CSP CADERNOS DE SAÚDE PÚBLICA
REPORTS IN PUBLIC HEALTH

ARTIGO
ARTICLE

"Tobacco denormalization at home": the contribution of the smoking ban in enclosed workplaces in Brazil

"Desnormalização do uso de tabaco em casa": a contribuição da proibição de fumar em ambientes fechados de trabalho no Brasil

"Desnormalización del tabaco en casa": contribución de la prohibición de fumar en lugares de trabajo cerrados en Brasil

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doi: 10.1590/0102-311X00107421

Abstract

Estimates suggest that exposure to environmental tobacco smoke is related to 1.2 million deaths per year worldwide. Synergy between various anti-smoking legislative and educational measures is essential to stimulate cessation and prevent initiation. This article aimed to explore how legislative protection from exposure to environmental tobacco smoke in enclosed workplaces in Brazil, whose strengthening occurred in a phased manner between 1996 and 2014, possibly contributed to the protection from passive smoking at home. We evaluated, via generalized linear models, the absolute and relative differences in the proportion of individuals living in smoke-free homes between those exposed and not exposed to passive smoking in enclosed workplaces, both crude and adjusted by sociodemographic and smoking behavior variables, and stratified by non-smokers and smokers. Data from three national surveys conducted in 2008, 2013, and 2019 were used. Regardless of smoking status and year when the data were analyzed, individuals who were employed in smoke-free workplaces were more likely to live in smoke-free homes than smokers who were employed in workplaces that allowed smoking. Adjusted absolute difference increased from +5.5% in 2008 to +10.5% in 2013 among non-smokers, and from +7.1% in 2013 to 15.6% in 2019 among smokers (p-values for additive interaction ≤ 0.05). Strengthening the Brazilian smoke-free legislation was likely associated with a reduction in passive smoking at home, which, therefore, may also reduce the burden of mortality, morbidity, and costs for society related to smoking.

Smoke-Free Policy; Tobacco Smoke Pollution; Tobacco Use; Workplace

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Introduction

The tobacco epidemic is a huge catastrophe in the modern world, having contributed to 100 million deaths in the 20th century. Currently, estimates suggest that more than eight million people die each year due to the harmful health effects of tobacco use [1], and environmental exposure to tobacco smoke is related to 1.2 million deaths per year, of which about 60,000 of its victims are children under 10 years of age [2]. In Brazil, estimates suggest that approximately 157,000 people die annually from smoking, including 18,000 deaths due to passive smoking and perinatal diseases (passive smoking by the mother), such as low birth weight and sudden infant death syndrome [3].

Based on the latest report, published in 2021, by the World Health Organization (WHO) on the global tobacco epidemic, a more comprehensive law covers only 24% of the world population, protecting individuals from exposure to environmental tobacco smoke in enclosed public spaces, such as workplaces, public transportation, bars, and restaurants [4]. Smoke-free laws are part of a broader set of measures which are systematized in the first international public health treaty, the WHO Framework Convention on Tobacco Control (WHO-FCTC) [5], aimed at reducing the demand for and supply of tobacco products. Brazil ratified this treaty in 2005.

Brazil strengthened smoke-free legislation in a phased manner [6]. The national law of December 14, 2011 [7] for the comprehensive protection from exposure to environmental tobacco smoke in public closed places, which also covered public spaces partially closed by a wall, partition, ceiling or awning, was only regulated by the *Decree-Law n. 8,262/2014* [8]. Note that the 2011 law replaced the national law of July 15, 1996 [9], which intended, in its essence, to be very comprehensive and restrictive. However, the tobacco industry interfered with the approval/implementation of this law, allowing for so-called segregated smoking rooms, i.e., "spaces of harmonious coexistence" between smokers and non-smokers [10]. Thus, in practice, the Brazilian population continued to be exposed to environmental tobacco smoke [11]. This embarrassing situation, combined with the widespread disclosure of the guidelines of Article 8 of the WHO-FCTC, which claimed the absence of safe levels for exposure to secondhand smoke [5], have encouraged some states and municipalities to enact local laws which were more restrictive than the national law in force between 2008 and 2011 [12,13].

Since Brazil has put in place a comprehensive system for monitoring the tobacco epidemic, consisting of inserting a series of questions about smoking behavior in national periodic surveys conducted with both young and adult populations [14,15,16], it is possible to evaluate the effectiveness of the implementation of anti-smoking legislation over time [17,18]. For example, a recent study estimated that an additional 15,000 children under the age of one year would have died between 2000 and 2016 if Brazil had failed to implement some level of protection from environmental tobacco smoke in this period [6]. However, if the comprehensive smoke-free law regulated in 2014 had come into effect since 1996, another 10,000 children could have been saved. Likewise, another study analyzed the impact of various legislative measures in effect between 1989 and 2010 on the number of deaths that the Brazilian adult population will avoid between 1989 and 2050, and found that the smoke-free law will prevent about 1.2 million deaths [17]. However, if the smoke-free legislation had been more restrictive since 2010, around 270,000 additional deaths would have been avoided between 2011 and 2050. In the same line of reasoning, another study based on the current comprehensive smoke-free legislation in Brazil [8] estimated that, between 2017 and 2027, the country will avoid 80,500 deaths and save BRL 19.2 million [19].

