



Full length article

## Association of attention-deficit/hyperactivity disorder and conduct disorder with early tobacco and alcohol use



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### ABSTRACT

**Background:** The association of attention-deficit/hyperactivity disorder (ADHD) and conduct disorder (CD) with tobacco and alcohol use has not been assessed in a young adolescent sample representative of the U.S. population.

**Methods:** Data are from the 2000–2004 National Health and Nutrition Examination Survey, a cross-sectional sample representative of the U.S. population. Participants were age 12–15 years ( $N=2517$ ). Exposure variables included diagnosis of ADHD and CD, and counts of ADHD and CD symptoms based on caregiver responses to the Diagnostic Interview Schedule for Children. Primary outcomes were adolescent-report of any use of tobacco or alcohol and age of initiating use. Multivariate logistic regression and Cox proportional hazard models were conducted.

**Results:** Adolescents with ADHD + CD diagnoses had a 3- to 5-fold increased likelihood of using tobacco and alcohol and initiated use at a younger age compared to those with neither disorder. Having ADHD alone was associated with an increased likelihood of tobacco use but not alcohol use. Hyperactive-impulsive symptom counts were not independently associated with any outcome, while every one symptom increase in inattention increased the likelihood of tobacco and alcohol use by 8–10%. Although participants with a diagnosis of CD alone (compared to those without ADHD or CD) did not have a higher likelihood of tobacco or alcohol use, for every one symptom increase in CD symptoms the odds of tobacco use increased by 31%.

**Conclusions:** ADHD and CD diagnoses and symptomatology are linked to higher risk for a range of tobacco and alcohol use outcomes among young adolescents in the U.S.

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## 1. Introduction

Early onset of substance use is a significant public health concern as adolescents who use before the mid-teen years are more likely to develop dependence than those who start later (Escobedo et al., 1993; Grant and Dawson, 1997). The two most commonly used substances are tobacco and alcohol (Johnston et al., 2012). Prior studies suggest that risk for early use of these substances is increased for adolescents with attention-deficit/hyperactivity

disorder (ADHD) and conduct disorder (CD; Barkley et al., 1990; Burke et al., 2001; Chilcoat and Breslau, 1999; Elkins et al., 2007; Lee et al., 2011; Milberger et al., 1997; Molina et al., 2007a, 1999; Molina and Pelham, 2003; Sibley et al., 2014; Tercyak et al., 2002), but it is uncertain whether these disorders confer independent risk and whether their combination synergistically magnifies risk. Further, relatively few studies have focused on initiation of substance use among young adolescents (e.g., 12–15 year olds) and none have included a sample representative of the U.S. population.

Adolescents with ADHD, compared to those without ADHD, use tobacco earlier (Barkley et al., 1990; Elkins et al., 2007; Groenman et al., 2013; Milberger et al., 1997; Molina et al., 2007a; Molina and Pelham, 2003; Sibley et al., 2014), which has been linked to high levels of inattentive (IA) symptoms (Barman et al., 2004; Burke et al., 2001; Tercyak et al., 2002) and high levels of hyperactive-impulsive (HI) symptoms (Elkins et al., 2007). Adolescents with CD

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also use tobacco earlier (Elkins et al., 2007; Groenman et al., 2013). Disentangling the effects of ADHD and CD has been a challenge. In some (Burke et al., 2001), but not all (Elkins et al., 2007; Milberger et al., 1997) studies, controlling for diagnosis of CD nullifies the relationship between ADHD and early tobacco use. In addition, Molina et al. found that a comorbid ADHD+CD group, but not an ADHD only group, had higher rates of tobacco use than did a group with neither diagnosis (Molina et al., 1999).

Adolescents with ADHD, compared to those without, have been shown to use alcohol earlier in some studies (Molina et al., 2007a; Sibley et al., 2014), but not others (Burke et al., 2001; Elkins et al., 2007), and linkages to ADHD symptom domains are inconsistent (Burke et al., 2001; Elkins et al., 2007). Similarly, the independent effect of CD on early alcohol use has been mixed (Elkins et al., 2007; Molina et al., 2007a, 2007b; Sibley et al., 2014). The single study investigating joint effects of ADHD and CD found that the combination of these two disorders compounded risk for alcohol use (Molina et al., 1999).

Research on the relationship between ADHD, CD, and risk of early tobacco and alcohol use generally utilized relatively small, clinically-referred (Barkley et al., 1990; Burke et al., 2001; Milberger et al., 1997; Molina et al., 2007a, 2007b; Molina and Pelham, 2003; Sibley et al., 2014) or school-based (Molina et al., 1999; Tercyak et al., 2002) samples, potentially limiting the generalizability of findings, though some studies have used population-based twin samples (Barman et al., 2004; Elkins et al., 2007; Groenman et al., 2013). Most studies were longitudinal (Barkley et al., 1990; Barman et al., 2004; Burke et al., 2001; Elkins et al., 2007; Groenman et al., 2013; Milberger et al., 1997; Molina et al., 2007a, 2007b; Molina and Pelham, 2003; Sibley et al., 2014), but two were cross-sectional (Molina et al., 1999; Tercyak et al., 2002). The majority of prior studies with young adolescent samples compared those with and without a diagnosis of ADHD and CD or clinically significant symptoms, and it has been recognized that such categorical approaches may obscure dimensional influences above or below the diagnostic threshold (Burke et al., 2001). Indeed, studies with older adolescent or young adult samples have found that the number of ADHD symptoms is related to tobacco dependence (Elkins et al., 2007; Kollins et al., 2005) and alcohol use disorder (Elkins et al., 2007), but the impact of the full range of ADHD symptomatology in younger adolescent samples remains uncertain.

