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The Association Between Attention Deficit Hyperactivity Disorder in Adolescence and Smoking in Adulthood

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Abstract

Objective—This longitudinal study examined the interrelationships between early and/or middle adolescent attention deficit hyperactivity disorder (ADHD), middle adolescent conduct disorder (CD), and later adult smoking behavior.

Method—This is a prospective longitudinal study. Data were collected via structured interviews of representative families in the northeastern United States (N = 641). The mean ages of the offspring were as follows: 14 years (T2, 1983), 17 years (T3, 1985–1986) and 32 years (T6, 2002).

Results—The dependent variable was the participants' daily cigarette smoking in their early thirties. Logistic regression analyses indicated that the relationship between ADHD and daily smoking behavior was mediated by CD with control on gender, age, SES, and adolescent smoking. CD had a direct effect on daily smoking in adulthood.

Conclusions—Our findings suggest that ADHD is related to CD, which in turn is associated with daily smoking. Therefore, interventions with ADHD adolescents who have ADHD at an early age might lead to some reduction in smoking provided that the intervention has a positive effect on CD. For those adolescents who never had ADHD, our findings suggest that prevention or treatment aimed at reducing CD may be most successful in reducing daily smoking later in adulthood.

Keywords

ADHD; CD; Adolescence; Daily Smoking; Adulthood

Introduction

Smoking is a major public health issue worldwide, and is a leading cause of substantial morbidity and mortality.¹ It is a significant cause of cardiac and pulmonary disease as well as a number of types of cancer.² One possible risk factor for smoking is attention deficit hyperactivity disorder (ADHD). Studies of clinical populations indicate that individuals with ADHD have higher rates of smoking than adolescents or adults from the general population.^{3–5} Community studies have also reported that ADHD is related to nicotine dependence.^{6,7}

While we build on these studies, we also depart from them in two significant ways. First, the present prospective longitudinal study is unique in that it examines adolescents (age 14) with ADHD, using a community sample, as their ADHD relates to their smoking behavior in the fourth decade of life. Second, we examine conduct disorder (CD) as a mediator between

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adolescent ADHD and adult smoking behavior. An understanding of the consequences of early adolescent ADHD for later adult smoking has significant implications for clinical treatment and public health. In assessing whether the individual is likely to smoke, clinicians would benefit from knowing under what circumstances adolescent ADHD increases the risk for adult smoking behavior. From a predictive perspective, longitudinal research extending from childhood to adulthood may be able to identify the significant childhood and adolescent risk factors, some of which may be malleable, that predict smoking in adulthood. Operating within a public health framework, one can identify those children and adolescents with ADHD who are at higher risk for daily smoking behavior in adulthood.

Another major risk factor for smoking is conduct disorder (CD). Studies demonstrate that ADHD increases the risk not only for smoking, but also for conduct disorder.⁸ For example, in two independent samples, it has been found that childhood ADHD predicted adolescent conduct disorder.^{9,10} ADHD is thought to typically precede the development of conduct problems.¹¹ Indeed, some researchers maintain that ADHD is the ‘motor’ that drives the development of early-starting conduct problems.¹² As noted by Molina and Pelham¹³ and Mannuzza et al.,¹⁴ the persistence of ADHD and the development of CD in some individuals may be a natural outgrowth of the pervasiveness and severity of ADHD in childhood.

Conduct disorder in adolescence is a well-established early predictor of later adult tobacco use as well as other drug use in both clinical and non-clinical samples.^{15,16} Furthermore, the relationship between adolescent conduct problems and subsequent tobacco use is quite robust.¹¹ This relationship has been demonstrated in community,¹⁶ high-risk,¹⁷ and clinical³ samples. Indeed, conduct disorder is related to several aspects of tobacco use, including age of initiation³ and regular (e.g., daily) smoking. One of the goals of the present study is to extend these findings by demonstrating that CD in adolescence is linked over time with smoking behavior in the fourth decade of life.

