Environmental Research 165 (2018) 220–227

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Second-hand smoke exposure in outdoor hospitality venues: Smoking visibility and assessment of airborne markers

Xisca Sureda[a,*], Usama Bilal[a,b], Esteve Fernández[c,d], Roberto Valiente[a,e], Francisco J. Escobar[a,e], Ana Navas-Acien[f], Manuel Franco[a,g]

[a] Social and Cardiovascular Epidemiology Research Group, School of Medicine, University of Alcalá, Alcalá de Henares, Madrid, Spain
[b] Urban Health Collaborative, Drexel Dornsife School of Public Health, Philadelphia, PA, USA
[c] Tobacco Control Unit, Cancer Control and Prevention Programme, Institut Català d'Oncologia-ICO, Hospitalet de Llobregat, Spain
[d] Department of Clinical Sciences, School of Medicine, Campus de Bellvitge, Universitat de Barcelona, L'Hospitalet del Llobregat, Barcelona, Spain
[e] Department of Geology, Geography and Environmental Sciences, University of Alcalá, Alcalá de Henares, Madrid, Spain
[f] Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, USA
[g] Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

ARTICLE INFO

Keywords:
Second-hand smoke
PM2.5
Airborne nicotine
Smoke-free policies
Hospitality venues

ABSTRACT

Introduction: After the implementation of smoke-free policies in indoor hospitality venues (including bars, cafeterias, restaurants, and pubs), smokers may have been displaced to their outdoor areas. We aimed to study smoking visibility and second-hand smoke exposure in outdoor hospitality venues.

Methods: We collected information on signs of tobacco consumption on entrances and terraces of hospitality venues in 2016 in the city of Madrid, Spain. We further measured airborne nicotine concentrations and particulate matter of less than 2.5 μm in diameter (PM2.5) in terraces with monitors by active sampling during 30 min. We calculated the medians and the interquartile ranges (IQR) of nicotine and PM2.5 concentrations, and fitted multivariate models to characterize their determinants.

Results: We found 202 hospitality venues between May and September (summer), and 83 between October and December 2016 (fall) that were opened at the time of observation. We found signs of tobacco consumption on 78.2% of the outdoor main entrances and on 95.1% of outdoor terraces. We measured nicotine and PM2.5 concentrations in 92 outdoor terraces (out of the 123 terraces observed). Overall median nicotine concentration was 0.42 (IQR: 0.14–1.59) $\mu g/m^3$, and overall PM2.5 concentration was 10.40 (IQR: 6.76–15.47) $\mu g/m^3$ (statistically significantly higher than the background levels). Multivariable analyses showed that nicotine and PM2.5 concentrations increased when the terraces were completely closed, and when tobacco smell was noticed. Nicotine concentrations increased with the presence of cigarette butts, and when there were more than eight lit cigarettes at a time.

Conclusions: Outdoor hospitality venues are areas where non-smokers, both employees and patrons, continue to be exposed to second-hand smoke. These spaces should be further studied and considered in future tobacco control interventions.

1. Introduction

Second-hand smoke (SHS) was responsible for 603,000 deaths among children and adult non-smokers in 2004 worldwide and this number has increased over the years (Oberg et al., 2011; Word Health Organization (WHO), 2015). Long-term SHS exposure has been associated with many adverse health effects including low birth weight and increased risk of respiratory diseases in children, lung cancer and coronary heart disease (IARC Working Group on the Evaluation of Carcinogenic Risks to Humans, 2004; U.S. Department of Health and Human Services, 2006). Short-term exposure to SHS has been linked to the irritation of the eyes and respiratory tract, (Junker et al., 2001) and there is also evidence suggesting that it can cause significant adverse effects on the human respiratory system, (Flouris and Koutedakis, 2011) and contribute to an increased risk of cardiovascular mortality (Pope et al., 2001).

To protect people from the harms of SHS exposure the World Health Organization (WHO) encouraged countries to follow Article 8 of the

* Correspondence to: Social and Cardiovascular Epidemiology Research Group, School of Medicine, University of Alcalá, Campus Universitario - Crta. de Madrid-Barcelona, Km. 33,600, Alcalá de Henares, Madrid 28871, Spain.
E-mail address: francisca.sureda@uah.es (X. Sureda).

https://doi.org/10.1016/j.envres.2018.04.024
Received 16 March 2018; Received in revised form 19 April 2018; Accepted 20 April 2018

WHO Framework Convention on Tobacco Control (FCTC) to create complete smoke-free environments in all indoor workplaces, public places, and on public transport (Word Health Organization (WHO), 2003). By the year 2017, 20% of the world's population, were protected by comprehensive national smoke-free laws (Word Health Organization (WHO), 2017). In recent years, some countries have also extended smoke-free policies to some outdoor public places such as health centers, playgrounds, beaches, sports facilities, entrances to public buildings, dining patios, or public transportation stops (Kaufman et al., 2010; Global Smokefree Partnership, 2009; Repace, 2008). However, outdoor smoke-free policies are not as popular as indoor smoking bans, although in some outdoor places such as hospitality venues people would continue to be exposed to considerable levels of SHS (Fu et al., 2016; Licht et al., 2013; Sureda et al., 2013; Sureda et al., 2015).

