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Second-hand smoke exposure in 4-year-old children in Spain: Sources, associated factors and urinary cotinine

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ABSTRACT

Introduction: Second-hand smoke exposure (SHS) in children remains as a major pollution problem, with important consequences for children's health. This study aimed to identify the sources of exposure to SHS among 4-year-old children, comparing self-reports to a urinary biomarker of exposure, and characterize the most important variables related to SHS exposure in this population.

Methods: 4-year-old children's exposure to SHS was assessed by a parental-reported questionnaire and by urinary cotinine (UC) measurements in 1757 participants from 4 different areas of the Spanish INMA (INfancia y Medio Ambiente – Environment and Childhood) Project. The questionnaire about SHS included information about smoking habits at home by household members, and about exposure to SHS in other places including other homes, bars, restaurants or transportation. The association between quantified UC levels (>4 ng/ml) and sociodemographic variables and the different sources of SHS exposure was examined using logistic regression.

Results: Based on parental reports, 21.6% of the children were exposed to SHS at home and 47.1% elsewhere; making a total 55.9% of the children exposed to SHS. In addition, 28.2% of the children whose parents reported being not regularly exposed to SHS had quantified UC values. Children from younger mothers (<34 vs. ≥ 39.4 y) had a higher odds of exposure to SHS [OR (95% CI): 2.28 (1.70–3.05) per year], as well as from families with a lower educational level [OR secondary: 2.12 (1.69–2.65); primary or less: 2.91 (2.19–3.88)]. The odds of quantifiable UC in children dropped after the smoking ban in public places [OR = 0.59 (0.42–0.83)]. Regarding the sources of SHS exposure we observed that quantifiable UC odds was increased in children whose parents smoked at home in their presence [OR mother occasionally: 13.39 (7.03–25.50); mother often: 18.48 (8.40–40.66); father occasionally: 10.98 (6.52–18.49); father often: 11.50 (5.96–22.20)] or in children attending other confined places, mainly other houses where people smoked [OR: 2.23 (1.78–2.80)].

Conclusions: Children's SHS exposure is nowadays an unresolved major public health problem in Spain. After the ban of smoking in public places health care professionals should put more emphasis to the parents on the importance of controlling the exposure of their children in private spaces.

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1. Introduction

Exposure to second-hand smoke (SHS) in children is associated with respiratory problems such as lower respiratory illness (CDC, 2006; Fuentes-Leonarte et al., 2014); middle ear disease and otitis media (CDC, 2006; Fuentes-Leonarte et al., 2014); increased risk of sinusitis (Hur et al., 2014), chronic rhinitis and allergic rhinitis (Higgins and Reh, 2012), asthma (CDC, 2006; Tinuoye et al., 2013) and lower lung function level (CDC, 2006; Brunst et al., 2012; Merghani and Saeed, 2013); increased risk of invasive meningococcal disease (Murray et al., 2012); and higher blood pressure (Simonetti et al., 2011). Furthermore, sudden infant death syndrome and childhood cancer, as leukaemias, lymphomas and brain tumours, could be related to SHS exposure (CDC, 2006). Oberg et al. (2011) estimated that in 2004 the SHS would produce worldwide in children less than 5 years of age, a total of 168,840 deaths mostly from lower respiratory infections and asthma. Behavioural problems, neurocognitive decrements, and increased rates of adolescent smoking are associated also with children's SHS exposure (DiFranza et al., 2004).

SHS exposure has been usually assessed using self-reported questionnaire. Difficulties in recognising smoking could bias these assessments. Therefore, higher probability of misreporting SHS exposure has been reported in areas with a high-prevalence of young female smokers, as occurs in Mediterranean countries (Joya et al., 2014). Cotinine is the current best measure of internal exposure (Kalkbrenner et al., 2010). In fact, it has been proposed by different authors as a tool to validate the information provided in questionnaires (Benowitz, 1996). Children aged 4–11 years old have shown similar cotinine half-life (about 18 h) than adults (Hukkanen et al., 2005). Moreover, children could be exposed, on average, to higher SHS levels than non-smoking adults (CDC, 2006). Furthermore, the questionnaire provides information on sources of exposure and it does not refer only to the hours preceding urine sampling to quantify cotinine.

