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The Association Between Attention-Deficit Hyperactivity Disorder and Nicotine Use Among Adolescents and Young Adults

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Abstract

Previous research indicates that youth with ADHD are more susceptible to nicotine use compared to those without ADHD and one explanation for this association is the self-medication theory. The present study examines nicotine use in a prospective sample derived from a community sampling procedure rather than a clinical setting. Nicotine use was measured through young adulthood (mean ages: 18, 20 and 22) and three groups were compared based on childhood status: ADHD-only, ADHD-extemalizers and control groups. Results indicated that at all three data points, individuals with childhood ADHD plus an externalizing disorder reported higher nicotine use on all variables compared to the ADHD group absent of an externalizing disorder and the comparison group of non-ADHD youth. The group differences were significant even after controlling for possible confounding variables (age, gender, and current treatment with psychostimulant medication). Study results are discussed in light of the self-medication hypothesis and of the importance of including nicotine prevention programs for adolescents and young adults with ADHD and externalizing problems.

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Keywords

ADHD; Externalizing disorder; Nicotine; Self-medication hypothesis

Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) is one of the most common neurobehavioral disorders in children and youth, with a prevalence of approximately 8.7% in the US (Froehlich, Lanphear, Epstein, Barbaresi, Katusic, et al., 2007). ADHD is defined by three core behavioral domains: inattention, hyperactivity, and impulsivity. It is common for ADHD to be associated with a broad range of functional impairments and behavioral comorbidities including a diagnosis of one of the externalizing disorders, that is, Conduct Disorder (CD) or Oppositional Defiant Disorder (ODD) (Weinberg, Rahdert, Colliver, & Glantz, 1998). For many with ADHD, the diagnosis persists into the adulthood, resulting in possible justice system contacts and drug abuse problems (Barkley, Fischer, Smallish, & Fletcher, 2004).

Multiple studies have examined the association between ADHD and drug involvement, including nicotine use (Charach, Yeung, Climans, & Lillie, 2011; Lee, Humphreys, Flory, Liu, & Glass, 2011). A spate of studies have specifically compared adolescents and/or young adults with and without a childhood diagnosis of ADHD, with findings indicating that those with ADHD experience a significantly greater risk to nicotine use than non-ADHD individuals (e.g., Barkley, Anastopoulos, & Guevremont, 1991; Lambert & Hartsough, 1998; McMahon, 1999; Milberger, Biederman, Faraone, Chen, & Jones, 1997; Molina & Pelham, 2003). One such study found that among adolescents with ADHD, 19%–46% smoked cigarettes, whereas only 10–24% of non-ADHD individuals smoked (Fuemmeler, Kollins, & McClernon, 2007). Milberger and colleagues (1997) found that ADHD youth started smoking earlier than non-ADHD youth. Lambert and Hartsough (1998) studied a community sample of children with and without clinically-significant ADHD symptoms into adulthood and found that the ADHD group, in contrast to the non-ADHD group, began smoking regularly at a significantly earlier age (15.7 years vs. 17.1 years) and had a significantly higher proportion of regular smokers by age 17 (50% vs. 27%) (Lambert & Harsough, 1998). Furthermore, Lambert (2005) found that those with ADHD are more likely to use other psychoactive substances as the age of onset of nicotine use decreased (Lambert, 2005). This tendency appears to be more prevalent if the youth began smoking cigarettes prior to the age of 13. Although some exceptions exist (Molina & Pelham, 2003), there are data showing that youth with ADHD-inattentive subtype may be at elevated risk for nicotine use (Burke, Loeber, White, Stouthamer-Loeber, & Pardini, 2007). In this study, youth diagnosed with ADHD inattention-type showed a 16% increase in the number of cigarettes smoked per day compared to those diagnosed with ADHD hyperactive- or combined-type. A similar finding has been reported by Kollins and colleagues (Kollins, McClernon, & Fuemmeler, 2005).

