

## Smoking trend indicators in Brazilian capitals, 2006-2013

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**Abstract** *This study aims to analyze the trend of indicators related to smoking in the capitals of Brazil from 2006 to 2013. Information on smoking trends extracted from the survey of risk and protective factors for chronic non-communicable diseases (NCDs) are analyzed through telephone interviews - VIGITEL conducted from 2006-2013 for the adult population in Brazilian capitals. To estimate the trend, the simple linear regression model was used. The prevalence of smokers in Brazil showed a relative reduction of 0.62% for each year of the survey, ranging from 15.6% in 2006 to 11.3% in 2013. A decrease was observed in both sexes in all age ranges except between 55 and 64 years in all education levels and regions. The total population of former smokers remained stable, with a reduction for men. Smoking 20 or more cigarettes per day decreased from 4.6% (2006) to 3.4% (2013), or 0.162 percentage points per year. Passive smoking at home decreased among women 13.4% (2009) to 10.7% (2013), a reduction of 0.72% per annum. Passive smoking at work has remained stable over the period. The smoking trend reduced in the period in most indicators, reflecting the importance of the tobacco control actions in the country.*

**Key words** *Smoking, Chronic non-communicable diseases, Trend, Survey, Passive smoking*

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## Introduction

Noncommunicable diseases (NCDs) are the leading cause of death worldwide, accounting for approximately 36 million deaths per year, mainly in low- and middle-income countries<sup>1</sup>.

Despite major increases in morbidity and mortality associated with NCDs and their significantly unequal distribution, some studies indicate that a large part of such deaths may be prevented by means of health promotion activities aiming at modifying the exposure to risk factors<sup>1</sup>. Smoking, alcohol use, obesity, inadequate nutrition and physical inactivity stand out among the risk factors for most NCDs<sup>1-3</sup>.

Contact with tobacco exposes the body to several carcinogens, resulting in a predisposition to several types of cancer (e.g., lung, oral cavity and breast), in addition to cardiac diseases, hypertension and other conditions<sup>1-3</sup>. Smoking is estimated to cause approximately 71% of the deaths by lung cancer, 42% of chronic respiratory diseases and almost 10% of cardiovascular diseases<sup>1</sup>. Smoking is also a significant risk factor for communicable diseases, such as tuberculosis<sup>1</sup>. According to estimates by the World Health Organization (WHO), there are one billion smokers worldwide, and approximately six million deaths per year are associated with smoking, corresponding to 6% of deaths among women and 12% among men<sup>4</sup>. The health risks posed by smoking derive from both direct tobacco use and passive exposure to tobacco smoke<sup>1-4</sup>.

According to the WHO, if no global high-impact measures are implemented, tobacco-related deaths will increase to approximately eight million by 2030, corresponding to 10% of the deaths worldwide<sup>1,3</sup>.

The prevalence of tobacco use is high worldwide, especially in Europe, where it reaches approximately 29%, while the lowest prevalence is in Africa. Men smoke more than women globally, and the gender difference is largest in the Western Pacific Region, where the prevalence of smokers is 46% among men and 15 times higher compared to women, followed by Southeast Asia, where men smoke up to 10 times more than women. The highest prevalence of female smokers is found in Europe (20%)<sup>1</sup>, and the smallest disparity between men and women occurs in the Americas, where approximately 1.5 times more men smoke than women<sup>1</sup>.

The first studies on the prevalence of smoking in Brazil were conducted in 1989; the Health and Nutrition National Survey reported a 34.8%

prevalence of smoking among adults<sup>5</sup>. Subsequently, the World Health Survey (2003) found that the prevalence of smoking had fallen to 22.4%<sup>5</sup>; according to the 2008 Special Research on Tobacco (Pesquisa Especial de Tabagismo - PETab)<sup>6</sup>, to 17.2%. Some studies attributed such success to the leading role played by Brazil in reducing tobacco use by means of educational, preventive and regulatory actions<sup>5,7,8</sup>.

