



ORIGINAL ARTICLE

## Children's exposure to second hand smoke at home: A cross-sectional study in Portugal



Paulo D. Vitória<sup>a,b,\*</sup>, José Cunha Machado<sup>c</sup>, Ana Carolina Araújo<sup>d</sup>, Sofia B. Ravara<sup>e,f</sup>,  
Catarina Samorinha<sup>g</sup>, Henedina Antunes<sup>h</sup>, Manuel Rosas<sup>i</sup>, Elisardo Becoña<sup>j</sup>,  
José Precioso<sup>d</sup>

<sup>a</sup> Faculdade de Ciências da Saúde, Universidade da Beira Interior, Covilhã, Portugal

<sup>b</sup> CIS-IUL, Instituto Universitário de Lisboa (ISCTE-IUL), Av. Das Forças Armadas, Lisboa, Portugal

<sup>c</sup> Instituto de Ciências Sociais, Universidade do Minho, Campus de Gualtar, Braga, Portugal

<sup>d</sup> Instituto de Educação, Universidade do Minho, Campus de Gualtar, Braga, Portugal

<sup>e</sup> Centro de Investigação de Ciências da Saúde, Faculdade de Ciências da Saúde, Universidade da Beira Interior, Covilhã, Portugal

<sup>f</sup> Centro Hospitalar da Cova da Beira, Unidade de Cessação Tabágica, Covilhã, Portugal

<sup>g</sup> Instituto de Saúde Pública, Universidade do Porto, R. Das Taipas, 135, Porto, Portugal

<sup>h</sup> Serviço de Pediatria, Hospital de Braga, Instituto de Investigação em Ciências da Vida e da Saúde (ICVS), Escola de Ciências da Saúde, Universidade do Minho e ICVS/3B's – Laboratório Associado, Braga/Guimarães, Campus de Gualtar, Braga, Portugal

<sup>i</sup> Divisão da Promoção da Saúde, Câmara Municipal de Viana do Castelo, Passeio das Mordomas da Romaria, Viana do Castelo, Portugal

<sup>j</sup> Unidade de Tabaquismo, Faculdade de Psicologia, Universidade de Santiago de Compostela, Campus Vida, Santiago de Compostela, Spain

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**Abstract** Second-hand tobacco smoke (SHS) is a major indoor pollutant that causes serious health problems for all exposed, especially children. Children are often exposed to SHS at home, due to parental or other households' or guests' smoking. This study describes Portuguese children's exposure to SHS at home (total and by Portuguese main regions).

In 2010/2011, a questionnaire was applied to a sample of Portuguese children in the 4th grade ( $N=3187$ , mean age  $9.05 \pm 0.7$  years, 51.1% male). Descriptive analysis, chi-square tests and crude odds ratios were performed.

Of the participants, 62.9% of those with smoking parents and 19.2% of those with non-smoking parents were exposed to SHS at their home. Parental smoking varied significantly among regions and was significantly associated with children's exposure to SHS at home.

Children's exposure to SHS at home was high, especially if their parents smoke. Children living in Lisbon Region presented the highest SHS exposure rate. The association of SHS exposure with geographic regions suggests the influence of social and contextual factors on smoking behaviour

\* Corresponding author.

E-mail address: [pvitoria@fcsaude.ubi.pt](mailto:pvitoria@fcsaude.ubi.pt) (P.D. Vitória).

and on tobacco control effectiveness. Our findings highlight the need to effectively prevent children's SHS exposure at their home and to develop tailored tobacco control measures by region.

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## Introduction

Second-hand smoke (SHS) is the smoke released into the environment mainly by burning cigarette tobacco. It is composed of a complex mixture of thousands of gases and micro-particles, including nicotine and several carcinogens, toxic and irritating substances. In 1992, the U.S. Environmental Protection Agency (EPA)<sup>1</sup> declared SHS as a group A amongst human carcinogens, concluding that there is no safe limit to this exposure. In 2000, the World Health Organization (WHO) European Office published the indoor air quality guidelines also concluding that it is not possible to define a safe limit for SHS exposure.<sup>2</sup>