Also, the relative contribution of disorders often comorbid with ADHD has received a great deal of attention in the literature. Whereas two previous studies have isolated cigarette

smoking as uniquely associated with ADHD independent of CD (Burke, Loeber, & Lahey, 2001; Milberger et al., 1997), numerous studies have found that the association of ADHD and drug involvement is accounted for by co-occurring CD or ODD (e.g., Barkley et al., 1990; Biederman, Wilens, Mick, & Faraone, 1997; Clark, Parker, & Lynch, 1999; Lynsky & Fergusson, 1995; Molina & Pelham, 2003). For example, August and colleagues found that adolescents with ADHD + comorbid ODD or CD show an elevated risk for a SUD as they age into adulthood and are more inclined to use mood altering drugs, including nicotine (August et al., 2006). These findings are not surprising given that conduct problems during childhood have been reliably linked to adolescent drug (e.g., Brook, Whiteman, Finch, & Cohen, 1996), and that CD/ODD often accompanies ADHD.

The relationship of ADHD and nicotine risk is significant in light of the fact that not only is cigarette smoking the leading cause of preventable disease and death in the United States (U.S. Department of Health and Human Services, 2000), but there is a wealth of evidence that most adult smokers begin the habit during the teenage years (Substance Abuse and Mental Health Services Administration, 2004). Thus, a greater understanding of the role that ADHD and its comorbid conditions serve in initiating and maintaining nicotine use in youth may inform smoking prevention efforts of this high-risk youth group.

The Self-Medication Theory

A number of factors may contribute to nicotine use among youth with ADHD, with the self-medication hypothesis receiving the most attention. This hypothesis posits that individuals with ADHD use stimulant-like substances such as nicotine to manage their ADHD symptoms (Castle, Aubert, Verbrugge, Khalid, & Epstein, 2005; Lambert, 2005; Levin, Conners, Silva, Canu, & March, 2001). A related phenomenon that may enhance the self-medication properties of nicotine is that ADHD youth with previous exposure to psychostimulant medication may experience behavioral sensitization to nicotine (Robinson & Berridge, 2000). In addition, the relatively easy and affordable access to nicotine compared to other stimulant drugs (e.g., cocaine) may further contribute to the link between ADHD and nicotine. Support for the self-medication hypothesis is provided by two general lines of evidence: 1) although these studies have not been conducted on youth, positive effects of nicotine among ADHD adults have been shown in the areas of attention, concentration, and the amelioration of ADHD symptoms (Conners et al., 1996; Levin et al., 1996; Burke et al. 2001; Lerman et al., 2001; Tercyak, Lermna, & Audrain, 2002); and 2) youth with ADHD who are not taking psychostimulant medication (e.g., methylphenidate [Ritalin]; amphetamine [Adderall]), are more likely to smoke cigarettes than individuals with ADHD who are receiving stimulant medication (Whalen, Jamner, Henker, Gehricke, & King, 2003; Lerman, et al., 2001; Pomerleau, Downey, Stelson, & Pomerleau, 1995). The present authors have reported elsewhere, based on the same sample analyzed in the present paper, that history of *childhood* psychostimulant medication was not related to drug used, including nicotine use, at all three young adult outcomes (mean ages: 18, 20 and 22; Winters et al., 2011). However, in the present analysis we will explore if *current* psychostimulant medication is related to nicotine use.

In summary, there is strong empirical support to indicate that youth with ADHD are at greater risk for using nicotine than youth without ADHD. However, most of the extant ADHD literature has not examined the nature of this association as youth mature into young adulthood. Whereas recent national data indicate a downturn in nicotine use by adolescents (Johnston, O'Malley, Bachman, & Schulenberg, 2011), nicotine use by young adults is on the increase (e.g., Johnston, O'Malley, Bachman, & Schulenberg, 2009). Childhood ADHD status may contribute an additional source of risk for nicotine use during young adulthood. Also, the present study contributes to the literature in other ways. Our sample is a well-characterized longitudinal, community-based sample, which contrasts with the majority of ADHD studies that are based on clinical samples. Community samples may have different nicotine trajectories than clinical samples. Also, we will compare ADHD groups that have and do not have a co-existing externalizing disorder. As already noted, this issue is important given that ADHD youth with a co-existing CD/ODD typically report elevated rates of drug involvement compared to ADHD without a co-existing externalizing disorder (e.g., August et al., 2006). Finally, we are including in the analysis the possible impact of three variables on nicotine involvement – childhood inattentiveness and recent treatment with psychostimulant medication. Childhood inattentiveness has been shown to be a risk factor for nicotine use (Burke et al., 2007), and the inclusion of psychostimulant medication is important because the ADHD-nicotine association may be moderated by use of prescribed psychostimulant medication.

