



## Trends in children's exposure to second-hand smoke in the INMA-Granada cohort: An evaluation of the Spanish anti-smoking law



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### ABSTRACT

The smoke-free legislation implemented in Spain in 2006 imposed a partial ban on smoking in public and work places, but the result did not meet expectations. Therefore, a more restrictive anti-smoking law was passed five years later in 2011 prohibiting smoking in all public places, on public transport, and the workplace. With the objective of assessing the impact of the latter anti-smoking legislation on children's exposure to second-hand smoke (SHS), we assessed parent's smoking habits and children's urine cotinine (UC) concentrations in 118 boys before (2005–2006) and after (2011–2012) the introduction of this law. Repeated cross-sectional follow-ups of the "Environment and Childhood Research Network" (INMA-Granada), a Spanish population-based birth cohort study, at 4–5 years old (2005–2006) and 10–11 years old (2011–2012), were designed. Data were gathered by ad-hoc questionnaire, and median UC levels recorded as an objective indicator of overall SHS exposure. Multivariable logistic regression was used to examine the association between parent's smoking habits at home and SHS exposure, among other potential predictors. An increase was observed in the prevalence of families with at least one smoker (39.0% vs. 50.8%) and in the prevalence of smoking mothers (20.3% vs. 29.7%) and fathers (33.9% vs. 39.0%). Median UC concentration was 8.0 ng/mL (interquartile range [IQR]: 2.0–21.8) before legislation onset and 8.7 ng/mL (IQR: 2.0–24.3) afterwards. In the multivariable analysis, the smoking status of parents and smoking habits at home were statistically associated with the risk of SHS exposure and with UC concentrations in children. These findings indicate that the recent prohibition of smoking in enclosed public and workplaces in Spain has not been accompanied by a decline in the exposure to SHS among children, who continue to be adversely affected. There is a need to target smoking at home in order to avoid future adverse health effects in a population that has no choice in the acceptance or not of SHS exposure-derived risk.

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### 1. Introduction

Over recent decades, a vast array of findings has associated both active and passive smoking with multiple adverse health effects. Young children are not smokers; however, their exposure

to second-hand smoke (SHS) is considered a major global public health issue, given the vulnerability of this age group to the health effects of passive smoking. This has been attributed to their higher respiratory rates and less mature immune, nervous, and respiratory systems (Polanska et al., 2006) and it has been reported that SHS is among the leading causes of respiratory morbidity and mortality among infants (Puig et al., 2008). SHS has also been associated with recurrent wheezing, respiratory illnesses, decreased lung function, and asthma (Akinbami et al., 2013), as well as obesity (Lisboa et al., 2012), behavioral disorders (Desrosiers

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et al., 2013), and kidney and endocrine dysfunction (García-Esquinas et al., 2013) in young children. Indeed, it has been reported that the annual excess mortality in children aged 5 years or younger due to SHS exposure may be higher than that due to all other causes (Florescu et al., 2009). According to the EPA, children's exposure to SHS in the USA is responsible for: (i) increases in the number of asthma attacks and severity of symptoms in 200,000–1 million children with asthma; (ii) between 150,000 and 300,000 lower respiratory tract infections in children under 18 months of age; and (iii) respiratory tract infections that result in 7500–15,000 hospitalizations each year (EPA, 2011).

Public health authorities have taken various steps to reduce smoke-related diseases. In 2006, Spanish government approved an initial law to prevent smoking in all enclosed workplaces (Law 28/2005), although the degree of restriction depended on the decision of each business owner. This legislation, aimed to protect the health of non-smokers, did not meet expectations. Some studies showed major reductions in the exposure to SHS at the workplace, but no significant changes were observed at home or in leisure spaces (Galán et al., 2007; Jiménez-Ruiz et al., 2008). As a result, the law was amended five years later on January 2 2011, establishing a more severe anti-smoking regime (Law 42/2010, of December 30) and imposing a complete ban on smoking in enclosed public places, on public transport, and in the workplace. The aims of this law were: (i) to protect non-smokers from SHS exposure, (ii) to prevent smoking initiation among young people, and (iii) to promote smoking cessation.

According to the National Health Survey carried out in Spain in 2012, a quarter of the population smoked daily; the prevalence of exposure to SHS in the workplace (2.6%) and in enclosed places and on public transport (2.4%) had markedly decreased; and the household was the most frequent place for exposure to tobacco smoke (17.8%) (National Health Survey, 2011–2012). This is especially relevant to children, given the amount of time they spend in the home.

