Characterizing Impaired Driving in Adults With Attention-Deficit/Hyperactivity Disorder: A Controlled Study

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Objective: We sought to confirm previously documented findings that individuals with attention-deficit/hyperactivity disorder (ADHD) demonstrate impaired driving behavior when compared with controls.

Method: Subjects were adults with (N = 26) and without (N = 23) DSM-IV ADHD ascertained through clinical referrals to an adult ADHD program and through advertisements in the local media. Driving behavior was assessed using the Manchester Driving Behavior Questionnaire (DBQ) and 10 questions from a driving history questionnaire. Neuropsychological testing and structured interviews were also administered to all subjects.

Results: Substantially more ADHD subjects had been in an accident on the highway (35% vs. 9%, p = .03) or had been rear-ended (50% vs. 17%, p = .02) compared with controls. Analysis of the DBQ findings showed that ADHD subjects had significantly higher mean ± SD scores than control subjects on the total DBQ (34.1 ± 15.2 vs. 18.0 ± 8.6, p < .001) and in all 3 subscales of the DBQ: errors (9.3 ± 5.4 vs. 4.6 ± 3.5, p < .001), lapses (12.4 ± 6.2 vs. 6.1 ± 3.5, p < .001), and violations (12.4 ± 5.2 vs. 7.4 ± 4.1, p < .001). Using the score that separated ADHD from control drivers on the DBQ as a cutoff, ADHD drivers at high risk for poor driving outcomes had more severe rates of comorbidity and exhibited more impaired scores on neuropsychological testing.

Conclusions: Our results confirm and extend previous work documenting impaired driving behavior in subjects with ADHD. Results also suggest that ADHD individuals at high risk for poor driving behavior might be distinguishable from other ADHD individuals on DBQ scores, neuropsychological deficits, and patterns of comorbidities.

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It is now estimated that attention-deficit/hyperactivity disorder (ADHD) afflicts approximately 4% of adults in this country.[1–3] Emerging data from clinical and community[4] samples document that ADHD in adults is associated with high levels of morbidity and dysfunction.[5]

One of the key areas of dysfunction associated with ADHD is impaired motor vehicle operation. As shown in Table 1, a small emerging literature documents that drivers with ADHD are more likely than drivers without ADHD to commit traffic violations and have adverse driving outcomes. These published studies include a longitudinal study of hyperactive children followed up into young adult years,[6] a follow-up of adolescents and young adults with and without ADHD,[7] and epidemiologic longitudinal studies of New Zealand children with ADHD[8] as well as New Zealand children with attentional difficulties.[9] ADHD adults have also been found to have worse driving histories in comparison with psychiatric population subjects.[10]

However, despite positive gains in understanding the relationship between ADHD and driving, limited progress has been made toward understanding what particular characteristics contribute to high-risk driving behaviors of ADHD individuals. In a study of 105 young adult ADHD drivers, Barkley et al.[11] reported that ADHD subjects had less knowledge of driving laws and rules than

Table 1. Studies of ADHD and Driving Behaviors and Outcomes

Study	N	Age (y)	Driving Measures	ADHD Measures	Impairments/Results
Barkley et al[11]	ADHD (N = 105) Control (N = 64)	17–28	DMV records, self-reports, test of driving rules and battery of executive function tasks	DSM-IV and clinical evaluation	ADHD group had worse performance on test of rules and decision-making Control group "employed safer routine driving habits"
Barkley et al[7]	ADHD (N = 35) Control (N = 36)	16–22	Parent report of driving behaviors, habits, and outcomes	Parent ratings of current ADHD symptoms, using DSM-III-R criteria	ADHD group "used less sound driving habits": more likely to have auto accidents (and more of them, with more bodily harm, and more at fault) and more likely to receive traffic citations (eg, speeding)
Woodward et al[9]	N = 941	18–21	Adverse driving outcomes: self-reports of motor vehicle accidents, drinking and driving, and traffic violations	"Parent and teacher report measures of attentional difficulties" (at age 13)	"Young people with high levels of attentional difficulties were at greater risk" for adverse driving outcomes
Nada-Raja et al[8]	N = 916	15–18	Self-report and official traffic conviction records	Self- and parent report, DSM-III symptom scale (at age 15)	"Adolescents with a history of ADHD and conduct problems are significantly more likely to commit traffic offenses"
Weiss et al[6]	Hyperactive (N = 76) Control (N = 44)	17–24	Open-ended psychiatric interviews	Clinical evaluation (assessed between age 6–12)	Hyperactive group reported higher number of automobile accidents
Murphy and Barkley[10]	ADHD (N = 25) Control (N = 25)	17–30	Self-report, DMV records, video test of driving knowledge	DSM-IV	ADHD group more likely to have negative driving outcomes (speeding citations, automobile crashes and resulting bodily harm)