Given the extant literature on the link between ADHD and substance use disorders, it is hypothesized that youth with a childhood history of ADHD will report greater use of nicotine than non-ADHD individuals, and within the ADHD sample, the highest rates will be observed in the ADHD youth with an externalizing disorder. We expect this pattern of results to occur after correcting for the possible influences of the aforementioned confound variables.

Method

Participants

Participants for this analysis were derived from a prospective study initiated in 1990 entitled The Minnesota Competence Enhancement Program (MNCEP). A more detailed description is described elsewhere (August, Realmuto, Crosby, & MacDonald, 1995). Briefly, a *screening procedure* was conducted among 7,231 children aged 7 to 11 who attended 22 suburban elementary schools that utilized the teacher version of the Conners' Hyperactivity Index (HI-T; Goyette, Conners, & Ulrich, 1978). Students, whose HI-T score was 1.75 SD above the mean, were then screened by their parent using the Conners' Hyperactivity Index (HI-P; Goyette et al. 1978). Those students with a HI-P score of greater than 1.75 SD were placed in the "disruptive" group (n = 318). A comparison group was derived from the entire sample whose HI-T score was less than 1.0 SD. HI-P scores were not obtained on the comparison group (n = 144). All students had an IQ score 80 or higher, and were predominantly middle class (levels II and III of the Hollingshead Socioeconomic Index; Hollingshead, 1975), Caucasian (95%), and resided in suburban neighborhoods of a major metropolitan area (August et al., 1995).

Detailed *baseline* (*T1*) and *follow-up* (*T2 and T3*) assessments (all conducted roughly within a 5-year period) determined that among the 318 disruptive children, 205 met DSM-III-R criteria for ADHD (based on the Diagnostic Interview for Children and Adolescents-Revised Parent Version; DICA-R-P; Reich, Shayla, & Taibleson, 1992) at one or more of these assessment points (T1-T3). *Late adolescent and young adult assessments* (*T4-T6*) were sought only for cases with a full set of T1-T3 data, as dictated by the grant that funded these evaluations. Thus, the small number of families assessed at T1 who then dropped out of study and did not receive a T2 and T3 assessment (37 ADHD subjects and 28 controls) were not eligible for T4-T6 evaluations and were not approached. (No differences at T1 were found between these T1 attrition cases and those that were enrolled in the T4-T6 study on any demographic or clinically-related variables – gender, age, BASC scales of Inattention and Hyperactivity, IQ, family SES, and parent marital status.)

Two groups of individuals were also not included in the present analysis: 1) those with ADHD and a co-existing internalizing disorder (e.g. depression or anxiety; n=30); and 2) the 17 participants in the comparison group were later diagnosed with ADHD (n = 6) or an externalizing disorder (n= 11) at the T2 or T3 assessments. Finally, missing assessments at T4-T6 also led so some sample reduction. The final sample sizes for the present analysis are the following: 119 ADHD youth (out of 138 eligible ADHD), and 93 controls (out of 99 eligible controls).

The demographics for the sample groups are summarized in Table 1. Of the 212 participants, 51 were female and 161 were male. Nicotine outcomes were assessed at three late adolescent and young adult time points (T4, T5, & T6). The mean ages at these data points are as follows: 18.3, 20.2 and 21.9, respectively. In terms of group comparisons, the three groups (ADHD-externalizers, ADHD-only and Controls) did not differ in terms of gender, ethnicity, and mean ages at T4-T6. The two ADHD groups had significantly higher group mean scores on a measure of inattention (based on a teacher scale of the BASC; Reynolds & Kamphaus, 1992) at T1 compared to controls ($p < .001$), and the ADHD-externalizers had a slightly higher that did not finish high school.

Measures

Inattention—The Teacher Report Form of the Behavioral Assessment Scale for Children – (BASC-TRF; Reynolds & Kamphaus, 1992) was administered at T1 (baseline). This instrument contains several scales, one of which is Inattention. Items were rated on 4-point Likert scale ranging from 0 = never to 4 = almost always. The BASC has been normed and validated on both clinical and normative populations and have favorable psychometric properties (Reynolds & Kamphaus, 1992).