As noted above, ADHD is related to CD and to smoking behavior, and CD is related to smoking behavior. Therefore, in this paper, we also propose to examine CD as a possible mediator between ADHD and smoking behavior.

There is also data suggesting that demographic factors, such as socioeconomic status (SES) and gender, are associated with ADHD and conduct disorder as well as with smoking behavior. Higher SES is inversely related to ADHD, conduct disorder, and smoking behavior.^{18–20} With regard to gender, males as compared with females are more likely to be diagnosed with both ADHD and conduct disorder.¹² Therefore, in the present study, we controlled for these demographic factors in the analyses.

We report a longitudinal study of ADHD, CD and cigarette smoking in a community sample of adolescents interviewed prospectively from early and/or middle adolescence into adulthood. We test the following hypotheses: 1) ADHD is associated with conduct disorder in middle adolescence; 2) conduct disorder in middle adolescence is associated with smoking behavior in adulthood; and 3) ADHD is associated with CD, which in turn is related to smoking behavior in adulthood, controlling for gender and SES. To the best of our knowledge, this study is the first to examine the relationships between ADHD in early and/or middle adolescence, conduct disorder in middle adolescence, and later smoking in adulthood in a community sample extending over a period of 27 years.

Methods

Participants and Procedure

The sample consisted of 641 participants (46% were male). The participants were interviewed in 1975, 1983, and 1985–1986 and 2002. The mean age of the participants was 14.45 years (SD, 2.79 years) in 1983, 16.7 years (SD, 2.8 years) in 1985–1986, and 32 years (SD, 2.8 years) in 2002. Their mothers were interviewed in 1975, 1983, and 1985–1986, and provided information about their children. The participating families were a subset of families, with whom maternal interviews had been conducted in 1975 when the mean age of their offspring was 5 years of age. The families in this study in 1980 were representative of families in the northeastern United States with regard to socioeconomic status and most demographic variables (e.g., marital status), with the exception of ethnicity. The sample, which was predominantly white, had a drop-out rate of 15% from 1983 to 2002. The sample in 2002 did not differ from the 1983 sample with respect to the demographic factors. Study procedures were approved according to appropriate institutional guidelines. The study received IRB approval from the New York University School of Medicine; a Certificate of Confidentiality was obtained from the National Institute on Drug Abuse to protect the confidentiality of the participants. Written informed consent from the participants and their mothers was obtained after the interview procedures were fully explained. For children under 18, assent was obtained. Participants and their mothers were interviewed separately by extensively trained and supervised lay interviewers; interviewers of participants were blind to the responses of the mothers and vice versa. Additional information regarding the study methods is available from previous reports.²¹

Measures

The parent and youth versions of the Diagnostic Interview Schedule for Children (DISC-I) were administered in 1983, and again in 1985–1986 to assess psychiatric disorders including ADHD and CD. In addition, the participants were interviewed in 2002 at mean age 32 to assess their smoking behavior.

Symptoms of ADHD include an unusually high and chronic level of inattention, hyperactivity, or both. DSM-IV diagnostic criteria were used to classify the participants with respect to ADHD. In 1983, 8% (N = 52) of the adolescents met the criteria for ADHD (see Table 1).

According to DSM-IV, conduct disorder is a repetitive and persistent pattern of behavior in which the basic rights of others or major age-appropriate societal norms are violated, as manifested by the presence of 3 (or more) of several criteria in the past 12 months, with at least one criterion present in the past 6 months. The number and percent of participants who had ADHD and CD, CD alone, and neither ADHD nor CD appear in Table 1.

SES was assessed using a composite measure consisting of parental years of education and family income, where parental years of education were assessed as the maximum number of maternal and paternal years of education by 1985–1986. The average of family income in 1983 and 1985–1986 was used as a component for the SES measure. Adolescent smoking was assessed in 1982/1983. Adolescent smoking was a self-report measure of cigarette smoking during the past 5 years. The response range was similar to the adult measure of smoking noted below. Adolescent smoking was treated as a continuous measure.

