Secondhand smoke exposure and other correlates of susceptibility to smoking: A propensity score matching approach

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HIGHLIGHTS

- We test association of secondhand smoke and smoking susceptibility among adolescents.
- We use propensity score matching to reduce selection bias in sample.
- Secondhand smoke exposure predicts smoking susceptibility before and after matching.
- Odds ratio increase after matching suggests that pre-match estimates were biased.
- We find a robust estimate of secondhand smoke and smoking susceptibility association.

ARTICLE INFO

ABSTRACT

Secondhand smoke (SHS) exposure is responsible for numerous diseases of the lungs and other bodily systems among children. In addition to the adverse health effects of SHS exposure, studies show that children exposed to SHS are more likely to smoke in adolescence. Susceptibility to smoking is a measure used to identify adolescent never-smokers who are at risk for smoking. Limited research has been conducted on the influence of SHS on susceptibility to smoking. The purpose of this study was to determine a robust measure of the strength of correlation between SHS exposure and susceptibility to smoking among never-smoking U.S. adolescents. This study used data from the 2009 National Youth Tobacco Survey to identify predictors of susceptibility to smoking in the full (pre-match) sample of adolescents and a smaller (post-match) sample created by propensity score matching. Results showed a significant association between SHS exposure and susceptibility to smoking among never-smoking adolescents in the pre-match (OR = 1.47) and post-match (OR = 1.52) samples. The odds ratio increase after matching suggests that the strength of the relationship was underestimated in the pre-match sample. Other significant correlates of susceptibility to smoking identified include: gender, race/ethnicity, personal income, smoke-free home rules, number of smoking friends, perception of SHS harm, perceived benefits of smoking, and exposure to pro-tobacco media messages. The use of propensity score matching procedures reduced bias in the post-match sample, and provided a more robust estimate of the influence of SHS exposure on susceptibility to smoking, compared to the pre-match sample estimates.

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1. Introduction

Secondhand smoke (SHS), which is composed of both mainstream smoke exhaled by smokers and side-stream smoke produced by the burning end of tobacco products (U.S. Department of Health and Human Services (DHHS), 2014), exerts a dramatic burden on the health of nonsmokers throughout the world. There is much evidence showing that SHS exposure is responsible for the development of lung cancer, heart disease, bronchitis, pneumonia, thrombosis, and sudden infant death syndrome, and is especially detrimental to the respiratory development of children (DHHS, 2006, 2012). In addition to the adverse health effects of SHS exposure, studies have shown that children exposed to SHS are more likely to smoke in adolescence, even after controlling for numerous confounders (Becklake, Ghezzo, & Ernst, 2005; Leonardi-Bee, Jere, & Britton, 2011).

Although rates of cigarette use among U.S. adolescents have decreased over the past two decades, 20% of U.S. adolescents currently smoke cigarettes (U.S. Centers for Disease Control and Prevention (CDC), 2010). Most people develop their beliefs and attitudes about

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smoking during adolescence. Studies indicate that once adolescents initiate cigarette use, they can quickly develop nicotine addiction (DiFranza et al., 2002), and the majority of young people who begin to use tobacco products on a regular basis have great difficulty breaking this addiction (DHHS, 2012). Research has shown that virtually all smokers report initiating cigarette smoking before the age of 18 (DHHS, 2012).

Based on the research of Pierce, Farkas, Evans, and Gilpin (1995), susceptibility to smoking is a measure used to identify adolescent never-smokers who exhibit intentions and expectations of smoking in the future. Susceptibility to smoking identifies adolescents who lack a firm commitment not to smoke, indicating that they might smoke if presented with the opportunity. This characterization places adolescents in the preparation stage of Leventhal and Cleary's (1980) stages of smoking onset. Studies have demonstrated that adolescent never-smokers who are identified as susceptible to smoking are two to three times more likely to become smokers than non-susceptible youth (Pierce, Choi, Gilpin, Farkas, & Merritt, 1996; Unger, Johnson, Stoddard, & Nezami, 1997).

Many smoking-related factors have been identified as influencing susceptibility to smoking among never-smoking adolescents including smoking in the social environment (whether friends/peers or parents smoke) (O'Loughlin, Karp, Koulis, Paradis, & DiFranza, 2009), observing smoking in movies (Sargent et al., 2002), and smoking-related beliefs (Song, Glantz, & Halpern-Felsher, 2009). However, more research is needed to determine the effect of factors in the physical environment, such as the influence of SHS exposure, on susceptibility to smoking.

