



POPULATION STUDY ARTICLE

Knowledge and attitudes toward thirdhand smoke among parents with children under 3 years in Spain

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INTRODUCTION: The knowledge and beliefs about what is thirdhand smoke (THS) are limited. Our objective is to characterize the knowledge and beliefs about THS in parents of children under 3 years old in Spain.

METHODS: A cross-sectional study ($n = 1406$ parents) was conducted online in 2017. We collected information about the knowledge of THS given later, written information with the definition of THS, and asking about beliefs of the effects of THS on children's health.

RESULTS: A total of 27% of the respondents had heard about THS. We only found significant differences among smoking status, being the smokers who declare higher knowledge about THS. A total of 86% of the respondents believed that THS is harmful to their children with statistically significant differences according to educational level, higher among parents with a university degree ($ORa = 2.6$), and according to the previous knowledge on THS ($ORa = 2.1$).

CONCLUSIONS: This is the first study in Europe to describe the knowledge and belief of THS. Around 3 out of 10 parents have heard about THS and more than 8 out of 10 parents believed that THS is harmful to their children. Currently, they were not aware of THS but after providing brief information about it, most of them agreed that THS exposure is harmful to their children.

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INTRODUCTION

In 2006, the term thirdhand smoke (THS) was first mentioned in commercial press,¹ also known as *residual tobacco smoke* or *aged tobacco smoke*.^{2,3} However, the concept was not defined until 2011 as “residual tobacco smoke pollutants that remain on surfaces and in dust after tobacco has been smoked; are re-emitted into the gas phase; or react with oxidants and other compounds in the environment to yield secondary pollutants” by Matt et al.²

Numerous studies showed the adverse health consequences of secondhand smoke (SHS), with no minimum safe level to tobacco smoke exposure.^{4,5} In fact, there are some components of SHS that adhere to indoor surfaces, or are reissued back into the indoor air and may react with atmospheric species creating other pollutants that are not present in the original fresh smoke.^{6,7} Therefore, it has been postulated that some of the components of THS could have greater toxicity than tobacco smoke or SHS due to the oxidation and reconstitution processes that occur on the surfaces when deposited.^{8–10} Some of the components of THS found in indoor dust and surfaces could be ingested, inhaled, or even absorbed through the skin.^{11–13} Moreover, some of the components of THS are kept in the fibers of the clothes up to 19 months.¹⁴ Recently, some author's review has been published summarizing the effects of THS on cells, animals, and humans.^{10,15,16} Also, THS has been related with an increase in mortality risk due to living with a smoker.⁷

Children have a developing immune system, a higher respiratory rate, and in addition, infants crawl and carry things continuously to the mouth.^{17,18} These specific characteristics of

children make them more vulnerable to THS exposure.^{17,19} Furthermore, in children population, exists as an inability to move away from the principal settings of passive exposure to contaminants as private settings, particularly houses and cars, making them especially vulnerable to THS.²⁰ In this sense, a previous cross-sectional study found associations between exposure to THS and adverse respiratory symptoms in children.¹⁸ Related to this, a guidance for the clinical management of THS exposure in child healthcare setting has recently been published.¹⁹

To the best of our knowledge, there are few descriptive studies describing the knowledge and beliefs of THS in adults related to the pediatric population, and there is no study conducted in Europe.^{10,21–26} This is the first study in which parents and caregivers of children are asked about their knowledge of THS, and after explaining briefly the THS term, they are asked again if they believe that THS is harmful to the health of their children. The objective of this study is to describe the knowledge and beliefs about THS in parents or caregivers of children under 3 years in Spain.

METHODS

This was a cross-sectional study of a sample of parents ($n = 1406$) with children between 3 and 36 months carried out in Spain (1112 from Catalonia region, 168 from other Spanish regions, and 126 without information of the region) who accepted to participate in the study. We used the data from a study about the quality of the sleep of the children called EpiSon conducted via online

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questionnaires to parents or caregivers with children between 3 and 36 months. The objective of the EpiSon study was to analyze the relationship between sleep quality in children and the adherence to sleep hygiene routines in families according to sociodemographic variables. The questionnaire of EpiSon study also included a section about THS.