The Brazilian Health Ministry established a system of surveillance of risk factors for NCDs based on household, telephone and school surveys. Within that context, the 2006 establishment of the National System of Surveillance of Chronic Diseases by Telephone Survey (Sistema Nacional de Vigilância de Doenças Crônicas por Inquérito Telefônico - Vigitel), encompassing all 26 state capitals and the Federal District, was important. Vigitel performs continuous annual surveillance of risk factors for NCDs<sup>9,10</sup>.

The aim of the present study was to describe the trends exhibited by indicators of tobacco use corresponding to the Brazilian state capitals and the Federal District from 2006 to 2013.

## Methods

A study on the trends exhibited by tobacco use was performed based on data on risk factors (RFs) and protective factors extracted from Vigitel NCD telephone surveys of adults ( $\geq 18$  years old) residing in all 26 Brazilian state capitals and the Federal District, conducted from 2006 to 2013.

Vigitel surveys probabilistic samples of the adult population ( $\geq 18$  years old) based on the registry of landline owners provided by the main telephone operating companies every year. Five thousand landlines are randomly selected from each city by means of the lottery method, which are then divided into replicates (or subsamples) with 200 landlines each to identify the eligible ones, i.e., the active landlines. After the eligibility of each landline is established, the resident to be interviewed is selected.

Post-stratification weights were applied to extend the surveillance results to the overall adult population of each investigated city. The final weight attributed to each individual interviewed by Vigitel seeks to equate the estimated sociodemographic composition of the adult population with access to landlines – based on the sample selected at each investigated city – to the estimated sociodemographic composition of the total adult

population of the same city in the year of data collection.

The initial weight attributed to each individual from all 27 cities interviewed by Vigitel takes two factors into consideration. One is the inverse of the number of landlines at the interviewee's home, which corrects for the higher odds of individuals residing in households with more than one landline to be selected for sampling. The second factor corresponds to the number of adults residing in the interviewee's home, which corrects for the lower odds of individuals residing in households inhabited by a larger number of people to be selected for sampling. The product of these two factors provides a sampling weight that allows obtaining reliable estimates of the adult population with access to landlines in each city. The variables considered to characterize the sociodemographic composition of both the total population and the population with access to landlines were gender (female and male), age range (18-24, 25-34, 35-44, 45-54, 55-64 and 65 years old or older) and educational level (no formal schooling or incomplete primary education; complete primary education or incomplete secondary education; complete secondary education or incomplete higher education; and complete higher education).

Starting in 2012, the 'raking'<sup>11</sup> technique has been used to establish the post-stratification weight of each individual included in Vigitel samples through the application of a specific SAS macro<sup>12</sup>. The raking technique involves iterative procedures that take into account successive comparisons between estimates of the distribution of each sociodemographic variable in both a Vigitel sample and the total population of the corresponding city. Such comparisons allow detecting the weights useful to equate the sociodemographic distribution of a Vigitel sample to the one estimated for the total population of the corresponding city.

The distributions of each estimated sociodemographic variable per city and year were obtained based on projections that took into account the distribution of each such variable in demographic censuses and its mean annual variation (geometric rate) during the inter-census period. The post-stratification weight was used to generate all of the estimates provided by the system relative to all 27 cities both together and on an individual basis<sup>9</sup>.

The Vigitel questionnaire consists of approximately 94 questions distributed across several modules: i) individuals' demographic and socio-

economic characteristics; ii) dietary and physical activity patterns; iii) reported body weight and height; iv) tobacco and alcohol use; and v) self-assessed state of health and reported morbidity; in the case of women, the performance of cancer screening tests is also included<sup>9</sup>.

