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Active smoking, environmental tobacco smoke and bronchitic symptoms among adolescents in Taiwan: A prospective cohort study

Jer-Min Chen [a,b], Bing-Fang Hwang [c], Yang-Ching Chen [a,b], Yungling Leo Lee [a,d,*]

[a] Institute of Epidemiology and Preventive Medicine, College of Public Health, National Taiwan University, Taipei, Taiwan
[b] Department of Family Medicine, Taipei City Hospital, Taipei, Taiwan
[c] Departiment of Occupational Safety and Health, College of Public Health, China Medical University, Taichung, Taiwan
[d] Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan

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ABSTRACT

Objective. The study investigates the association between active smoking, exposure to environmental tobacco smoke (ETS) and the development of bronchitis and bronchitic symptoms among adolescents.

Methods. A prospective cohort study was conducted with 4134 adolescents aged 12–14 from the Taiwan Children Health Study in 14 communities in Taiwan since 2007. Parents or guardians completed written questionnaires regarding demographic information, household ETS and respiratory symptoms at baseline. The adolescents themselves completed identical questionnaires on respiratory outcomes in the 2009 survey. Associations between active smoking, exposure to ETS and the 2-year incidence of respiratory outcomes were analyzed by multiple Poisson regression models, taking overdispersion into account.

Results. Active smoking was associated with an increased risk of developing chronic cough and chronic phlegm. We found significant dose–response associations between the duration of smoking, the numbers of cigarettes and the onset of bronchitic symptoms. Exposure to ETS was a significant risk factor for the development of chronic cough. Among asthmatic adolescents, exposure to ETS was associated with an additional risk for the onset of chronic phlegm.

Conclusion. This study demonstrates that active smoking and exposure to ETS are associated with higher risks for developing bronchitic symptoms among adolescents.

Introduction

Smoking and exposure to environmental tobacco smoke (ETS) are serious and growing public health problems worldwide (CDC, 2006). The increasing prevalence of regular smoking up to 10% among youths was found in some countries (Warren et al., 2009), and more than 50% of children in Taiwan live with smokers (Wen et al., 2005). Both active smoking and exposure to ETS are linked to a multitude of respiratory diseases and symptoms (Strachan and Cook, 1998; Withers et al., 1998). These illnesses include chronic bronchitis and associated symptoms can have a marked influence on the performance of children in school (Liberty et al., 2010) and are associated with poorer exercise capacity, incident airflow limitation and increased mortality risk later in life (Guerra et al., 2009; Martinez et al., 2014).

Most previous studies designed to determine the effects of smoking on asthma and other bronchitic symptoms have been conducted among older participants with a long history of smoking (Forey et al., 2011). The evidence for an association between smoking and bronchitis among adolescents has been limited, and most of these studies are cross-sectional in design (Forey et al., 2011); thus, causal inferences have been difficult to establish. Some studies have concluded that active smoking increases the risk of developing bronchitis and bronchitic symptoms (Karunanayake et al., 2011; Withers et al., 1998), while others have found weak associations (Eagan et al., 2002; Frank et al., 2007). Previous studies have also suggested that ETS is a substantial risk factor for the incidence of respiratory diseases. However, Stoddard and Miller reported that younger children may be more affected by ETS than older children (Stoddard and Miller, 1995) and longitudinal data on adolescents has remained scarce. Many adolescents with a history of asthma or wheezing disorders have taken up smoking and have a continued exposure to ETS. Numerous studies have shown that tobacco smoke can cause decrements in lung function and can increase the frequency of asthma attacks (Cook and Strachan, 1999). Trédaniel et al. has reported that there was no sufficient evidence to infer a causal relationship between ETS exposure and respiratory symptoms among adults with asthma (Trédaniel et al., 1994).

In the present study, we used a longitudinal study with a nationally representative sample to investigate the relationship between cigarette

* Corresponding author at: Institute of Epidemiology and Preventive Medicine, College of Public Health, National Taiwan University, No. 17, Xuzhou Road, 516R, Taipei 100, Taiwan. Fax: +886 2 2392 0456.
E-mail addresses: airobo33@gmail.com (J.-M. Chen), bfhwang@mail.cmu.edu.tw (B.-F. Hwang), melisa26@gmail.com (Y.-C. Chen), leolee@ntu.edu.tw (Y.L. Lee).

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smoking and ETS exposure and the incidence of bronchitis and bronchitic symptoms. We also assessed the risk of developing respiratory symptoms associated with ETS exposure in asthmatic participants.

Materials and methods

Study design

The Taiwan Children Health Study (TCHS) is a prospective study of the determinants of children's respiratory health. The details of the design and methods of this study have been described in previous publications (Tsai et al., 2010). In brief, a total 4134 seventh-grade children were enrolled into the study from public schools in 14 communities covering different parts of Taiwan in 2007. Parents or guardians of each participant completed a self-administered questionnaire that provided demographic information, respiratory health conditions, tobacco smoke exposure and household environmental characteristics at cohort entry. The cohort participants were followed up on during the school visit in 2009 with an updated questionnaire that contained identical questions concerning respiratory outcomes. The study was approved by the Institutional Review Board at the National Taiwan University Hospital and complied with the principles outlined in the Declaration of Helsinki.

Definition of respiratory health outcomes

Questions regarding respiratory diseases were modified from the questionnaire used in the Children's Health Study in Southern California (McConnell et al., 1999). The respiratory health outcomes of interest were bronchitis and bronchitic symptoms. Participants who were disease-free at baseline and who reported a "yes" answer to the question: "Has a physician ever diagnosed you as having bronchitis?" on the follow-up questionnaire were classified as having new-onset bronchitis. Chronic cough was defined on the follow-up questionnaire by the questions: "During the past 12 months, have you had a cough first thing in the morning that lasted for as much as 3 months in a row?" or "During the past 12 months, have you had a cough at other times lasting at least 3 months in a row?". The presence of new-onset chronic phlegm was determined by a "yes" answer to the following question: "Other than with colds, did you usually seem congested in the chest or bring up phlegm?".