Exposure to SHS causes lung cancer and cardiovascular diseases and has a particularly negative impact on pregnancy and on children's health, namely, causing reduced intrauterine growth, spontaneous abortion, preterm birth, low birth weight, sudden death syndrome, ear problems, and respiratory diseases.<sup>2,3,4</sup>

Children are particularly vulnerable to SHS since they have a less developed airways system and a still immature immune system.<sup>5,6,7</sup> Prevalence of chronic respiratory symptoms, such as cough, wheezing and dyspnoea, is higher among children exposed to SHS.<sup>4,7,8</sup> These children have also a greater risk of lower respiratory tract infections (pneumonia and bronchiolitis), asthma attacks, and recurrent otitis media.<sup>4,5,8,9</sup>

Children's exposure to SHS is quite often the result of the tobacco smoked by their parents at home and/or from permissiveness towards the smoking behaviour of others indoors.<sup>10</sup> Another important risk of this parental behaviour is the proven influence on the likelihood of children becoming smokers in the future.<sup>11,12</sup>

Despite these consequences, the WHO estimates that worldwide about half of the children (700 million) are exposed to SHS, mainly in their own homes.<sup>9,13</sup> Two Portuguese studies revealed that 38% and 41% of the children were daily or occasionally exposed to SHS caused by their parents' smoke.<sup>14-16</sup>

To better prevent children's exposure to SHS we need more information about the parents, other cohabitants and houseguests smoking habits. This study describes smoking habits in Portugal and children's exposure to SHS at home. It was carried out by region to get a more detailed view of the situation and to support decisions on prevention of this risk for children's health.

## Material and methods

### Study design and sampling procedure

This is a cross-sectional study conducted in the school year of 2010/2011 based on a self-administered questionnaire filled

in by 3187 Portuguese children in the 4th grade (mean age  $9.05 \pm 0.7$  years; 51.1% male).

Convenience and random sampling methods were combined to select the participants of this study. Nine municipalities (Angra do Heroísmo, Braga, Covilhã, Évora, Faro, Funchal, Lisboa, Porto, Viana do Castelo) representing the seven main regions of Portugal (NUTs II: Azores, Alentejo, Algarve, Centre, Lisbon, Madeira and North) were chosen for the sake of convenience. Considering the number of 4th grade students from the nine municipalities as a total population, and estimating that each class has 20 students, a proportional number of classes per each municipality were randomly chosen to participate in the study. The students' response rate per municipality was between 69.2% (Funchal) and 91.9% (Angra do Heroísmo) with an average of 77.5%.

### Questionnaire

The questionnaire that was used had been developed and validated for this study. It contained multiple choice questions and four open-ended questions to measure the following variables:

Socio-demographic variables: Age, Sex, Fathers' and Mothers' Education level and Socio-economic level.

Children's exposure to SHS at home: Smoker family members ('does not smoke', 'yes, sometimes', 'yes, every day' or 'I don't know/I do not have any'), Family members and visitors' permission to smoke at home ('does not smoke', 'yes, every day', 'yes, sometimes' and 'does not smoke at home' or 'I don't know/I do not have any/does not live in my house') and rules concerning smoking inside the house ('smoking is not allowed in any part of the house'; 'smoking is allowed in some parts/rooms of the house'; 'smoking is allowed in any parts/rooms of the house' and 'smoking is allowed only on special occasions').

### Procedure

The project and the questionnaire were approved by the Portuguese Ministry of Education. Once authorization was granted by the Governing Body of each School Group, head teachers were contacted and guidelines were given about obtaining parental or guardian authorization and about administration of the questionnaire. The questionnaires were administered according to a protocol in the classrooms by trained teachers or by members of the project team.

### Data analysis

The data gathered were analyzed through the statistical software IBM SPSS Statistics version 20 for Windows.

