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Assessment of exposure to secondhand smoke by questionnaire and salivary cotinine in the general population of Barcelona, Spain (2004–2005)

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ABSTRACT

Objectives. To estimate the prevalence of self-reported exposure to secondhand smoke (SHS) in different settings and to describe salivary cotinine concentration and its determinants among non-smokers.

Methods. Cross-sectional study of a representative sample (N=775) of adult non-smokers in Barcelona, Spain (years 2004–2005). We assessed exposure to SHS using a questionnaire and measurement of salivary cotinine concentration. We calculated prevalence rates of self-reported exposure and medians and geometric means of salivary cotinine concentration. We adjusted for potential confounding factors with multinomial logistic regression models.

Results. The prevalence rate of self-reported exposure to SHS among non-smokers in any setting was 75.7% (95% CI: 72.7%–78.8%). The prevalence of exposure to SHS tended to decrease with age. The geometric mean of cotinine concentrations among non-smokers was 1.49 ng/ml (95% CI: 1.39–1.60 ng/ml) among all subjects, and 1.80 ng/ml (95% CI: 1.37–2.35 ng/ml) in subjects who reported exposure to SHS in all settings. In bivariate and multivariate analyses, the cotinine concentration increased with the number of smokers and the number of cigarettes smoked per day in the presence of non-smokers in the household.

Conclusions. In this population, self-reported exposure to SHS is very high. Salivary cotinine concentrations in non-smokers are associated with exposure at home.

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Introduction

Secondhand smoke (SHS) has been associated with a variety of health effects among non-smokers, especially lung cancer and ischemic heart disease, as well as other respiratory effects and diseases in children and adults (US Department of Health and Human Services, 2006; IARC, 2004). In Spain, little attention was directed at exposure to SHS, until a national smoke-free law came into effect in January, 2006 to protect non-smokers' health. The law bans smoking in all enclosed workplaces except in some hospitality venues (Fernandez, 2006). Exposure to SHS had been assessed in Spain using questionnaires (Nebot et al., 2004; Perez-Rios et al., 2007; Twose et al., 2007) and airborne markers (Jane et al., 2002; Lopez et al., 2004; Nebot et al., 2005) before the law was enacted. The prevalence of self-reported SHS exposure in any setting among non-smokers was approximately 60–70% before January 2006 (Twose et al., 2007). Airborne nicotine measurements showed high levels of SHS in bars and restaurants, schools, airports, and

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subways (Lopez et al., 2004). However, studies using personal biomarkers, such as nicotine or cotinine in body fluids, at the population level have not been conducted in Spain. Salivary cotinine is a specific biomarker of recent exposure to SHS that has been used in observational studies (Benowitz, 1996).

Our aims were to describe the salivary cotinine concentrations among the smoking and non-smoking population, to estimate the prevalence of self-reported SHS exposure in a variety of settings and the determinants of salivary concentrations among the adult non-smoking population of Barcelona (Spain). The study was carried out before the new national regulations went into effect.

Methods

Design and study participants

This is a cross-sectional study conducted between March 2004 and December 2005 on a representative random sample (1245 people, 694 women and 551 men) of the non-institutionalized population of Barcelona, Spain. We obtained the personal data and addresses from the updated official Census, as provided by the Municipal Institute of Statistics of Barcelona. We sent a letter of introduction about the study; afterwards trained interviewers visited the subjects at home. When the index person was not contacted (after several attempts following a strict protocol that included visits on weekends and during non-working hours) or refused to participate, we randomly selected a substitute in the same sex-, age-, and district-group. Substitutions accounted for 50.7% of the final sample. After contacting the participants and obtaining written informed consent, trained interviewers administered a face-to-face questionnaire at the participant's home to gather information on socio-demographic data and active and passive smoking. Participants provided a saliva sample for cotinine analysis, and weight and height were measured. We ended the study by December 31st, 2005, as the new law on smoking came into effect on January 1st, 2006 (Fernandez, 2006) and changes in active and passive smoking were expected after this date; hence, 315 subjects were not approached. We found no differences in terms of sex, age, and district of residence between those subjects not approached and the final sample. The final sample was representative of that from Barcelona in terms of sex, age, district, and smoking status (Villalbí et al., in press).

At the end of the study, 1245 participants had been interviewed: 347 were adult smokers (≥16 years old), 885 were adult non-smokers, and 13 were children aged <16 years with no information on exposure to SHS. Of the non-smokers, 62 were excluded because they did not provide a saliva sample and ten others were excluded because cotinine analysis was not possible (i.e., insufficient sample). Additionally, 38 non-smoking subjects were excluded because they had a cotinine concentration compatible with active smoking (>20 ng/ml) (Etzel, 1990; Patrick et al., 1994). Therefore, the final sample for analysis consisted of 775 non-smokers. The research and ethics committee of the Bellvitge University Hospital provided ethical approval for study protocol.