Worldwide, at least 40% of children are regularly exposed to SHS (Oberg et al., 2011). The 2006 CDC report also referred that almost 60% of U.S. children aged 3–11 years old were exposed to SHS and 25% lived with at least one smoker. A Spanish study reported 39.0% of 4–5-year children exposed to SHS at home, defined as presence of cohabitant smokers (Fernández et al., 2015). SHS exposure is therefore an important public health problem for children. Values are different across countries and changing over time, in particular after implementing the laws banning smoking in public places. However control laws do not affect private places, where children spend much time. In Spain, a law in 1998 (Royal Decree 192/1988) limited smoking at work and in public transport. In January 2006, a second law banned smoking at work and in cultural/educational centres but only partially banned in bars and restaurants (Law 28/2005). This law was modified in January 2011 (Law 42/2010), during the data collection of the present study, extending the smoking ban to all closed public places.

The prevalence of self-reported smoking in 2263 women of the INMA (INfancia y Medio – and Childhood) Project in the third trimester of pregnancy was 18.5%, with an additional 3.9% of potential smokers with urinary cotinine (UC) above 50 ng/ml (Aurrekoetxea et al., 2013). Furthermore, among the 1783 non-smoking women 55.5% reported being exposed to SHS (Aurrekoetxea et al., 2014). The prospective nature of the INMA Project gives us the opportunity to evaluate the impact of the law banning smoking in public places implemented in Spain in January 2011. This study aimed to identify the sources of SHS exposure among 4-year-old children, comparing self-reports to a urinary biomarker of exposure, and characterize the most important variables, as sociodemographic lifestyle and legislation changes, related to SHS exposure in this population.

2. Methods

2.1. Study population

Pregnant women were recruited during the first trimester in four Spanish areas (Asturias, Gipuzkoa, Sabadell and Valencia) within the study population of the INMA Project between 2003 and 2008, following a common protocol (Guxens et al., 2012). Inclusion criteria were: age $\geq$16 years, singleton pregnancy, no assisted conception, intention to deliver at the reference hospital and to have no communication problems. All women participating in the study signed an informed consent form and the Ethical Committees of the centres involved in the study approved the research protocol. A total of 2644 mothers were recruited and 2506 children continued the follow up after birth. At the 4th year 2064 children remained in the cohort. This cross-sectional study analyses the data on SHS exposure at 4 years of life obtained from 1757 children (85.1%) who attended the 4 year visit and who gave a urine sample, obtaining valid results of urinary cotinine (UC). Fig. 1 shows the follow-up of the cohort from recruitment during pregnancy to age 4 years, the sample size, and the moment of enactment of the laws by area.

2.2. Self-reporting of SHS exposure

Current exposure to SHS was assessed at the four year visit by a specific questionnaire to the parents. Information on smoking by parents and other family members or people living with the child was gathered. It was collected for each person living with the child: smoking (yes/no), the number of cigarettes smoked (total and at home), and smoking near the child (never, almost never, occasionally, often). Child's frequency of exposure to SHS in other places was also gathered, including other homes, bars/restaurants (yes/no) and other places (as open question).

In addition, we created three variables summarizing existing information: reported exposure to SHS at home, when someone at home referred smoking beside the child; overall referred exposure to SHS, when someone at home referred smoking beside the child or the child went to other places where people smoke; and proximity to SHS, when someone at home referred smoking, beside the child or not, or the child went to other sites where smoked.

2.3. Assessment of children urinary cotinine

We used the UC as a biomarker of SHS exposure. Children urine sampling started in November 2008 in Valencia and ended in January 2013 in Gipuzkoa. Urine samples were collected at different hours during the morning, in 100 ml polyethylene containers and stored at -20 °C; fasting was not required. One aliquot of the sample was sent to the Public Health Laboratory of Bilbao (Spain) to be analysed. All urine samples were stored for a minimum of one year and a maximum of five years before analysis. Laboratory method for UC quantification was described in a previous paper (Aurrekoetxea et al., 2013). The quantification limit (LOQ) was 4.0 ng/ml. UC above 4 ng/ml is a specific indicator of SHS exposure in non-smokers (Benowitz, 1996).

2.4. Other variables

Sociodemographic characteristics and life-style variables were obtained by questionnaires administered to the parents at the different follow-up visits. The following variables were taken into account: age of mother and father at the date of urine sampling; parity (0, 1, $\geq$2); educational level of parents (up to primary, secondary, university studies), child sex, and cohort/area of study.