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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

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Contributors

Drs. Brinkman, Epstein, Tamm, and Froehlich conceptualized and designed the study and contributed to the interpretation of results. Drs. Brinkman and Froehlich and Ms. Auinger contributed to the acquisition of data. Ms. Auinger conducted data analyses. Dr. Brinkman drafted the initial manuscript and critically revised the manuscript for important intellectual content. Drs. Epstein, Tamm, Froehlich and Ms. Auinger critically revised the manuscript for important intellectual content. All authors approved the final manuscript as submitted.

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Conflict of Interest

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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.

Keywords

attention-deficit/hyperactivity disorder; conduct disorder; tobacco; alcohol; early onset substance use

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; Molina and Pelham, 2003; Molina et al., 1999; 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 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; Molina et al., 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 US population. In 2000–2004, a total of 3,039 adolescents aged 12 to 15 years participated in NHANES. Of these, 2,517 adolescents had complete data on ADHD/CD symptoms and at least one substance use outcome. Adolescents with (n=2,517) 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 the other

Hispanic and other (including multiracial) groups, the groups were combined into a single “other race/ethnicity” category that constituted a weighted prevalence of 12.6% in the sample. Household income/poverty line ratio is the ratio of reported household income to the poverty threshold appropriate for household size. Ratios below 1.00 indicate that the income for the respective family is below the official definition of poverty (Orshansky, 1965). Living with a smoker was defined by parent response to the question “Does anyone smoke at home?”

2.5. Analysis

The institutional review board determined this study to be exempt from review. Sample weights were applied according to National Center for Health Statistics guidelines for generation of all estimates, with all analyses performed using SUDAAN 9 (Research Triangle Institute, Research Triangle Park, NC). We used adjusted logistic regression analyses to analyze associations between the exposure variables and tobacco and alcohol use. Adjusted Cox proportional hazards analyses were used to analyze associations between the exposure variables and time from birth to initiating use, right-censoring cases who had not yet tried the substance of interest based on their age at the time of the interview. We adjusted all models for covariates and used $p < 0.05$ to indicate significance throughout. We conducted regression diagnostics and found no evidence of collinearity among the predictor variables. We calculated DFBETAS to identify potential outliers and no observations were considered strongly influential in the models. We tested the proportionality assumption of the Cox proportional hazard model by including time-dependent covariates (interactions of the predictors and time) in the model. All time-dependent variables were not statistically significant ($p > 0.05$), thus supporting the assumption of proportional hazard. Initial models separately examined the effect of each exposure variable. Subsequently, full models included both diagnoses simultaneously to examine the independent effect of each. To test our hypotheses and aid in the interpretation of joint effects, we first modeled the potential ADHD+CD diagnosis interaction by using a variable with 4 categories: neither diagnosis (reference category), CD alone, ADHD alone, and comorbid ADHD+CD (Rothman, 2002). In separate models, we also used a Wald F statistic to test whether the ADHD*CD diagnosis interaction term was statistically significant to determine if the effect is greater than would be expected based upon the addition of their individual contributions. We followed the same procedures when analyzing the symptom count variables. Secondary analyses expanded the definition of diagnosis of ADHD to also include those adolescents with a past clinical diagnosis of ADHD (in addition to those who currently meet DSM criteria for ADHD). This approach served as a sensitivity analysis, guarding against risk of misclassifying adolescents with ADHD (e.g., those that were being successfully treated) and examining the robustness of our analyses.

3. RESULTS

3.1. Prevalence of ADHD and CD

Prevalence of ADHD and CD symptoms and diagnoses are presented in Table 1. Adolescents aged 12- to 15-year olds in the U.S. in 2000–2004 had a mean (standard error [SE]) of 2.2 (0.1) ADHD symptoms (median of 0, range of 0–18) and a mean (SE) of 0.3

(0.03) CD symptoms (median of 0, range of 0–9). Of those with a diagnosis of ADHD, 14.8% (95% CI: 9.0, 23.3) also met criteria for CD, while 43.2% (95% CI: 27.0, 61.0) of those with CD also met criteria for ADHD. When the definition of ADHD was expanded to also include those adolescents with a parent-reported past physician diagnosis of ADHD, more adolescents were classified as ADHD alone and ADHD+CD resulting in a higher prevalence of those diagnostic groups.

