ANNALS OF PUBLIC HEALTH

MIDITERRANEAN JOURNALS

Original Research

DOI: 10.55085/aph.2022.617

Thirdhand Smoke Exposure in Homes with Children under 48 Months during the First Wave of the COVID-19 Pandemic Confinement in Barcelona (Spain)

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Check for updates

Received: 05 Dec 2021
Revised: 15 Mar 2022
Accepted: 03 Apr 2022
Published: 16 Apr 2022

Academic Editor: Scott C Kogan

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Cite this article as: Lidón-Moyano C, Díez-Izquierdo A, Cassanello P, Cartanyà-Hueso À, Martín-Sánchez JC, Balaguer A, Martínez-Sánchez JM. Thirdhand Smoke Exposure in Homes with Children under 48 Months during the First Wave of the COVID-19 Pandemic Confinement in Barcelona (Spain). Ann Public Health. 2022;1:617. [https://doi.org/10.55085/aph.2022.617]

Authors' contributions
The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

Acknowledgments
None.

Funding
No funding was received from any organization to conduct the present study.

Conflict of interest
The authors declare that there is no conflict of interest regarding the publication of this article.

ABSTRACT

Background/Objectives: Due to serious restrictions on mobility, some children might have increased exposure to THS due to home confinement. To characterize third-hand smoke (THS) exposure in children under 48 months at homes in Spain during the confinement of the first wave of COVID-19.

Methods: Cross-sectional study of a non-probabilistic sample of parents (n = 311). The gathered information was about smoking status, second-hand smoke (SHS) exposure of their children, and voluntary regulation of tobacco consumption at their home. A variable of THS exposure at home was derived, classifying as 'THS exposed' those children whose parents reported living with a smoker or with smoking parents and non-exposed to SHS; 'Non exposed' children were, therefore, all other children.

Results: Almost a quarter of the children (23.5%) were exposed to THS. This prevalence was significantly higher among those children whose parents increased tobacco consumption during confinement (40.5%), whose parents had lower or medium educational levels (42.9% and 41.7%), and with younger parents (24.8%). In contrast, the prevalence was significantly lower among those children living in homes with complete voluntary smoke restrictions (21.1%).

Conclusions/Recommendations: To reduce THS exposure among children, it is important to work on information campaigns to raise awareness regarding THS exposure, promote recommendations to avoid exposure to THS, and develop legislation promoting smoke-free environments (in homes and vehicles).

Keywords: Third-hand Smoke, THS Exposure, Tobacco Exposure, Smoke-free Homes, Pediatric Population.

1. INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV- 2) became a public international health emergency declared by the World Health Organization (WHO) in January 2020 (1). This exceptional situation caused by the SARS-CoV2 pandemic has spread worldwide with an outbreak affecting patients mostly with respiratory symptoms (2). Virus transmission happens through direct personal contact, droplets, hands, or contaminated surfaces and could remain in aerosols for hours and on surfaces for days (2-4). To control the spread of the virus, governments implemented serious restrictions on mobility, particularly during the first wave of the pandemic, leading to confinement in homes in countries around the world (1). In Spain, the state of alarm was decreed with restrictions on mobility from March 14th, 2020, to June 21st, 2020 (5,6).

In Spain, previous to the state of alarm, children spent most of their time at high schools, schools, or kindergartens, places protected by tobacco control legislation. However, tobacco smoke exposure remains high in private places with a lack of control regulation in most countries (7). The confinement forced parents and children to live together locked in the same space 24/7, being especially reduced spaces in urban areas and, in some cases, without access to balconies, terraces, yards, or courtyards. In fact, even if parents smoke in separate rooms, near an open window, or when children are not present in the same room, third-hand smoke (THS) may still be present, and in some cases, second-hand (SHS) as well (8,9).

THS is defined as those residual pollutants from tobacco smoke that remain on surfaces and dust after smoking; THS may phase into gas or react with oxidants and other environmental compounds producing secondary pollutants (10). The components of THS are found in dust or on surfaces that may be ingested, inhaled, or even absorbed through the skin, primarily in private environments (10,11). Although long-term effects are currently unknown, the effects of THS in the pediatric population are particularly worrying, evidencing an increase in respiratory diseases such as asthma exacerbations in exposed children, and there are existing recommendations to decrease exposure to THS (11,12). Children are more vulnerable to tobacco smoke exposure, SHS and THS because they are still developing their immune system, they have a faster breathing rate, and due to their inability to independently avoid the exposure (13,14). In addition, there are certain behaviors characteristic of child developmental milestones, like putting things in the mouth, crawling, and licking objects, that increase THS exposure. Moreover, children exposed to SHS are at the same time exposed to THS. SHS exposure has been associated in pediatric populations with an increase in respiratory diseases such as asthma or persistent wheezing (14–17) and also with an increased risk of sudden infant death syndrome (16,18) or otitis media, among others (16,17).