The inclusion criteria from the study were all those parents or caregivers with a child from 3 to 36 months of age who spoke Spanish and agreed to participate. The exclusion criteria from the study were all those parents or caregivers with a child from less than 3 months or more than 36 months of age, or parents or caregivers who did not speak Spanish.

The surveys were conducted in Spanish from March to November of 2017 with a duration of approximately 15 min for all questions (questions regarding the study of sleep patterns and a section about thirdhand smoke). Even though respondents filled in personal information, the data were treated anonymously. The recruitment of the participants was done through ballots distributed in the waiting room of the pediatric consultation of HUGC. The ballots explained briefly the EpiSon project and offered the voluntary participation through a link to the website to complete the survey. In addition, digital media such as social network, private emails, and kindergarten emails were used, and mobile applications explaining with the same text as the ballot the purpose of the study and requesting participation. To gain access to completing the survey, participants filled in the informed consent online. In the informed consent document, the voluntariness, confidentiality, and anonymization of personal data were specified. The participants did not receive an economic incentive or a gift. To carry out the study, approval from the Ethics Committee of the HUGC and the Ethics Committee of Research (CER) of the Universitat Internacional de Catalunya (UIC-Barcelona) was obtained.

Variables

We gathered information about the smoking status, the secondhand smoke exposure of their children, the voluntary regulation of tobacco consumption at their home, and their knowledge and beliefs regarding THS harmful effects for their children. First, we 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, we asked about the secondhand smoke exposure of the children with the following questions: “During the past 2 weeks, ¿Has your child been exposed to secondhand smoke in your home?” with a possible dichotomous answer (Yes or No) and “¿Has your child been exposed to secondhand smoke in another place different from your home?” with a possible dichotomous answer (Yes or No). In addition, we asked about the voluntary regulation of tobacco consumption at homes 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”. Then, we asked about general knowledge of THS using the following question: “Have you heard about “Thirdhand smoke” before?” with a possible dichotomous answer (Yes or No). Just after, written information about the concept of THS was given to all the participants with the following sentence: “Thirdhand smoke” (or third-hand smoke) is the smoke generated by tobacco and deposited in the form of waste on surfaces such as furniture, textiles or food. We then asked about the beliefs of the effects of THS on children’s health using the following question: “Do you think exposure to Thirdhand smoke is harmful to children?” with six possible answers: “Yes, totally agree”, “Yes, agree”, “Neither agree, nor disagree”, “Disagree”, “Strongly disagree”, and “Don’t know/no answer”. We recoded this variable according to whether

the respondents agreed with THS being harmful to their children (“Yes, totally agree”, “Yes, agree”) or disagreed (“Neither agree, nor disagree”, “Disagree”, “Strongly disagree”, and “Don’t know/no answer”). All the variables questions with the possible answers have been added to Appendix 1.

Statistical analysis

We calculated the percentages for responses about THS knowledge and beliefs of the effects of THS on children, and SHS exposure at home among those respondents who previously knew THS. THS knowledge and belief responses were stratified by the following categories: sex of the child; age of the child (categorized as less than 1 year, 1–2 years, and more than 2 years); siblings (categorized as yes or no); relationship of the child with the respondent (categorized as mother, father, and other); smoking status (categorized as smokers, former smokers, and never smokers); level of education of the respondent (categorized as primary or less, secondary, and university); age of the respondent (categorized as less than 25 years old, between 25 and 35 years old, and more than 35 years old). For the belief of the effects of THS, we stratified according to the previous knowledge of THS (categorized as yes or no). We also calculated the adjusted odds ratio (ORa) with 95% confidence intervals (CI) for sex, age, educational level, and smoking status of respondents through logistic regression. Data analyses were performed using the R statistical software program, version 3.4.2.