3.2. Prevalence of Tobacco and Alcohol Use by Demographics and Diagnoses

Twenty-eight percent of adolescents reported use of tobacco and 29.7% reported use of alcohol (Table 2). Prevalence of use increased with age for both outcomes, but did not differ by gender or race/ethnicity for either. Prevalence of tobacco use was higher among adolescents from low-income households, while differences across income categories were not significant for alcohol use. Adolescents living with a smoker were significantly more likely to have tried tobacco. The percentage reporting use also varied based on DSM-defined ADHD and CD diagnosis.

3.3. Main Effects of ADHD and CD

Meeting diagnostic criteria for ADHD was independently associated with a 2-fold increased likelihood of tobacco use in models that adjusted only for demographic factors and household smoke exposure, as well as in full models controlling for these covariates *plus* CD (Table 3). In secondary analyses expanding the definition of ADHD to also include those adolescents with a parent-reported past physician diagnosis of ADHD and adjusting for CD, we found that ADHD was linked to a 2-fold higher risk of tobacco use and use was initiated earlier.

In models adjusting for socio-demographic covariates but not ADHD, CD diagnosis was associated with a more than 3-fold increased likelihood of tobacco use; however, CD was no longer linked to increased likelihood of tobacco use when adjusting for an ADHD diagnosis. CD was not linked to initiating tobacco use at a younger age in multivariate models, whether or not we adjusted for ADHD diagnosis.

Neither ADHD nor CD was significantly associated with alcohol use or the age of initiating alcohol use in adjusted models.

3.4 Joint ADHD*CD Effects

When the effects of having both DSM-defined ADHD and CD were tested in adjusted models, we found that adolescents with comorbid ADHD+CD had a more than 3-fold increased likelihood of tobacco and alcohol use and use was initiated earlier -- compared to those with neither diagnosis (Figure 1). In addition, adolescents with DSM-defined ADHD +CD were at significantly higher risk of alcohol use and initiated alcohol and tobacco and younger ages compared to those with ADHD alone. The formal ADHD*CD interaction terms were not significant for the adjusted odds ratio (AOR) and adjusted hazard ratio (AHR) for tobacco use (both $p>0.33$) and alcohol use ($p=0.12$ and $p=0.09$ respectively), indicating that the independent effects of ADHD and CD appear to be additive, but are not greater than would be expected based upon their individual contributions.

Sensitivity analyses which counted both those who currently met DSM criteria for ADHD *and* those with a prior parent-reported diagnosis of ADHD confirmed our finding above that having comorbid ADHD+CD was linked to significant increases in the likelihood of all substance use outcomes compared to having neither diagnosis (Figure 2). In fact, AORs for ADHD+CD using the expanded ADHD definition were more robust than those obtained using our DSM-based primary definition of ADHD (4.7- to 5.6-fold increased likelihood for substance use outcomes versus 3.5- to 3.7-fold increased likelihood respectively). Furthermore, formal tests of the ADHD*CD interaction term using the expanded ADHD definition revealed significant joint effects for alcohol use (AOR and AHR both $p < 0.001$), indicating that the combined effects of ADHD and CD are greater than would be predicted by the sum of their individual effects.

3.5. Main and Joint Effects of ADHD and CD Symptom Counts

The AOR and AHR for substance use varied by ADHD and CD symptom counts (Table 4). IA symptoms were significantly associated with use of both tobacco and alcohol: for every one symptom increase, the likelihood of tobacco and alcohol use increased by 10% and 8%, respectively, and the likelihood of initiating tobacco or alcohol use at a younger age increased by 8% for each. HI symptoms were not independently associated with any outcome in fully adjusted models. CD symptoms were significantly associated with tobacco use, but no other outcome. Of note, for every one symptom increase in CD symptoms, the likelihood of tobacco use increased by 31%. The interactions between symptom count variables (e.g. IA*HI) were non-significant and thus were excluded from the final models.

