



# Attention deficit/hyperactivity disorder symptoms and depression symptoms as mediators in the intergenerational transmission of smoking

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## ABSTRACT

**Background:** Attention deficit/hyperactivity disorder and depression have been found to be comorbid with smoking behaviors, and all three behavioral syndromes have been shown to be familially transmitted. The present paper reports on the results of analyses testing whether child attention deficit/hyperactivity disorder and depression symptoms were mediators in the intergenerational transmission of cigarette smoking.

**Method:** Path analyses using bootstrapped mediation procedures were conducted on data from a community sample of 764 families (one or both parents and one adolescent offspring) from the Indiana University Smoking Survey. Parents reported on their smoking behaviors, ADHD, and depression and their child's ADHD, while offspring reported on their smoking behaviors and depression.

**Results:** Although fathers' and mothers' smoking status, depression, and ADHD were not significantly correlated with boys' smoking initiation, there was a significant mediated (indirect) pathway from mothers' depression to boys' smoking initiation through boys' depression. Several parental variables were significantly correlated with smoking initiation in girls, and the pathways from mothers' smoking status, mothers' ADHD, and fathers' smoking status to girls' smoking initiation were significantly mediated by girls' ADHD.

**Conclusions:** For adolescent girls, the intergenerational transmission of ADHD appears to be important in understanding the intergenerational transmission of cigarette smoking. Sex differences in the intergenerational transmission of psychopathology as it leads to smoking initiation were also discussed.

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## 1. Introduction

Every year over 438,000 people die from smoking related illness in the United States (Centers for Disease Control and Prevention, 2005), making cigarette smoking the leading preventable cause of death and disability. The public health significance of smoking prevention highlights the importance of understanding how smoking is first initiated.

Although influences on smoking are numerous and complex, studies have shown that parents have a significant influence on adolescent smoking (Chassin et al., 1998, 2008; Monteaux et al., 2008; Sherman et al., 2009; Melchior et al., 2010), that is, smoking behavior is intergenerationally transmitted. For example, Chassin et al. (1998) showed that parent smoking was related to offspring smoking in two generations, such that grandparent smoking

influenced parent smoking, and parent smoking then influenced adolescent smoking. Melchior et al. (2010) found that children of long-term smokers were at a higher risk of initiating smoking than children of parents who were not long-term smokers, and Chassin et al. (2008) found that parent-smoking characteristics (age at initiation, frequency, longevity) were predictive of the child's smoking initiation.

There are multiple explanations for the intergenerational transmission of smoking. First, there are likely to be genetically mediated pathways (True et al., 1997; Boomsma et al., 1994; Heath et al., 1993; Heath and Martin, 1993). For example, heritable individual differences in nicotine metabolism or nicotinic effects are likely to underlie the intergenerational transmission of smoking (e.g., Tobacco and Genetics Consortium, 2010). Environmental pathways may also influence the intergenerational transmission of smoking (Mulienburg et al., 2009; True et al., 1997; Boomsma et al., 1994; Kim et al., 2010). Parents who smoke provide models of smoking, access to cigarettes, and have more permissive rules about children's smoking (Otten et al., 2008). The current study focuses on two additional possible mechanisms that mediate the intergenerational transmission of smoking, namely, whether

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smoking parents transmit symptoms of depression and/or attention deficit/hyperactivity disorder (ADHD), which then influence children's smoking.

Multiple studies have found a relation between smoking and depression (Chang et al., 2005; Audrain-McGovern et al., 2009; Steuber and Danner, 2006; Brown et al., 1996; Fucito and Juliano, 2009; Fergusson et al., 2003; Upadhyaya et al., 2002; Morrell et al., 2010; Vogel et al., 2003). Longitudinal studies of adolescents by Fergusson et al. (2003) and Brown et al. (1996) found significant relations between major depression and smoking, with the latter study finding evidence of a bi-directional relationship. Cigarette smoking may represent one way that adolescents cope with depressive symptoms.

ADHD has also been shown to have a strong relation with smoking (McClernon et al., 2008; Chang et al., 2005; Lynskey and Fergusson, 1995; Upadhyaya et al., 2002; Barkley et al., 1990; Monteaux et al., 2008; Burke et al., 2001). Barkley et al. (1990) found that hyperactive children were more likely to have smoked cigarettes than were controls, and Burke et al. (2001) found that the inattentive aspect of ADHD was linked with tobacco use. Adolescents with ADHD may smoke to obtain the beneficial effects of nicotine on attention. Several studies have shown that nicotine can improve attention in both people with and without ADHD (Potter and Newhouse, 2008; Rezvani and Levin, 2001; McClernon et al., 2008; Levin et al., 2006).

Not only is smoking associated with both depression and ADHD, but both ADHD and depression may be intergenerationally transmitted. ADHD has been shown to be transmitted from parent to child (Biederman et al., 2008; Faraone and Biederman, 1998; Monteaux et al., 2008; Lange et al., 2005; Cunningham and Boyle, 2002; Minde et al., 2003). In the case of ADHD, this transmission appears to reflect strong genetic influence (Faraone and Biederman, 1998; Smalley et al., 2000; Levy et al., 1997; Biederman, 2005; Wallis et al., 2008).