Current Use of Prescribed Psychostimulant Medication—Using a semi-structured interview, the parent provided at each time point (T4-T6) a record of their child's recent status in terms of receiving psychostimulant treatment. At T4, this period covered the prior 5 years; at T5 and T6, this period covered the interval since the last interview (roughly a 1.5 year period). Based on these data, youth were categorized at each time point as either yes or no in terms of receiving psychostimulant treatment. The percentages of yes to the

psychostimulant treatment variable (both ADHD groups combined) per time point were as follows: 33.6% (T4), 18.5% (T5), and 12.6% (T6).

Nicotine Use—As noted above, nicotine use (cigarettes and other nicotine products) was assessed at T4, T5 and T6 utilizing 1) the *Cigarettes Use Questionnaire* (CUQ; Winters & Gerard, 2005) and 2) a DSM-IV-based structured interview. The CUQ frequency item that was used in this study assessed current (prior year) nicotine use (cigarettes, cigars, pipe smoking, chew, and snuff) with the following response options; never/less than monthly/ about monthly/about weekly/about daily. This variable was coded 1 (never) to 5 (about daily). Regular nicotine users were defined as those who reported about weekly or about daily use during the prior year. The diagnostic interview assessed both age of onset of nicotine use and prior year nicotine addiction symptoms, as defined by DSM-IV criteria for nicotine dependence (American Psychiatric Association, 1994) (e.g., habitual use, loss of control, and preoccupation). The nicotine addiction score used in the analysis was a count of endorsed symptoms. The CUQ frequency item is associated with favorable psychometric properties (Winters & Gerard, 2005). For example, regular vs. non-regular nicotine user status is highly associated with the addiction severity scale on the CUQ (point-biserial correlation coefficient, .77). With respect to the DSM-IV symptoms of nicotine addiction, the count of symptoms reveals high internal consistency (coefficient alpha = .89), and its factor structure indicates that it measures a single dimension (eigen value = 5.9).

Procedure

All participants were given a $75 stipend for participation in the study. For each of the three assessment points for the current study, the participants were interviewed by highly trained research technicians, who were aware of the participants' diagnostic status such as "disruptive" or "control." However, the technicians were not aware of the specific diagnostic status such as ADHD-externalizers or ADHD-only. Most participants were interviewed in person; however, a small number of participants moved out of the metro area and were interviewed over the telephone.

Statistical Analysis

Statistical analysis was done using Statistical Package for the Social Sciences (SPSS version 18.0). Analysis of covariance (ANCOVA) was used to examine group differences (ADHD groups) on continuous variables (age of onset of tobacco use, nicotine symptom severity) after controlling for covariate effects. Covariates included these variables: age, gender, and current stimulant medication use. Post hoc Bonferroni test was conducted once a significant main effect of ADHD was found to determine which groups where statistically different. Logistic regression was conducted to examine group differences in dichotomous tobacco use variables (any tobacco use [y/n], regular tobacco use [y/n]). The same covariates were included in the model to control for their effects.

Results

Age of Onset

An ANCOVA was used to examine whether there was a significant main effect of ADHD group (ADHD-externalizers vs. ADHD-only vs. controls) on the age of onset of nicotine use. Only participants who reported that they had used nicotine at least once at any of the given time points (T4, T5 and T6 assessments) were used in this analysis (n = 176). The adjusted mean ages of onset of tobacco use for the three groups are as follows: ADHD-externalizers, 13.9, ADHD-only, 14.2, and controls, 15.3. Results showed that there was a significant ADHD group effect on the age of onset of tobacco use, after controlling for covariates [n = 176; F (2, 169) = 4.58, p = .012]. Post hoc comparisons revealed that the ADHD-externalizers had a significantly lower mean age of onset compared to the comparison group (p = .004).

Any Nicotine Use

The percent that reported at least some nicotine use when considering all three time points (T4-T6) are the following: ADHD-externalizers, 90.0%, ADHD-only, 79.3% and controls, 77.4%. Table 2 presents the prevalence rates of any nicotine use for each time point and results of the logistic regressions (controlling for covariates). The results showed that the ADHD-externalizers were more than twice as likely to use any nicotine as the comparison group at all three time points. Current stimulant medication use had no significant impact on any nicotine use at T4, T5 and T6. The results indicated that young adults who had ADHD plus an externalizing disorder during their childhood were significantly more likely to have recently used nicotine products at T4, T5 and T6 compared to the comparison groups.