**Table 1** Socio-demographic characteristics, by total and region.

	Total (N=3187)		North (n=1356)		Centre (n=139)		Lisbon (n=949)		Alentejo (n=153)		Algarve (n=196)		Madeira (n=239)		Azores (n=155)		Chi-squared test	
	n	%	n	%	n	%	n	%	n	%	n	%	N	%	n	%	$\chi^2$	p
<b>Sex</b>																	16.584	<0.011
Male	1626	51.1	709	52.5	66	47.5	442	46.6	82	53.6	117	59.7	130	54.4	80	51.6		
Female	1555	48.9	642	47.5	73	52.5	506	53.4	71	46.4	79	40.3	109	45.6	75	48.4		
<b>Age</b>																		
8	24	0.8	6	0.5	–	–	16	1.7	–	–	1	0.5	–	–	1	0.6		
9	1824	58.3	935	70.6	75	54.0	489	52.4	74	48.7	101	53.4	106	44.5	44	28.6		
10	1081	34.5	356	26.9	60	43.2	345	36.9	64	42.1	76	40.2	107	45.0	73	47.4		
11	170	5.3	25	1.9	4	2.9	67	7.2	11	7.2	9	4.8	22	9.2	32	20.8		
12	27	0.9	3	0.2	–	–	12	1.3	3	2.0	2	1.1	3	1.3	4	2.6		
13	5	0.2	–	–	–	–	5	0.5	–	–	–	–	–	–	–	–		
Average (DP)	9.5 (0.7)	9.3 (0.5)	9.5 (0.6)	9.6 (0.8)	9.6 (0.7)	9.5 (0.6)	9.7 (0.7)	10.0 (0.8)										
<b>Father's education level</b>																	52.544	<0.001
≤9 years old	930	48.8	406	50.6	34	38.2	272	50.0	49	41.9	38	32.5	56	40.6	75	75.8		
>9 years old	977	51.2	397	49.4	55	61.8	272	50.0	68	58.1	79	67.5	82	59.4	24	24.2		
<b>Mother's education level</b>																	74.178	<0.001
≤9 years old	980	45.5	460	49.4	29	29.0	292	48.9	38	29.9	33	25.0	56	36.6	72	63.7		
>9 years old	1174	54.5	472	50.6	71	71.0	305	50.1	89	70.1	99	75.0	97	63.4	41	36.3		
<b>Graffard's Index (socio-economic level)</b>																	39.120	<0.001
Classes A and B	882	31.1	383	31.5	53	42.4	219	27.0	51	35.4	67	38.3	82	39.4	26	17.4		
Classes C and D	1950	68.9	835	68.5	72	57.6	593	73.0	93	64.6	108	61.7	126	60.6	123	82.6		

**Table 2** Prevalence of smokers among mothers, fathers, both parents and mother or father, by region and total.

Regions	Mother smokes				Father smokes				Both parents smoke				Mother or father smokes			
	n	%	OR (95% CI)	p	n	%	OR (95% CI)	p	n	%	OR (95% CI)	p	n	%	OR (95% CI)	p
North	308	23.3	1	–	535	41.2	1.11 (0.81–1.52)	0.521	198	14.8	1	–	645	48.1	1.07 (0.75–1.52)	<0.700
Centre	38	27.2	1.3 (0.9–1.9)	0.248	54	40.9	1.10 (0.70–1.73)	0.693	28	20.3	1.47 (0.95–2.29)	0.087	64	46.4	1	–
Lisbon	347	38.2	2.03 (1.7–2.4)	<0.001	427	48.4	1.48 (1.07–2.05)	0.017	226	24.1	1.84 (1.49–2.27)	<0.001	548	58.5	1.63 (1.14–2.34)	<0.007
Alentejo	42	28.2	1.3 (0.9–1.9)	0.187	65	44.5	1.27 (0.82–1.97)	0.286	26	17.0	1.18 (0.76–1.85)	0.465	81	52.9	1.30 (0.82–2.06)	0.264
Algarve	56	29.3	1.4 (1.0–1.9)	0.070	72	38.7	1	–	32	16.5	1.14 (0.76–1.72)	0.528	96	49.5	1.13 (0.73–1.75)	0.577
Madeira	69	29.5	1.4 (1.0–1.9)	0.043	95	42.4	1.17 (0.78–1.73)	0.448	41	17.3	1.21 (0.84–1.75)	0.316	123	51.9	1.25 (0.82–1.90)	0.303
Azores	45	29.6	1.4 (1.0–2.0)	0.086	68	47.2	1.42 (0.91–2.20)	0.121	32	20.9	1.53 (1.01–2.32)	0.047	81	52.9	1.30 (0.82–2.06)	0.264
$\chi^2$ (p)	57.70 (<0.001)		14.34 (=0.026)		34.06 (<0.001)			26.60 (<0.001)								
Total	905	29.3			1316	43.7			583	18.5			1638	52.0		

**Table 3** Prevalence of children's SHS exposure at home, considering family member smoking status, by region and total.

