



# A systematic review of secondhand tobacco smoke exposure and smoking behaviors: Smoking status, susceptibility, initiation, dependence, and cessation



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## HIGHLIGHTS

- Secondhand smoke exposure is associated with being a smoker.
- Secondhand smoke exposure increases smoking susceptibility and initiation.
- Secondhand smoke exposure may increase nicotine dependence in adults.
- Secondhand smoke exposure hinders smoking cessation

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## ABSTRACT

**Objectives:** To examine the association between secondhand tobacco smoke exposure (SHSe) and smoking behaviors (smoking status, susceptibility, initiation, dependence, and cessation).

**Methods:** Terms and keywords relevant to smoking behaviors and secondhand tobacco smoke exposure were used in a search of the PubMed database. Searches were limited to English language peer-reviewed studies up till December 2013. Included papers: a) had clearly defined measures of SHSe and b) had clearly defined measures of outcome variables of interest. A total of 119 studies were initially retrieved and reviewed. After further review of references from the retrieved studies, 35 studies were finally selected that met all eligibility criteria.

**Results:** The reviewed studies consisted of thirty-five (89.7%) studies with differing measures of SHSe (including questionnaire and biological measures) and varying definitions of main outcome variables of interest between studies. The majority of the studies (77%) were cross-sectional in nature. The majority of studies found that SHSe was associated with greater likelihood of being a smoker, increased susceptibility and initiation of smoking, greater nicotine dependence among nonsmokers, and poorer smoking cessation.

**Conclusions:** The review found positive associations between SHSe and smoking status, susceptibility, initiation and nicotine dependence and a negative association with smoking cessation. In light of design limitations, future prospective and clinical studies are needed to better understand the mechanisms whereby SHSe influences smoking behaviors.

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## 1. Introduction

Secondhand tobacco smoke exposure (SHSe) remains a global health problem with 40% of children and 34% of non-smoking adults exposed and resulting in 603,000 attributable deaths from ischemic heart disease, respiratory infections, asthma, and lung cancer (Öberg et al., 2011). This global impact continues to spur the need for tobacco control measures that aim to limit and protect individuals from SHSe. Particularly, Article 8 of the WHO Framework Convention recommends effective measures to protect exposure from tobacco smoke in both indoor and public spaces (World Health Organization, 2009). These recommendations come from extensive studies suggesting that there is no risk free level of SHSe (U.S. Department of Health and Human Services, 2006). Indeed, even brief and transient SHSe confers health risks (Flouris et al., 2010; Raupach et al., 2006).

Although the adverse physical health consequences of SHSe is extensively recognized, (Barnoya & Glantz, 2005; Jones et al., 2011; U.S. Department of Health and Human Services, 2010; Zhong et al., 2000) a growing body of research has begun to assess its behavioral effects. Notably, studies have demonstrated the neurocognitive detriments (Herrmann, King, & Weitzman, 2008; Llewellyn et al., 2009; Swan & Lessov-Schlaggar, 2007; Yolton et al., 2005) and mental health effects (Bandiera, 2011; Bandiera et al., 2010, 2011; Hamer et al., 2011; Hamer, Stamatakis, & Batty, 2010) associated with SHSe. Given its acknowledged psychological and neurocognitive effects, the risks conferred by SHSe may extend to behaviors which reinforce smoking. For instance, environments of tobacco smoke exposure are associated with increased smoking cues that may potentiate smoking behaviors among smokers (Field et al., 2007; McRobbie, Hajek, & Locker, 2008). Additionally, through the psychoactive effect of nicotine exposure from SHSe, novice smokers may be at increased susceptibility to initiate tobacco use (Anthonisen & Murray, 2005). Indeed, clinical studies have found that SHSe results in increased occupancy of nicotine-acetylcholine receptors in the brains of adult smokers and non-smokers, (Brody et al., 2011) suggesting increased neural vulnerability to nicotine exposure from SHS.