Some children might have an increased intensity of exposure to THS. Along this line, THS exposure might be exacerbated when sharing a bed with smokers. Therefore, children co-sleeping with smoking parents might have higher exposure to THS. Moreover, although the benefits of breastfeeding in childhood are undeniable, especially in the development of the immune system, (19) the proximity between baby and mother during breastfeeding might also increase exposure to THS.

We did not identify previous literature regarding the prevalence of THS exposure. Therefore, the objective of this study was to characterize THS exposure in children under 48 months at homes in Spain during the confinement of the first wave of COVID-19.

2. METHODS

This is a cross-sectional study of children under 48 months. The surveys were conducted online (www.epison.es) in Spanish from April to June 2020, with a duration of close to 15 minutes for all questions. We stopped the fieldwork at the end of the lockdown of the first wave of the COVID-19 pandemic. We used a non-probabilistic method of snowball. The theoretical sample size was 323 individuals, assuming an expected prevalence of 30% (with an alpha error of 5% and a precision of 5%), which was the estimated percentage of smokers in Spain and, therefore, the potential source of THS exposure among children. The inclusion criteria were all those parents or caregivers who spoke Spanish and agreed to participate. The exclusion criteria were all those parents or caregivers who did not speak Spanish, living outside Catalonia (other Spanish regions: n=19, other world regions: n=4), reported their children to be older than 48 months (n=7), to be exposed to SHS (n=2) or not reporting their children SHS information (n=1). The final sample included 311 parents. Although the respondents completed personal information, the data were treated anonymously. The recruitment of the participants was carried out through digital media: social networks, private emails, kindergarten emails, and mobile applications were used to spread the purpose of the study and request participation. Before accessing the survey, the informed consent was completed online and specified the voluntariness, confidentiality, and anonymization of personal data. The participants did not receive an economic incentive or gift. The approval of the Ethics Committee of XXXX1 and the Research Ethics Committee (CER) of XXXX2 was obtained to carry out the study. Information about the smoking status of the parents and the voluntary regulation of tobacco consumption at home was obtained. First, we were asked whether, during confinement, there was a smoker living in the house, with a possible dichotomous answer (Yes or No). Also, we were asked about the smoking status of the respondent of the questionnaire using the following question: "¿Do you smoke?" with three possible answers: "Yes, currently," "No, but I smoked," and "No, I have never smoked." Then, smokers were asked if they had increased their smoking consumption during confinement, with a possible dichotomous answer (Yes or No). In addition, we were asked about the voluntary regulation of tobacco consumption at home with the following question:

"Which situation describes better the 'rules' of smoking INSIDE your home?" with four possible answers: "Nobody can smoke (smoke is not allowed)," "You can only smoke in some places inside the house," "You can smoke anywhere (there are no rules)," and "Don't know/no answer." Finally, the variable of THS exposure at home was derived by classifying as 'THS exposed' those children reported to live with a smoker or with smoking parents; 'Non exposed' children were, therefore, all other children. Child and parent demographic variables were also included: sex, age, and parent education level.

Chi-squared test, or Fisher test, was used to compare THS exposure prevalence with non-exposure prevalence. The prevalence of THS exposure in children was obtained, the raw prevalence ratio (PR), and its 95% confidence interval (95%CI), comparing children exposed to THS and non-exposed children. Moreover, the results were stratified by the following categories: Tobacco-Related variables: Parents increased consumption (categorized as yes or no), and Smoke restrictions at home (categorized as complete rules or partial rules); Child demographic variables: Child age in months (categorized as from 2 to 11 months, 12 to 23 months, more than 24 months), and Child sex (categorized as male or female). Child demographic variables were included, as the behaviour of parents with their children might vary according to their age and sex (i.e., newborns are expected to be carried in arms, potentially increasing THS exposure, while children more than 24 months are more independent). Also included were parent demographic variables (17): Person answering questionnaire (categorized as mother or father), parent educational level (categorized as low, medium, high), and parent age (categorized as: less than 35 years or more than 35 years).