The time trends exhibited by the following indicators of tobacco use from 2006 to 2013 were analyzed. i) Smokers: the indicator prevalence of smokers was constructed, i.e., individuals who reported being "current smokers". The individuals who answered the question *Do you smoke?* in the affirmative were considered to be smokers, independently from the number of cigarettes smoked, frequency and duration of smoking habit. ii) Ex-smokers: the prevalence of ex-smokers was established, for which purpose the individuals who answered the question *Have you ever smoked?* in the affirmative were considered to be non-smokers, independently from the number of cigarettes smoked and duration of smoking habit. iii) Percentage of individuals who smoke 20 or more cigarettes per day: the proportion of individuals who smoke 20 or more cigarettes per day relative to the total number of interviewees was established based on the answer to question *How many cigarettes do you smoke per day?*

Starting in 2009, questions on passive smoking were included; thus, the trends exhibited by two additional indicators are described for the period from 2009 to 2013. iv) Indicator passive smoking at home: the ratio of the number of non-smokers who reported at least one smoker in the household to the number of interviewees was established based on the answer to question *Does someone you live with smoke in the house?* v) Percentage of passive smokers in the workplace: the ratio of the number of non-smokers who reported at least one smoker in the workplace to the number of interviewees was established based on the answer to the question *Does any colleague smoke at your workplace?*

The trend analysis of the time series of indicators of tobacco use was stratified per educational level and geographical region. The indicator was expressed as the proportion of adults who answered yes to the question on the consumption of tobacco indicators per year included in the survey. The trends were estimated by means of a simple linear regression model, in which the response variable ( $Y_i$ ) is the indicator proportion and the explanatory variable ( $X_i$ ) is time (survey year). A negative regression coefficient ( $\beta$ , slope) indicates that indicator and time have a decreasing relationship; otherwise, they exhibit an increas-

ing relationship. A positive  $\beta$  value represents the mean annual increase of the indicator proportion per unit of time; otherwise, it represents the mean drop of that proportion per year<sup>12</sup>.

The proportions corresponding to the period from 2006 to 2013, the trends as expressed by the regression coefficient and their level of significance are presented. The measures of model adequacy used were residual analysis and 5% significance level. Data processing and statistical analysis were performed using the application Stata version 11.1<sup>13</sup>. The commands for proportions were used, taking the weights attributed to the individuals included in Vigitel surveys into consideration<sup>9</sup>.

The present study was approved by the National Commission on Ethics in Research with Humans (Comissão Nacional de Ética em Pesquisa em Seres Humanos - CONEP). Instead of signing informed consent forms, the participants expressed their agreement to participation verbally upon being contacted by phone.

## Results

This study identified differences in the prevalence of smoking as a function of gender, age range and educational level. The highest prevalence rates throughout the entire investigated period corresponded to males, individuals with low educational levels and age range 45 to 54 years old.

In the trend analysis, the indicator prevalence of smokers in Brazil exhibited an average 0.62% decrease per year, varying from 15.6% in 2006 to 11.3% in 2013. The prevalence of male smokers decreased by an average of 0.71% during the investigated period, varying from 19.3% (2006) to 14.4% (2013). The prevalence of female smokers exhibited an average 0.55% decrease, varying from 12.4% (2006) to 8.6% (2013) (Table 1). The number of smokers decreased in all of the investigated age ranges, except for the 55- to 64-year-old range. The largest mean reduction corresponded to the 45- to 54-year-old age range (1.01%) and the lowest to the 25- to 34-year-old (0.36) and 65-year-old and older (0.28) age ranges (Table 2).

The regression analysis detected a decreasing trend in the prevalence of smokers in all educational levels. The prevalence of smokers decreased from 10.9% in 2006 to 7.4% in 2013 among the interviewees with the highest educational level. Among the interviewees with eight or fewer years of formal education, although higher, the prevalence of smokers also decreased, from 19.1% in 2006 to 15% in 2013 (Table 3).