RESULTS

Table 1 shows the baseline characteristics of the respondents. Table 2 shows the knowledge about THS among respondents. A total of 27% of respondents reported having heard about THS. We only found statistically significant differences in the THS knowledge to smoking status, being that this awareness was higher among smokers (35.3% smokers, 22.7% former smokers, and 27% never smokers) (Table 2). There were not significant differences according to child characteristics (sex, age, siblings, and relationship with the respondent) and characteristics of the parents (level of education and age of the respondent) (Table 2).

A total of 86% (95% CI: 84–87.8) of participants believed that THS is harmful to their children (after being informed of the meaning of THS in the questionnaire). We found statistically significant differences about the perception of THS harmful effect according to educational level (being higher among parents with university degree) (90.4% university degree, 82.9% secondary degree, and 81.3% primary degree or less) and the previous knowledge about THS (93.9% and 83.4%, respectively) (Table 3).

We did not find statistically significant differences in SHS exposure at home from children among those respondents who previously knew THS (ORa = 0.9; 95% CI: 0.6–1.6). We also did not find statistically significant differences in smoke-free rules at home between those respondents who previously knew THS against those who did not (ORa = 0.7; 95% CI: 0.5–1.1).

DISCUSSION

This is the first study in Europe to describe the knowledge and beliefs of THS among parents with children under 3 years. Around 3 out of 10 parents had previously heard about THS and more than 8 out of 10 parents believed that THS exposure is harmful to their children. There were no differences in the knowledge and belief of THS according to sociodemographic variables. We only found statistically significant differences according to smoking status.

A total of 86% of the respondents believed that THS is harmful to their children. Moreover, it is interesting to point out that 90% of respondents with higher education level believe that THS is harmful for children’s health. In addition, the belief increases to

Table 1. Baseline characteristics of the respondents of EpiSon study, 2017

	<i>n</i>	%
Sex of the child		
Men	726	48.4
Women	680	51.6
Age of the child		
Less than 1 year old	368	26.2
Between 1 and 2 years old	984	67
More than 2 years old	54	3.8
Age of the child (mean, sd)	1.15 (0.8)	
Brothers or sisters		
No	539	38.3
Yes	867	61.7
Relationship with the child		
Mother	1326	94.3
Father	72	5.1
Other	8	0.6
Smoking status		
Smokers	252	18
Former smokers	480	34.3
Never smokers	666	47.6
Educational level		
Primary or less	109	7.9
Secondary	378	27.3
University	896	64.8
Age of the respondent (mother and father)		
Less than 25 years old	44	3.4
Between 25 and 35 years old	719	56.2
More than 35 years old	517	40.4
Age of the respondent (mean, sd)	34.23 (4.9)	

sd standard deviation

Table 2. Knowledge of the concept of thirdhand smoke (THS) in parents with children younger than 3 years old according to sociodemographic and smoking status in Spain (2017)

	<i>n</i>	%	95% CI	<i>p</i> -Value	OR ^a	95% CI
Overall	1406	27	(24.7–9.4)			
Sex of the child				0.413		
Men	726	28	(24.7–31.4)		1	—
Women	680	25.9	(22.7–29.4)		0.9	(0.5–1.3)
Age of the child				0.489		
Less than 1 year old	368	26.4	(22–31.2)		1	—
Between 1 and 2 years old	984	27.5	(24.8–30.5)		1	(0.7–1.2)
More than 2 years old	54	20.4	(11.1–33.9)		0.7	(0.3–1.4)
Brothers or sisters				0.226		
No	539	25	(21.5–29)		1	—
Yes	867	28.1	(25.2–31.3)		1.2	(0.9–1.6)
Smoking status ^b				0.001		
Smokers	252	35.3	(29.5–41.6)		1	—
Former smokers	480	22.7	(19.1–26.8)		0.6	(0.4–0.8)
Never smokers	666	27	(23.7–30.6)		0.7	(0.5–1)
Educational level ^b				0.053		
Primary or less	109	34.9	(26.1–44.6)		1	—
Secondary	378	28.6	(24.1–33.5)		0.7	(0.5–1.2)
University	896	24.9	(22.1–27.9)		0.6	(0.4–1)
Relationship with the child ^b				0.520		
Mother	1326	27.2	(24.9–29.7)		1	—
Father	72	23.6	(14.7–35.3)		0.8	(0.4–1.4)
Other	8	12.5	(0.7–53.3)		0.7	(0–4.8)
Age ^b				0.168		
Less than 25 years old	45	37.8	(21.2–53.5)		1	—
Between 25 and 35 years old	720	26.9	(23.8–30.4)		0.6	(0.3–1.2)
More than 35 years old	523	25	(21.4–29)		0.6	(0.3–1.1)

