Dose–response relations between second-hand smoke exposure and depressive symptoms among middle-aged women

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ABSTRACT

A growing body of evidence indicates a strong association between smoking and depression. However, little is known about the possible effects of second-hand smoke (SHS) exposure on depression. This study aimed to examine the potential dose–response relation between SHS exposure and depressive symptoms among non-smoking middle-aged women. A cross-sectional survey was conducted using a stratified three-stage sampling method. Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale with a cut-off point of 16. Self-reported SHS exposure was defined as non-smokers' inhalation of the smoke exhaled from smokers on at least one day a week. The multivariable logistic regression analysis was completed with adjustment for potential confounders. Among 1280 middle-aged women, 19.4% were classified as having depressive symptoms. There was a 104% increased odds of depressive symptoms corresponding to SHS exposure in general (OR=2.04, 95% CI 1.48–2.79) using no exposure as reference. There were significant positive relations between SHS exposure in general and depressive symptoms in a dose–response manner. These significant trends were observed consistently whether SHS exposure occurred in homes or workplaces. Our findings suggest that long-term and regular SHS exposure is associated with a significant, dose-dependent increase in risk of depressive symptoms.

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1. Introduction

It is well established that smoking causes serious diseases (eg, cancer, heart disease, respiratory disease and many others; Lim et al. (2012)). There is increasing evidence suggesting that smoking may also cause or worsen depressive symptoms (Edwards et al., 2011; Edwards and Kendler, 2012; Menezes et al., 2013). It is conceivable that non-smokers who are exposed to a high level of second-hand smoke (SHS) may also experience depression as a result. If this hypothesis is true, previous findings associating smoking and depression could be underestimated because the referent group in most studies of smoking included non-smokers with potential SHS exposure (Edwards et al., 2011; Edwards and Kendler, 2012).

But so far it was unclear whether depression and mental health are associated with SHS exposure. A few studies demonstrated a positive relation of SHS exposure with poor mental health (such as generalized anxiety disorder, attention-deficit/hyperactivity disorder, and conduct disorder), neurodevelopmental delay, and depressive symptoms/depression (Bandiera et al., 2010a, 2011; Lee et al., 2011; Lee, 2014), while a non-significant association between SHS exposure and poor mental health was found in the cross-sectional and prospective analyses using the UK Health and Lifestyle survey (Lam et al., 2013). A previous study also found that SHS exposure at work had a significant relation with depressive symptoms, but no significant association were found in never smokers exposed to SHS in homes (Nakata et al., 2008).

To note, little is known about the dose–response relations between SHS exposure and depression, or the setting-specific associations. In addition, depression has a greater incidence in menopause (Soares and Zitek, 2008), and thus it is critical to consider how SHS may be affecting the mental health of menopausal women so that appropriate preventive measures can be implemented. This study builds on the previous literature to examine the possible dose–response relations between SHS exposure in different venues and depressive symptoms among middle-aged women.

2. Methods

2.1. Ethics statement

The study was approved by the ethics committee of Guangdong Pharmaceutical University, and this survey was qualified as involving no risks to participants. All

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participants gave a verbal informed consent regarding the goals of the study and the willingness to participate.

2.2. Study sample and procedures

This cross-sectional study was conducted in Guangzhou city, Guangdong province, China, from September to December 2012. The target population was middle-aged women (40–60 years) in Guangzhou city. Participants were selected based on a stratified three-stage sampling method. In the first stage, all 12 districts were divided into two categories according to geographical representations and levels of economic development, which are urban and rural areas. Two districts were randomly sampled from each of the two categories. In the second stage, two street districts (Jie Dao) were randomly drawn from the selected districts. In the third stage, a number of samples of women aged 40–60 years were selected by a convenience sampling method. Participants were intercepted in each sampled street district and eligible women were asked to complete a face-to-face survey after having given a verbal informed. A total of 1401 participants were interviewed, of whom 1356 (96.8%) were willing to participate this survey and 45 (3.2%) were refused to participant. To note, only non-smokers were included in the analyses and a total of 1280 non-smokers were included in this study.

Interviewers were enrolled voluntarily from the 5th year undergraduate students of Guangdong Pharmaceutical University. All interviewers in each area were trained by experts from Guangdong Pharmaceutical University to ensure that the operation procedures were identical across all areas. All participants received a towel (RMB ¥6) as a reward for participating.

2.3. Study variables

The main outcome variable was self-reported depressive symptoms measured by a Chinese version of the Center for Epidemiologic Studies Depression (CES-D) scale (Radloff, 1977). The 20-item depressive symptom scale measures the level of depressive symptoms experienced in the past week. Each question was answered using a four-point Likert scale (0-1-2-3) and higher scores indicate higher levels of depressive symptoms. Cronbach's alpha (good at coefficient ≥ 0.7) (Ishikawa, et al., 2008) was calculated to examine the internal consistency of the questionnaire, and Cronbach's alpha for the CES-D scale in this sample was 0.878. In our study, the prevalence of depressive symptoms was defined as the proportion of individuals with a total score of 16 or more in the CES-D scale (Nakata et al., 2008).

