medication treatment provided to children with ADHD in this birth cohort was also similar across the IQ spectrum, including the rate, age at onset, and duration of treatment. It has been suggested that high IQ could contribute to delayed diagnosis of ADHD and deferred treatment with stimulant medication [15]. However, this was not the case in our birth cohort, perhaps because our subjects were similar with regard to symptoms and comorbidities, regardless of IQ.

Our subjects with High IQ and ADHD did differ from their peers with ADHD in several ways. It appears that there is a greater concentration of males in the high IQ group, in comparison to both the normal and low IQ groups. Not surprisingly, levels of maternal education were significantly higher among mothers of children with High IQ and ADHD versus those with Normal or Low IQ.

We found that High IQ ADHD cases tended to have better school outcomes than Normal IQ and Low IQ ADHD cases. These ADHD youths with high IQ had higher mean reading scores. They also appear to have had somewhat lower rates of grade retention and school dropout, although these findings were not statistically significant. According to Leroux et al., who identified ADHD in gifted adults, the cognitive ability of individuals with ADHD and high IQ tends to mask weaknesses associated with the diagnosis of ADHD [12]. It should be noted that the tendency toward improved school performance for High IQ subjects was found despite the observation that these children were just as likely as children with Normal or Low IQ to have co-morbid learning disorders.

This study's population, setting, and resources provide an excellent foundation for conducting long-term epidemiologic research that allows for a more comprehensive understanding of ADHD. Several potential limitations, however, should be noted. First, as this is a retrospective study, we did not directly assess our study subjects either for ADHD or cognitive ability. Three independent, but complementary sources of information (i.e. school, REP-medical, private-medical), were reviewed on all 5718 members of the birth cohort who were included in the study, making it unlikely that significant numbers of ADHD cases were not identified. A second potential limitation is related to the emigration of subjects from the original birth cohort (N=8548). Detailed comparison of children who stayed in the community (N=5718) and those who left before age 5 strongly suggest that the 5718 children are representative of the entire birth cohort [17]. Rochester, MN is largely white, middle class community which may limit the ability to generalize this data to other populations. Since we did not have measures of cognitive ability available on all children in the birth cohort who did not have ADHD, we were not able to compare rates of ADHD for children with high versus normal or low IQ. It would be interesting to be able to report on additional, detailed neuropsychological findings on our cohort. However, that is beyond the scope of the retrospective data available to us, as well as beyond the limitations of time and resources that were available to us during primary data collection. Since decisions about grade retention may be subjective, with highly variable criteria contributing to the decision

to retain, data on this outcome should be interpreted with caution. However, we were able to compare grade retention rates across the three IQ groups, providing another opportunity to assess an important functional outcome associated with ADHD. Finally, the number of children with High IQ and ADHD in this study is relatively small, potentially limiting our ability to generalize these findings. The small number of children with High IQ and Low IQ also limited the statistical power to detect differences across the three groups. This may, for example, have precluded the possibility of identifying significant differences in rates of grade retention and school dropout. Nevertheless, our subject numbers compare favorably to other published reports. Also, unlike other studies that employed referred and potentially biased samples, our subjects constitute a population-based sample.

In summary, the results of our study suggest that the characteristics of children with ADHD are similar among children with ADHD and High IQ compared to those with Normal or Low IQ. Similarities among these groups in the rates of co-morbid conditions and risk for substance abuse are particularly striking. While strong cognitive ability may buffer the impact of ADHD on school performance, ADHD still places these children at risk for some of the most worrisome psychosocial outcomes. These findings clearly indicate the importance of diagnosing and treating children with ADHD across the spectrum of cognitive ability.

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Table 1

Research criteria for ADHD case definition.

ADHD Cases	Meets* DSM-IV Criteria for AD/HD	ADHD Questionnaire Results	Clinical Diagnoses of AD/HD	Number of Subjects		
Research-identified ADHD cases	+	+	+	169	228	379
	+	+	--	41		
	+	--	+	17		
	--	+	+	123	151	
	--	--	+	29		

ADHD, attention-deficit/hyperactivity disorder.