Abbreviations: ADHD = attention-deficit/hyperactivity disorder, DMV = Department of Motor Vehicles.

control subjects. These investigators also identified correlations between impairments in inhibition capacity and accident frequency and between interference control impairment and traffic violations. These findings suggested that cognitive differences might contribute to the effect of ADHD on driving deficits.

Likewise, although ADHD is known to be highly comorbid with other psychiatric disorders,[12,13] limited information is available on the impact of psychiatric comorbidity on driving behavior in ADHD individuals. Although Barkley et al. reported that the subgroup of ADHD young adults who also had oppositional defiant disorder (ODD) and conduct disorder (CD) were at greatest risk for poor driving outcomes,[7] they failed to replicate these findings in a subsequent study of ADHD adults.[14] A questionnaire survey of 56 adults with ADHD identified more driving-related anger and aggressive driving than control subjects,[15] suggesting that comorbid mood disorders may adversely impact driving in individuals with ADHD. However, because previous research examining factors contributing to poor driving in ADHD subjects has focused largely on differences between ADHD and non-ADHD drivers, more information is needed to assess whether patterns of comorbidity and neuropsychological deficits moderate driving behavior in ADHD individuals.

The identification of factors contributing to poor driving in ADHD subjects is a subject of high clinical and public health importance. Such research may allow clinicians and researchers to focus intervention efforts aimed at improving driving behavior in ADHD individuals who are at particularly high risk for poor driving outcomes. Such efforts have the potential to improve individual and public traffic safety.

The main goal of this study was to examine factors contributing to poor driving in ADHD subjects. We hypothesized that ADHD symptomatology, neuropsychological deficits, and patterns of comorbidity would correlate with impaired driving in ADHD individuals. To the best of our knowledge, this is the first study to investigate correlates of impaired driving in subjects with ADHD.

METHOD

Subjects

Subjects were 26 adults with DSM-IV ADHD and 23 controls without ADHD. All ADHD subjects met full DSM-IV criteria and had symptom onset in childhood and persistent symptomatology into adulthood. ADHD subjects with and without histories of treatment for the condition were included. Controls were included if they failed to meet criteria for ADHD and endorsed fewer than 3 ADHD symptoms at any level of severity. All control subjects denied any current DSM-IV ADHD symptoms except 1 subject who endorsed 2 impulsive/hyperactive symptoms and another control subject who reported "sometimes" experiencing 1 impulsive/hyperactive symptom. Participants were required to be English speakers. Excluded were subjects with an IQ less than 80. Subjects were recruited through clinical referrals to an adult ADHD program at a major medical center and through advertisement in local media. The local institutional review boards of both Massachusetts General Hospital and

Massachusetts Institute of Technology approved this study separately, and all subjects provided written informed consent for participation to both institutions on the day they participated at the particular site.

Clinical Assessments

Diagnostic assessment relied on the Structured Clinical Interview for DSM-IV[16] supplemented for childhood disorders by modules from the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic Version (K-SADS-E).[17] Raters performing assessments and interviews were blind to the ascertainment status of the probands. Socioeconomic status (SES) was assessed with the Hollingshead 4-factor scale.[18]

To have been given a full diagnosis of adult ADHD, the subject must have (1) met full DSM-IV criteria (at least 6 of 9 symptoms) for inattentive or hyperactive/impulsive subtypes, with the onset of multiple symptoms by age 7 years; (2) described a chronic course of ADHD symptoms from childhood to adulthood; and (3) endorsed a moderate or severe level of impairment attributed to the ADHD symptoms.

To elicit ADHD symptomatology, we used the ADHD module from the K-SADS-E, wording questions to inquire if symptoms in childhood were currently present and then asking whether the symptoms were present currently to a clinically meaningful degree. By using this method, we assured that the syndrome observed in adulthood had some continuity with the syndrome reported in childhood.