Daily smoking was assessed in 2002 as the outcome measure. Daily smoking was selected as the dependent variable as it is frequently used as a measure of the individual's smoking behavior.²² Furthermore, individuals who report daily smoking are more likely to exhibit health problems.^{22,23} Smoking in 2002 was a self-report measure of the adult's cigarette

smoking during the past five years. The response range of the adult smoking scale was (1) none, (2) some, but less than daily, (3) 1–5 cigarettes a day, (4) about half a pack a day, (5) about a pack a day, (6) about 1.5 packs a day, and (7) about 2 packs a day or more. In 2002, 32.3% (N = 207) of the participants smoked on a daily basis (see Table 1). The dependent variable was dichotomized as follows: 1 = daily smoking, 0 = less than daily smoking.

Data Analysis

Chi-square tests were used to test whether gender, age, and SES were associated with smoking. Separate logistic regression analyses were conducted to examine the association of earlier adolescent ADHD (in 1983 or 1985–1986) and CD (1985–1986) with later smoking behavior (in 2002) controlling for demographic factors (i.e., gender, age, and SES). Then we examined: 1) the relationship of ADHD (in 1983 or 1985–1986) to later smoking (in 2002), controlling for CD (1985–1986), gender, age, SES, and adolescent smoking (1983); and 2) the relationship of CD in 1985–1986 and later smoking behavior (in 2002), controlling for earlier ADHD (in 1983 or 1985–1986), gender, age, SES, and adolescent smoking (1983). We also conducted logistic regression to examine the relationship of ADHD (in 1983 or 1985–1986) to CD (1985–1986). Finally, we tested the interaction of ADHD (in 1983 or 1985–1986) and CD in 1985–1986 as related to later daily smoking behavior. All analyses were performed using SAS version 9.1.3.

Results

In 2002, 32.3% of the adults (mean age = 32 years) interviewed smoked on a daily basis. There were 111 (32.4%) male and 96 (32.2%) female daily smokers. Participants from the younger age group (<32 years) reported somewhat more daily smoking than participants from the older age group (>32 years) (34.4% and 29.5%, respectively). Chi-square tests showed that neither of the differences were significant ($p > 0.05$). However, participants with high SES were significantly less likely to smoke on a daily basis in 2002 ($\chi^2(1) = 5.56$, $p\text{-value} < 0.02$). The participants who had earlier ADHD reported significantly ($p < .001$) more daily smoking than participants who did not have earlier ADHD (46.4% and 30.2%, respectively). The participants who had earlier CD reported significantly ($p < .001$) more daily smoking than the participants without earlier CD (50.8% and 30.2%, respectively).

As noted in Table 2, the logistic regression analyses revealed that ADHD (in 1983 or 1985–1986) was significantly related to daily smoking in 2002, with gender, age, and SES controlled (A.O.R. = 1.47, 95% C.I. = [1.01, 2.43], $p = 0.0440$). Similarly, CD in 1985–1986 was significantly associated with daily smoking in 2002 (A.O.R. = 2.71, 95% C.I. = [1.47, 4.99], $p = 0.0014$) with gender, age, and SES controlled.

In a separate analysis (See Table 2), the results of the logistic regression analyses indicated that (1) the relationship between ADHD in adolescence and later daily smoking in adulthood was no longer significant with control on CD, demographic factors, and adolescent smoking (A.O.R. = 1.11, 95% C.I. = [0.73, 1.69], $p = 0.6246$). (2) However, CD was significantly associated with daily smoking in 2002 with control on ADHD, demographic factors, and adolescent smoking (A.O.R. = 2.24, 95% C.I. = [1.12, 4.46], $p = 0.0222$).

We then conducted logistic regression analyses to examine the association between ADHD (T2 or T3) and CD (T3). The result indicated that adolescents with ADHD are 4.7 times more likely to have CD ($p < 0.001$). Therefore, the findings suggest a mediation effect of ADHD on adult smoking via CD. Using the formula created by MacKinnon et al.,²⁴ we calculated the mediational effect, which was 0.11 (SE = 0.001, $t = 3.08$, $p < 0.001$).