Regular Nicotine Use

Prevalence rates of regular tobacco use and summary of logistic regressions are presented in Table 2. The results from the logistic regressions (controlling for covariates) showed that ADHD plus externalizers were more than twice as likely to use nicotine products regularly as the comparison group at T4 and T5. However, this effect did not hold significant at T6. The results also showed that ADHD plus externalizers were 2.8 times more likely to use nicotine products regularly compared to the ADHD-only group at T4 (no differences at T5 and T6).

Nicotine Addiction Symptom Severity

Means and standard deviations on the severity of nicotine addiction for the three groups are presented in Table 3. Scores reflected a count of positive DSM-IV symptoms for tobacco dependence. A one-way (Group) ANCOVA was conducted on nicotine addiction severity at each time point. Results showed that there was a significant main effect of ADHD status after controlling for covariate effects on tobacco symptom count at all three time points. Post hoc Bonferroni test conducted at each time point showed that ADHD plus externalizers had significantly higher nicotine symptom counts compared to the comparison groups.

Discussion

The results of the present study indicate that individuals who met diagnostic criteria for ADHD with an externalizing disorder as a child reported a higher rate of nicotine use and more nicotine addiction symptoms during their late adolescent and young adult years when compared to individuals in the ADHD-only and non-ADHD groups. Statistical significance was reached in the evaluation between ADHD-externalizers vs. the non-ADHD comparison group at each time point for all nicotine variables (categorical and dimensional). The ADHD-only group showed scores on the categorical and dimensional nicotine variables that were generally comparable to the non-ADHD comparison group. This led to statistical significance with respect to the ADHD-externalizers vs. ADHD-only comparison groups in one instance with the categorical variables (T4, regular nicotine use) and for the dimensional variable at each time point. The study results support the view that ADHD *without* an externalizing disorder does not give rise to additional risk for nicotine use beyond the risk found in non-ADHD youth, a pattern that held across the late adolescent and young adulthood data points.

This major finding is consistent with both the general drug abuse risk literature that the relation between ADHD and substance use, including nicotine, outcomes may be partially or fully accounted for by the co-existence of ADHD and externalizing disorders (Lee et al., 2011). However, our study extends this complimentary literature in several ways. In the meta-analysis of ADHD longitudinal studies by Lee and colleagues (Lee et al., 2011), whereas 16 studies assessed nicotine outcomes, only a small number of these were established on a community-based ADHD sample and included both ADHD-only and ADHD-externalizers, and only four followed their cohort into adulthood. Also, some of the extant community-based studies used proxy dimensional measures to determine ADHD status; the current study's sample was well-defined and identified with rigorous diagnostic assessment procedures. Moreover, none of the studies in the literature controlled for the possible influences of inattentiveness and psychostimulant medication, factors known or hypothesized to impact nicotine involvement.

Another relatively unique aspect of this study is that this sample had a much higher proportion of ODD subjects than CD subjects. It is common for prospective studies of childhood ADHD and substance involvement that include a coexisting externalizing group to have very high proportions of youth with CD rather than ODD. Thus, this study's finding that even a mild-to-moderate form of conduct problems enhances risk for nicotine use and extends the current ADHD-externalizing disorder literature that has primarily examined the distinctive or additive role of CD on nicotine use.

The smoking rates for all groups tended to decrease from T4 to T6. This decline may be associated with several factors, including efforts at smoking cessation by some individuals, maturation into adult roles and responsibilities, or the influence of public health sentiment against smoking. Nonetheless, the relatively high percentage of nicotine use confirms the continuing need for public health prevention and intervention efforts aimed at youth. Even the non-ADHD group had prevalence rates of regular nicotine use above 30% at each time point.