Synergy between various anti-smoking legislative and educational measures is essential to stimulate cessation and prevent initiation, thus decreasing the number of smokers in the population [6,17,18] and, consequently, reducing treatment costs and productivity losses associated with smoking [3]. Moreover, these measures also contribute to reducing the social acceptance of smoking, i.e., "tobacco denormalization" [20]. In Brazil, recent studies have indicated an increase, between 2008 and 2019, in the proportion of individuals living in smoke-free homes [11,14,15,16], a private space lacking legislative restriction on smoking. And there is a vast international literature showing that individuals who were employed in smoke-free workplaces were also more likely to live in smoke-free homes [21,22,23,24,25]. Thus, these findings do not support the concern that, in places in which smoke-free laws were enacted, smokers who continued smoking would have compensated for the restriction by consuming more cigarettes in their homes [21,22,23,24,25,26].

This article aimed to explore, based on data from serial cross-sectional surveys [14,15,16] with both smokers and non-smokers, the possible relation between being employed in smoke-free workplaces, which the law regulated, and living in smoke-free homes ("workplace-home tobacco denormalization"). As far as the authors know, no study has analyzed the evolution over time of the relation between these "two ways of protection", stratified by individuals' smoking status.

Methodology

Sociodemographic and smoking behavior data from the *Special Tobacco Survey* (PETab) [14], conducted in 2008 as a supplement to the *Brazilian National Household Sample Survey* (PNAD), were used in addition to data from the *Brazilian National Health Survey* (PNS) conducted in 2013 [15] and 2019 [16]. These surveys had questions taken from a global standard questionnaire for the consistent monitoring of tobacco use [4], in accordance with article 20 of the WHO-FCTC [5], which encourages countries to progressively establish a national system for the epidemiological surveillance of tobacco consumption and track the evolution of the tobacco epidemic. These surveys were conducted by the Brazilian Institute of Geography and Statistics (IBGE) via a complex probabilistic sample with four selection stages (municipalities, census tracts, households, and individuals) to represent the Brazilian population aged 15 or older (PETab and PNS 2019) or 18 years or older (PNS 2013). Further details on the survey methodologies can be found elsewhere [14,15,16].

The following question defined non-exposure to environmental tobacco smoke at home in 2013 and 2019: "How often does someone smoke inside your home?", to be answered as "never" (vs. "daily", "weekly", "monthly", or "less than monthly"), grouped to obtain the dichotomous variable ("yes" vs. "no") of non-exposure to passive smoking at home (i.e., "living in a smoke-free home"). The PETab had not only the same question but also another one about smoking rules in homes. Individuals who answered "smoking is never allowed inside my home" (vs. "smoking is allowed", "smoking is generally not allowed, but there are exceptions," or "there is no rule") were automatically classified as living in smoke-free homes.

The dichotomous variable ("yes" vs. "no") of no exposure to passive smoking in enclosed workplaces in the last month (i.e., "being employed in a smoke-free workplace") was obtained, in 2013 and 2019, from a question that was part of a section about work characteristics, as follows: "Thinking about all your jobs, during the last 30 days, did anyone smoke in indoor areas where you work?" Before answering this question, informants had to answer, considering all their jobs in the reference week of the survey, whether some of them were usually performed in enclosed or partially enclosed areas. In the PETab, the question about employment in smoke-free workplaces was already part of the tobacco survey and adhered to the following scheme: "Do you currently work outside of your home?" If so, "Usually, do you work indoors, outdoors or both?", in which the "outdoors" answer option preceded the following question "Are there any indoors areas at your workplace?" Then, individuals who reported working in enclosed spaces (usually or unusually) were asked the following question: "During the past 30 days, did anyone smoke in any indoor area where you work?"

Our analysis was restricted to individuals aged 18 or over who worked indoors in the month prior to the survey. Sociodemographic and smoking behavior variables, widely described in the literature as related to both passive smoking at home and at work [21,22,23,24,25], were used in the analyses as categorical variables, as follows: (1) age was stratified into "18 to 24 years" or "25 years or older"; (2) sex was categorized as "male" or "female"; (3) educational attainment was grouped into "incomplete elementary school" or "complete elementary school or higher" [16,18,27,28,29]; (4) area of residence was categorized as "rural" or "urban"; (5) household population density was estimated as the total number of residents in the household divided by the total number of rooms, in which the cut-off point for the dichotomous variable was the average value obtained for the three surveys; (6) individuals' residence region was divided into "North", "Northeast", "Central-West", "Southeast", or "South"; (7) degree of nicotine dependence among daily smokers was categorized according to the Heaviness of Smoking Index [30] ("very low/low/moderate" vs. "high/very high"); and (7) users of illicit cigarettes were categorized as "yes" or "no". To establish a boundary between both licit and illicit cigarette consumption among adult smokers, a threshold price was defined based on the amount paid per pack in smokers'

last purchase (2008 or 2013 surveys) [27], or information on the self-reported brand last purchased (2019 survey) and the Brazilian Health Regulatory Agency (ANVISA) list of legal brands [28] were used.

