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## Motor vehicle driving in high incidence psychiatric disability: Comparison of drivers with ADHD, depression, and no known psychopathology

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## ABSTRACT

Although not often discussed in clinical settings, motor vehicle driving is a complex multitasking endeavor during which a momentary attention lapse can have devastating consequences. Previous research suggests that drivers with high incidence psychiatric disabilities such as ADHD contribute disproportionately to collision rates, which in turn portend myriad adverse social, financial, health, mortality, and legal outcomes. However, self-referral bias and the lack of psychiatric comparison groups constrain the generalizability of these findings. The current study addressed these limitations and examined the unique associations among ADHD, Depression, and adverse driving outcomes, independent of self-selection, driving exposure, and referral bias. The Strategic Highway Research Program (SHRP-2) Naturalistic Driving Study comprises U.S. drivers from six sites selected via probability-based sampling. Groups were defined by Barkley ADHD and psychiatric diagnosis questionnaires, and included *ADHD* ( $n = 275$ ), *Depression* ( $n = 251$ ), and *Healthy Control* ( $n = 1828$ ). Primary outcomes included self-reported traffic collisions, moving violations, collision-related injuries, and collision fault (last 3 years). Accounting for demographic differences, ADHD but not Depression portended increased risk for multiple violations (OR = 2.3) and multiple collisions (OR = 2.2). ADHD but not Depression portended increased risk for collision fault (OR = 2.1). Depression but not ADHD predicted increased risk for self-reported injury following collisions (OR = 2.4). ADHD appears uniquely associated with multiple collisions, multiple violations, and collision fault, whereas Depression is uniquely associated with self-reported injury following a collision. Identification of the specific mechanisms underlying this risk will be critical to designing effective interventions to improve long-term functioning for drivers with high incidence psychiatric disability.

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The upsurge of research into adult attention-deficit/hyperactivity disorder (ADHD) reflects an improved understanding of the lifetime course of this chronic and potentially impairing neurodevelopmental disorder (Klein et al., 2012; Barkley et al., 2002). Prospective studies reveal that most children with ADHD continue to meet full diagnostic criteria in adolescence (70%–80%)

and adulthood (46%–66%) (Mannuzza et al., 1993; Barkley et al., 2002; Biederman et al., 2010). These findings are consistent with epidemiological estimates for childhood (5%) (Polanczyk et al., 2007) relative to adult ADHD (4%) (Faraone et al., 2003), and clearly position ADHD as a high incidence disability throughout the lifespan when considered in the context of the disorder's broad impact on functioning (Wilens et al., 2004).

In childhood, ADHD is associated with impairments in academic, peer, and family functioning (Pelham and Fabiano, 2008; Bagwell et al., 2001). Adult ADHD studies confirm continued impairments in these areas, (Wilens et al., 2004) and have identified two additional areas of concern: occupational functioning, (Barkley and Fischer, 2011) and motor vehicle driving (Jerome et al., 2006;

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Barkley and Cox, 2007). Although not often discussed in the clinical setting, motor vehicle driving is a complex, cognitive-motor-perceptual, multitasking endeavor that involves controlling a multi-ton projectile through time and space while negotiating road, traffic, passenger, and technology demands (Cox et al., 2011). In this context, a momentary attentional lapse can have devastating consequences; U.S. car crashes are associated annually with over 34,000 deaths, 2.3 million non-fatal injuries, and \$99 billion in costs. Converging data suggest that drivers with high incidence disabilities such as ADHD disproportionately contribute to automobile collision rates, as well as moving violations and license suspensions/revocations (Cox et al., 2011).

Studies of drivers with ADHD consistently report that they have more citations and collisions, more expensive collisions, and are more likely to be at-fault for collisions, with relative risk ranging from 1.23 to 1.88 across meta-analyses (Cox et al., 2011; Vaa, 2003, 2014). A serious shortcoming of most studies, however, is their reliance on self-selected samples recruited specifically to examine the impact of ADHD on their driving behavior (Cox et al., 2011; Chang et al., 2014). This potential for self-referral bias and associated demand characteristics are significant confounds that constrain the external validity of previous findings. In addition, no study has directly compared drivers with ADHD to drivers with other clinical disorders (e.g., Depression) despite meta-analyses suggesting similar driving risk among drivers with ADHD and Depression (Vaa, 2003). This omission is critical given that drivers with Depression have a relative risk for increased collision rates ranging from 1.10 to 2.55 (Vaa, 2003; Bulmash et al., 2006). Whether ADHD portends increased risk for adverse driving outcomes beyond other high incidence disorders such as Depression remains unknown. Finally, fewer than 50% of previous studies reported annual miles/kilometers driven, despite the known association between exposure and collision/violation risk (Vaa, 2014). Thus, the extent to which previous findings are attributable to participant perception, self-selection processes, comorbidity, exposure, or other high incidence psychopathology remains unknown.