The study's findings provide mixed support for the self-medication hypothesis linking ADHD and young adult use of nicotine. The higher rates of nicotine use in both ADHD groups is consistent with the notion that they are using stimulants such as nicotine to help control their ADHD symptoms (Lerman et al., 2001). Also, it was discovered that a large proportion of them started to use nicotine on a regular basis prior to age 18. Youth with ADHD may turn to nicotine because of its attention-enhancing pharmacologic properties. Laboratory studies have shown improvements in vigilance with nicotine challenges for both ADHD and non-ADHD adults (Conners et al., 1996; Levin et al., 1996), and a related finding is that when healthy adults were given low dosage of stimulants, tobacco smoking increased (Henningfield, 1995; Vansickel, Stoops, Glaser, & Rusch, 2007). Nonetheless, this study did not find a relationship between current psychostimulant treatment and nicotine use at any outcome point. The self-medication hypothesis would have predicted lower nicotine use among those receiving psychostimulant treatment compared to those not receiving this treatment. In a similar manner, this study failed to find an association of *childhood* psychostimulant treatment and later (T4-T6) nicotine use in this sample (Winters et al., 2011).

It is important to consider that other factors contribute to nicotine use among ADHD youth. The extant, but relatively small, literature suggests the following factors are likely contributors: delinquent peer affiliation, parental substance use, and poor parenting (Burke et al., 2007; Marshal, Molina, & Pelham, 2003; Molina, Marshal, Pelham, & Wirth, 2005). The finding that ADHD-externalizers consistently revealed higher levels of nicotine use compared to ADHD-only youth may be due to the former group's greater association with these contributory psychosocial factors. ADHD youth with a conduct or an oppositional defiant disorder may be more likely to break rules, endorse unconventional values, and affiliate with more delinquent peers – all possible risk factors that may contribute to early use of nicotine – compared to ADHD youth without an externalizing disorder. Thus, externalizing behaviors, even at the relatively mild form that characterized our sample, may operate to set in motion a chain of negative events that lead to experimentation and eventual use of nicotine, and these events may include affiliation with deviant peers who have with similar disruptive behavioral characteristics as the individual (Cairns, Cairns, Neckerman, Gest, & Gairepy, 1988). Also, the findings concerning elevations on the nicotine use variables in the ADHD-externalizer group compared to the ADHD-only group is consistent with a large body of work (albeit, some exceptions exist) that have found a similar pattern of findings when these two groups are compared on alcohol and illicit drug use variables (see reviews by Charach et al., 2011, and Lee et al., 2011).

The results of this study support the importance of including nicotine prevention programs for adolescents and young adults with ADHD and signs of conduct problems. Also, this research indirectly supports the continued development and implementation of programs designed to address risk factors believed to contribute to the association between ADHD and nicotine use, such as affiliation with delinquent peers, parental substance use, and poor parenting. Such prevention programs seem to be particularly important for youth with ADHD given that stimulant medications may be effective for only about half of ADHD youth (e.g., Smith, Pelham, Gnagy, Molina & Evans, 2000; Wilens et al., 2007).

Limitations

There are important limitations of the present study to consider when interpreting the study results. We only examined ADHD status at baseline (childhood) in this analysis. The course of ADHD during adolescence and young adulthood might also impact nicotine and other substance use, a topic that we are addressing in a future paper. The relatively small samples restrict the statistical power for detecting small to moderate effect sizes. The amount of detail regarding psychostimulant mediation history is less than optimal and, thus, our ability to conduct a more sophisticated analysis of medication dosage, compliance and nicotine outcomes is not possible. Variables not assessed in this study could also impact nicotine use (e.g., living with a smoker, parents smoked, place of employment). The results of the present study should also be interpreted within the context of its sample composition and research design. Subjects were primarily Caucasian and from Minnesota suburban school areas, which limits the generalizability of the findings. The community sample was ascertained from relatively affluent suburban schools (e.g., only 13% of students at the participating schools were receiving free or reduced priced lunches). In contrast, many extant studies sample clinic attendees residing in urban, low SES settings. This research design feature may have contributed to the general finding of no differences between the ADHD-only and control groups. The ADHD-only group may represent a milder version of the disorder compared to ADHD groups in other studies. A less severe form of ADHD may confer a lower drug abuse liability, perhaps in part due to such youth living in an environment with more assets, such as favorable parenting.

Another limiting factor is that all of the participants self-reported their nicotine use. Whereas studies support the validity of adolescent drug abuse self-report (Maisto, Connors, & Allen, 1995), it cannot be ruled out that this study's self-report data may reflect inaccuracies. However, there are some considerations regarding the accuracy of the self-report in the present study: it was found that youth admitted to relatively high rates of nicotine use across all groups; the control group reported rates of nicotine use that are comparable to rates observed in both national and Minnesota high school student surveys; and a comparison of self-reported alcohol and illicit drug use self-report data and results from urine testing as part of the T4 assessment did not produce a single instance of a positive drug urine test in conjunction with a self-report denial of use of that drug. Whereas no laboratory measure of nicotine use was collected, the latter point provides support for the validity of self-report in our participants.

