



Impact of the Spanish smoking legislation among smokers: A longitudinal study with biomarkers in Barcelona (Spain)

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HIGHLIGHTS

- After smoke-free laws, salivary cotinine increased (29%) among continuing smokers.
- We also observed a switch from conventional cigarette to RYO cigarettes.
- Policies should focus on reduction of use any type of tobacco product.
- Implementing better treatment policies to help smokers stop smoking are needed.

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ABSTRACT

Background: The aim of this study is to assess the impact of the Spanish tobacco control legislation on smoking behavior and salivary cotinine concentration among smokers.

Methods: We used data from a longitudinal study, before (2004–2005) and after (2013–2014) the implementation of the two national smoking bans (in 2006 and 2011), in a representative sample of adults (≥ 16 years old) from Barcelona (Spain). We only analyzed a subsample of continuing smokers ($n = 116$). We conducted a survey on smoking behavior and obtained saliva sample for cotinine analyses. For this report, we analyzed a subsample of continuing smokers ($n = 116$). We calculated geometric means (GM).

Results: Among continuing smokers, salivary cotinine concentration significantly increased by 28.7% (GM from 91.7 ng/ml to 117.3 ng/ml, $p = 0.015$) after the implementation of the two Spanish smoke-free bans. Nonetheless, no pattern of change was observed in the self-reported number of cigarettes smoked daily.

Conclusions: Our study shows a significant increase in the salivary cotinine concentration among adult continuing smokers after both Spanish legislations. This increase could be due to differences in smoking topography (increase in the depth of inhalation when smoking) along with changes in the type of tobacco smoked (increase in smoking roll-your-own cigarettes or mixed use of roll-your-own and manufactured cigarettes). Our results suggest the need to extend tobacco control policies, focusing on the reduction of use of any type of tobacco product and implementing better treatment to help smokers stop smoking.

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1. Introduction

Tobacco is the first single leading cause of preventable death in the world (WHO report on the global tobacco epidemic, 2017), being related to more than 25 diseases and being responsible for 30% of all cancers, respiratory diseases and cardiovascular diseases (Tan & Glantz, 2012). In 2015, WHO estimated that about 15% (1.1 billion people) of the worldwide population smoked (WHO, 2016) and that tobacco use is responsible for about six million deaths across the world each year, including about 600,000 deaths from the effects of second-hand smoke (SHS) (WHO, 2017). In Spain, the latest data reported showed that 28% of men and 19% of women were tobacco users in 2014 (OECD/EU, 2016) and that more than 60,000 deaths per year were attributable to active smoking (Gutiérrez-Abejón et al., 2015).

Consequently, two smoke-free laws have been passed in Spain after the approval of the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) (WHO, 2015). On the 1st of January 2006, a smoke-free legislation came into effect (Law 28/2005). The law was a compendium of public health measures against smoking and included regulations on publicity, sales, supply, and consumption of tobacco products (Fernández, 2006). Smoking was banned in all indoor workplaces, public places, public transport facilities including enclosed stations, hospitals and other health care facilities, schools and universities, as well as in retail stores and shopping centres. However, hospitality venues were subject to only a partial ban. In bars and restaurants smaller than 100 m², the proprietor could choose between permitting or prohibiting smoking those larger than 100 m² were defined as smoke-free, but the law allowed the proprietor to provide a physically separated and independently ventilated smoking area comprising no more than 30% of the total floor area. Moreover, several tax reforms followed the implementation of the partial ban (Fernández, 2006). This law was a great advance for public health in Spain; however, it was not complete in terms of health protection from SHS exposure. The scientific evaluation of this law showed the need to promote a total ban (Fernández et al., 2009; Grupo de Trabajo sobre Tabaquismo de la Sociedad Española de Epidemiología, 2009; Nebot et al., 2009). On the 2nd of January 2011, a new law came into force (Law 42/2010), including several tax reforms and extending the smoke-free regulation to all hospitality venues without exception (Fernández & Nebot, 2011) and to some outdoor areas, including hospital premises, educational campuses, and playgrounds. However, designated smoking rooms are still permitted in psychiatric services, nursing homes, prisons and up to 30% of hotel rooms.