Regions	Family member	Total	Smokes daily at home		Smokes occasionally at home		Does not smoke or does not smoke at home		Chi-squared test		Logistic regression	
			n	%	n	%	n	%	$\chi^2$	p	OR (95% CI)	p
North	Only mother	1286	80	6.2	111	8.6	1095	85.1	63.59	<0.001	1.37 (0.80–2.36)	0.251
Centre		134	1	0.7	18	13.4	115	85.8			1.30 (0.64–2.65)	0.468
Lisbon		885	89	10.1	140	15.8	656	74.1			2.75 (1.60–4.72)	<0.001
Alentejo		142	6	4.2	10	7.0	126	88.7			1	-
Algarve		185	13	7.0	23	12.4	149	80.5			1.90 (1.01–3.59)	0.047
Madeira		229	11	4.8	18	7.9	200	87.3			1.14 (0.60–2.19)	0.689
Azores		148	12	8.1	17	11.5	119	80.4			1.92 (0.99–3.71)	0.053
North	Only father	1234	107	8.7	148	12.0	979	79.3	46.32	<0.001	1.64 (1.09–2.49)	0.019
Centre		129	8	6.2	23	17.8	98	76.0			2.00 (1.34–3.50)	0.016
Lisbon		833	103	12.4	147	17.6	583	70.0			2.71 (1.78–4.11)	<0.001
Alentejo		138	10	7.2	16	11.6	112	81.2			1.47 (0.82–2.61)	0.196
Algarve		175	14	8.0	23	13.1	138	78.9			1.69 (0.99–2.89)	0.054
Madeira		212	12	5.7	17	8.0	183	86.3			1	-
Azores		136	16	11.8	26	19.1	94	69.1			2.82 (1.65–4.81)	<0.001
North	Mother and/or Father	1326	154	11.6	193	14.6	979	73.8	56.66	<0.001	1.47 (1.04–2.09)	0.029
Centre		136	9	6.6	28	20.6	99	72.8			1.55 (0.94–2.56)	0.083
Lisbon		922	151	16.4	197	21.4	574	60.5			2.52 (1.77–3.58)	<0.001
Alentejo		150	13	8.7	21	14.0	116	77.3			1.22 (0.74–2.01)	0.441
Algarve		188	24	12.8	30	16.0	134	71.3			1.68 (1.06–2.64)	0.026
Madeira		232	19	8.2	26	11.2	187	80.6			1	-
Azores		150	20	13.3	29	19.3	101	67.3			2.02 (1.26–3.23)	0.002
North	Guests	1337	180	13.5	212	15.9	945	70.7	68.61	<0.001	1.49 (1.07–2.07)	0.019
Centre		137	10	7.3	29	21.2	98	71.5			1.43 (0.88–2.32)	0.149
Lisbon		931	169	18.2	220	23.6	542	58.2			2.58 (1.84–3.61)	<0.001
Alentejo		151	14	9.3	23	15.2	114	75.5			1.17 (0.72–1.89)	0.537
Algarve		189	29	15.3	29	15.3	131	69.3			1.59 (1.02–2.46)	0.038
Madeira		234	24	10.3	27	11.5	183	78.2			1	-
Azores		150	21	14.0	33	22.0	96	64.0			2.02 (1.28–3.18)	0.003
Total	Mother	3009	212	7.0	337	11.2	2460	81.8				
	Father	2857	270	9.5	400	14.0	2187	76.5				
	Mother and/or father	3104	390	12.6	524	16.9	2190	70.6				
	Guests	3129	447	14.3	573	18.3	2109	67.4				

**Table 4** Prevalence of children's SHS exposure at home, comparing cases with non smoking parents and cases with smoking parents, by region and total.