In addition, although we were not able to assess exposure intensity in our work, given our interest in children with potentially increased THS exposure, we carried out a sub-analysis in order to analyze changes in the THS exposure prevalence according to the child's feeding (categorized as breastfeeding and non-breastfeeding), and the place where the child sleeps (categorized as co-sleep with parents and no co-sleeping), in a stratified analysis according to the child age. The statistical program used was R-3.0.2.

3. RESULTS

The final sample included 71 (23.8%) children living with smokers and 46 (14.8%) whose parents were smokers.

According to our results, 23.5% of the children were exposed to THS (Table 1). This prevalence was significantly higher among those children whose parents increased tobacco consumption during home confinement (PR: 2.47; 95%CI: [1.94, 3.29]), whose parents had lower (PR: 2.36; 95%CI: [1.28, 3.86]) or medium (PR: 2.29; 95%CI: [1.47, 3.44]) educational level, and with younger parents (PR: 1.73; 95%CI: [1.11, 2.70]). Moreover, THS exposure prevalence was significantly lower among those children living in homes with complete voluntary smoke restrictions (PR: 0.24; 95%CI: [0.18, 0.34]) (Table 1).

Table 1: Table 1. THS exposure prevalence, prevalence ratio (PR), and 95% confidence interval (95%Cl), according to tobacco-related variables, child demographic variables, and parent demographic variables.

	N	THS Exposed	PR (95%Cl)	p-value
Overall	311	23.9%	-	-
Tobacco related variables				
Parent increased consumption (only among smokers)				
Yes	26	100%	2.47 (1.94, 3.29)	<0.001[(1)]
No	79	40.5%	Ref.	
Smoke restrictions at home				
Complete rules	251	21.1%	0.24 (0.18, 0.34)	<0.001[(1)]
Partial rules	17	88.2%	Ref.	
Child demographic variables				
Child age in months				
2-11	90	27.8%	0.92 (0.78, 1.06)	0.331[(1)]
12-23	80	22.5%	1.06 (0.63, 1.75)	0.966[(1)]
24-48	141	21.3%	Ref.	
Child sex				
Male	154	26.6%	0.77 (0.51, 1.14)	0.244[(1)]

Female	157	20.4%	Ref.	
Parent demographic variables				
Person answering questionnaire				
Mother	297	23.9%	1.67 (0.58, 6.04)	0.533(2)
Father	14	14.3%	Ref.	
Parent educational level				
Low	21	42.9%	2.36 (1.28, 3.86)	0.019(2)
Medium	48	41.7%	2.29 (1.47, 3.44)	0.001(1)
High	242	18.2%	Ref.	
Parent age				
<35 years	109	24.8%	1.73 (1.11, 2.70)	0.022(2)
>35 years	127	17.3%	Ref.	

P-values were obtained through Chi-squared test (1) or Fisher test (2).

In addition, a significantly higher prevalence of THS has been observed among non breastfed children when compared to breastfed children in the lower age group (0-12 months) (Figure 1, Panel A). However, no statistically significant differences were found regarding THS exposure between co-sleeping and non-co-sleeping children (Figure 1, Panel B).