Although a total ban on smoking at home could be expected to significantly reduce the children's SHS exposure, there appears to be no short-term prospect of this type of legislation in Europe. Most EU member states, including Spain, have implemented complementary strategies to protect children and adolescents, following the Tobacco Products Directive of the EU Commission (2001/37/EC 2001) and the Framework Convention on Tobacco Control (FCTC), which has been ratified by 177 countries. One key aspect of these strategies is to raise the consciousness of citizens about the need for a smoke-free environment in the home (Borland et al., 2006).

Research carried out in countries with an established anti-smoking law has warned that national anti-smoking legislation for workplaces and public places is inadequate to protect children and adolescents from SHS (Akhtar et al., 2007; Protano et al., 2012). Thus, it was reported that the 2006 anti-smoking law in Scotland had no significant effect on the prevalence of smoke-free homes (64.5% vs. 64.3% just before and after smoke-free legislation, respectively) or on the exposure of school students to environmental tobacco smoke (Akhtar et al., 2007).

There has been some research into the effects of the 2010 Spanish anti-smoking law on SHS exposure in adults (Villaverde Royo et al., 2012; Perez-Rios et al., 2014; Sureda et al., 2014; Sánchez-Rodríguez et al., 2015). However, it is also important to establish whether the stricter smoking ban has had an impact on the reduction of exposure in children, by evaluating, for example, the cotinine load in this population. The objectives of the present study were: to assess the impact of the Spanish anti-tobacco legislation (Law 42/2010) on children's exposure to passive smoking exposure by comparing urine cotinine (UC) excretion before and after implementation of the law; and to review how the smoking

status of parents and smoking habits at home were related to SHS exposure among boys from the Spanish INMA-Granada cohort evaluated at follow-ups in 2005–2006 and 2011–2012.

## 2. Methods

### 2.1. Study population and design

The study sample was drawn from the “Environment and Childhood Research Network” (INMA network), a population-based cohort study in different regions of Spain that focuses on prenatal environmental exposures in relation to growth, development, and health from early fetal life until childhood. The INMA study protocol includes medical follow-ups of the children during childhood as well as epidemiological questionnaires and biological sample collections (Guxens et al., 2012).

From October 2000 to July 2002, 668 eligible mother–son pairs registered at the San Cecilio University Hospital of Granada (a province in Southern Spain) were recruited at delivery, establishing the INMA-Granada cohort, with the initial aim of assessing the prevalence of urogenital male malformations (cryptorchidism and hypospadias) (Fernandez et al., 2007). The inclusion and exclusion criteria were published elsewhere (Freire et al., 2009). Between April 2005 and June 2006, 1 out of 3 mothers of control boys was randomly contacted to arrange a follow-up appointment, which included completion of an ad hoc questionnaire on their home environment. Two hundred-twenty families agreed to participate; urine samples were collected for 196 of the 220 children, but self-report questionnaire and urine was only available for 166 of these (Freire et al., 2009). Six years later (between February 2011 and December 2012), all families in the cohort ( $n=668$ ) were contacted and invited to participate in this follow-up. A total of 300 boys were finally enrolled and their families again completed an ad hoc questionnaire on their home environment. Twenty-four of these were excluded for an inadequate urine sample or incomplete questionnaire; therefore, urine was available for 276 of these boys. The present study only included the 118 boys who attended both follow-ups in order to compare SHS exposure levels before and after the anti-smoking law entered into force (Fig. 1). Written informed consent was obtained from the parents (mother or father) on behalf of children enrolled in our study. The families registered in the follow-ups signed the informed consent form, which included completion of ad hoc questionnaires. The study followed the guidelines laid down in the Declaration of Helsinki and was approved by the Ethics Committee of San Cecilio University Hospital, Granada, Spain.

### 2.2. Covariates and SHS exposure data gathered by questionnaire

The structured questionnaire completed by parents in both follow ups included information on the smoking habits of parents; maternal smoking habits during pregnancy, the number of cigarettes per day smoked by family members, and the presence or absence of cohabitant smokers (global SHS exposure).

Children were considered to be exposed to SHS when at least one family member declared a smoking habit, based on responses to the questionnaire item: “are there smokers living with the child?”, defining smokers as those consuming any amount of tobacco (> 2 times per week). The degree of exposure was assessed according to: the smoking habit of the mother during the pregnancy; current smoking habits of the parents (yes/no) and of all cohabitants (cigarettes/day, and cigarettes/day smoked in the house).

The questionnaire yielded additional information on the children's age, area of residence, and parent's education. Parental

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