All subjects were also evaluated using neuropsychological testing and structured diagnostic interviews. Full-Scale IQ was formulated by the Vocabulary and Matrix Reasoning subtests of the Wechsler Abbreviated Scale of Intelligence[19] or estimated[20] from the Vocabulary and Block Design subtests of the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III).[21] Additional tests included: (1) the Oral Arithmetic, Digit Span, Digit Symbol-Coding, and Symbol Search subtests from the WAIS-III[21,22]; and (2) the Stroop Color-Word Test[23] or Color-Word Interference subtest from the Delis-Kaplan Executive Function System.[24]

Driving Assessments

Subjects completed 2 driving questionnaires: a U.S. version of the Manchester Driver Behavior Questionnaire (DBQ) and a survey that collected information about each subject's driving history. The DBQ was developed as an inventory of behaviors associated with poor driving outcomes. It measures self-reported risky driving behaviors categorized as lapses, errors, and violations.[25–27] Lapses are minor attention or memory failures. Errors are defined as the failure of planned actions to achieve their intended consequences with potential for dangerous outcome. Violations are deliberate deviations from safe driving practice. High DBQ violation scores have correlated with past accident involvement and the likelihood of involvement in future accidents.[26,28]

The DBQ consists of 24 items in which participants are asked to indicate how often they engaged in each type of behavior while driving. Responses are recorded on a 6-point scale, ranging from 0 to 5, where higher scores indicate engaging in risky driving behaviors more frequently. The U.S. version of the DBQ was created by clarifying language and translating DBQ driving descriptions found in versions of the DBQ created for United Kingdom drivers[28,29] to refer to equivalent North American driving experiences. The original 3-factor structure of the DBQ that divides responses into measures of errors, violations, and lapses was utilized.[25–27]

The second survey was a driving history questionnaire consisting of 62 questions on a person's driving experience. This survey, which was not previously validated, collects history of driving behaviors and motor vehicle accidents. These 10 items were chosen a priori to minimize multiple comparisons as the relevant set of poor driving outcomes (i.e., accidents and moving violations) from the more extensive driving history questionnaire used. Items from the questionnaire not used included driving history (e.g., "Did you have a learner's permit?") or behaviors (e.g., "Do you wear a seatbelt?") not associated with moving violations or accidents.

Statistical Analyses

Continuous outcomes were analyzed using 2-sample t tests. Degrees of freedom were calculated using the Satterthwaite approximation in the case of unequal variances. The Pearson χ^2 test was used for binary and categorical outcomes, and the Fisher exact test was used in its place if the distributional assumptions were violated. Negative binomial regression was used for count variables (i.e., total number of comorbidities). Effect sizes were calculated using Cohen's d and Cohen's w (also known as phi in the 2×2 case). Alpha was set at 0.01 to avoid type I errors, and all tests were 2-tailed. Results were also considered meaningful trends if a medium or large effect size was found (at least 0.5 for Cohen's d and at least 0.3 for Cohen's w).

RESULTS

Comparisons Between ADHD and Control Subjects

ADHD and control subjects did not differ as to gender or socioeconomic status. Although the mean ages for all subjects ranged from 18 to 51 years, the mean ± SD age of ADHD subjects was somewhat older than that for controls (32.8 ± 8.9 vs. 27.3 ± 7.1, $p = .02$).

Examination of findings stemming from the 10 items representative of driving history showed that rates of both types of moving violations and all types of collisions were higher in the ADHD group than the control group