All analyses were stratified by non-smokers and current smokers, considering that individuals' smoking status and the proportions of individuals living in smoke-free homes can provide different information about the impact of the "workplace-home tobacco denormalization" on the Brazilian society. For example, as smokers tend to live with other smokers at home [31,32], assessing non-exposure to passive smoking at home among smokers who continued smoking (or have started smoking) gives us an indication of their future willingness to follow anti-smoking laws and, therefore, to quit smoking [29]. Evaluating non-exposure to secondhand smoke at home among current non-smokers may be particularly influenced by the decline in smoking prevalence, especially if ex-smokers, who are also current non-smokers, are those who were doubly "pressured" by the law to refrain from smoking in enclosed workplaces and by greater restrictions at their own homes, imposed by non-smoking family members.

Initially, we estimated the proportion of individuals living in smoke-free homes by the sociodemographic and smoking behavior variables described previously for 2008, 2013, and 2019, both among smokers and non-smokers. We also estimated the proportion of individuals who reported employment in smoke-free workplaces by year of the survey and smoking status. Differences in these proportions between the categories of selected variables for each year, and over time (2013 vs. 2008 or 2019 vs. 2013) for each category, were assessed by Pearson's chi-squared test with a significance level set at 5%. Subsequently, as the outcome variable was dichotomous, a generalized linear model with binomial distribution and an identity link function was used to estimate, for each year of analysis, crude and adjusted absolute differences in non-exposure to passive smoking at home between those exposed and not exposed to passive smoking in enclosed workplaces (obtained directly from the regression coefficient of the model) [33,34], stratified by smoking status. The logarithmic link function was also used to evaluate crude and adjusted relative differences (obtained from the exponential of the regression coefficient of the model – 1) [33,34]. Furthermore, due to the different implementation stages of the smoke-free legislation in Brazil [6,13], the interaction terms "smoke-free workplace (reference category "no") × year of the survey (reference category "year 2013")" were initially added to the models to assess whether differences in the proportion of individuals living in smoke-free homes by the "status of protection" from passive smoking in enclosed workplaces were homogeneous by year of the survey. The interaction terms were kept in the final adjusted models, if statistically significant at p-value ≤ 0.05.

All analyses were performed using the Stata version 15.0 (https://www.stata.com) due to the complex sample design of the surveys.

Results

Table 1 shows that the proportion of individuals who reported living in smoke-free homes increased over time among non-smokers who worked indoors (p-values ≤ 0.05 in Pearson's chi-squared tests). Regardless of year when the data were analyzed, individuals over 25 years of age, with higher educational attainment, from less crowded households or who were urban residents were less exposed to tobacco smoke at home than their counterparts.

Among smokers who worked in enclosed spaces (Table 2), we also found an increase over time in the proportion of individuals who reported living in smoke-free homes (p-values ≤ 0.05 in Pearson's chi-squared tests). For each year of analysis, this proportion was lower than that among nonsmokers (Tables 1 and 2). Male smokers or individuals with complete elementary education or higher were those least exposed in 2008 and 2019. Note the increase in the proportion of individuals not exposed to passive smoking at home among smokers aged 18 to 24 years or from more crowded households between 2013 and 2019. Heavier (more addicted) smokers or those who consumed illicit cigarettes were more likely to be exposed to environmental tobacco smoke inside their homes than their counterparts in 2013 and 2019. Supplementary Material (http://cadernos.ensp.fiocruz.br/static//arquivo/suppl-e00107421_9002.pdf) shows the total number of individuals (non-smokers or smokers) living in smoke-free homes by sociodemographic characteristics in 2008, 2013, and 2019.

Table 1

Proportion of adult non-smokers who reported living in smoke-free homes among those who worked in enclosed spaces in the last 30 days *, by sociodemographic characteristics. Brazil, 2008, 2013, and 2019.