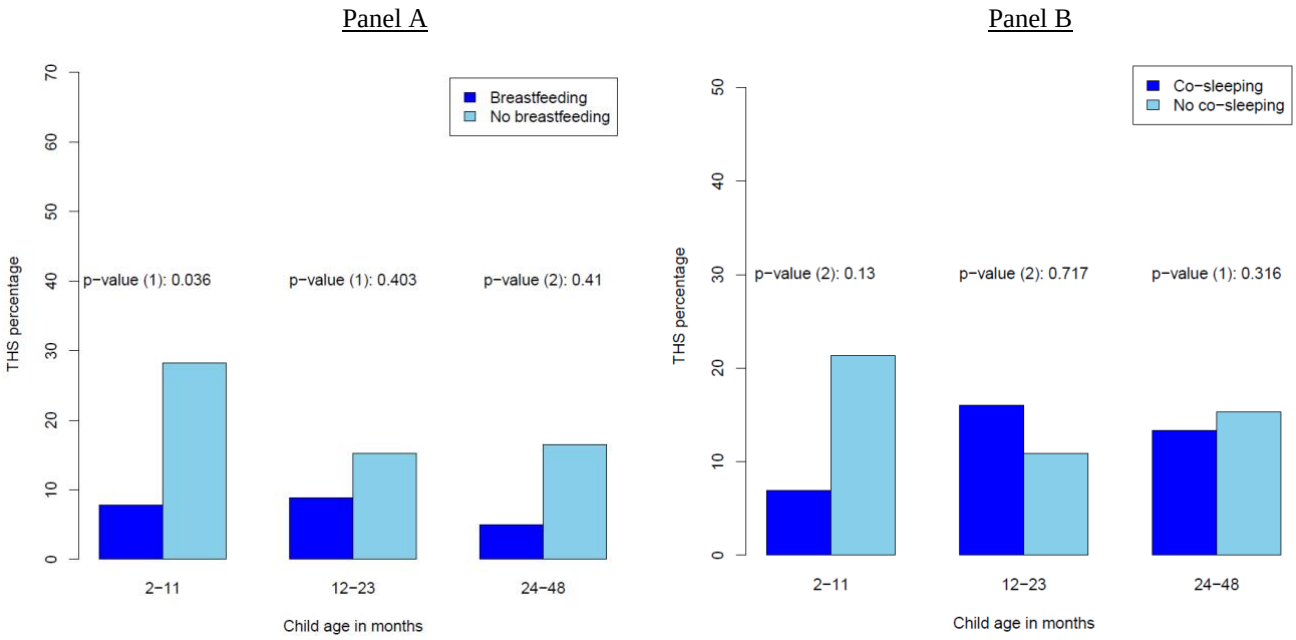

Figure 1: THS prevalence compared to breastfeeding and non-breastfeeding children (Panel A) and comparing co-sleeping and no co-sleeping children (Panel B), stratifying according to child age in months.

Children were classified as 'breastfeeding' whether they exclusively breastfeed or they follow mixed feeding, including breastfeeding and formula or solid foods.
Children were classified as 'Co-sleeping' if they slept in their parent's bed and were classified as 'No co-sleeping' if they slept in a crib inside or outside their parent's room.
P-values were obtained through the Chi-squared test (1) or Fisher test (2).

4. DISCUSSION

More than one out of five children are estimated to be exposed to THS during the first wave of the Covid-19 pandemic confinement in Barcelona (Spain). This exposure is higher among children with younger parents, parents increasing smoking, and parents with lower and medium educational levels.
We did not identify previous literature regarding the prevalence of THS exposure. We observed that 23.5% of children could be considered to be exposed to THS, coinciding with the fact that 22.8% of children live with a smoker. A previous study showed that professionals working with children believe that confinement might strongly impact

children's health through some factors such as tobacco exposure (21). In this sense, during the debate on implementing smoke-free policies in different countries, the tobacco industry and the hospitality sectors argued that the restriction of smoking in public places would displace tobacco consumption in private venues, particularly at home. Although most of the published works counteract the displacement hypothesis (22), the lockdowns derived from the pandemic certainly forced tobacco consumption at home, increasing tobacco exposure among children and other non-smokers living with smokers. In this sense, smoke-free environments especially focused on smoke-free homes, are the only way to avoid SHS and THS exposure. In recent years, smoke-free multi-unit housing (MUH), defined as completely smoke-free buildings, has proliferated in some countries (e.g., Germany or the United States), promoted by their governments as the only way to completely avoid tobacco smoke exposure from neighbors. In this sense, it is urgent to spread the promotion of this type of legislation among other governments(23,24).

According to our results, higher THS exposure prevalence was observed among children with younger parents, parents with increasing consumption, and parents with lower and medium educational levels. This is in line with previous research regarding SHS exposure showing increased exposure among children living with a higher number of smokers (25) and whose parents have lower and medium educational levels or with younger parents (26), which may be due to a lack of knowledge about the harmful effects of THS exposure on their infant's health. Hence, additional educational measures are needed, especially among smokers, those with lower educational levels, and younger parents.

Moreover, a higher prevalence of THS was obtained among non breastfed children when compared to breastfed children in the lower age group (0-12 months). This result is in line with previous work carried out in Cantabria (Spain), showing that the probability of feeding newborns with formula doubled if the mother was a smoker (27). In addition, it was shown that feeding formula is more prevalent if there is a lower educational level, emphasizing the urgent necessity of more educational measures to promote the benefits of breastfeeding among the population.

