CHARACTERIZING IMPAIRED DRIVING IN ADULTS WITH ADHD: A CONTROLLED STUDY

R. Fried, EdD; C. Petty, MA; C. Surman, MD; B. Reimer, PhD; M. Aleardi, BA; J. Martin, MA; J. Coughlin, PhD; J. Biederman, MD
Clinical and Research Program in Pediatric Psychiatry and Adult ADHD at Massachusetts General, Massachusetts Institute of Technology, and Harvard Medical School

ABSTRACT

Introduction: Individuals with ADHD have been shown to have poor driving behavior compared to those without ADHD. We sought to confirm these previous findings as well as determine the correlates of poor driving behavior within the adults with ADHD. **Methods:** We compared 26 adults with ADHD and 23 without ADHD on driving history using the Driver Behavior Questionnaire (DBQ). **Results:** ADHD subjects had significantly poorer driving histories and driving behavior compared to Control subjects. When ADHD subjects were stratified into High (N=15) and Low (N=11) Risk Drivers based on their scores on the DBQ, ADHD High Risk Drivers had higher rates of ADHD on several comorbid disorders compared to the ADHD Low Risk Drivers. Medium to large effects were found for processing speed and inhibition scores when comparing ADHD High and Low Risk Drivers. **Conclusion:** Our findings suggest that high and low risk drivers with ADHD can be identified using the DBQ. High-risk drivers differ from other drivers with ADHD by slower processing speed and higher rates of comorbidity.

BACKGROUND

It is estimated that Attention Deficit Hyperactivity Disorder (ADHD) afflicts approximately 4% of adults in this country. Emerging data from clinical and community samples document that ADHD in adults is associated with high levels of morbidity and dysfunction. One of the key areas of dysfunction associated with ADHD is impaired motor vehicle operation. 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. However, despite positive gains in understanding the relationship between ADHD and driving, limited progress has been made towards understanding what particular characteristics contribute to high risk driving behaviors of ADHD individuals.

METHODS

Subjects
• Adult subjects with (n=26) and without DSM-IV ADHD (n=23).
• All ADHD subjects met full DSM-IV criteria, and had symptom onset in childhood and persistent symptomatology into adulthood.
• Control subjects were included if they failed to meet criteria for ADHD or had fewer than three ADHD symptoms.
• Diagnostic assessment relied on the Structured Clinical Interview for DSM-IV supplemented for childhood disorders by modules from the Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children-Epidemiologic Version. Raters performing assessments and interviews were blind to the ascertainment status of the probands.

Driving Assessment

Subjects completed two driving questionnaires:
• The DBQ was developed as an inventory of behaviors associated with poor driving outcomes. It consists of 24 questions on self-reported risky driving behaviors categorized as lapses, errors, and violations.
  • 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.
  • Responses are recorded on a six-point scale (0-5) where higher scores indicate engaging in risky driving behaviors more frequently.
  • High DBQ violation scores have correlated with past accident involvement and the likelihood of involvement in future accident.
• The second survey was a driving history questionnaire consisting of 62 questions on a person's driving experience.

RESULTS

• The driving histories of the ADHD and control subjects were compared using ten representative items from the driving history questionnaire (Table 2). These ten 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.

• Examination of findings stemming from these 10 representative items showed that rates of both types of moving violations and all types of collisions were higher in the ADHD group than the control group. Significant differences were found for two types of collisions. Specifically, significantly more ADHD subjects had been in an accident on the highway (35% versus 9%, p=0.03) or had been rear-ended (50% versus 17%, p=0.02) compared to controls (Table 2).

• Consistent with these results were those obtained in the analysis of the Driver Behavior Questionnaire (DBQ). This analysis showed that ADHD subjects scored significantly higher than control subjects on the total DBQ (34.1 ± 15.2 versus 18.0 ± 8.6, p<0.001) and in all three subscales of the DBQ: errors (9.3 ± 5.4 versus 4.6 ± 3.5, p<0.001), lapses (12.4 ± 6.2 versus 6.1 ± 3.5, p<0.001), and violations (12.4 ± 5.2 versus 7.4 ± 4.1, p<0.001) (Table 2).