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Table 1

Demographics of the Study groups

	ADHD-externalizers[a] (n=90)	ADHD-only (n=29)	Comparison (n=93)	χ^2 or F (df=2)	p
Male, %	80	86.2	68.8	5.07	.08
Caucasian, %	91.1	96.6	97.8	4.43	.11
Inattention (BASC), Time 1	63.5 (9.2)[b]	61.4 (8.8)[c]	46.5 (9.0)[bc]	85.78	<.001
Mean Age, Time 4	18.4 (1.1)	18.1 (0.9)	18.3 (1.2)	0.62	.54
Mean Age, Time 5	20.5 (1.5)	19.9 (1.5)	19.9 (1.5)	2.85	.12
Mean Age, Time 6	22.0 (1.3)	21.5 (1.1)	21.9 (1.3)	1.04	.36
Did Not Complete HS, %	11.9	6.9	4.3	1.91	.15
Childhood Stimulant Medication Use, %	53.1	30.8	-	3.93	.047
Current Stimulant Medication Use at T4, %	36.7	17.2	-	3.81	.051

Note.

[a]Conduct Disorder diagnosis, 11.1%; Oppositional Defiant Disorder diagnosis, 88.9%.

[b,c]Significant post hoc comparison pairs at $p < .001$ with Bonferroni corrections.

Table 2

Prevalence Rates of Categorical Measures of Tobacco Use by Group and Summary of Logistic Regressions

	ADHD-Ext		ADHD-Only		Comparison		ADHD-Ext > C	ADHD-only > C	ADHD-Ext > ADHD-Only
	n	%	*n*	%	*n*	%	OR (95%CI)[a]	OR (95%CI)[a]	OR (95%CI)[a]
Time 4									
Any tobacco use	76	84.4	21	75.0	65	69.9	2.29* (1.04–5.08)	1.14 (0.42–3.07)	2.01 (0.70–5.80)
Regular tobacco use	61	67.8	12	41.4	39	41.9	2.68** (1.39–5.16)	1.00 (0.42–2.39)	2.82* (1.17–6.81)
Time 5									
Any tobacco use	71	81.6	18	72.0	58	63	2.76* (1.28–5.96)	1.38 (0.50–3.78)	2.00 (0.69–5.79)
Regular tobacco use	55	61.1	12	41.4	34	36.6	2.61* (1.34–5.07)	1.37 (0.55–3.42)	1.90 (0.76–4.77)
Time 6									
Any tobacco use	59	80.8	14	70.0	48	57.1	2.46* (1.12–5.40)	1.41 (0.48–4.15)	1.74 (0.55–5.51)
Regular tobacco use	38	42.2	10	34.5	30	32.3	1.62 (0.80–3.28)	1.58 (0.58–4.30)	1.02 (0.37–2.83)

Note. ADHD-Ext = ADHD-externalizers; ADHD-Only = ADHD only; C=Comparison group; OR=odds ratio.

[a]Odds ratios were from logistic regressions controlling for age, gender, and current stimulant medication use.

*$p < .05$,

**$p < .01$

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Table 3

Group Comparison on Nicotine Addiction Symptom Severity Measures for Three Waves of Data

	ADHD-Externalizers		ADHD-Only		Comparison		ADHD main effect	
	M	***SD***	***M***	***SD***	***M***	***SD***	***F***	***p***
Time 4	3.84[a]	4.15	2.04	3.40	1.99[a]	3.07	5.28	.006
Time 5	3.98[b]	4.09	2.52	3.36	2.36[b]	3.39	7.33	.001
Time 6	4.12[c]	4.03	2.40	3.76	2.12[c]	3.34	4.15	.017

Note. ANCOVAs were conducted with ADHD group as independent variable with age, gender and current stimulant medication use as covariates.

[a] Significant post hoc comparison pair at $p < .01$ with Bonferroni corrections

[b] Significant post hoc comparison pair at $p < .001$ with Bonferroni corrections

[c] Significant post hoc comparison pair at $p < .05$ with Bonferroni corrections

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