Our results are especially worrisome, taking into account that Europe is currently facing consecutive waves of the Covid-19 pandemic. The variability in the pandemic situation, with periodic covid incidence increases, has led to subsequent re-enforcement of mobility restrictions (among other measures such as curfew) or new confinements according to the region and the Covid-19 incidence (28). For this reason, it is crucial to work on information campaigns to raise awareness regarding THS exposure among individuals and healthcare professionals. In this sense, data from 2017 showed that in Spain, only 27% of the parents of children under three years of age had heard of the THS, but, after providing them with brief information on the subject, up to 86% of the parents agreed that THS is harmful to their children (29). The population lacks information regarding how THS hinders children and adult non-smokers. Current protection through smoke-free legislation includes public spaces and workplaces, but private places (including homes and vehicles), where exposure to THS is high, are never or rarely included. Therefore, it falls upon individuals to decide to establish smoke-free home rules. In Spain, almost half of the adult population has implemented a complete smoke-free rule at home (7). This entails that individuals' decisions are based on protecting children and non-smokers from SHS but could neglect THS protection. Moreover, children, and adult non-smokers, living in a smoke-free home might avoid exposure to SHS, but they may not completely avoid exposure to THS if they are living with a smoker (20). For this reason, recommendations to avoid exposure to THS should be promoted among individuals and healthcare professionals. In this regard, a previous work addressed to Spanish pediatricians supplied a list with eight recommendations to avoid exposure to THS, including a tryptic to help promotion (12). The first and most obvious recommendation is to quit smoking. Therefore, it is important to continue working on the reduction of consumption of any kind of tobacco product by increasing the price of all tobacco products, as it is proved to be the most effective policy (30) in this regard, and implementing better treatment policies to help smokers stop smoking. Moreover, some of the measures made by the World Health Organization to avoid the spread of Coronavirus (COVID-19) may help to decrease SHS and THS exposure, including keeping rooms well ventilated, avoiding crowds, and cleaning hands frequently (31).

Limitations

The most important limitations of our study are those derived from the use of an online survey that could create an information bias. However, carrying out an online survey, and not having an interviewer present, is expected to reduce the unacceptability bias, as was noted in previous studies (29). Another limitation of this study lies in the difficulty of differentiating SHS and THS exposure. Nevertheless, previous studies have found no difference in cotinine levels between people exposed to SHS and THS at home (32). First,

THS exposure cannot be completely separated from SHS due to individuals exposed to THS might also be exposed to SHS still present in space (i.e., when smoke takes place in a room and individuals enter after smoking ends). Second, individuals reporting not being exposed to SHS might actually be unaware of their exposure (i.e., when smokers smoke outside the house without closing doors/windows or when smokers light the cigarette inside the home). Actually, 17 (23,9%) of the 71 THS exposed children lived in a house with partial smoking rules. However, even though these children lived in a house with partial smoking rules, they declared not being exposed to SHS, indicating that smoking was not taking place when children were present. THS might be overestimated due to SHS non-reported exposure.
Moreover, SHS's negative health effects are well-known nowadays, and most parents try to avoid SHS exposure among their children. In this regard, only two parents self-reported SHS exposure among their children, and those questionnaires were removed from the study. Another limitation of this study is that our sample may not represent the general population of Barcelona (Spain) due to using a non-probabilistic sample of parents, which might limit external validity. However, another type of sampling during the first wave of the pandemic in Spain was not possible for our research team. In this sense, we have compared the characteristics of respondents with the latest data of 2019 published by the National Institute of Statistics in Spain (INE) to test the representativeness of the sample, looking for limitations of our sample (33). First, the average age of the respondents is similar to the INE Spanish average. Second, in our sample, smokers are underrepresented, and parents with university studies are overrepresented compared to the INE Spanish data. All these discrepancies may bias the estimations obtained in this study, underestimating exposure to THS.

5. CONCLUSION

In conclusion, more than one out of five children are estimated to have been exposed to THS during the first wave of the Covid-19 pandemic confinement in Barcelona (Spain), increasing considerably among children with parents who increased consumption during confinement, had a lower educational level or were younger. To reduce THS exposure among children, it is especially important to work on information campaigns to raise awareness regarding THS exposure and promote recommendations to avoid exposure to THS among individuals and healthcare professionals. Legislation promoting smoke-free private environments (homes and vehicles) may be encouraged. Moreover, there is a need to continue working on the reduction of smoking.

ACKNOWLEDGMENTS

None.

AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

COMPETING INTERESTS

The authors declare no competing interests with this study.

FUNDING SOURCES

None.

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