The main independent variable was self-reported SHS exposure. Self-reported SHS exposure was defined as non-smokers' inhalation of the smoke exhaled from smokers on at least one day a week (one day means in that day there are smokers smoking totally up to 15 min or longer) for at least the last 12 months (Wang et al., 2009; Cai et al., 2013). Participants were asked if they had smoked ≥ 100 cigarettes in their lifetime, and those responding "no" were non-smokers and were included in this study. Frequency of SHS exposure was continuous data (days/week), and was also categorized into three groups: no exposure (less than one day a week or less than 12 months), occasional exposure (1–3 days a week for at least the last 12 months), and regular exposure (4–7 days a week for at least the last 12 months). Duration of SHS exposure was continuous data (years), and was also categorized into three groups: no exposure, 1–20 years (below median among SHS exposed persons), and > 20 years (above median among SHS exposed persons). SHS exposure in homes, in workplaces and in public places was asked separately.

Covariates including potential mediators and confounders were chosen a priori on the basis of literature review. Covariates in our study were age, number of chronic diseases (0,1, ≥ 2), marital status (married, or not married), employment (yes or no), education (elementary school, junior and senior high school, college and above), family monthly income ($\leq$¥1000, ¥1001–3000, or $\geq$¥3001), locality type (urban or rural), body mass index (BMI; $< 18.5, 18.5–24.9$, or $\geq 25 \, kg/m^2$), pressures in life (no, slight, or high), social support from family members and friends (high or low), Kupperman menopausal index(< 5 or ≥ 5) (Sun et al., 2014), negative life events in the last month (yes or no) and history of depression (yes or no). BMI was calculated as weight in kilograms divided by the square of height in meters. For the question of number of chronic diseases, participants were asked if they were currently under treatment for any of the following diseases: menopausal disorder, hypertension, coronary heart disease, diabetes mellitus, hyperlipidemia, chronic obstructive pulmonary disease, osteoarthritis or other diseases. Negative life events referred to responding 'yes' to any of the following events having occurred in the past month in participants' families: poor housing, financial problems, serious medical problems of the participants, theft, violent/suicidal/criminal behaviors of family members, death of extended family members, accident/disaster or separation from parents. For the question of history of depression, participants were asked if they had ever been diagnosed with depression by a doctor.

2.4. Data analysis

All data were entered in duplicate into the EpiData version 3.1 database, and then every inconsistency was checked by the consistency test. The dose–response relations between SHS exposure and depressive symptoms were evaluated by calculating odds ratios (ORs) and 95% confidence intervals (CIs), using logistic regression models. Linear trends of SHS exposure were assessed by modeling exposures as continuous variables (arithmetic or logarithmic scale) or categorized variables in logistic regression models. Potential confounders were identified based on a review of putative risk factors for depressive symptoms and a 10% or greater change in the β coefficients for SHS exposure between the crude and the adjusted models. Effect modification was assessed by the likelihood ratio tests comparing nested models with and without interaction variables, and no of the tests for interactions showed statistical significance. We defined a two-sided p-value of ≤ 0.05 as being of statistical significance. All statistical analyses were conducted using STATA version 13.0 (StataCorp LP, College Station, Texas, USA).

3. Results

3.1. Characteristics of the sample

Sample characteristics are given in Table 1. A total of 1280 non-smoking middle-aged women were analyzed in this study, of whom 248(19.4%) were classified as having depressive symptoms. Roughly 21% of non-smokers were regular, 34% were occasional, and 45% were not exposed to SHS in any venues. In analyses stratified by settings, SHS exposure was highest in homes (44.4%), while lower figures were observed in workplaces (28.9%) and in public places (6.2%).

3.2. Exposure versus non-exposure to SHS

Compared with no SHS exposure, women with SHS exposure in general experienced a significantly higher odds of having depressive symptoms (OR=2.04, 95% CI 1.48–2.79; Table 2). Similar positive association was observed among women with SHS exposure in homes (OR=2.32, 95% CI 1.66–3.26; Table 2) or in workplaces (OR=2.18, 95% CI 1.35–3.50; Table 2). However, no significant associations were found in women exposed to SHS in public places.

3.3. Relation between frequency of SHS exposure and depressive symptoms

The odds for having depressive symptoms increased with increasing frequency of SHS exposure in general (OR=1.33, 95% CI 1.17–1.50, expressed days per week). Compared with no SHS exposure, frequency of SHS exposure in general (expressed a categorized variable) was also positively associated with depressive symptoms in a dose–response manner (OR=1.78, 95% CI 1.25–2.54, for occasional SHS exposure; OR=2.44, 95% CI 1.67–3.58, for regular SHS exposure; p for linear trend < 0.001; Table 3). Similar increasing relations were observed among women with increasing frequency of SHS exposure in homes or in workplaces.

3.4. Relation between duration of SHS exposure and depressive symptoms

The odds for having depressive symptoms increased with increasing years of SHS exposure in general (OR=1.60, 95% CI 1.32–1.95, expressed as a continuous variable). Compared with no SHS exposure, years of SHS exposure in general (expressed a categorized variable) was also positively related with depressive symptoms in a dose–response manner (OR=1.63, 95% CI 1.13–2.34, for 1–20 years of SHS exposure; OR=2.75, 95% CI 1.86–4.07, for > 20 years of SHS exposure; p for linear trend < 0.001; Table 4). Similar increasing relations were observed among women with increasing years of SHS exposure in homes or in workplaces.