Sociodemographic characteristic	Individuals living in smoke-free homes [% (95%CI)]		
	PETab 2008	PNS 2013	PNS 2019
Total	69.8 (68.6; 70.9) **	89.6 (88.8; 90.3) **	91.0 (90.4; 91.6) **
Gender			
Male	70.5 (69.0; 72.0) **	90.7 (89.6; 91.6) **,***	92.1 (90.4; 91.6) **,***
Female	69.0 (67.4; 70.5) **	88.6 (87.5; 89.6) **,***	90.1 (89.2; 90.8) **,***
Age (years)			
18-24	64.4 (61.6; 67.0) **,***	84.0 (81.5; 86.2) **,***	84.5 (81.5; 86.2) ***
25 or older	71.1 (69.9; 72.2) **,***	90.7 (89.9; 91.5) **,***	92.1 (91.5; 92.6) **,***
Educational attainment			
Incomplete elementary school	65.8 (63.6; 67.9) **,***	86.0 (84.2; 87.6) **,***	88.4 (87.0; 89.7) **,***
Complete elementary school or higher	71.1 (69.8; 72.3) **,***	90.5 (89.6; 91.3)**,***	91.5 (90.9; 92.2) **,***
Household population density #			
> 0.61	68.4 (66.6; 70.1) **,***	86.1 (84.5; 87.4) **,***	88.2 (86.8; 89.4) **,***
≤ 0.61	70.9 (69.6; 72.2) **,***	91.6 (90.7; 92.4) **,***	92.5 (91.9; 93.1) ***
Area of residence			
Rural	61.3 (56.5; 65.8) **,***	86.2 (83.0; 88.8) **,***	88.7 (86.9; 90.3) ***
Urban	70.3 (69.2; 71.5) **,***	89.8 (88.9;90.5) **,***	91.2 (90.5; 91.8) **,***
Region of residence			
North ##	74.1 (71.0; 76.9) **,***	90.8 (88.5; 92.7) **	92.4 (91.1; 93.5) ***
Northeast	68.8 (66.3; 71.2) **,***	88.7 (87.1; 90.1) **	90.8 (90.0; 91.7) **,***
Central-West	70.2 (66.9; 73.2) **	89.4 (87.7; 90.9) **	91.5 (90.1; 92.8) **
Southeast	69.7 (67.9; 71.4) **,***	90.1 (88.7; 91.3) **	90.6 (89.5; 91.6) ***
South	69.4 (66.9; 71.8) **,***	88.9 (86.9; 90.6) **	91.7 (90.4; 92.9) **

95%CI: 95% confidence interval; PETab: *Special Tobacco Survey*; PNS: *Brazilian National Health Survey*.

* Represents 41.5%, 45% and 46.2% of non-smokers in 2008, 2013, and 2019 respectively;

** p-value ≤ 0.05 when comparing the proportion of individuals who reported living in smoke-free homes between 2008 and 2013 (or between 2013 and 2019) for each category of the selected variable;

*** p-value ≤ 0.05 when comparing the proportion of individuals who reported living in smoke-free homes between the categories of the variable for each year;

Total number of residents divided by the total number of rooms, in which the cut-off point for the dichotomous variable was the average value obtained for the three surveys;

Reference category for individuals' residence region.

The proportion of non-smokers employed in smoke-free workplaces increased over time (between 2008 and 2019), and, among smokers, we only observed this increase between 2013 and 2019 (p-values ≤ 0.05 in Pearson's chi-squared tests) (Table 3).

Table 4 shows that, regardless of smoking status and year when the data were analyzed, individuals who were employed in smoke-free workplaces were more likely to live in smoke-free homes than those who were employed in workplaces that allowed smoking (e.g., crude absolute and relative differences, respectively, statistically significant at p ≤ 0.05. Non-smokers: 2008, +5.6% and +8.5%; 2013, +11.3% and +14.1%; 2019, +12.3% and +15.5%; smokers: +10.2% and +36.6%; 2013, +10.4% and +30.1%; 2019, +17.7% and +51.6%). Among non-smokers, differences in the proportion of individuals living in smoke-free homes between those employed and not employed in smoke-free workplaces increased between 2008 and 2013 (crude [or adjusted] p-value of additive [or multiplicative] interaction ≤ 0.05). Among smokers, absolute differences in the proportion of non-exposure to environmental tobacco smoke at home between those employed in smoke-free workplaces and those employed in

Table 2

Proportion of adult smokers who reported living in smoke-free homes among those who worked in enclosed spaces in the last 30 days *, by sociodemographic and smoking behavior characteristics. Brazil, 2008, 2013, and 2019.