Table 2. Driving History and Behavior in ADHD and Control Subjects

Measure	ADHD (N = 26)	Controls (N = 23)	Statistic: Type	Statistic: Significance	Statistic: Effect Size
Driving history	N (%)	N (%)	χ^2 (df = 1)	p Value	Cohen's w
Moving violations					
≥ 2 Speeding	16 (64)	12 (52)	0.69	.41	0.12
Other	15 (60)	9 (43)	1.34	.25	0.17
Collisions					
Vehicle in roadway	16 (64)	12 (52)	0.69	.41	0.12
At intersection	11 (44)	6 (26)	1.68	.20	0.19
At night	11 (44)	5 (22)	2.67	.10	0.24
On highway	9 (35)	2 (9)	4.71	.03	0.31
Did not stop to tell	6 (23)	1 (4)	3.50	.06	0.27
Rear-ended someone	14 (54)	7 (30)	2.73	.10	0.24
Was rear-ended	13 (50)	4 (17)	5.73	.02	0.34
Stationary object causing damage	13 (50)	9 (39)	0.58	.45	0.11
Driver Behavior Questionnaire	Mean ± SD	Mean ± SD	t	p Value	Cohen's d
Errors	9.3 ± 5.4	4.6 ± 3.5	–3.71	< .001	1.13
Lapses	12.4 ± 6.2	6.1 ± 3.5	–4.44	< .001	1.41
Violations	12.4 ± 5.2	7.4 ± 4.1	–3.74	< .001	1.10
Total DBQ score	34.1 ± 15.2	18.0 ± 8.6	–4.62	< .001	1.46

Abbreviations: ADHD = attention-deficit/hyperactivity disorder, DBQ = Driver Behavior Questionnaire, SD = standard deviation.

(Table 2). Although no statistically significant differences were found, interesting trends were found for 2 types of collisions. Specifically, more ADHD subjects had been in an accident on the highway (35% vs. 9%, p = .03) or had been rear-ended (50% vs. 17%, p = .02) compared with controls (Table 2).

Consistent with these results were those obtained in the analysis of the DBQ. This analysis showed that ADHD subjects had significantly higher mean ± SD scores than control subjects on the total DBQ (34.1 ± 15.2 vs. 18.0 ± 8.6, p < .001) and in all 3 subscales of the DBQ: errors (9.3 ± 5.4 vs. 4.6 ± 3.5, p < .001), lapses (12.4 ± 6.2 vs. 6.1 ± 3.5, p < .001), and violations (12.4 ± 5.2 vs. 7.4 ± 4.1, p < .001) (Table 2).

Comparisons of ADHD Subjects at High and Low Risk for Poor Driving Outcomes

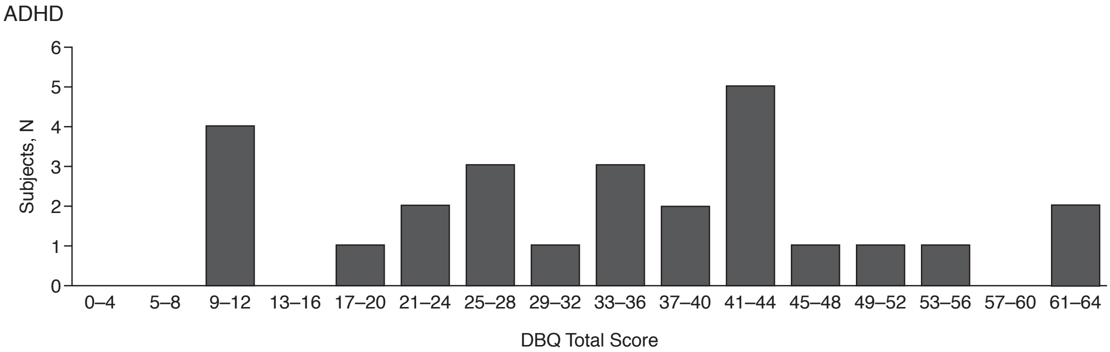
DBQ total scores for ADHD participants are shown in Figure 1, and DBQ scores for controls are shown in Figure 2. These figures illustrate the large variance in DBQ total score in the ADHD group compared with the control group. As can be seen in Figure 2, all of the control subjects had scores less than 35 on the DBQ. Thus, we used this cutoff score to stratify ADHD subjects into 2 dichotomous groups at "high" (≥ 35) (ADHD High-Risk Drivers; N = 15) and "low" (< 35) (ADHD Low-Risk Drivers; N = 11) risk for poor driving outcomes. That is, ADHD Low-Risk Drivers had a DBQ score in the same range as the control subjects, while the ADHD High-Risk Drivers had higher DBQ scores than all the control subjects. Using the mean ADHD DBQ score would have provided the same cutoff score.