The principal aim of both Spanish tobacco control laws was to protect non-smoking population from tobacco smoke exposure. Therefore, their scientific evaluation focused on their effect on SHS reduction, often neglecting research about the effect on active smokers. In this sense, a systematic review (Hoffman & Tan, 2015) has concluded that the implementation of smoke-free policies and restrictions in public spaces, workplaces or residences lead to a decrease in smoking prevalence and cigarette consumption. Moreover, previous studies (Lidón-Moyano, Martín-Sánchez, Saliba, Graffelman, & Martínez-Sánchez, 2017a; Sureda et al., 2017) suggest that active smokers could be changing their smoking pattern to consuming cheaper tobacco products, such as roll-your-own (RYO) cigarettes, which are subject of little taxation in Spain (López-Nicolás, Cobacho, & Fernández, 2013). In addition, RYO are usually not filtered (Rosenberry, Strasser, Canlas, Potts, & Pickworth, 2013) and as a result more nicotine (as well as other toxicants) is delivered with smoke. There are few studies that assess the impact of smoking legislation among the smoking population using a specific biomarker of tobacco smoke absorption such as cotinine, which is the major proximate metabolite of nicotine. In Spain, a previous study assessed the impact of the first law among hospitality workers who smoke, using self-reported data and information regarding salivary cotinine (Martínez-Sánchez et al., 2009a). Cotinine concentration in biological fluids (blood, urine or oral fluid, widely referred to as saliva)

(Jarvis, Tunstall-Pedoe, Feyerabend, Vesey, & Salloojee, 1984) indicates tobacco exposure over the previous 1–2 days (Repace, Jinot, Bayard, Emmons, & Hammond, 1998) and is strongly correlated with the number of cigarettes smoked daily (Benowitz, 1983). Moreover, cotinine concentration could vary within each stage of change (defined in the methods section), according to the number of cigarettes smoked, time to first cigarette of the day, and nicotine dependence (Fu et al., 2011).

The objective of this study is to assess the impact of the Spanish tobacco control legislations (laws 28/2005 and 42/2010) on smoking behavior and salivary cotinine concentration among smokers by using a cohort study of adult smokers in Barcelona (Spain) along with bio-marker information.

2. Methods

This is a longitudinal study (cohort study) from a representative sample of the adult population (≥ 16 years at baseline, ≥ 25 at follow-up) of the city of Barcelona (Catalonia, Spain). The baseline study was carried out during the years 2004–2005 (Fu et al., 2009; Martínez-Sánchez et al., 2009b) ($n = 1245$) and the follow-up took place in 2013–2014, after the implementation of both Spanish tobacco control legislations.

To obtain the baseline sample, a representative random sample by age, sex, and district was drawn from the official 2001 population census of Barcelona, a reliable source of population-based information explained elsewhere (Fu et al., 2009; Martínez-Sánchez et al., 2009b). Briefly, the procedure was as follows: a personal letter was sent to eligible participants, and trained interviewers contacted the subjects at home and informed them about the study. 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. We asked participants to answer a face-to-face questionnaire and to sign a consent form in order to be contacted in the follow-up. From the sample at the follow-up, we excluded 235 subjects: 150 after checking their data in the Insured Central Registry of Catalonia (101 died and 49 migrated out of the province of Barcelona) and 85 subjects who did not give consent to be followed up or were minors (< 18 years old) in 2004–2005 and we did not ask consent to re-contact. The percentage of follow-up in this first stage was 81.1%. The follow-up was conducted in 2013–2014. In total, 72.9% of the eligible sample agreed to participate (736 out of 1010 traced, second stage of follow-up), 18.5% refused to participate, 7.2% had moved elsewhere and 1.4% had died. The final sample included 736 individuals (Fig. 1) and was skewed as slightly older in comparison with the general population of Barcelona. For this reason, we weighted our data according to the age distribution of the city of Barcelona to maintain its representativeness. The percentage of participation in both stages was 51.9% (736 out 1245). We did not find statistically significant differences between the followed-up sample ($n = 736$) and the participants lost in the second stage ($n = 274$) according to age, sex, educational level (categorized as low: unschooled, elementary school completed or uncompleted and special education; intermediate: high school and training cycles; and high: university education) and smoking status. However, there were statistically significant differences according to age, level of education and smoking status between the sample followed up ($n = 736$) and the participants lost in both stages of the follow-up ($n = 509$) (Table 1).

We asked the participants to provide a 9 ml sample of saliva for cotinine analysis, using the same protocol before and after the Spanish tobacco control legislations. Participants were asked to rinse their mouths and then suck a lemon candy (Smint) to stimulate saliva production. Saliva samples were frozen and sent to the IMIM-Hospital del Mar Medical Research Institute in Barcelona. Saliva samples were analyzed using liquid chromatography-tandem mass spectrometry (LC/

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