Selected characteristics	Individuals who reported living in smoke-free homes [% (95%CI)]		
	PETab 2008	PNS 2013	PNS 2019
Total	34.8 (32.5; 37.3) **	41.6 (38.6; 44.5) **	47.2 (44.4; 50.0) **
Gender			
Male	37.3 (34.3; 40.4) **,***	43.7 (39.7; 47.9) **	50.2 (46.5; 54.0) **,***
Female	30.7 (27.2; 34.5) **,***	38.3 (34.3; 42.4) **	43.0 (39.1; 47.0) ***
Age (years)			
18-24	37.8 (31.2; 44.9)	35.7 (27.2; 45.2) **	53.8 (44.2; 63.1) **
25 or older	34.4 (31.9; 36.9) **	42.4 (39.4; 45.5) **	46.2 (43.5; 49.0)
Educational attainment			
Incomplete elementary school	30.7 (27.4; 34.2) **,***	38.1 (33.7; 42.8) **	40.0 (35.6; 44.6) ***
Complete elementary school or higher	38.0 (34.8; 41.3) **,***	43.2 (39.5; 47.0) **	50.1 (46.8; 53.5) **,***
Household population density #			
> 0.61	36.3 (32.7; 40.0)	40.3 (35.9; 44.9) **	48.0 (43.1; 52.8) **
≤ 0.61	33.5 (30.4; 36.6) **	42.5 (38.7; 46.4) **	46.7 (43.5; 49.9)
Area of residence			
Rural	29.3 (21.4; 38.7) **	45.2 (36.9; 53.7) **	45.0 (34.7; 55.8)
Urban	35.2 (32.8; 37.7) **	41.3 (38.2; 44.5) **	47.3 (44.5; 50.2) **
Region of residence			
North ##	40.4 (32.6; 48.8) ***	48.3 (40.8; 56.0) ***	46.9 (40.1; 53.7)
Northeast	30.5 (25.8; 35.6) ***	35.7 (30.0; 41.9) **,***	45.0 (39.5; 50.7) **
Central-West	38.7 (33.0; 44.7)	42.0 (36.1; 48.3)	45.7 (39.8; 51.7)
Southeast	34.4 (30.7; 38.2) **	44.7 (40.0; 49.4) **	48.1 (43.5; 52.7)
South	37.0 (32.0; 42.3)	36.6 (30.6; 43.1) **,***	47.2 (42.3; 52.1) **
Level of nicotine dependence ###			
Low/Moderate	34.5 (31.7; 37.5) **,***	43.2 (39.5; 47.0) **,***	46.8 (43.6; 50.0) ***
High	25.6 (20.5; 31.4) **,***	18.0 (13.5; 23.6) **,***	29.0 (23.3; 35.5) **,***
Consumption of illicit cigarettes §			
No	35.3 (32.5; 38.2) **	42.8 (39.3; 46.2) **,***	50.5 (47.2; 53.8) **,***
Yes	32.4 (25.6; 40.1)	34.1 (28.5; 40.3) ***	40.3 (34.8; 46.1) ***

95%CI: 95% confidence interval; PETab: *Special Tobacco Survey*; PNS: *Brazilian National Health Survey*.

* Represents 38.5%, 39.9% and 40.6% of smokers in 2008, 2013, and 2019 respectively;

** p-value ≤ 0.05 when comparing the proportion of individuals who reported living in smoke-free homes between 2008 and 2013 (or between 2013 and 2019) for each category of the selected variable;

*** p-value ≤ 0.05 when comparing the proportion of individuals who reported living in smoke-free homes between the categories of the variable for each year;

Total number of residents divided by the total number of rooms, in which the cut-off point for the dichotomous variable was the average value obtained for the three surveys;

Reference category for individuals' residence region;

Degree of nicotine dependence among daily smokers was categorized according to the Heaviness of Smoking Index ("very low/low/moderate" vs. "high/very high");

§ Illegal status was categorized according to the price paid for a pack of cigarettes on smokers' last purchase (2008 or 2013 surveys) or to the criterion of self-reported last brand purchased (2019 survey).

Table 3

Proportion of individuals who reported employment in smoke-free workplaces among those who worked in enclosed spaces in the last 30 days *, stratified by non-smokers and smokers. Brazil, 2008, 2013, and 2019.

Smoking status	Individuals employed in smoke-free workplaces [% (95%CI)]		
	PETab 2008	PNS 2013	PNS 2019
Non-smokers	76.4 (75.4; 77.4) **,***	86.6 (85.7; 87.4) **,***	91.6 (91.0; 92.2) **,***
Smokers	67.2 (64.8; 69.4) ***	65.7 (62.6; 68.6) **,***	71.8 (69.4; 74.1) **,***

95%CI: 95% confidence interval; PETab: *Special Tobacco Survey*; PNS: *Brazilian National Health Survey*.
* Represents 41.5%, 45% and 46.2% of non-smokers, and 38.5%, 39.9% and 40.6% of smokers, in 2008, 2013, and 2019 respectively;
** p-value ≤ 0.05 when comparing the proportion of individuals who reported employment in smoke-free workplaces between 2008 and 2013 (or between 2013 and 2019) for non-smokers (or smokers);
*** p-value ≤ 0.05 when comparing the proportion of individuals who reported employment in smoke-free workplaces between non-smokers and smokers for each year.

Table 4

Crude and adjusted differences in the proportion of individuals who reported living in a smoke-free homes between those exposed and not exposed to passive smoking in enclosed workplaces, by year of the survey and smoking status. Brazil 2008, 2013, and 2019.