As noted in the analysis section, we then tested the following interaction term: ADHD (in 1983 or 1985–1986) by CD (in 1985–1986). The dependent variable was daily smoking behavior in 2002. The results indicated that the interaction term (ADHD by CD) was not significantly related to smoking behavior with control on gender, age, and SES ($\chi^2(1) = 0.0006$, $p\text{-value} = 0.9802$). Thus, our hypothesis that individuals with both ADHD and CD are most likely to smoke was not supported.

Discussion

As we hypothesized, a significant relationship between both adolescent ADHD and CD and later adult smoking emerged with control on gender, age, and SES. However, with control on the demographic factors, adolescent smoking, and CD, the relationship between ADHD and adult smoking was not significant. Nevertheless, the findings suggest that ADHD is related to CD, which in turn is related to adult smoking. The results extend the present literature by identifying one of the factors (i.e. CD) mediating between ADHD in adolescence and smoking behavior in adulthood. In addition, this is the first prospective longitudinal study of a community cohort that examines the relationship of conduct disorder in middle adolescence to smoking behavior in the fourth decade of life.

Our findings indicate that 32% of the adults reported daily smoking during the prior five years. These findings are in accord with those of previous investigations.²⁵ The prevalence of ADHD in our sample was 8 percent. These results are consistent with earlier results based on community samples. For example, Scahill and Schwab-Stone²⁶ reported that the prevalence of ADHD ranged from 5 to 10 percent.

Our findings regarding the association between ADHD and smoking are consistent with those of several previous investigations.^{3,7,13} For example, Milberger et al.³ reported that ADHD predicted cigarette smoking in adolescence. In a community sample, Tercyak et al.⁷ reported that adolescents with ADHD were at greater risk for smoking than adolescents without ADHD. In their study of adult patients, Pomerleau et al.⁵ concluded that ADHD is related to an increased risk for smoking behavior. Our longitudinal findings add to the literature by suggesting that ADHD in early and/or middle adolescence predicts daily smoking behavior later in adulthood (at mean age 32).

This study extends the findings of the literature in two important ways. First, in contrast to earlier studies, we examined the participants over several developmental periods and then followed them up into the fourth decade of life. This is particularly significant as no large-scale community studies have followed youth with ADHD and their subsequent daily smoking behavior in the fourth decade of life. As noted above, the results are in accord with the literature highlighting the fact that earlier ADHD is related to later cigarette smoking. Future investigations will be required to determine whether the relationship between ADHD in adolescence and smoking in the thirties will change as the participants grow older, as smoking in some individuals generally decreases with age. Second, our results indicate that ADHD is associated with conduct disorder, which in turn is related to smoking behavior. Besides the mediation of conduct disorder, other mechanisms may account for the association between ADHD and smoking. For instance, the regulation of the neurotransmitters dopamine and serotonin have been linked with both smoking and ADHD symptomatology.²⁷ Another possibility based on the Self-Medication Theory²⁸ is that adolescents who have ADHD and/or have CD may smoke to alleviate the stressful symptoms caused by ADHD or CD. Nicotine appears to improve general attention and the acquisition of new material, and has positive effects on behavioral inhibition in youngsters who have been diagnosed with ADHD.²⁹ Several investigators reported that nicotine in adults was linked with a reduction in attentional impairment, improved accuracy of

estimation of time and self-rated vigor and concentration.^{30,31} Furthermore, Potter and Newhouse³² suggested that nicotine administered to adolescents with ADHD have a positive effect on cognitive/behavioral inhibition. In a pilot study, Upadhyaya³³ recently reported poor smoking cessation among adolescents with ADHD. Future research will be required to study other factors operating as mediators between ADHD symptoms and smoking.