Outdoors hospitality venues (such as terraces and patios in bars and restaurants or their main entrances outdoors) are places frequented and used by smokers since the implementation of smoking ban inside those venues (Fu et al., 2016; Sureda et al., 2013; Sureda et al., 2015). Previous studies measuring SHS exposure in those areas have found levels above the values recommended not to be exceeded by the WHO Air Quality Guidelines (Sureda et al., 2013; Cameron et al., 2010; Edwards and Wilson, 2011; Klepeis et al., 2007; Lopez et al., 2012; St Helen et al., 2011; Sureda et al., 2012; Travers et al., 2007; Wilson et al., 2007; Wilson et al., 2011). In a study conducted in Barcelona, Spain, non-smokers claimed that most SHS exposure in all types of outdoor settings occurred in outdoor areas of bars and restaurants (Sureda et al., 2015). In the same study, more than half of the smokers reported smoking in those areas. These results suggest that the effectiveness of indoor smoke-free policies is reduced in hospitality venues by the occurrence of smoking in outdoor spaces when smoking is permitted.

From January 2nd, 2011 smoking in all enclosed public places and workplaces including hospitality venues was banned in Spain (Sanidad, 2010). It was also the first time in Europe that smoking was also banned in some outdoor places including health care premises campuses, primary schools and high school courtyards, and children's playgrounds. The law also prohibited smoking in terraces in hospitality venues when they had a roof and more than two sidewalls.

This study is part of the “Heart Healthy Hoods” (HHH) study which seeks to understand how social and physical urban environment relates to cardiovascular outcomes in European cities (https://hhhproject.eu/) (Bilal et al., 2016; Carreño et al., 2017). The HHH project includes in its objectives the characterization of tobacco urban environment (Franco et al., 2015). The objective of the present study is to describe smoking visibility and SHS exposure in outdoor hospitality venues in the city of Madrid, Spain.

2. Methods

2.1. Study design and area of study

This is a cross-sectional study conducted in the city of Madrid, Spain. Madrid is divided into 21 districts, which, in turn, are divided into 128 neighborhoods and 2412 census sections. Census sections are the smallest administrative area for the Spanish Census with approximately 1500 residents per census section.

We conducted the present study in 42 census sections used in the HHH study to guarantee the representativeness of the demographic characteristics of the city (Fig. 1). Briefly, we used a multistage design to select the area of study. In the first stage, we selected two neighborhoods for each district of the municipality of Madrid, in total 42 neighborhoods. The selection was representative of socio-economic characteristics of Madrid including unemployment, precarious work, occupational class, educational level and immigration. This was a non-probabilistic sample. In the second stage, we selected the median census section in each neighborhood in terms of population density, business density, educational level, immigration, and aging.

2.2. Variables and instruments

2.2.1. Systematic social observation: tobacco questionnaire in outdoor hospitality venues

We adapted a questionnaire that had already been used in previous studies (Fu et al., 2016; Sureda et al., 2012; Navas-Acien et al., 2016) aimed to characterize hospitality venues including outdoor main entrances and terraces. The questionnaire included information on:

a. General characteristics of hospitality venue measurements: date of measurement, address and type of hospitality venue. We included bars or similar (including cafeterias, breweries or bodegas (Spanish traditional drinking venues where wine or beer are produced by the owners); restaurants (including take-away and fast food); and pubs/cocktail bars.
b. Presence of terraces and their physical characteristics: we indicated if the hospitality venue had terrace or not. If it did, we collected information on the number of tables, presence of roof (yes/no), and presence (yes/no) and number of sidewalls. We considered roofs as any permanent or temporary structure that impedes upward airflow. Walls were defined as any structure that impedes lateral airflow, regardless their full attachment to the roof.
c. Signs of tobacco consumption at the entrance of the venue and on its terrace (if present): number of smokers, presence of ashtrays (yes/no), presence of cigarette butts (yes/no), and tobacco smell (yes/no).
   For the entrances, we also registered if there were tables or barrels (or similar) with signs of tobacco consumption (yes/no). Venues use those elements attached to the entrance to facilitate tobacco consumption outdoor when they do not have permission to have a terrace (Fig. 2).
d. Information related to the airborne marker measurements: we indicated if we measured or not airborne markers at the terrace. If yes, we recorded the time of onset and completion of the measurement, number of lit cigarettes every 5 min, and the total number of smokers and lit cigarettes during the measurement.

The tobacco questionnaire was integrated in an app called Open Data Kit (ODK) (https://opendatakit.org/use/collect/) that allowed us to collect the data using smartphones. This app allows data collection, including the possibility of taking pictures and geo-locating the data using the smartphone GPS.

2.2.2. Airborne markers

a. Vapor-phase nicotine concentrations: We used an active sampling method connecting nicotine sampler's devices through a tub to a pump (flow 3.02 ml/min), as conducted in previous studies (Fu et al., 2016; Sureda et al., 2012). Sampler's devices contained a 37 mm in diameter filter treated with sodium bisulfate. The pump was calibrated every 3–4 measurements using a Defender 510-M Calibrator (Bios International Corp, USA). Nicotine was analyzed in the Laboratory of the Public Health Agency of Barcelona by gas chromatography/mass spectrometry. We estimated the time-weighted average nicotine concentration ($\mu g/m^3$) by dividing the amount of nicotine extracted by the volume of sampled air multiplied by the total number of minutes the filter was exposed. The limit of quantification was 5 ng per filter, equivalent to 0.06 $\mu g/m^3$ of nicotine for an exposure time of 30 min. Samples with values below the quantification limit were assigned half of this value (0.03 $\mu g/m^3$).
b. PM2.5 concentrations: We used a hand-held-operated monitor of particle size and mass concentration (TSI SidePak AM510 Personal Aerosol Monitor) as used in previous studies (Sureda et al., 2012; Sureda et al., 2014). The monitor was fitted with a 2.5-μm impactor to measure the concentration of particulate matter with a mass-