Regions	Parents smoking behaviour	Total	There's SHS at home (regularly or occasionally)		There's no SHS at home		Chi-squared test	
			n	%	n	%	$\chi^2$	p
North	Parents are no-smokers	667	128	19.2	539	80.8	246.6	<0.001
	One or both parents smoke(s)	645	399	61.9	246	38.1		
Centre	Parents are no-smokers	71	11	15.5	60	84.5	31.5	<0.001
	One or both parents smoke(s)	64	41	64.1	23	35.9		
Lisbon	Parents are no-smokers	363	77	21.2	286	78.8	202.0	<0.001
	One or both parents smoke(s)	548	381	69.5	167	30.5		
Alentejo	Parents are no-smokers	68	11	16.2	57	83.8	17.8	<0.001
	One or both parents smoke(s)	81	41	50.6	40	49.4		
Algarve	Parents are no-smokers	95	13	13.7	82	86.3	44.4	<0.001
	One or both parents smoke(s)	96	59	61.5	37	38.5		
Madeira	Parents are no-smokers	106	21	19.8	85	80.2	16.7	<0.001
	One or both parents smoke(s)	123	57	46.3	66	53.7		
Azores	Parents are no-smokers	66	14	21.2	52	78.8	26.9	<0.001
	One or both parents smoke(s)	81	53	65.4	28	34.6		
Total	Parents are no-smokers	1436	275	19.2	1161	80.8	598.8	<0.001
	One or both parents smoke(s)	1638	1031	62.9	607	37.1		

Frequencies, contingency tables, chi-squared tests and logistic regressions were used to perform the data analysis. Bi-variable analyses were conducted using chi-square to compare categorical variables and crude odds ratios (ORs) when appropriate. A two-sided *p* value less than 0.05 was considered statistically significant.

## Results

Participant socio-demographic characteristics and their distribution throughout the Portuguese regions (NUTs II) are presented in [Table 1](#). Fathers' education level was inferior or equal to the 9th grade in 48.8% of the cases. Mothers' education level was inferior or equal to the 9th grade in 45.5% of the cases. In terms of socioeconomic level, 68.9% of the cases were classified in the lowest level (classes C and D) and the remaining in the classes A and B. Observed differences according to sex, fathers' and mothers' education level and socioeconomic level by Portuguese regions were statistically significant.

More than half (52.0%) of the children had at least one smoking mother or father ([Table 2](#)), consequently, these children were potentially exposed to SHS in their own homes. The differences between the various regions regarding the prevalence of a smoking mother or father were statistically significant ( $\chi^2 = 26.6$ ;  $p < 0.001$ ) and vary from 46.4% in the Centre Region to 58.5% in the Lisbon Region (OR = 1.6;  $p = 0.007$ ).

In this sample, 43.7% of the fathers and 29.3% of the mothers were smokers. The prevalence of smoking fathers

differs by region ( $\chi^2 = 24.3$ ;  $p = 0.026$ ) from 38.7% in Algarve to 48.4% in Lisbon. Also among mothers, the smoking prevalence varies significantly by region, from 23.3% in the North to 38.2% in Lisbon ( $\chi^2 = 57.7$ ;  $p < 0.001$ ).

Among the participants, 18.5% both parents were smokers. The differences between regions in this category were statistically significant ( $\chi^2 = 34.1$ ;  $p < 0.001$ ) and vary between 14.8% in the North to 24.1% in Lisbon.

Children's exposure to SHS at home is presented in [Table 3](#). In the total sample, 29.5% of the participants claimed they were exposed to SHS caused by a smoking parent—mother and/or father (16.9% occasionally and 12.6% on a daily basis). The exposure to the fathers' smoke (23.5% in total and 30.0% in Lisbon) is more common than the exposure to the mothers' smoke (18.2% in total and 25.9% in Lisbon). A smoking guest was the most frequent cause of children's exposure to SHS and affected around a third of the participants (32.6%, 18.3% occasionally and 14.3% daily).

Comparing children with non-smoking parents and with smoking parents ([Table 4](#)), we found great differences in the prevalence of children's exposure to SHS at home. These differences are statistically significant in the total sample and in all regions considered. For instance, in relation to the total sample, of the children with non-smoking parents, 19.2% were exposed to SHS at home, whereas of the children with smoking parents, the prevalence rate of those exposed was 63.3% ( $\chi^2 = 598.8$ ;  $p < 0.001$ ). On the other hand, in the subgroup with smoking parents, 37.1% of the participants declared that they were not exposed to SHS at home.