Self-reported exposure to secondhand smoke

Self-reported exposures to SHS were gathered by questionnaire with regard to the following settings: home, work or education venue, and other places (transport and leisure time).

Exposure to SHS at home was obtained using two questions: "Nowadays, how many persons per day usually smoke inside your home?" (recoded as 0, 1 and ≥2 persons per day) and "During the past week, how many cigarettes (per day) have been smoked in your presence inside your home?" Answers were gathered for a typical working and non-working day (recoded as 0, 1, 2–6, and ≥7 cigarettes per day). Based on these two questions, we derived a dichotomous variable of exposure to SHS at home (non-exposed those with no exposure from both questions and otherwise exposed).

Exposure to SHS at work or education venue was obtained using two questions: "Does anybody smoke in close proximity to you at work?" (recoded as 0, 1, and ≥2 persons per day) and "How many hours per day do you think you are exposed to tobacco smoke at your education venue?" (recoded as 0, 1, and ≥2 hours per day). We also derived a dichotomous variable of exposure to SHS at work and/or education venue (non-exposed those with no exposure from both questions and otherwise exposed).

Exposure to SHS in other places (transport and leisure) was obtained using two questions: "During last week, have you used any transportation where somebody smoked?" (answers were gathered for a typical working and non-working day) and "How long have you spent in any place with tobacco smoke not at home nor at work?" (answers were gathered for a typical working and non-working day). For analysis, answers were grouped into two categories: "yes" (exposure to SHS in other places) and "no" (no exposure to SHS in other places).

Salivary cotinine

We obtained a saliva sample for cotinine analysis. Participants were asked to rinse their mouths and then suck a lemon candy (Smint®) to stimulate saliva production. They were asked to spit out a small amount of saliva and then to provide about 8 ml of saliva by spitting into a funnel placed in a test tube (Jaakkola et al., 2003; Campuzano et al., 2004; Blackford et al., 2006). The sample was separated into 3 ml aliquots and frozen to −20 °C for storage. The frozen samples were sent to the Bioanalysis Research Group of the Municipal Institute for Medical Research (IMIM-Hospital del Mar) in Barcelona. Salivary cotinine was measured by gas chromatography with detection by mass spectrometry (GC/MS), as done in similar studies (Garcia-Algar et al., 2003; Pichini et al., 2003) (limit of quantification: 1 ng/ml; limit of detection: 0.3 ng/ml; quantification error <15%).

Statistical analysis

We calculated prevalence rates (%) and 95% confidence intervals (CI) of exposure to SHS among non-smokers in the different settings. We restricted all analyses to non-smokers, except in the description of the distribution of salivary cotinine concentration. Given the skewed distribution of cotinine concentrations, we performed univariate analyses with medians, geometric means (GM), interquartile ranges (IQR) and geometric standard deviations (GSD) to describe the data. For cotinine concentration between the limit of quantification and detection, we assigned half the level of detection (0.5 ng/ml). The independent variables were age (16–44, 45–64, and ≥65), sex, body mass index (BMI, computed as height/(weight)^2 in m/kg^2, as underweight: <18.50; normal: 18.50–24.99; overweight: 25.00–29.99; and obese: ≥30.00), educational level (less than primary, primary, secondary, and university), number of smokers in the house (0, 1, and ≥2), number of cigarettes smoked in presence of the subject at home (0, 1, 2–6, and ≥7), house size (number of rooms and total home surface in m^2: <50, 50–99, and ≥100), number of smokers at work (0,1, and ≥2), and number of hours per day exposed to SHS at work (0, 1, and ≥2).

We used linear and logistic regression models for estimating the determinants of cotinine in non-smokers. The linear models, which used log transformation of the cotinine concentration as the outcome variable, did not provide reliable estimates. We categorized the salivary cotinine concentration and applied multinomial logistic regression models. Cotinine concentrations were categorized as: <1 ng/ml (limit of quantification); 1–2.1 ng/ml and >2.1 ng/ml, which are approximate thirds of the distribution. To evaluate the effect of the independent variables (number of smokers in the house, number of cigarettes smoked in presence of the subject at home, house size, number of smokers at work and number of hours exposed to SHS at work) on the salivary cotinine concentrations, we fitted multinomial logistic regression models and derived odds ratios (OR) and 95% CI. All

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