4. DISCUSSION

Among U.S. 12- to 15-year olds, ADHD and CD diagnoses and symptomatology were independently associated with use of substances, and children with ADHD+CD had a 3- to 5-fold increased likelihood of tobacco and alcohol use and initiated use at younger ages. We found some evidence for significant joint effects of ADHD and CD on alcohol use, such that the adverse effect of having comorbid ADHD+CD was greater than would be expected based on their individual independent contributions. In models accounting for joint ADHD +CD effects, having ADHD alone was associated with an increased likelihood of tobacco but not alcohol use, and having CD alone was not significantly associated with either. In addition, when we considered the effects of ADHD and CD *symptoms* rather than meeting diagnostic thresholds, we found differential effects of the ADHD symptoms domains on substance use outcomes: HI symptom counts were not independently associated with any outcome while every one symptom increase in IA increased the likelihood of tobacco and alcohol use by 8–10%. CD symptomatology was also linked to tobacco use: every one symptom increase in CD symptoms increased the odds of lifetime tobacco use by 31%.

Meeting diagnostic criteria for ADHD was independently associated with an increased likelihood of tobacco use consistent with past studies (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). Our finding that the comorbid ADHD+CD group had significantly higher rates of tobacco and alcohol use than did the group with neither diagnosis is consistent with past studies that employed a similar analytic approach (Barkley

et al., 1990; Groenman et al., 2013; Molina et al., 1999). In addition, the significant joint ADHD*CD effects on alcohol use that we observed in models that used the expanded definition of ADHD (either report of a prior ADHD diagnosis *or* currently meeting ADHD diagnostic criteria) is congruent with our hypothesis and Molina et al.'s findings. The more robust findings with the expanded definition of ADHD may relate to greater precision of estimates that resulted when more adolescents were classified as ADHD+CD and ADHD alone. The absence of a significant interaction between ADHD and CD diagnoses on tobacco use is discrepant from previous research (Molina et al., 1999). Discrepant findings may be attributable to the Molina et al. sample being purposefully enriched with adolescents with disruptive behavior disorders. As a result of this sampling method, the Molina et al. sample had a much higher prevalence of comorbid ADHD+CD (e.g., 1.2% vs. 4.9%) and a much higher rate of CD comorbidity among those with ADHD (e.g., 14.8% vs. 41.6%) than we found in our epidemiological sample.

Our analysis of ADHD symptoms as a continuous variable allowed us to examine the link between the full range of symptoms and risk of substance use in the general population. This is important as nearly 16% of children in the U.S. present with ADHD symptoms below the diagnostic threshold (Lewinsohn et al., 2004), and these children appear to be at increased risk for a variety of functional impairments (Scahill et al., 1999) and novelty seeking behaviors, albeit less so than those who meet full ADHD diagnostic criteria (Cho et al., 2009). We hypothesized that HI and CD symptoms would be related with tobacco use and only CD symptoms would be related to alcohol use. However, we found that IA and CD symptoms but not HI symptoms were independently associated with tobacco use, and only IA symptoms were independently associated with alcohol use. We based our hypotheses on the one prior study that examined the association of dimensional measures of ADHD and CD symptoms and substance use in young adolescents (Molina et al., 1999). As mentioned previously, discrepant findings might be explained by the much higher rates of CD in that sample. Our tobacco findings are consistent with three prior studies relating IA counts with tobacco use using a categorical approach (Barman et al., 2004; Burke et al., 2001; Tercyak et al., 2002). Because nicotine acts as an indirect dopamine agonist and improves attention and arousal, some have speculated that the association between IA symptoms and higher rates of tobacco use suggests a form of self-medication for ADHD (Conners et al., 1996). Prior studies of alcohol use which employed a categorical approach to symptoms have been mixed, with one reporting IA and HI (but not CD) being related to alcohol use (Elkins et al., 2007) and another finding no relationship with alcohol use for either IA or HI (Burke et al., 2001).