The present study addressed these limitations by examining violations, collisions, collision-related injuries, and collision fault in a large, nationally representative sample of U.S. drivers with (a) ADHD, (b) Depression, and (c) no known psychopathology participating in the Strategic Highway Research Program 2 (SHRP-2) Naturalistic Driving Study. SHRP-2 is a 6-center, prospective, naturalistic driving study (Antin et al., 2011). Importantly, drivers were not selected based on diagnostic status but rather completed diagnostic measures after study enrollment (Antin et al., 2011). Thus, the present study allows us to examine the extent to which two high incidence psychopathologies (ADHD, Depression) are associated with adverse driving outcomes, independent of the potential role of self-selection, demand characteristics, driving exposure, and referral bias.

We hypothesized that drivers with ADHD, (Vaa, 2014) and drivers with depression, (Vassallo et al., 2008; Scott-Parker et al., 2013) would endorse more violations, collisions, collision-related injuries, and collision faults relative to Healthy Controls. No predictions were made regarding the relative risk for drivers with ADHD relative to drivers with Depression given the paucity of research.

## 1. Method

### 1.1. Design and overview

The SHRP-2 Naturalistic Driving Study consists of 3,600 drivers from six U.S. sites (New York, Washington, Pennsylvania, Indiana,

Florida, and North Carolina). A detailed description of study recruitment, participants, and methodology is provided in Antin et al. (2011). Briefly, participants were selected through a probability-based sampling approach and consented to have their vehicles outfitted with a sophisticated data acquisition system to capture day-to-day driving data continuously for 1–2 years. The current study is based on self-report data collected during the initial evaluation that included driver demographic, driving history, and psychiatric screening questionnaires.

### 1.2. Measures

#### 1.2.1. Barkley adult ADHD quick screen (BAQS)

The BAQS includes six items assessing self-reported ADHD symptoms on a 4-point Likert scale (0 = Never/Rarely, 1 = Sometimes, 2 = Often, 3 = Very Often); scores are summed across the six items and correlate 0.97 with the full, 18-item DSM-IV symptoms (Barkley et al., 2008). The recommended BAQS cutoff score of 7 correctly identifies 93% of ADHD and 99% and non-ADHD adults (Barkley et al., 2008).

#### 1.2.2. Psychological diagnoses questionnaire

The psychological diagnoses questionnaire instructed participants to indicate if they currently met diagnosis for Depression, Anxiety, Bipolar Disorder, ADHD/ADD/Tourette's, Psychotic or Personality Disorders. Participants selected all diagnoses that were applicable. Drivers who endorsed "ADHD/ADD/Tourette's" were included in the ADHD group unless they met the exclusion criteria below given the rarity of Tourette's Syndrome in adulthood (0.002%–0.04%) (Burd et al., 1989; Apter et al., 1993).

#### 1.2.3. Driving history and demographic questionnaire

The driving history and demographic questionnaire assessed participant age, gender, marital status, and annual miles driven. Participants reported violation and collision frequency over the past 3 years (0, 1, 2 + collisions/violations) as well as crash severity and fault for up to two collisions. Endorsement of violations encompassed both moving and traffic violations.

### 1.3. Inclusion and exclusion criteria

Participants who did not complete the BAQS or the psychological diagnoses questionnaire ( $n = 341$ ) were excluded (final  $N = 3,259$ ; 90.5% of SHRP-2 drivers). Group membership was assigned based on the following criteria. Participants were included in the ADHD Group with a positive BAQS screen (7+) and/or self-reported ADHD, alone ( $n = 229$ ) or comorbid with anxiety ( $n = 46$ ; total  $n = 275$ ). Participants with positive BAQS screens who reported other clinical disorders but not ADHD ( $n = 52$ ) were excluded from the ADHD group as recommended because 83% of mood disorders screen positive on the BAQS (Barkley et al., 2008). Participants were included in the Depression Group if they endorsed Depression, alone ( $n = 170$ ) or comorbid with anxiety ( $n = 81$ ), but did not self-report ADHD (total  $n = 251$ ); no BAQS criteria were set for the Depression Group. Individuals with self-reported anxiety were included in the ADHD and Depression groups if they met all other inclusion criteria given anxiety's high comorbidity with both adult ADHD and Depression (Kessler et al., 2006, 2008). Individuals were assigned to the Healthy Control Group (no known psychopathology) based on negative BAQS screen ( $<4$ ) and no self-reported psychological diagnoses ( $n = 1828$ ). Participants were excluded from all groups if they self-reported personality, psychotic, or bipolar disorders ( $n = 32$ ). The remaining 821 cases were excluded for failing to meet any group criteria (i.e., no self-reported depression

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