Selected characteristics	Smoke-free home [% (95%CI)]	Absolute difference [% (95%CI)] *		Relative difference [% (95%CI)] *	
		Crude	Adjusted	Crude	Adjusted
Non-smokers					
PETab 2008/Smoke-free workplace					
No	65.5 (63.2; 67.8) **	Reference	Reference	Reference	Reference
Yes	71.1 (69.8; 72.4) **	5.6 (3.2; 8.0) ***	5.5 (3.1; 7.9) ***	8.5 (4.6; 12.4) ***	8.4 (4.5; 12.2) ***
PNS 2013/Smoke-free workplace					
No	79.8 (76.9; 82.5) **	Reference	Reference	Reference	Reference
Yes	91.1 (90.3; 91.8) **	11.3 (8.4; 14.1) ***	10.5 (7.7; 13.4) ***	14.1 (10.0; 18.2) ***	13.6 (9.6; 17.7) ***
PNS 2019/Smoke-free workplace					
No	79.7 (77.1; 82.2)	Reference	Reference	Reference	Reference
Yes	92.1 (91.4; 92.6) **	12.3 (9.5; 15.1)	10.5 (7.7; 13.4)	15.5 (11.4; 19.5)	13.6 (9.6; 17.7)
Smokers					
PETab 2008/Smoke-free workplace					
No	28.0 (24.0; 32.3) **	Reference	Reference	Reference	Reference
Yes	38.2 (35.4; 41.1) **	10.2 (5.4; 15.0)	7.1 (1.0; 13.6)	36.6 (15.3; 57.8)	32.1 (18.2; 45.9)
PNS 2013/Smoke-free workplace					
No	34.7 (29.5; 40.3) **	Reference	Reference	Reference	Reference
Yes	45.1 (41.6; 48.7) **	10.4 (4.3; 16.6) ***	7.1 (1.0; 13.6) ***	30.1 (8.7; 51.4)	32.1 (18.2; 45.9)
PNS 2019/Smoke-free workplace					
No	34.4 (30.0; 39.1)	Reference	Reference	Reference	Reference
Yes	52.2 (48.9; 55.4) **	17.7 (13.2; 22.3) ***	15.6 (10.5; 20.8) ***	51.6 (29.4; 73.7)	32.1 (18.2; 45.9)

95%CI: 95% confidence interval; PETab: *Special Tobacco Survey*; PNS: *Brazilian National Health Survey*.
* Generalized linear model with binomial family and identity link function (absolute difference) or logarithmic link function (relative difference), crude and adjusted by sex, age, educational attainment, household population density, area of residence, region of residence, Heaviness of Smoking Index (smokers only), consumption of illicit cigarettes (smokers only) and interaction term (when applicable) "smoke-free workplaces" vs. "year of the survey";
** p-value ≤ 0.05, when comparing the proportion of non-exposure to passive smoking at home between 2008 and 2013 (or between 2013 and 2019) for individuals employed in workplaces which allowed smoking (or for those employed in smoke-free workplaces);
*** p-value ≤ 0.05 for the additive (or multiplicative) interaction term "smoke-free workplaces (reference category "no") × "year of the survey (reference category "year 2013")".

workplaces that allowed smoking increased between 2013 and 2019 (crude [or adjusted] p-value for additive interaction ≤ 0.05). Although data also suggested an increase in relative differences for the most recent period, they were statistically homogeneous by year of analysis.

Discussion

Our findings showed a positive association between working in smoke-free workplaces and living in smoke-free homes, regardless of the year of the survey and smoking status. Among non-smokers, this relation became stronger between 2008 and 2013, remaining stable between 2013 and 2019, probably due to the high protection levels from passive smoking at home that had already been reached in 2013. Since we also found an increase over time in the proportion of individuals who were employed in smoke-free workplaces, this represented, in absolute terms, millions of individuals more protected from exposure to environmental tobacco smoke in Brazil for the total analytical period of this study (Supplementary Material: http://cadernos.ensp.fiocruz.br/static//arquivo/suppl-e00107421_1128.pdf). This finding is in line with one of the initial hypotheses of a study suggesting that smokers who have quit smoking in Brazil between 2008 and 2019 (smoking prevalence among adults who worked indoors decreased from 17.1% in 2008 to 11.2% in 2019; data not shown in the table) [14,15,16,17,29] may have been those most pressured, among other aspects, both by the effective implementation of restrictive smoking legislation in enclosed workplaces and by non-smoking family members exposed to passive smoking at home.