Disentangling the effects of ADHD and CD on substance use is challenging with cross-sectional data. Longitudinal studies have demonstrated that CD can influence tobacco and alcohol use (Barkley et al., 1990; Burke et al., 2001; Elkins et al., 2007; Groenman et al., 2013) and a recent analysis by Sibley et al. (2014) sheds some light on how this might occur. Sibley et al. found that increasing ADHD symptoms was the strongest predictor of increasing CD symptoms, which in turn was the most consistent predictor of adolescent substance use (i.e., increases in CD largely mediated the relationship between ADHD and substance abuse). While we cannot test this developmental pathway in our sample, it is a

plausible mechanism which may help explain how risk of substance use emerges in children with ADHD and CD.

Our study has important limitations. First, data from NHANES was collected one decade ago. To our knowledge, these years of NHANES are the only nationally representative dataset that includes both parent report of current adolescent DSM symptoms based on a standardized diagnostic instrument, and adolescent report of substance use. In addition, confidence intervals are wide around the outcome estimates for adolescents with CD, either alone or in combination with ADHD, because relatively few adolescents met criteria for CD and reported tobacco or alcohol use. Our definitions of use for tobacco (“ever” trying tobacco) and alcohol (having “more than a sip”) are also broad. Using narrower definitions (e.g., requiring frequent or daily use) might lead to different results, but we were unable to examine this due to small numbers of participants who met these more stringent requirements. Similarly, we were unable to assess the effect of other comorbidities (e.g., anxiety and depressive disorders) because there were not enough young adolescents with both the exposure and outcome. Parent report of past clinical diagnosis of CD was not collected, precluding inclusion in our sensitivity analyses. Parental history of substance abuse and/or psychopathology, which are typically higher among children with ADHD+CD (Chronis et al., 2003), were not available for inclusion as covariates. Finally, it is beyond the scope of this cross-sectional study to determine the effect of lifetime ADHD medication use on substance use, which remains controversial as some studies have suggested that stimulant medication use may be associated with a reduction in substance use disorders (Wilens et al., 2003).

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. Our finding that increasing IA symptoms is associated with increased risk of tobacco and alcohol use may have significant implications for prevention efforts. This notion is supported by a randomized controlled trial of a universal school-based behavioral intervention to prevent disruptive behaviors in mainstream classrooms in the Netherlands in which reductions in ADHD symptoms over the ages of 7–9 years mediated decreases in the probability of tobacco use at age 10–11 years (Huizink et al., 2009). Thus, interventions that promote ADHD and CD symptom reduction in the general population, including environmental modifications, may represent important measures to reduce or delay onset of tobacco and alcohol use.

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Highlights

- Data are from a young adolescent sample representative of the U.S. population.
- We relate attention-deficit/hyperactivity disorder (ADHD) and conduct disorder (CD) diagnoses and symptoms with substance use.
- Adolescents with comorbid ADHD+CD are more likely to use tobacco and alcohol.
- Each inattention symptom increased the odds of tobacco and alcohol use by 8–10%.
- Each conduct disorder symptom increased the odds of tobacco use by 31%.

Figure 1. Joint Effects of ADHD (current DISC diagnosis) and CD Diagnosis on Substance Use
 ADHD = attention-deficit/hyperactivity disorder, CD = conduct disorder, Ref = referent group

* Differs from referent group, $p < 0.05$

† Differs from ADHD alone group, $p < 0.05$

Figure 2. Joint Effects of ADHD (past clinical diagnosis and/or current DISC diagnosis) and CD Diagnosis on Substance Use

ADHD = attention-deficit/hyperactivity disorder, CD = conduct disorder, Ref = referent group