ADHD High-Risk Drivers did not differ from ADHD Low-Risk Drivers on any of the demographic variables assessed (Table 3). Although failing to reach our threshold for statistical significance, ADHD High-Risk Drivers showed trends of having substantially higher rates of several comorbidities compared with ADHD Low-Risk Drivers, including major depressive disorder (60% vs. 27%, p = .13, w = 0.32), ODD (40% vs. 9%, p = .18, w = 0.34), language disorder (33% vs. 0%, p = .053, w = 0.42), and multiple anxiety disorders (27% vs. 0%, p = .11, w = 0.37) (Table 3). ADHD High-Risk Drivers also exhibited a trend toward more impaired mean ± SD scores on Digit Symbol-Coding (8.6 ± 2.1 vs. 10.5 ± 3.1, p = .08, d = 0.75) and Symbol Search (8.9 ± 2.7 vs. 10.6 ± 2.9, p = .17, d = 0.64) compared with ADHD Low-Risk Drivers. In addition, ADHD High-Risk Drivers showed a trend of more impaired mean ± SD performance on the Stroop inhibition score compared with ADHD Low-Risk Drivers (42.3 ± 12.1 vs. 50.1 ± 18.7, p = .21, d = 0.53) (Table 3).

DISCUSSION

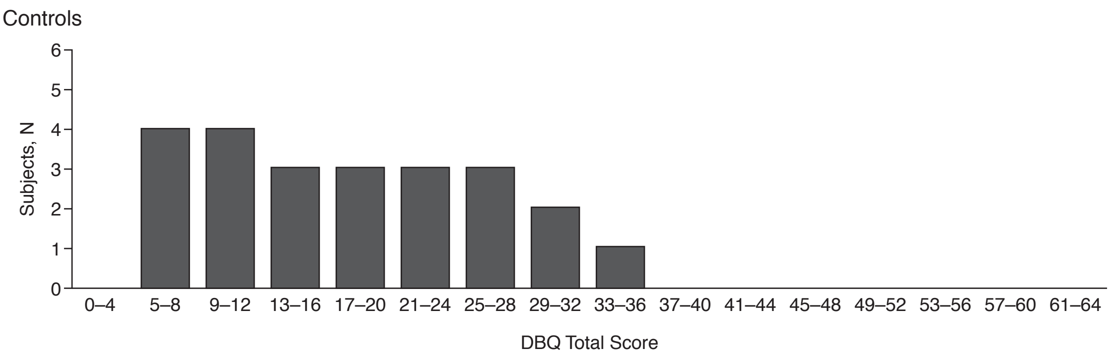
This study compared the driving behavior of subjects with and without ADHD on the Manchester Driving Behavior Questionnaire (DBQ) and a driving history questionnaire. Our results document that ADHD subjects scored significantly worse than non-ADHD subjects on all aspects indexing impaired driving behavior. ADHD subjects at high risk for impaired driving differed from other ADHD drivers in patterns of comorbidity and neuropsychological deficits. These findings confirm and extend previous research linking ADHD to impaired driving behavior and suggest that a subgroup of ADHD drivers at high risk for impaired driving could be identified.

Figure 1. Distributions of Driving Behavior Questionnaire (DBQ) Total Score for ADHD Participants



Abbreviation: ADHD = attention-deficit/hyperactivity disorder.

Figure 2. Distributions of Driving Behavior Questionnaire (DBQ) Total Score for Controls



The trends we found suggesting that adults with ADHD had higher rates of collisions on the highway and rear-ended accidents compared with those reported by control subjects are consistent with previous studies. For example, an early longitudinal study[6] found that adolescents and young adults diagnosed with ADHD were more likely to be involved in traffic accidents and more likely to incur greater damage to their automobiles relative to normal controls. Woodward et al.,[9] using a longitudinal sample in New Zealand, also found a relationship between ADHD individuals and accident risk involving injury, driving without a license, and traffic violations even after controlling for conduct problems and driving experience. Additionally, findings have been reported in previous studies using Department of Motor Vehicles records.[11,30]

The DBQ results not only documented significant differences between ADHD subjects and controls in impaired driving behavior, but there was also a cutoff score above which no non-ADHD drivers scored. ADHD drivers scoring above this cutoff point had high DBQ violations scores in comparison with other ADHD drivers, suggesting that the DBQ could be useful to stratify ADHD drivers into "High-Risk" and "Low-Risk" categories for impaired driving behavior. More work will be needed to evaluate whether members of the High-Risk category are more likely to have worse driving outcomes than other ADHD drivers. Further validation of the relationship between the DBQ and poor driving outcomes is needed to evaluate our proposed stratification of ADHD subjects into Low- and High-Risk drivers.