CI confidence intervals, OR odds ratio

^aAdjusted for sex, age, smoking status, and level of education of the respondent

^bInformation of the respondent of the survey

more than 90% of respondents among those who knew THS prior to the survey. A study conducted in the United States (US) showed a higher prevalence than our study, with up to 91% of parents believing that THS was harmful to the health of their children.²⁵ In contrast, a study from Iran population recently published shows that 42.4% of parents completely agree with the harmful effects of THS exposure on their infant's health.²⁶ Furthermore, those parents who believed that THS was harmful used cessation assistance more frequently, up to 1.7 times more compared with parents who did not believe and were more likely to have a strictly enforced smoke-free home and car policies.^{25,26} In addition, another study showed that a brief intervention in education about THS to the caregivers attending an emergency room with their children under 36 months produced changes in their smoking behaviors (as changes in the smoking policy in home or car, a reduction in the number of cigarettes smoked, or quitting smoking).²⁴ This fact highlights the importance of educating on this subject, and the need of social educational policies especially focused on parents and caregivers. Moreover, one study showed an independent association between the belief that THS harms children and the voluntary adoption of smoke-free rule at home.²² At present, there are few studies on THS knowledge among general populations and as far as all have been carried out in low-income communities.^{27,28} One of them refers that most of its 39 participants do not know what THS was, although after defining the concept, some perceived risk in the exposure to THS in

children.²⁷ In another study, conducted in 2012 in Los Angeles, California with 24 participants recruited in a low-income neighborhood, none of the participants knew the definition of THS.²⁸ This is the first study, with a large sample size showing the prevalence of the knowledge of THS.

Previous studies showed a statistically significant relationship between those parents who believe that THS has an impact on the health of their children and home-smoking ban.^{22,25,26} Because of this, we expected to find differences among those participants who knew THS previously, in tobacco smoke exposure in their children, and in the percentage of smoke-free rules at home, as opposed to those who did not know. However, we have not found statistically significant differences, so we believe that more educational and training measures should be emphasized on the risks of exposure to SHS and THS.

Two studies assessed the impact of brief educational interventions on THS (i.e., motivational video or brief education) on the

Table 3. Belief that thirdhand smoke (THS) is harmful for children's health in parents with children younger than 3 years old according to sociodemographic and smoking status in Spain (2017)

	<i>n</i>	%	95% CI	<i>p</i> -Value	OR ^a	95% CI
Overall	1406	86%	(84–87.8)			
Sex of the child				0.339		
Men	726	86.9%	(84.2–89.2)		1	—
Women	680	85%	(82–87.6)		1	(0.7–1.6)
Age of the child				0.810		
Less than 1 year old	368	86.1%	(82.1–89.4)		1	—
Between 1 and 2 years old	984	85.8%	(83.4–87.9)		1.3	(0.8–2)
More than 2 years old	54	88.9%	(76.7–95.4)		4.1	(0.8–74)
Brothers or sisters				0.633		
No	539	86.6%	(83.4–89.3)		1	—
Yes	867	85.6%	(83–87.8)		0.8	(0.5–1.3)
Smoking status ^b				<0.001		
Smokers	252	81.3%	(75.9–85.8)		1	—
Former smokers	480	82.9%	(79.2–86.1)		1.1	(0.6–1.8)
Never smokers	666	90.4%	(87.8–92.5)		2.6	(1.4–4.8)
Educational level ^b				0.190		
Primary or less	109	81.6%	(72.8–88.2)		1	—
Secondary	378	82.4%	(80.2–87.8)		0.7	(0.3–1.6)
University	896	87%	(84.6–89.1)		0.8	(0.3–1.8)
Relationship with the child ^b				0.091		
Mother	1326	86.3%	(84.4–88.1)		1	—
Father	72	81.9%	(70.7–89.7)		0.6	(0.3–1.3)
Other	8	62.5%	(25.9–89.8)		—	—
Age ^b				0.220		
Less than 25 years old	45	86.7%	(72.5–94.4)		1	—
Between 25 and 35 years old	720	87.2%	(84.5–89.5)		1	(0.2–3.2)
More than 35 years old	523	83.7%	(80.2–86.7)		1.1	(0.2–3.4)
Knowing THS previously to the survey				<0.001		
No	1014	83.4%	(81–85.6)		1	—
Yes	379	93.9%	(90.9–96)		2.1	(1.2;3.8)