Depression can also be transmitted through families (Jones et al., 2001; Silberg et al., 2010; Loeber et al., 2009; Pettit et al., 2008; Beardslee et al., 1996). In the case of depression, however, this intergenerational transmission may reflect environmental influence. For example, Silberg et al. (2010) confirmed in a study of children of twins that depression is transmitted from one generation to the next, but also that the transmission was due entirely to family environmental factors. Similarly, Tully et al.'s (2008) study of parental depression in adoptive and biological families found that parental depression significantly predicted adolescent depression in both biological and adoptive families.

Given that ADHD, depression, and smoking are all intergenerationally transmitted, and given that both ADHD and depression are predictive of smoking, the current study hypothesizes that a possible mechanism for the intergenerational transmission of smoking is the co-transmission of ADHD and/or depression. In particular, the present study tests whether ADHD and depression act as mediators of the intergenerational transmission of smoking. Although Monteaux et al. (2008) have shown that ADHD and smoking are co-transmitted intergenerationally, to our knowledge, no studies have simultaneously examined the intergenerational co-transmission of smoking, depression, and ADHD in a community sample.

Separate models for both parent and child gender were considered in this study of intergenerational co-transmission of smoking, depression, and ADHD because previous literature demonstrates gender differences in depression and in ADHD as well as in genetic and environmental influences on smoking. For example, depression is more prevalent in female adolescents and adults than it is in males (Elliot, 2001; Jenkins et al., 2002), with about twice as many females reaching clinical levels of depression compared to males. However, studies have also shown that this gender difference does not appear until adolescence (Angold and Worthman,

1993; Doménech-Llaberia et al., 2009; Hankin et al., 1998)—around the age of 15. In other words, there is no gender difference in depression prevalence in children. In contrast, ADHD is more prevalent in males than females (Biederman et al., 1994; DuPaul et al., 2006), with boys having higher rates of ADHD than girls by at least a ratio of 2:1. Finally, studies have shown that environmental and genetic influences on smoking differ between genders (Heath et al., 1993; Boomsma et al., 1994; Hamilton et al., 2006), with genetic influences being found to be stronger in smoking initiation for males, whereas environmental influences are stronger in females.

In addition to child gender being important, parent gender is also an important factor in analysis. Mothers and fathers can contribute to ADHD vulnerability through both environment and genetics. One study by Nomura et al. (2010) found that mothers' smoking during pregnancy was a significant influence on ADHD outcome; children of women who smoked had significantly higher inattention, hyperactivity and ADHD scores than did children of women who did not smoke. This was true regardless of whether or not fathers smoked. Knopik et al. (2006) and D'Onofrio et al. (2008) found similar results. However, fathers have been reported to be more important than mothers in terms of heritable serotonergic and dopaminergic influences on the development of ADHD (Hawi et al., 2002, 2005; Kent et al., 2005; Quist et al., 2003), although a similar study by Anney et al. (2008) failed to find any significant parent gender effects in different genes that may influence susceptibility to ADHD. Differing from ADHD, mothers primarily influence depression. Studies by Brennan et al. (2002), Marmorstein et al. (2004) and Tully et al. (2008) all found that maternal, but not paternal, depression was a significant predictor of offspring depression. There are inconsistent findings concerning the impact of parent gender on the intergenerational transmission of smoking. Whereas some studies have found that parental influence can depend on adolescent gender, such that mothers have stronger influence on daughters or that fathers have stronger influence on sons (Wickrama et al., 1999; Kandel and Wu, 1995; Gilman et al., 2009), one study found that paternal smoking had no effect on child smoking initiation (Rohde et al., 2003), and still another found that gender had no effect on the influence that parents have on smoking initiation (Peterson et al., 2006). Given the previous findings, albeit inconsistent, that mothers and fathers may influence sons and daughters differently, the current study tested mothers' and fathers' effects in separate models.

In the current study, the independent variables were parent smoking status, ADHD symptoms, and depression symptoms, the mediators were child ADHD symptoms and depressive symptoms, and the dependent variable was child smoking initiation. The following hypotheses were tested: (1) parents who smoke will have higher levels of ADHD symptoms than parents who do not smoke; (2) parents with higher levels of ADHD symptoms will have children who have higher levels of ADHD symptoms than will parents with lower rates of ADHD symptoms; (3) children with higher levels of ADHD symptoms will be more likely to begin to smoke than will children with lower rates of ADHD symptoms; (4) parents who smoke will have higher levels of depression symptoms than parents who do not smoke; (5) parents with higher levels of depression symptoms will have children with higher levels of depression symptoms than will parents with lower rates of depression symptoms; (6) children with higher levels of depression symptoms will be more likely to begin to smoke than children with lower rates of depression symptoms. We also tested the indirect effects of parental smoking and parents' ADHD symptoms on child's smoking through the child's ADHD symptoms and the indirect effects of parental smoking and parents' depression symptoms on child's smoking through the child's depression symptoms. Finally, we tested possible child gender moderation of all of these direct and indirect effects.

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