Although failing to reach our threshold for statistical significance, several noteworthy trends of medium to large effect sizes between ADHD subjects at High and Low Risk for impaired driving were identified. High-Risk ADHD drivers exhibited more deficits on the Digit Symbol-Coding and Symbol Search subtests of the WAIS-III. Together, these results reflect impairments in processing speed.[21,22] Processing speed deficits have been documented in the literature as differing significantly when ADHD subjects are compared with controls.[31] Willcutt et al.[32] have also documented that slow and variable processing speed was characteristic of the 3 groups that they studied including those with reading disorders

Table 3. Comparisons Between High- and Low-Risk Drivers With ADHD

Measure	ADHD High-Risk (N = 15)	ADHD Low-Risk (N = 11)	Statistic: Test	p Value	Effect Size
Demographics					
Age (y), mean ± SD	32.4 ± 8.5	33.5 ± 9.8	t = 0.29	.77	d = 0.12
Males, N (%)	7 (47)	6 (55)	χ^2 (df = 1) = 0.16	.69	w = 0.08
Socioeconomic status, mean ± SD	1.8 ± 0.6	1.8 ± 0.6	t = 0.06	.95	d = 0.03
DBQ violation score,[a] mean ± SD	15.4 ± 4.4	8.3 ± 3.0	t = –4.65	< .001	d = 1.92
ADHD characteristics					
Total number of current symptoms, mean ± SD	13.3 ± 3.3	13.1 ± 2.9	t = –0.14	.89	d = 0.06
Inattentive type, N (%)	8 (53)	5 (45)	χ^2 (df = 1) = 0.16	.69	w = 0.08
Hyperactive/impulsive type, N (%)	0 (0)	0 (0)			
Combined type, N (%)	7 (47)	6 (55)			
Neuropsychological tests, mean ± SD					
Cognitive					
WASI Vocabulary	13.3 ± 2.2	13.4 ± 2.7	t = 0.03	.98	d = 0.01
WAIS-III Digit Span	11.1 ± 3.2	10.0 ± 2.4	t = –0.93	.36	d = 0.39
WAIS-III Arithmetic	11.3 ± 1.7	12.0 ± 1.4	t = 1.05	.30	d = 0.43
WAIS-III Digit Symbol-Coding	8.6 ± 2.1	10.5 ± 3.1	t = 1.82	.08	d = 0.75
WAIS-III Symbol Search	8.9 ± 2.7	10.6 ± 2.9	t = 1.53	.17	d = 0.64
WAIS-III Full-Scale IQ	111.6 ± 10.9	115.6 ± 12.6	t = 0.87	.39	d = 0.36
Stroop					
Word Reading	43.1 ± 11.6	45.4 ± 13.2	t = 0.47	.64	d = 0.19
Color Naming	39.7 ± 10.9	44.3 ± 11.9	t = 1.02	.32	d = 0.42
Inhibition	42.3 ± 12.1	50.1 ± 18.7	t = 1.29	.21	d = 0.53
Psychiatric comorbidity, N (%)*					
Multiple comorbidites[b]	10 (67)	5 (45)		.43	w = 0.21
Major depressive disorder	9 (60)	3 (27)		.13	w = 0.32
Bipolar disorder	2 (13)	0 (0)		.49	w = 0.25
Psychoactive substance use disorders	10 (67)	10 (91)		.20	w = 0.28
Oppositional defiant disorder	6 (40)	1 (9)		.18	w = 0.34
Conduct disorder	1 (7)	1 (9)		1.00	w = 0.04
Antisocial personality disorder	2 (13)	0 (0)		.49	w = 0.25
Language disorder	5 (33)	0 (0)		.05	w = 0.42
Tic disorder	1 (7)	0 (0)		1.00	w = 0.17
Multiple (≥ 2) anxiety disorders[c]	4 (27)	0 (0)		.11	w = 0.37

[a]Total of the 8 DBQ items that measure driving violations.
[b]Having at least 2 of the 9 disorders individually assessed.
[c]Defined as having at least 2 of the following: separation anxiety disorder, avoidant disorder, simple phobia, social phobia, panic disorder, agoraphobia, obsessive-compulsive disorder, generalized anxiety disorder, and posttraumatic stress disorder.
*Fisher exact test.
Abbreviations: ADHD = attention-deficit/hyperactivity disorder, DBQ = Driver Behavior Questionnaire, SD = standard deviation, WAIS-III = Wechsler Adult Intelligence Scale, Third Edition, WASI = Wechsler Abbreviated Scale of Intelligence.