Pluses and minuses indicate the presence or absence, respectively, of a given criterion.

*All DSM-IV criteria were met, with the exception that the age criterion (some symptoms documented before age 7 years) was not used.

Table 2

Summary of characteristics of ADHD subjects, by level of IQ.

Characteristic	High IQ (IQ ≥ 120; N=34)	Normal IQ (80≤IQ<120; N=276)	Low IQ (IQ<80; N=21)	P-value
Male gender, n (%)	31 (91.2)	202 (73.2)	14 (66.7)	0.052
Maternal education at birth, n (%)				<0.001
Less than high school	0	27 (9.8)	0	
High school graduate	8 (23.5)	101 (36.6)	11 (52.4)	
Some post secondary	9 (26.5)	91 (33)	5 (23.8)	
College graduate	15 (44.1)	32 (11.6)	3 (14.3)	
Unknown	2 (5.9)	25 (9.1)	2 (9.5)	
Age met AD/HD research criteria (years)				0.64
Mean (SD)	10.5 (3.4)	10.3 (3.5)	11.1 (3.4)	
Median	9.5	9.7	9.8	
Range	(4.5–17.8)	(2.3–22.1)	(6.6–17.3)	
LD by MN, DIS, or LA research criteria, n (%)	29 (85.3)	216 (78.3)	16 (76.2)	0.61
Psychiatric disorder prior to 18 years of age, n (%)	16 (47.1)	139 (50.4)	10 (47.6)	0.92
Substance abuse prior to 18 years of age, n (%)	6 (17.6)	65 (23.6)	4 (19.0)	0.68

LD, Learning Disability; MN, State of Minnesota regression-based discrepancy formula for determining the presence of LD; DIS, non regression-based discrepancy formula for determining presence of LD; LA, Low Achievement, non discrepancy-based formula for determining presence of LD.

Table 3

Summary of stimulant treatment characteristics of ADHD subjects, by level of IQ.

Characteristic	High IQ (N=34)	Normal IQ (N=276)	Low IQ (N=21)	P-value
Any treatment with stimulants, n (%)	27 (79.4)	207 (75.0)	19 (90.5)	0.25
No. of subjects with sufficient information regarding dates and dosages for stimulant treatment	25	199	17	
Age at onset of treatment with stimulants (years)				0.97
Mean (SD)	10.3 (3.3)	10.4 (3.4)	10.2 (3.2)	
Median	9.6	9.9	9.4	
Range	(4.5–17.1)	(2.0–18.4)	(4.9–15.7)	
Duration of treatment with stimulants (months)				0.45
Mean (SD)	46.3 (40.0)	43.1 (37.5)	33.2 (32.1)	
Median	36.7	35.9	24.6	
Range	(1.0–138.6)	(0.5–160.0)	(0.5–110.9)	

Table 4

Summary of school outcomes among ADHD subjects, by level of IQ.

Outcome	High IQ (N=34)	Normal IQ (N=276)	Low IQ (N=21)	P-value
Reading score, national percentile				<0.001
No. with available scores	33	263	17	
Mean (SD)	74.6 (23.3)	42.5 (25.2)	26.9 (17.4)	
Median	77.0	42.0	29.0	
Range	(13.0–99.0)	(1.0–97.0)	(1.0–61.0)	
Cumulative incidence of being retained (%)				0.47
By age 9 years	2.9	5.9	14.3	
By age 12 years	6.0	9.3	19.3	
By age 15 years	9.2	11.3	19.3	
By age 18 years	12.5	20.5	24.7	
Dropped out of school, N (%) †	3/28 (10.7)	59/223 (26.5)	5/19 (26.3)	0.19
Type of educational intervention, n (%)				0.13
EBD or both	7 (20.6)	78 (28.3)	6 (28.6)	
Non-EBD	11 (32.4)	103 (37.3)	12 (57.1)	
None	16 (47.1)	95 (34.4)	3 (14.3)	

† Subjects who emigrated from the school district prior to graduation or who had unknown graduation status were not included in the denominator for the determination of the percentage of subjects who dropped out of school.

EBD, emotional/behavior disturbance.