• Analysis of the DBQ findings showed that ADHD subjects scored significantly higher than control subjects on the total DBQ (34.1 15.2 versus 18.0 8.6, p<0.001) (Figure 1)

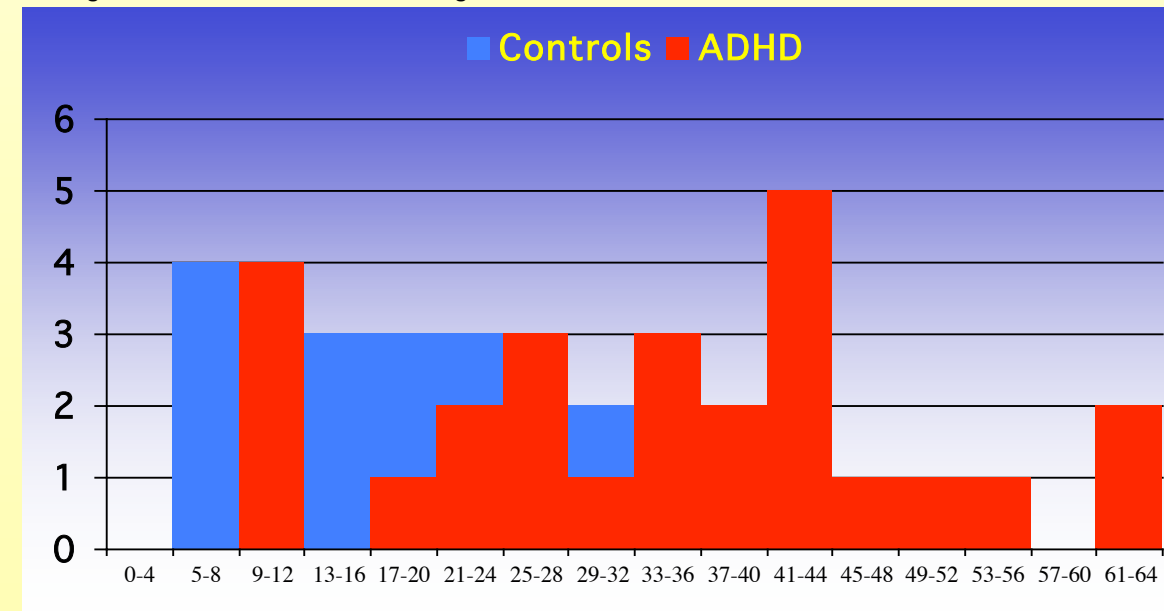**Figure 1: Distributions of Driving Behavior Questionnaire Total Score for ADHD and Controls.**

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

Driving History	ADHD (N=26) N (%)	Controls (N=23) N (%)	Test Statistic $\chi^2_{(1)}$	p-value	Effect Size Cohen's w
Moving Violations					
?2 Speeding	16 (64)	12 (52)	0.69	0.41	0.12
Other	15 (60)	9 (43)	1.34	0.25	0.17
Collisions					
Vehicle in Roadway	16 (64)	12 (52)	0.69	0.41	0.12
At Intersection	11 (44)	6 (26)	1.68	0.20	0.19
At Night	11 (44)	5 (22)	2.67	0.10	0.24
On Highway	9 (35)	2 (9)	4.71	0.03	0.31
Did Not Stop to Tell	6 (23)	1 (4)	3.50	0.06	0.27
Rear-ended Someone	14 (54)	7 (30)	2.73	0.10	0.24
Was Rear-ended	13 (50)	4 (17)	5.73	0.02	0.34
Stationary Object Causing Damage	13 (50)	9 (39)	0.58	0.45	0.11

Driver Behavior Questionnaire	Mean ± SD	Mean ± SD	t-statistic	p-value	Effect Size (Cohen's d)
Errors	9.3 ± 5.4	4.6 ± 3.5	-3.71	<0.001	1.13
Lapses	12.4 ± 6.2	6.1 ± 3.5	-4.44	<0.001	1.41
Violations	12.4 ± 5.2	7.4 ± 4.1	-3.74	<0.001	1.10
Total DBQ Score	34.1 ± 15.2	18.0 ± 8.6	-4.62	<0.001	1.46

Comparisons of ADHD Subjects at High and Low Risk for Poor Driving Outcomes
• Figure 1 displays the distributions of the ADHD and control subjects' DBQ total scores. The figure illustrates the large variance in DBQ total score in the ADHD group compared to the control group. As can be seen in Figure 1, all of the control subjects had scores less than 35 on the DBQ. Thus, we used this cutoff score to stratify ADHD subjects into two 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.