The prevalence of smoking exhibited a decreasing trend among the following categories of ex-smokers: males, 25- to 54-year-old age range, and 12 or more years of formal education. The prevalence of smoking exhibited an increasing trend among the individuals aged 55 years old and older. Relative to the remainder of the cat-

**Table 1.** Smoking trend indicators, by gender, in Brazilian capitals, Vigitel 2006 to 2013.

Factors investigated	Sex	2006	2007	2008	2009	2010	2011	2012	2013	p-value*	Average annual variation over the period	Intercept
Smokers	Male	19.3	19.6	18	17.5	16.8	16.5	15.5	14.4	<0.001#	-0.714	1452.6
	Female	12.4	12.3	12	11.5	11.7	10.7	9.2	8.6	<0.001#	-0.545	1106.7
	Both	15.6	15.7	14.8	14.3	14.1	13.4	12.1	11.3	<0.001#	-0.625	1269.9
Ex-smokers	Male	26.7	26.9	26.3	26.8	26.5	25.8	24.5	25.6	0.0238#	-0.256	540.5
	Female	18.4	19.5	18.9	18.7	19.3	18.9	18.1	18.9	0.656	-0.035	88.2
	Both	22.2	22.9	22.3	22.5	22.6	22.1	21	22	0.1255	-0.136	294.9
Smokers consuming 20 or more cigarettes per day	Male	6.3	6.3	6.2	5.4	5.4	5.2	5.5	4.5	0.0021#	-0.233	474.5
	Female	3.2	3.3	3.2	3.1	3.4	3	2.8	2.4	0.0274#	-0.1	204
	Both	4.6	4.7	4.6	4.2	4.3	4	4	3.4	0.0011#	-0.162	329.6
Passive smokers in the home	Male	-	-	-	11.9	9.9	9.9	9.3	9.6	0.1029	-0.52	1055.8
	Female	-	-	-	13.4	12.8	12.5	11	10.7	0.0062#	-0.72	1460
	Both	-	-	-	12.7	11.5	11.3	10.2	10.2	0.0112#	-0.63	1278.1
Passive smokers in the workplace	Male	-	-	-	17	15.3	16.1	15.5	14.1	0.0825	-0.56	1141.8
	Female	-	-	-	7.9	6.5	7.1	6	6.1	0.0877	-0.41	831.2
	Both	-	-	-	12.1	10.5	11.2	10.4	9.8	0.0721	-0.47	956

\* The calculation of the p-value is made by linear regression. # Statistically significant values with a declining trend.