* Differs from referent group, $p < 0.05$

† Differs from ADHD alone group, $p < 0.05$

^Differs from CD alone group, $p < 0.05$

Table 1

Prevalence of ADHD and CD Symptoms and Diagnoses ^a

Symptoms	N	%	95% CI
>=1 ADHD Symptom	1171	45.6	(42.5, 48.7)
>=1 CD Symptom	356	14.7	(12.1, 17.4)
ADHD via DISC			
ADHD only	119	6.9	(5.4, 8.8)
Conduct disorder only	41	1.6	(1.0, 2.5)
ADHD+CD	22	1.2	(0.7, 2.0)
Neither	2358	90.3	(88.2, 92.0)
ADHD via DISC or parental report of physician diagnosis			
ADHD only	271	14.2	(11.6, 17.2)
Conduct disorder only	32	1.3	(0.8, 2.1)
ADHD+CD	31	1.5	(0.9, 2.3)
Neither	2206	83.0	(79.9, 85.8)

^a N reflects actual sample size, % is weighted to reflect national prevalence estimates^b Differences on outcomes by diagnosis are examined in adjusted model

Table 2Prevalence of Substance Use by Sociodemographic Characteristics and Diagnoses ^a

	Tobacco Use (N=2,510)				Alcohol Use (N=2,440)			
	N	%	95%CI	p	N	%	95%CI	p
Overall	682	28.3	(25.5, 31.1)	--	754	29.7	(26.1, 33.3)	--
Age (yrs)				<0.001				<0.001
12	69	13.5	(8.7, 18.2)		94	14.6	(9.9, 19.3)	
13	146	22.9	(18.8, 26.9)		164	25.8	(19.6, 32.0)	
14	196	30.2	(24.9, 35.5)		232	33.7	(28.1, 39.3)	
15	271	49.1	(42.9, 55.3)		264	46.4	(39.0, 53.7)	
Gender				0.63				0.80
Female	340	28.9	(25.2, 32.6)		381	29.2	(24.8, 33.6)	
Male	342	27.7	(23.7, 31.6)		373	30.1	(24.5, 35.7)	
Race/ethnicity				0.41				0.18
African American	210	25.2	(22.0, 28.4)		220	27.8	(24.8, 30.9)	
Mexican American	226	28.1	(24.7, 31.6)		285	35.4	(29.0, 41.7)	
Other race/ethnicity	52	27.2	(21.6, 32.8)		55	31.6	(21.6, 41.6)	
White, non-Hispanic	194	29.3	(25.1, 33.4)		194	28.7	(24.2, 33.2)	
Income to Poverty Ratio				<0.01				0.16
<1.00	224	38.0	(29.8, 46.1)		192	29.4	(23.2, 35.6)	
1.00–1.85	161	34.1	(29.2, 38.9)		201	35.2	(29.0, 41.3)	
>1.85–3.00	122	28.1	(22.1, 34.1)		146	30.4	(23.5, 37.2)	
>3.00	145	21.7	(18.0, 25.3)		185	27.6	(23.1, 32.0)	
Household Smoke				<0.001				
Yes	214	44.7	(36.8, 52.7)		N/A			
No	464	23.5	(20.9, 26.2)		N/A			
Diagnoses				^b				^b
ADHD+CD	11	48.2	(23.1, 74.3)		10	54.2	(32.1, 74.7)	
ADHD alone	35	38.1	(27.5, 47.5)		35	27.8	(17.7, 40.9)	
CD alone	21	59.9	(33.2, 81.7)		10	29.1	(12.6, 53.7)	
Neither	615	26.7	(23.8, 29.9)		699	29.5	(25.9, 33.4)	

^a N reflects actual sample size, % is weighted to reflect national prevalence estimates

^b Differences on outcomes by diagnosis are examined in adjusted models in Table 3.