Our findings suggest that conduct disorder may play a mediating role between ADHD in adolescence and subsequent adult tobacco use. The effect of conduct disorder on smoking behavior is supported by previous studies, which have found that adolescents with conduct disorder are likely to smoke.^{3,11,13} While these results do not conclusively demonstrate that CD plays a causal role in subsequent smoking behavior, they are consistent with such a hypothesis. Since nicotine has been found to have the effect of reducing both internal and external stress,³⁴ the relationship of CD and daily smoking may be explained by the fact that adolescents with conduct disorder may be inclined to use tobacco in order to reduce anger and control impulsive tendencies and stressful emotions, as well as to mitigate the stress impinging from the outside world.³⁵ More research is required in order to support these intriguing hypotheses.

Consistent with the literature, participants with lower SES were more likely to have ADHD, and CD, and to smoke. Since we have controlled for SES in our analyses, it is likely that the relationships between ADHD, CD, and smoking behavior are not due to the influence of socioeconomic status.

Limitations

The study has several limitations. One limitation of the study is that the participants are predominantly white; consequently our results may not be generalizable to samples of ethnic minorities. A second limitation is that we were unable to assess the effects of prior psychiatric treatment on the relationships between ADHD, CD and smoking behavior. Related to this, the analyses did not include psychiatric assessments in 2002. For example, we did not account for persistent ADHD symptoms, antisocial personality disorders (ASPD), and other substance abuse in our analyses. Future research should include these measures as a number of adolescents with CD develop ASPD, which is a risk factor for smoking.

Despite these limitations, the results may highlight the significance of early recognition of ADHD for prevention and early intervention strategies with regard to later smoking. The findings suggest a developmental progression from ADHD in early and/or middle adolescence to conduct disorder in middle adolescence, leading to smoking behavior in adulthood. This may help clinicians in that individuals with ADHD are at greater risk for smoking. Our findings imply that there may be a window of opportunity during adolescence for the development of interventional techniques to lessen the likelihood of CD in youngsters with ADHD in order to prevent later cigarette smoking.

Conclusions

Our findings suggest that ADHD is related to CD, which in turn is associated with daily smoking. Therefore, interventions with ADHD adolescents who have ADHD at an early age might lead to some reduction in smoking provided that the intervention has a positive effect on CD. For those adolescents who never had ADHD, our findings suggest that prevention or treatment aimed at reducing CD may be most successful in reducing daily smoking later in adulthood.

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Table 1

Sample Characteristics in 1983, 1985–1986 and 2002

Gender:	
Male:	N = 295 (46%)
Female:	N = 346 (54%)
Ethnicity:	
Caucasian:	N = 583 (91%)
Other:	N = 58 (9%)
ADHD and CD, N (%)	
ADHD alone (1983):	N = 26 (4%)
CD alone (1985–1986):	N = 58 (9%)
ADHD and CD (1983 and 1985–1986):	N = 26 (4%)
Neither ADHD nor CD (1983 and 1985–1986)	N = 531 (83%)
Daily Smoking (2002), N (%)	
Daily:	N = 207 (32.3%)
Not Daily:	N = 434 (67.7%)

Table 2

Logistic Regression Analyses Predicting Daily Smoking in Adults: Adjusted Odds Ratios and 95% C.I.

Independent Variables	Daily Smoking in Adults			
	Coefficient (S.E.)	Wald Statistic	A.O.R. (95% C.I.)	P-Value
ADHD (T2 or T3)	0.38	4.06	1.47	0.0440
with control on demographic factors	(0.19)		(1.01–2.43)	
CD (T3)	1.00	10.16	2.71	0.0014
with control on demographic factors	(0.31)		(1.47–4.99)	
ADHD (T2 or T3)	0.19	0.84	1.11	0.6246
with control on demographic factors, CD and adolescence smoking	(0.21)		(0.73–1.69)	
CD (T3)	0.89	7.27	2.24	0.0222
with control on demographic factors, ADHD and adolescence smoking	(0.33)		(1.12–4.46)	

Note: 1. A.O.R.: adjusted odds ratio

2. Demographic factors include gender, age, and SES.