Among smokers, only after the *Decree-Law n. 8,262/2014* [8], which regulated the comprehensive ban on smoking in enclosed public places in Brazil, there was an increase in the proportion of smokers not exposed to passive smoking in enclosed workplaces (despite the fact that this "protection" should have been 100% in 2019). It is important to note that these smokers have also benefited from an increase in the proportion of individuals living in smoke-free homes ("workplace-home tobacco denormalization"). These findings can bring subsequent positive results toward smoking cessation for these "remaining smokers" who are more aware of the impacts of passive smoking on individuals' health. These smokers, who probably live with other smokers [31,32], spontaneously opted to follow an anti-smoking social norm without having, theoretically, the obligation to do so, possibly making them "more sensitive to interacting" in the future with other anti-smoking measures, such as the offer of help to stop smoking [29]. Between 2008 and 2013, the increase in the proportion of smokers who were living in smoke-free homes, but who were still employed in workplaces that allowed smoking is likely related to the implementation of other tobacco control policies intended to make smoking less desirable, acceptable, and accessible in the society (e.g., the tobacco tax reform that took place in 2011 and/or the introduction of new pictorial health warnings on cigarette packs in 2009) [35,36].

A recent study conducted in Brazil showed that medical students from a university that enforced an official policy banning smoking in school buildings and clinics were more likely to believe that health professionals should serve as role models to help their patients and the general population to quit smoking/not to start smoking than students from a university that allowed passive smoking [37]. This finding reinforces the fact that smoke-free laws may act synergistically with other tobacco control measures to more effectively reduce smoking prevalence [4,6,17,18]. Another study conducted in the United States among adolescents aged 15 to 17 years found an association between employment in smoke-free workplaces (and/or living in smoke-free homes) and prevention of smoking initiation [38], thus also corroborating the importance of implementing strategies which support the idea that tobacco use is a socially inacceptable behavior.

Our findings are largely consistent with those found in the international literature [21,22,23,24,25]. As Brazil has high protection levels from passive smoking at home, even among individuals who are employed in workplaces that allow smoking, when compared to other international studies, we found a smaller relative difference in the proportion of individuals who reported living in smoke-free homes between those exposed and not exposed to passive smoking in enclosed workplaces [21,22,23,24,25]. In fact, when combining data for both smokers and non-smokers (not shown in a table), percentages of individuals who reported living in smoke-free homes in 2008 (66.1% among those protected from passive smoking in enclosed workplaces and 57.1% among those exposed to passive smoking in

enclosed workplaces) were, for example, higher than the proportions found in 11 low- and middle-income countries between 2008 and 2011 [22], higher than those found in the United States in 2007 [24], or higher than those found among smokers living in four high-income European countries in 2009 [39]. More recently, the proportions of Brazilian adults living in smoke-free homes, stratified by employment in smoke-free workplaces or not in 2013 (86.3% and 67.2%, respectively) and in 2019 (88.5% and 66.3%, respectively), were also higher than those found in India in 2016/2017 [25].

Despite its recognition as a world leader in the fight against tobacco use [4], Brazil still faces enormous challenges to reduce the social acceptance of smoking and, as a consequence, the number of smokers, associated with approximately BRL 125 billion per year in direct and indirect costs [40]. In particular, it is necessary to increase tobacco tax rates and minimum prices by more than the inflation ratio, as they have not been adjusted in recent years and cigarettes have become more affordable [35,41]. It is also essential to combat the illegal cigarette market by implementing the Protocol, ratified in 2018, to eliminate illicit trade in tobacco products [5]. The fact that smokers of illicit cigarettes are more exposed to passive smoking either in the workplace or at home poses an additional barrier to smoking cessation. Moreover, it is important to enforce the current ban/restriction on the marketing, advertising, and use of electronic nicotine delivery systems [42], since these products seriously threaten the policy of protection from environmental tobacco smoke and, therefore, also the "workplace-home tobacco denormalization" [38]. Among other aspects, the tobacco industry misleadingly promotes these electronic devices as safe for indoor consumption, thus contributing to increasing the perception that tobacco use is a socially acceptable behavior.

One of the successful lessons learned from the implementation, in 2014 in Brazil, of the comprehensive smoking ban in enclosed public places, was the initiative of some states and municipalities to create their own, more restrictive laws [12,13], based on scientific evidence [4,5,6,19], thereby gaining the support of both smokers and non-smokers [43]. A recent proposal to expand "tobacco denormalization" in Brazil comes with a law bill that requires that smoking inside a vehicle be considered a traffic violation if in the presence of someone under 18 years of age [44]. Almost 90% of the surveyed population of three of the largest Brazilian capitals supports this initiative [45], corroborating the expected association between employment in smoke-free workplaces (and/or living in smoke-free homes) and the voluntary smoke-free rule inside a private vehicle [46]. However, as with the implementation of the 100% smoke-free law [6,10], this and many other proposals aimed at reducing tobacco use in Brazil are not fully protected from commercial and other vested interests of the tobacco industry [47,48], which cause delays that represent lost lives and increased costs to society for the treatment of tobacco-related diseases [1,2,3,6,17,40].