without ADHD, ADHD without a reading disorder, and those subjects with both reading disorders and ADHD. They conclude that measures of this domain may be useful for future studies that search for the common genes that increase susceptibility to reading disorder and ADHD. The findings of Rucklidge and Tannock[31] also purport difficulties on the Digit Symbol-Coding subtest of the Wechsler scales to be specifically predictive of inattentive symptoms within ADHD. Since driving studies[33] often refer to speed of mental processing as being important in the assessment of driving skills, more work is needed to correlate the effects of the processing speed deficits found on IQ tests with driving histories and questionnaires.

Our results are consistent with those reported by Barkley et al.,[11] who found that ADHD individuals exhibited less knowledge of driving rules and regulations than control subjects in a test that required rapid decision-making. As noted in their discussion of this finding, this performance difference could be due to a deficit in rapid decision-making in the ADHD subjects. Although further study is necessary to clarify whether rapid decision-making is more challenging for ADHD drivers than for those without ADHD, cognitive challenges such as lower processing speed could certainly contribute to poor performance in rapid driving decisions. Future studies of rapid decision-making by ADHD drivers could benefit from focusing on ADHD individuals who report poor driving behaviors, as they may be more likely to have slower processing speeds. If confirmed in future studies, processing speed deficits should be considered both in the clinical care of individuals diagnosed with ADHD and in making recommendations for management of safe driving, such as recommending that these individuals be medicated while driving.

Some noteworthy trends also emerged in the comorbidity profile of Low- and High-Risk ADHD drivers. Our results showed that High-Risk ADHD drivers had substantially higher rates of major depression, ODD, multiple anxiety disorders, and language disorders. The percentage of individuals with ODD was 4 times as large in the High-Risk ADHD drivers as in the Low-Risk group. These findings are consistent with the report by Barkley et al.[7] of a relationship between the presence of ODD and CD symptoms and measures of negative driving behaviors or outcomes.[7] However, our findings are discrepant with those reported by Barkley et al.[11] that failed to find associations between comorbidity with ODD, depression, and anxiety and driving characteristics in 105 ADHD individuals aged 17 to 28 years. Future studies are needed to better clarify the role of psychiatric comorbidity as a risk factor for poor driving in ADHD subjects.

Our study also found that ADHD High-Risk drivers might be more likely to have a comorbid language disorder than ADHD Low-Risk drivers. Although the reasons for this finding are not entirely clear, it is congruent with the other neuropsychological results identified in this study and in the literature where processing speed deficits are an underlying factor in many individuals diagnosed with a language disorder.

Our findings documenting impaired driving behaviors in adults with ADHD, as well as prior work on the subject, further support the morbidity and dysfunction associated with ADHD in adult life. Considering the fundamental and public health importance of reducing the risk to individuals with ADHD and others through their impaired driving behavior, more research is needed on driving outcomes in people with ADHD.

Our findings should be viewed in light of some methodological limitations. Our control group was somewhat younger than our ADHD group. However, because younger drivers are documented to have poorer driving outcomes compared with older drivers, any bias created by this age difference would be toward the null hypothesis that ADHD and control subjects do not differ on their driving history. Additionally, the DBQ has not been validated for use in an American sample, although versions of this instrument have been shown to be valid across cultures.[29] Although we identified differences between the High-Risk and Low-Risk DBQ groups reflected by medium to strong effects, statistical significance was often not met. Although these nonsignificant results in the context of medium to large effect sizes could have been due to type II errors secondary to our small sample size, until confirmed in better powered studies, our findings should be viewed as preliminary and hypothesis generating.

Despite the aforementioned limitations, our results confirm that ADHD subjects score significantly worse than non-ADHD subjects on all aspects of driving behavior. Our results also suggest that a subgroup of ADHD subjects at high risk for poor driving outcomes who have specific patterns of ADHD symptoms, comorbidity, and neuropsychological deficits can be identified. Although preliminary and awaiting confirmation, these results suggest that it may be possible to identify ADHD individuals at greatest risk for poor driving outcomes based on driving history and clinical characteristics.

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