Table 3

Likelihood of Substance Use by ADHD and CD Diagnosis

	Tobacco Use				Alcohol Use			
	AOR	95%CI	AHR	95%CI	AOR	95%CI	AHR	95%CI
ADHD based on DISC								
ADHD diagnosis	Single main effect model ^a							
	2.25	(1.34, 3.75)	1.54	(0.84, 2.4)	1.45	(0.76, 2.76)	1.40	(0.85, 2.29)
CD diagnosis	Full model ^b							
	1.95	(1.15, 3.33)	1.37	(0.77, 2.43)	1.38	(0.72, 2.64)	1.33	(0.82, 2.14)
ADHD based on DISC or parent report of past doctor diagnosis	Single main effect model ^a							
	3.48	(1.26, 9.61)	2.53	(0.95, 6.74)	1.64	(0.69, 3.85)	1.73	(0.97, 3.07)
ADHD diagnosis	Full model ^b							
	2.64	(0.88, 7.89)	2.29	(0.91, 5.76)	1.46	(0.62, 3.44)	1.59	(0.92, 2.75)
CD diagnosis	Single Main effect model ^a							
	2.12	(1.41, 3.19)	2.00	(1.19, 3.38)	1.28	(0.79, 2.06)	1.34	(0.93, 1.92)
ADHD diagnosis	Full model ^b							
	1.95	(1.31, 2.90)	1.96	(1.14, 3.36)	1.17	(0.72, 1.92)	1.25	(0.87, 1.79)
CD diagnosis	Single Main effect model ^a							
	3.48	(1.26, 9.61)	2.53	(0.95, 6.74)	1.64	(0.69, 3.85)	1.73	(0.97, 3.07)
ADHD diagnosis	Full model ^b							
	2.61	(0.98, 6.95)	2.07	(0.82, 5.24)	1.54	(0.65, 3.64)	1.63	(0.95, 2.81)

ADHD = attention-deficit/hyperactivity disorder, CD = conduct disorder, AOR = adjusted odds ratios, AHR = adjusted hazard ratios

All models adjusted for age, gender, race/ethnicity, poverty status, household smoke (tobacco outcome)

^aThe “single main effect” models separately examine the effect of ADHD and CD diagnoses (i.e., the main effect model for ADHD does not include CD, and the main effect model for CD does not include ADHD).

^bThe “full model” included all independent variables (ADHD and CD diagnosis) to examine the effect of each in the presence of the other.

Table 4

Likelihood of Substance Use by ADHD and CD Symptom Counts

	Tobacco Use				Alcohol Use			
	AOR	95%CI	AHR	95%CI	AOR	95%CI	AHR	95%CI
Inattentive count	Main effect ^a	1.15	(1.09, 1.21)	1.14	(1.07, 1.21)	1.07	(1.01, 1.14)	1.07 (1.02, 1.11)
	Full model ^b	1.10	(1.02, 1.19)	1.08	(1.01, 1.17)	1.08	(1.01, 1.15)	1.08 (1.03, 1.13)
Hyperactive-impulsive count	Main effect ^a	1.13	(1.06, 1.21)	1.11	(1.01, 1.22)	1.03	(0.96, 1.11)	1.02 (0.97, 1.08)
	Full model ^b	1.02	(0.93, 1.12)	1.00	(0.90, 1.12)	0.96	(0.89, 1.05)	0.96 (0.60, 1.02)
CD count	Main effect ^a	1.48	(1.21, 1.80)	1.33	(1.08, 1.66)	1.15	(0.95, 1.39)	1.13 (0.99, 1.28)
	Full model ^b	1.31	(1.06, 1.62)	1.18	(0.97, 1.43)	1.09	(0.86, 1.38)	1.10 (0.94, 1.29)

ADHD = attention-deficit/hyperactivity disorder, CD = conduct disorder, AOR = adjusted odds ratios, AHR = adjusted hazard ratios

All models adjusted for age, gender, race/ethnicity, poverty status, household smoke (tobacco outcome)

^aThe “single main effect” models separately examine each independent variable (i.e., the main effect model for inattentive symptom counts does not include hyperactive-impulsive and CD symptom counts, etc.)

^bThe “full model” included all independent variables (inattentive, hyperactive-impulsive, and CD symptom counts) to examine the effect of each in the presence of the others.