Studies have identified SHS exposure as a predictor of susceptibility to smoking among adolescent never-smokers using cross-sectional (Racicot, McGrath, & O'Loughlin, 2011; Seo, Torabi, & Weaver, 2008; Veeranki, Mamudu, Anderson, & Zheng, 2013) and prospective study designs (Lessov-Schlaggar, Wahlgren, Liles, Ji, et al., 2011; Wang, Ho, & Lam, 2011). The latter two studies showed that SHS exposure at baseline significantly predicted susceptibility to smoking at 3-year and 2-year follow-ups, respectively. While providing evidence for a strong connection between SHS exposure and susceptibility to smoking, these results may be limited because the studies did not measure and control potentially influential variables—for example, tobacco-related beliefs or exposure to tobacco media.

Additionally, while many studies that have identified SHS exposure as a predictor of susceptibility to smoking have controlled for variables that may confound results, all of these studies used traditional regression techniques that have not controlled for the selection bias inherent in non-experimental studies. Therefore, these studies have been limited in determining whether there is a causal effect of SHS exposure on susceptibility to smoking (Ellenberg, 1994; Rubin, 2001). Those exposed to SHS are likely different, along measured and unmeasured dimensions, from those who are not exposed. For example, they may socialize with more smokers, believe that SHS exposure is not harmful, or be exposed to more pro-tobacco media. These systematic differences, rather than exposure itself, may explain why the two groups differ in their susceptibility to smoking.

To identify a more robust measure of the correlation between SHS exposure and susceptibility to smoking, this study focused on identifying the effect of SHS exposure on susceptibility to smoking among never-smoking U.S. adolescents using propensity score matching techniques. Propensity score matching methods attempt to reduce bias in estimated coefficients by creating subsets of participants that are very similar on the probability or "propensity" to receive a treatment, in this case SHS exposure, based upon similarity on a range of measured variables (Newgard, Hedges, Arthur, & Mullins, 2004; Rosenbaum & Rubin, 1983). Propensity score matching procedures improve upon more common methods of producing correlation estimates, such as controlling for individual-level variables in regression models, by making the exposed and unexposed groups as comparable as possible based on relevant confounding variables. Within subsets of

participants with similar propensity scores, the effect of the treatment (i.e., self-reported SHS exposure) on the outcome (i.e., self-reported susceptibility to smoking) is determined by comparing outcome means between the treated and untreated participants. The average treatment effect on the treated is then determined by averaging the results of these comparisons among subsets. All of those participants in the control group who do not resemble participants in the treatment group (based on their propensity scores) are eliminated from the analyses such that only those with similar propensity scores but who differ on their treatment status are included. This ensures common support between the treatment and control groups on the variables used to determine the propensity score (Heckman, Ichimura, & Todd, 1997). In this way, adjusting for the propensity score provides an effective method to control for a large number of confounders without over-fitting the model that predicts the outcome.

In this study, first, we identified correlates of susceptibility to smoking by using a national sample of never-smoking U.S. adolescents; second, we compared correlates identified in the national sample to those identified in a reduced sample created by propensity score matching; and, third, we tested the presence and strength of correlation between SHS exposure and susceptibility to smoking by using the reduced sample model.

2. Method

2.1. Data source

The National Youth Tobacco Survey (NYTS) periodically measures tobacco use behaviors, various exposures to secondhand smoke, smoking cessation, tobacco-related school curriculum, minors' ability to purchase or obtain tobacco products, attitudes about tobacco, and familiarity with pro- and anti-tobacco media messages among middle and high school students (ages 9 to 21, hereafter referred to as adolescents) in the United States (CDC, 2009). To identify the relationship between SHS exposure and susceptibility to smoking among adolescents, we used data from the 2009 NYTS dataset. Additional information about NYTS administration procedures and sampling strategy is available elsewhere (CDC, 2009).

2.2. Participants

The total number of schools that participated in the 2009 NYTS data collection was 205, and the total number of students was 22,679. The overall response rate was 85% (CDC, 2009). Fig. 1 outlines the sample selection for the study. Our analyses included only those middle and high school students who self-identified as never-smokers. Of the 22,679 participants surveyed, 14,563 (64.2%) self-identified as never-smokers. After dropping participants who had missing values for any item used in the propensity score model, who were not in the common area of support, or who were not matched using propensity scores, 5938 participants were retained in the post-match sample for the final analysis.

2.3. Measures

2.3.1. Never-smoking status

We considered participants to be never-smokers if they reported never smoking a cigarette on the following item: "Have you ever tried smoking, even one or two puffs?" with response options yes or no.

2.3.2. Susceptibility to smoking

Consistent with prior research (Dube, Arrazola, Lee, Engstrom, & Malarcher, 2013; Pierce et al., 1995), we considered participants to be susceptible to smoking if they provided any response other than "No" to the question, "Do you think that you will try a cigarette soon?," any response other than "Definitely not" to the question, "Do you think