Our objective was to evaluate the association of ADHD and CD with early tobacco and alcohol use in a nationally representative young adolescent sample. We hypothesized that rates of tobacco and alcohol use would be higher and initiation would occur at younger ages in the ADHD+CD group compared to the group with neither diagnosis and that there would be a significant interaction between ADHD and CD such that having both of these disorders would magnify the likelihood of substance use beyond what would be expected based on each disorder's individual contribution. For models that included ADHD symptom domain counts and CD symptom counts, we hypothesized – based on the findings of Molina et al. (1999) – that only the HI and CD counts, but not IA counts, would be related to tobacco use and that only the CD count would be related to alcohol use.

## 2. Methods

### 2.1. Sample

The National Health and Nutrition Examination Survey (NHANES) is an annual multistage probability sample survey of the U.S. population. In 2000–2004, a total of 3039 adolescents aged 12 to 15 years participated in NHANES. Of these, 2517 adolescents had complete data on ADHD/CD symptoms and at least one substance

use outcome. Adolescents with ( $N=2517$ ) and without ( $N=522$ ) data available did not differ on age, gender, or race ( $p>0.05$ ). Adolescents from lower income families were less likely to contribute data ( $p<0.01$ ).

### 2.2. Outcomes

Primary outcomes were adolescent-report of any use of tobacco or alcohol and age of initiating use. These outcomes were derived from the Audio Computer Assisted Self Interview (A-CASI), which enables adolescents to complete questionnaires on sensitive health risk behavior topics in a private room without an interviewer. The A-CASI permits respondents to hear or read questions and to touch the computer screen to indicate their response. Substance use has been assessed similarly in other epidemiological studies and has been shown to be highly reliable (e.g. test–retest reliability  $r=0.91$ ) (Needle et al., 1983). Tobacco use was assessed by asking adolescents, “Have you ever tried cigarette smoking, even 1 or 2 puffs?” A “Yes” response constituted tobacco use. Alcohol use was assessed by asking adolescents, “How old were you when you had your first drink of alcohol, other than a few sips?” Any response other than “I have never had a drink of alcohol other than a few sips,” constituted alcohol use. Adolescents who endorsed smoking or alcohol use were asked to report the age at which smoking or drinking was initiated, which we used to calculate the time from birth to initiating use. These broad measures of ever having tried tobacco and alcohol in one's lifetime were the most relevant outcomes for adolescents age 12–15 as few are regular substance users. Lifetime use is commonly assessed with one question per substance (Needle et al., 1983).

### 2.3. Exposures

Exposure variables included diagnosis of ADHD and CD, and counts of ADHD and CD symptoms based on caregiver responses to the Diagnostic Interview Schedule for Children (DISC; Shaffer et al., 2000) which queries for information about the child's symptoms, age of onset, symptom pervasiveness, and related impairments in the previous year. Standardized DISC algorithms were used to determine (1) DSM-IV diagnoses of ADHD and CD, and (2) ADHD and CD symptom counts (APA, 1994; Shaffer et al., 2000). ADHD symptoms were reported in IA and HI domains, each with a range from 0 to 9 symptoms, with at least 6 symptoms in one domain required for diagnosis. CD symptoms range from 0 to 15, with at least 3 symptoms required for diagnosis. Because over half of children diagnosed with ADHD continue to have significant impairment but no longer meet formal diagnostic criteria during adolescence (Biederman et al., 2000), in secondary analyses, we expanded our definition of diagnosis of ADHD to include adolescents who had been diagnosed previously with ADHD based on caregiver report. Inclusion of past ADHD clinical diagnosis accounted for adolescents who did not currently meet ADHD DSM criteria because of effective treatment and/or waning of symptoms.

### 2.4. Covariates

We selected a range of covariates on the basis of their association with substance use in previous studies. These included child age (Eaton et al., 2012), child race/ethnicity (Eaton et al., 2012; Tercyak et al., 2002), child gender (Eaton et al., 2012; Molina et al., 2007a), household income (Gilman et al., 2003), and living with a smoker (Wilens et al., 2008). Child race/ethnicity was designated by caregivers and included the categories of ‘non-Hispanic black’, ‘Mexican American’, ‘other Hispanic’, ‘non-Hispanic white’, and ‘other (including multiracial)’. Because of relatively small numbers of subjects in

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