We also assessed the association between active smoking, ETS and new-onset bronchitic symptoms among asthmatic adolescents. An asthmatic participant was defined as someone who reported a positive answer to the questions: "Has a physician ever diagnosed your child as having asthma?" or "During the past 12 months, has this child had a wheezing or whistling sound in the chest?" on the baseline questionnaire.

Personal smoking history and environmental tobacco smoke exposures

Information on the personal smoking behavior of each adolescent was obtained by a confidential interview that was conducted by experienced field staff during the baseline school visits. Personal smoking was defined as a history of smoking more than 100 cigarettes during the participant's lifetime. The report of weekly smoking amount was classified as nonsmokers, infrequent (1 to 6 cigarettes) and regular smokers (7 or more cigarettes). The amount of yearly smoking was also categorized into 3 groups: none, 1–299 cigarettes and 300 or more cigarettes.

We obtained information about the smoking status of each participant's parents, adult household members and regular visitors. Current ETS exposure was defined as someone who was exposed to smoke continuously prior to the date of baseline interview. We categorized the intensity of ETS exposure into 2 groups: the amount of daily smoking exposure and the percentage of lifetime exposed to ETS. The amount of daily ETS exposure was categorized as none, 1–10 cigarettes and 11 or more cigarettes and the percentage of ETS exposure was determined by 20% of a person's lifetime.

Statistical analysis

The incidence of new cases of respiratory outcomes was calculated using the number of new cases divided by the person-years at risk over a 2-year period of follow-up. The relationships between active smoking and ETS and the incidence of respiratory diseases were analyzed by Poisson regression models. To account for overdispersion of incidence rates in Poisson models, the scale parameter was adjusted using Pearson Chi-square statistics (Le, 2003). Based on the study design and our a priori considerations of potential confounders, we introduced age, gender, parental history of asthma, parental history of atopy, maternal smoking during pregnancy and community into all of our models. If the estimates of smoking effects changed by more than 10% when a covariate was introduced into the base models, then the covariate was included in the final models. Participants with missing covariate information were included in the models using missing indicators. To investigate the effects on the relationship between active smoking and ETS and new-onset respiratory diseases among asthmatic adolescents, we conducted a stratified analysis using likelihood ratio tests to examine the interactive effects between tobacco smoke and personal history with or without asthma/wheeze. All analyses were carried out using SAS software version 9.1 (SAS institute, Cary, NC, USA).

Results

A total of 3909 participants completed the follow-up questionnaire, with a follow-up rate of 94.6%. The loss to follow-up of participants was mostly due to families moving out of the school district area based on interviews with the school staff and on telephone interviews with the families of participants. Because of baseline respiratory conditions and missing or "not known" answers to questions on three bronchitic outcomes, 3664 bronchitis-free, 3680 chronic cough-free and 3704 chronic phlegm-free participants were recruited at cohort entry. Table 1 shows the distribution of selected characteristics among participants in the separate respiratory health outcomes. At cohort entry, the proportion of gender was almost equal (51.1% female and 48.9% male) and the majority of children were 12 years of age. Exposure to maternal smoking in pregnancy was reported for 3.7% of the cohort. More than 40% of the children were exposed to ETS and 5.6% of the children had an active smoking habit.

The number of new cases of bronchitis, chronic cough and chronic phlegm were 59, 278 and 363 after a 2-year follow-up. The incidence of bronchitis was 8.1/1000 person-years, the incidence of chronic cough was 37.9/1000 person-years and the incidence of chronic phlegm was 49.2/1000 person-years for chronic phlegm.

The rate ratio (RR) and the 95% confidence interval (CI) for bronchitis and bronchitic symptoms in relation to active smoking are shown in Table 2. We found that active smoking was positively associated with new-onset chronic cough (RR = 1.72; 95% CI: 1.11 to 2.64) and chronic phlegm (RR = 1.64; 95% CI: 1.11 to 2.43). We observed a dose–response relationship between duration, weekly and yearly amounts of smoking and the incidence of bronchitic symptoms. Children who smoked cigarettes for more than one year had an increased risk for developing chronic cough (RR = 2.07, 95%: CI: 1.12 to 3.82) and chronic phlegm (RR = 2.23, 95% CI: 1.32 to 3.79) when compared with nonsmokers. Consistent with the risk associated with active smoking assessed on a duration basis, adolescents who reported active smoking on a weekly basis (more than 7 cigarettes per week) and yearly basis (more than 300 cigarettes) were at a 2.21-fold and 2.10-fold increased risk for the incidence of chronic cough.

Table 3 shows the association between ETS and the onset of bronchitic symptoms. In our cohort, exposure to ETS was significantly related to chronic cough (RR = 1.31, 95% CI: 1.03 to 1.67). The percentage of current ETS exposure also showed a trend toward increased risk of developing chronic cough. Restricting the analysis to participants without a history of asthma did not substantially alter the above findings (Appendix Tables 1 and 2).

We also analyzed our data for the incidence of asthma and wheezing disorders in the TCHS cohort. Similar risks were observed between active smoking and ETS and wheezing disorders; however it is difficult to make this conclusion firmly because of small numbers of cases over the 2-year period of follow-up (Appendix Table 3).

In further analyses, we observed the increased risk for new-onset chronic phlegm among asthmatic adolescents who had been exposed to ETS (Table 4). Children who had a history of asthma or wheeze and who were exposed to current ETS had an increased risk (RR = 1.98;