Limitations

Due to the cross-sectional nature of the nationally representative surveys included in this analysis, it is impossible to infer causality between being employment in smoke-free workplaces and living in smoke-free homes. However, longitudinal studies conducted in high-income countries have already shown this association [24,39]. Moreover, in Brazil, the increase over time in the proportion of individuals protected from passive smoking in enclosed workplaces is in line with the implementation of a comprehensive clean indoor air law [6,7,8,9]. Although we stratified our analyses by individuals' smoking status and "status of protection" from passive smoking in enclosed workplaces, it was impossible to fully assess the differential impact of other anti-smoking policies, implemented between 2008 and 2019, on the proportion of individuals living in smoke-free homes. Finally, biases may have resulted from self-reported information on tobacco behavior and exposure to environmental tobacco smoke, due to the growing social disapproval associated with smoking in Brazil/in the world [49].

Conclusion

Strengthening smoke-free legislation in Brazil was probably related to a reduction in passive smoking at home, which may also reduce the burden of mortality, morbidity, and costs for society associated with smoking.

Contributors

A. S. Szklo participated in data processing, data analysis, and the elaboration of the article. T. M. Cavalcante, N. B. Reis and M. C. Souza participated in the elaboration of the article. All authors approved the final version for publication.

Additional informations

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Resumo

Estima-se que a exposição à fumaça ambiental de tabaco esteja relacionada a 1,2 milhão de mortes por ano no mundo. A sinergia das diversas medidas antitabaco, tanto legislativas quanto educativas, é essencial para estimular a cessação e prevenir a iniciação do tabagismo. O artigo tem como objetivo explorar a possível contribuição da proteção legislativa contra a exposição à fumaça ambiental de tabaco nos locais fechados de trabalho no Brasil, cujo fortalecimento ocorreu por fases entre 1996 e 2014, para a proteção contra o tabagismo passivo em casa. Foram utilizados modelos lineares generalizados para avaliar as diferenças absolutas e relativas na proporção de brasileiros que vivem em domicílios sem fumaça ambiental de tabaco, entre aqueles expostos e não expostos ao tabagismo passivo em locais de trabalho fechados, brutas e ajustadas por variáveis sociodemográficas e de comportamento de tabagismo, estratificadas entre fumantes e não fumantes. Foram usados os dados de três inquéritos nacionais, realizados em 2008, 2013 e 2019. Independentemente de condição de tabagista e do ano de análise, os indivíduos empregados em locais de trabalho livres de tabaco apresentaram maior probabilidade de residir em domicílios livres de tabaco, comparado com aqueles que trabalhavam em locais onde fumar era permitido. A diferença absoluta ajustada aumentou de +5,5% em 2008 para +10,5% em 2013 entre não fumantes, e de +7,1% em 2013 para +15,6% em 2019 entre fumantes (valores de p de interação aditiva ≤ 0,05). É provável que o fortalecimento da legislação antitabaco no Brasil esteve associado a uma redução no tabagismo passivo em casa, o que, portanto, pode reduzir a carga de morbimortalidade e de custos para a sociedade, relacionados ao tabagismo.

Política Antifumo; Poluição por Fumaça de Tabaco; Uso de Tabaco; Local de Trabalho

Resumen

Se estimó que la exposición al humo del tabaco ambiental está relacionada con 1,2 millones de muertes por año en todo el mundo. La sinergia de varias medidas antitabaco legislativas y educacionales es esencial para estimular dejar de fumar y prevenir comenzar a fumar. La propuesta de este artículo fue explorar la posible contribución de la protección legislativa ante la exposición al humo del tabaco ambiental en lugares de trabajo cerrados en Brasil, cuyo afianzamiento se produjo de manera gradual entre 1996 y 2014, para la protección de los fumadores pasivos en casa. Se utilizaran modelos lineales generalizados para evaluar las diferencias absolutas y relativas en la proporción de individuos que viven en hogares libres de humos, entre quienes estaban expuestos y no expuestos como fumadores pasivos en lugares de trabajo cerrados, crudas y ajustadas por variables sociodemográficas y comportamiento de fumador, y estratificadas por no fumadores y fumadores. Se usaron los datos de las tres encuestas nacionales llevadas a cabo en 2008, 2013 y 2019. Independientemente del estatus del consumo de tabaco y el año de análisis, los individuos que fueron empleados en un lugar de trabajo libre de humos tenían más probabilidades de vivir en un hogar libre de humos en comparación con los fumadores que trabajaban en donde se fumaba. La diferencia ajustada absoluta aumentó del +5,5% en 2008 al +10,5% en 2013 entre no fumadores, y del +7,1% en 2013 al +15,6% en 2019 entre fumadores (valores de p de interacción aditiva ≤ 0,05). El fortalecimiento de la legislación antitabaco en Brasil estuvo presumiblemente asociado con una reducción con los fumadores pasivos en el hogar, y, por consiguiente, podría también reducir la carga de mortalidad, morbilidad y costes para la sociedad en relación con el tabaquismo.

Política para Fumadores; Contaminación por Humo de Tabaco; Uso de Tabaco; Lugar de Trabajo

Submitted on 27/Apr/2021
Final version resubmitted on 29/Oct/2021
Approved on 02/Dec/2021