• 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 had substantially higher rates of several comorbidities compared to ADHD Low Risk Drivers, including major depressive disorder (60% versus 27%, p=0.13, w=0.32), oppositional defiant disorder (40% versus 9%, p=0.18, w=0.34), language disorder (33% versus 0%, p=0.053, w=0.42), and multiple anxiety disorders (27% versus 0%, p=0.11, w=0.37) (Table 3).

ADHD High Risk Drivers also exhibited more impaired scores on Digit Symbol Coding and Symbol Search (compared to ADHD Low Risk Drivers. In addition, ADHD High Risk Drivers had more impaired performance on the Stroop inhibition score compared to ADHD Low Risk Drivers (Table 3).

Table 3. Comparisons between High and Low Risk Drivers with ADHD.

Demographics	ADHD High Risk (N=15)	ADHD Low Risk (N=11)	Test Statistic	p-value	Effect Size
Age	32.4 ± 8.5	33.5 ± 9.8	t = 0.29	0.77	d = 0.12
Males N (%)	7 (47)	6 (55)	$\chi^2_{(1)}$=0.16	0.69	w = 0.08
Socioeconomic Status	1.8 ± 0.6	1.8 ± 0.6	t = 0.06	0.95	d=0.03
DBQ Violation Score[a]	15.4 ± 4.4	8.3 ± 3.0	t = -4.65	<0.001	d = 1.92
ADHD Characteristics	ADHD High Risk (N=15)	ADHD Low Risk (N=11)	Test Statistic	p-value	Effect Size (Cohen's d)
	Mean ± SD	Mean ± SD			
Total Number of Current Symptoms	13.3 ± 3.3	13.1 ± 2.9	t=-0.14	0.89	0.06
	N (%)	N (%)	Test Statistic	p-value	Effect Size (Cohen's w)
Inattentive Type	8 (53)	5 (45)	$\chi^2_{(1)}$=0.16	0.69	0.08
Hyperactive/Impulsive Type	0 (0)	0 (0)			
Combined Type	7 (47)	6 (55)			
Neuropsychological Tests	Mean ± SD	Mean ± SD			
Cognitive					
WASI Vocabulary	13.3 ± 2.2	13.4 ± 2.7	0.03	0.98	0.01
Digit Span	11.1 ± 3.2	10.0 ± 2.4	-0.93	0.36	0.39
Arithmetic	11.3 ± 1.7	12.0 ± 1.4	1.05	0.30	0.43
Digit Symbol/Coding	8.6 ± 2.1	10.5 ± 3.1	1.82	0.08	0.75
Symbol Search	8.9 ± 2.7	10.6 ± 2.9	1.53	0.17	0.64
Full IQ	111.6 ± 10.9	115.6 ± 12.6	0.87	0.39	0.36
Stroop					
Word Reading	43.1 ± 11.6	45.4 ± 13.2	0.47	0.64	0.19
Color Naming	39.7 ± 10.9	44.3 ± 11.9	1.02	0.32	0.42
Inhibition	42.3 ± 12.1	50.1 ± 18.7	1.29	0.21	0.53
Psychiatric Comorbidity	N (%)	N (%)			
Major Depressive Disorder	9 (60)	3 (27)		0.13	0.32
Bipolar Disorder	2 (13)	0 (0)		0.49	0.25
Psychoactive Substance Use Disorders	10 (67)	10 (91)		0.20	0.28
Oppositional Defiant Disorder	6 (40)	1 (9)		0.18	0.34
Conduct Disorder	1 (7)	1 (9)		1.00	0.04
Antisocial Personality Disorder	2 (13)	0 (0)		0.49	0.25
Language Disorder	5 (33)	0 (0)		0.053	0.42
Tic Disorder	1 (7)	0 (0)		1.00	0.17
Multiple (?2) Anxiety Disorders [b]	4 (27)	0 (0)		0.11	0.37

[a] Total of the eight Driver Behavior Questionnaire items that measure driving violations
[b] Defined as having at least two 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.

CONCLUSIONS

Our results confirm that ADHD subjects score significantly worse than non-ADHD subjects on all aspects of driving behavior. They also suggest that a subgroup of ADHD subjects at high risk for poor driving outcomes can be identified who have specific patterns of ADHD symptoms, comorbidity, and neuropsychological deficits. More work is needed to further evaluate this high risk group.