## Discussion and conclusions

This study aims to describe children's exposure to SHS at home based on a sample of Portuguese children attending the 4th school grade. The study presents data from the total sample and from the main Portuguese administrative regions (NUTs II): Alentejo, Algarve, Azores, Centre, Lisbon, Madeira and North. The SHS at home is caused by the smoking of parents, other family members and guests.

In this sample, 43.7% of the fathers and 29.3% of the mothers were smokers. Comparing this with the prevalence for the group 35–44 years old obtained in the latest National Health Survey, the results of this study are similar for men (43.7% and 44.6%) and are substantially higher for women (29.3% and 20.9%).<sup>17</sup>

More than half of the participants had a smoking parent (mother or father) and for almost a fifth both parents smoked, thus increasing the risk of exposure to SHS and the severity of this exposure. These data were substantially different within the various regions studied, thus reinforcing the hypothesis that people's social context is an important determinant of parents smoking behaviour and of children's exposure to SHS at home.

A guest who smokes is the most common cause for children's exposure to SHS at home, suggesting that rules concerning smoking at home are more easily ignored when the family has visitors. Children's exposure to SHS at home due to the smoking of their parents (mother, father or both) is also common, including 30% of the study participants. Children's exposure to SHS resulting from the smoking of the father is slightly higher than that resulting from the smoking of the mother, but the percentage of smoking mothers who smoke at home was higher than the one of smoking fathers. These results put even more stress on the risks of female smoking and the need for more information and more awareness campaigns on this issue targeted to women.

The results show that a substantial proportion of smoking parents do not smoke at home. This is an important finding, confirming that it is possible to be a smoker and, yet, partially protect children and the family house from SHS – only partially since smokers pollute their house even when they do not smoke there because they carry toxic tobacco substances on their clothes and body (third-hand smoke).<sup>13</sup>

Of the parents who smoke at home, the majority smoke only occasionally, which might be seen as a sign that they are aware of the risks and that they are actively trying to avoid them. Investing in increasing the awareness of the smoking parents about the SHS risks may expand this home-protecting behaviour.

Comparing the subgroups with smoking and non-smoking parents, we found great differences in children's exposure to SHS. On the one hand, even in cases with non-smoking parents about a fifth of the children was exposed to SHS at home and, on the other hand, in cases with smoking parents more than a third seems to be protected from SHS exposure at home. These results confirm the need to raise awareness about this risk among general population and to insist on measures to prevent it.

The analysis by region reveals both significant and coherent differences. Lisbon has the highest prevalence of children exposed to SHS at home. In relation to the National Health Survey, Lisbon is also the Portuguese region with the

highest prevalence of women who smoke.<sup>17</sup> Lisbon is the main region of Portugal, so, these results may work as a negative forecast, suggesting that the Portuguese situation may worsen in the coming years.

This study has some limitations. First of all, the sample only includes children attending the 4th school grade, which is an important limitation to take into account. The sample size is quite small in some regions and the sampling method is limited, which means that the sample is not always totally representative at regional and at national levels. The data gathering was based on children's self-report without a biological validation, which is another limitation of the study: these limitations are the result of budgetary restrictions. Despite these limitations, this is the first study performed in Portugal with a large sample of the population attending the 4th school grade which includes participants from all of the seven main regions of Portugal, thus allowing a good description of the situation regarding Portuguese children's exposure to SHS at home.

To conclude, Portuguese children's exposure to SHS was high, especially when their parents smoke. SHS exposure association with geographic regions suggests the influence of social and contextual factors on smoking behaviour and on tobacco control. Our findings highlight the need of effective prevention measures to avoid children's SHS exposure at home and to promote a more equitable society.

## Ethical disclosures

**Protection of human and animal subjects.** The authors declare that no experiments were performed on humans or animals for this study.

**Confidentiality of data.** The authors declare that no patient data appear in this article.

**Right to privacy and informed consent.** The authors declare that no patient data appear in this article.

## Conflicts of interest

The authors have no conflicts of interest to declare.

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