CI confidence intervals, OR odds ratio

^aAdjusted for sex, age, smoking status, and level of education of the respondent

^bInformation of the respondent of the survey

smoking behavior of parents or caregivers of children who come to the emergency room or are hospitalized for respiratory illnesses.^{23,24} Both studies show that a greater knowledge of THS increases the smoking ban in houses and cars.^{23,24} In our study, explaining the definition of THS could be interpreted as a population educational message although it was not the objective of the study. Moreover, the design of our study is not adequate to evaluate a brief educational intervention from the point of view of public health.

In 2011, the Law 42/2010 that prohibits the tobacco consumption in bars, restaurants, and some outdoor spaces such as around hospitals or schools,²⁹ came into force in Spain. With the support

of the antismoking legislation, a greater social awareness of the effects of exposure to tobacco smoke has been created, with almost an 83% of households having any type of prohibition on tobacco consumption.³⁰ In recent years, smoke-free multiunit housing, completely smoke-free buildings, including both private and common areas, has proliferated in the United States and several European countries^{31–33} but in Spain, there are not yet specific policies.

The most important limitations of our study are those derived from the use of an online survey that it could create an information bias, although being an online survey and not having an interviewer present, the unacceptability bias would be lower.³⁴ Although the main topic of the survey was about sleep habits in children, we do not believe that this has influenced our results.

The fact that in the survey written information about THS was given followed by a question about the belief of the harmful effect of THS could have overestimated the perception of harmful effects of THS exposure. However, we believe that this overestimation is minimal because the parents who did not know the term THS had a lower perception of the harmful effects than parents who knew THS (83% vs. 94%, Table 3). Moreover, our sample may not be representative of the general population of our country due to the voluntary involvement of participants, and the dissemination was carried out in the general pediatric consultation of only one hospital, although also most of the samples through Internet and mobile recruitment. We have compared the characteristics of respondents with the latest data of 2017 published by the National Institute of Statistics in Spain (INE) to test the representativeness of the sample, finding certain limitations of our sample.³⁵ First, 94% of the respondents were mothers, so our data are not representative of the attitudes and beliefs of fathers about THS. However, the average age of the mothers is similar to the INE Spanish average. Second, children under 1 year are less represented (26%) in our sample than the average of Spain; otherwise, the percentage of siblings (62%) was higher than in the Spanish population. Finally, in our sample, smokers are underrepresented and parents with university studies are overrepresented compared to the INE Spanish data. For this reason, the result of our study could be some bias to infer to fathers.

Our study shows that current knowledge about THS is scarce. After reporting what THS is, a broad majority of parents believe that THS is harmful to their children's health. Due to the fact that the pediatric population may be more vulnerable to THS exposure,^{18,20} information about THS effects should be promoted and facilitate the implementation of smoke-free environments in private settings (cars and vehicles) to reduce the exposure to SHS and THS.

ADDITIONAL INFORMATION

The online version of this article (<https://doi.org/10.1038/s41390-018-0153-2>) contains supplementary material, which is available to authorized users.

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