Despite the putative mechanisms of action whereby SHSe may influence smoking behavior, it is important to first determine to what extent SHSe is associated with such behaviors. Therefore, our study aims to systematically examine the literature for studies assessing the associations between SHSe and smoking behaviors; particularly smoking status, susceptibility, initiation, dependence, and cessation. The finding of this review will be informative in strengthening policies to limit SHSe, prevent smoking uptake, and to promote strategies for cessation.

## 2. Methods

We performed a literature search for published articles in the English language that reported on the relationship between SHSe and smoking related behaviors (i.e., smoking status, smoking susceptibility, smoking initiation, nicotine dependence and smoking cessation) prior to December 2013, through PubMed electronic database. Key terms

used for the search were as follows: Secondhand tobacco smoke OR Environmental tobacco smoke AND smoking initiation OR smoking susceptibility OR risk for smoking AND nicotine dependence OR cravings OR addiction AND smoking cessation OR quit smoking. Only studies that had clearly defined measures of SHSe and of the main outcome variables of interest were included.

A total of 115 studies were initially retrieved and reviewed. Studies that examined the effect of smoking bans on smoking behaviors, (Edwards et al., 2008; Ma et al., 2010; Muilenburg et al., 2009) assessed the 'exposure to smoking' but not SHSe, (Bricker et al., 2012; Choi et al., 2002; Okoli et al., 2009) examined the effect of sensitivity to SHSe on behaviors (Lessov-Schlaggar et al., 2011a, 2011b) or examined SHSe but did not examine the relationship with smoking behaviors (Al-Bedah & Qureshi, 2011) were further excluded. In addition, studies that examined the effect of prenatal tobacco smoke exposure and their relationship to other substance use disorders (Goldschmidt, Cornelius, & Day, 2012) were further excluded from our analysis. After further review of references from the retrieved studies, 35 studies were finally selected that met all eligibility criteria. Meta-analytic techniques could not be adequately performed because of the heterogeneity in the definitions of measures and designs across studies. However, to facilitate our analysis and discussion, we have grouped the results of the review to examine the associations between SHSe and smoking status, smoking susceptibility, smoking initiation, nicotine dependence, and smoking cessation.

## 3. Results

### 3.1. Description of studies

The retrieved studies consisted of 27 (77%) cross-sectional analyses, seven (20%) longitudinal analyses, and one (3%) case-control study; representing findings from a population of 1,138,101 participants. The samples represent 14 countries with thirteen (37.1%) studies from the United States, six (17.1%) from Canada, four (11.4%) from China or Hong Kong, two (5.7%) from Turkey, one combined Global Health Survey data from Cambodia, Laos, and Vietnam, one combined Global Youth Tobacco Survey data from 168 countries, and one study each from Sweden, Norway, Spain, Italy, Taiwan, Ukraine, and New Zealand. Nineteen (54.3%) studies were among youth, 13 (37.1%) used data solely from adults, and three (8.6%) included data from both youth and adults.

Twelve studies (34.3%) examined the association between SHSe and smoking status; (Darling & Reeder, 2003; Glover et al., 2011; Homish et al., 2011; Hong, Kam, & Kim, 2013; Hopenhayn et al., 2013; Kalkhoran, Neilands, & Ling, 2013; Lee et al., 2007; Manzoli et al., 2005; Seo, Bodde, & Torabi, 2009; Skorge et al., 2007; Twose et al., 2007; Tyc, et al., 2004) seven (20.0%) examined the association between SHSe and smoking susceptibility; (Chen, Huang, & Chao, 2009; Guindon, Georgiades, & Boyle, 2008; Kalkhoran et al., 2013; Racicot, McGrath, & O'Loughlin, 2011; Schultz, Nowatzki, & Ronson, 2013; Veeranki et al., 2013; Yang, Leatherdale, & Ahmed, 2011) five (14.3%) examined the

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