**Table 2.** Smoking trend indicators, by age bracket, in Brazilian capitals, Vigitel 2006 to 2013.

Factors investigated	Age	2006	2007	2008	2009	2010	2011	2012	2013	p-value*	Inclination**	Intercept
Smokers	18 to 24	12	13.7	11.5	10.9	10.9	8.8	8.5	7.1	<0.001 <sup>#</sup>	-0.814	1646.7
	25 to 34	14.1	14.6	13.8	14.5	14.2	13.2	11.7	12.1	0.0142 <sup>#</sup>	-0.364	745.6
	35 to 44	18.5	17.5	16.5	14.8	15.1	13.9	12.9	11.2	<0.001 <sup>#</sup>	-0.971	1967.1
	45 to 54	22.6	21.7	19.6	18.9	18	18.6	16	15.1	<0.001 <sup>#</sup>	-1.011	2049.8
	55 to 64	15	15.8	17.2	16.7	16.7	15.9	15	13.6	0.2766	-0.211	439.2
	65 and over	9.4	8.5	9.3	8.4	8.1	9	7.6	6.9	0.0202 <sup>#</sup>	-0.276	563.4
Ex-smokers	18 to 24	11.9	10.7	10.1	9.6	10.2	9.2	8.7	10.3	0.0551	-0.277	567.5
	25 to 34	14.2	14	14	14.2	13.1	13.7	13	13.2	0.0146 <sup>#</sup>	-0.167	348.6
	35 to 44	22.4	23.3	20.8	20.5	19.9	19.2	16.5	17.7	<0.001 <sup>#</sup>	-0.861	1749.6
	45 to 54	34	33.5	33.7	33.9	33.9	33	30.4	30.1	0.0146 <sup>#</sup>	-0.535	1106.9
	55 to 64	31.8	36.1	36.4	36.4	37.3	37.3	39.1	39.1	0.0033 <sup>##</sup>	0.83	-1630.7
	65 and over	34.3	37.5	35.4	36.1	38.8	35.4	33.6	37	0.9329	0.025	-14.2
Smokers consuming 20 or more cigarettes per day	18 to 24	2.2	2.7	1.9	1.9	2.3	1.8	1.8	1.8	0.0837	-0.086	174.3
	25 to 34	2.9	3.7	3.5	3	3.5	2.9	3.2	2.7	0.2951	-0.062	127.6
	35 to 44	5.6	5.3	5.1	5.3	4.5	3.8	4.6	3.3	0.0037 <sup>#</sup>	-0.289	586
	45 to 54	9.5	7.9	7.3	6.8	6.9	7	5.7	5.5	0.0011 <sup>#</sup>	-0.474	959.2
	55 to 64	5.7	6.6	7.4	6.4	7.1	5.8	7	4.6	0.4544	-0.117	240.8
	65 and over	2.5	2.6	3.9	1.9	2.3	3.8	2.9	2.6	0.8219	0.027	-52.2
Passive smokers in the home	18 to 24	-	-	-	19.6	16.9	17.4	16.8	16.7	0.1297	-0.59	1204
	25 to 34	-	-	-	13.4	12.5	13.4	11	11.6	0.1432	-0.51	1038
	35 to 44	-	-	-	9.8	7.7	8.5	7.2	8	0.2314	-0.41	832.8
	45 to 54	-	-	-	10.8	9.4	8.4	8.2	6.6	0.0041 <sup>#</sup>	-0.96	1939.2
	55 to 64	-	-	-	10.9	11.5	9.2	8.3	9.1	0.103	-0.68	1377.3
	65 and over	-	-	-	10.1	10.8	8.7	9	8.2	0.0807	-0.56	1135.5
Passive smokers in the workplace	18 to 24	-	-	-	12.5	11	12.6	9.6	9.2	0.1043	-0.8	1619.8
	25 to 34	-	-	-	14	12.4	12.5	12.4	11.8	0.069	-0.44	897.5
	35 to 44	-	-	-	15.8	13.5	14.7	12.5	13.1	0.1322	-0.64	1301
	45 to 54	-	-	-	12.9	11	11.1	11.3	9.8	0.0735	-0.59	1197.7
	55 to 64	-	-	-	7.4	7.4	8.2	9.4	7.4	0.5507	0.2	-394.2
	65 and over	-	-	-	2.8	2.1	2.5	2.3	2.5	0.6942	-0.04	82.9

\*The calculation of the p-value is made by linear regression. \*\* Average annual variation over the period (regression coefficient).

# Statistically significant values with a declining trend. ## Statistically significant values with an increasing trend

egories, the prevalence of smoking exhibited a stable trend (Tables 1, 2 and 3).

The prevalence of individuals who smoked 20 or more cigarettes per day exhibited a decreasing trend from 4.6% (2006) to 3.4% (2013), corresponding to a 0.16% mean annual decrease. Although this reduction was detected in both genders, it was more pronounced among males. Reduced prevalence was also detected among the interviewees aged 35 to 54 years old and those with the highest educational level.

The proportion of passive smokers at home decreased among women from 13.4% in 2009 to 10.7% in 2013, corresponding to 0.72% mean annual decrease. A decreasing trend was also detected among the interviewees aged 45 to 54 years old and in all of the investigated educational levels.

The percentages of passive smokers in the workplace were the highest during the entire investigated period: 14.1% among the men and 6.1% among the women in 2013. The prevalence of passive smokers in the workplace exhibited stable trends in both genders and all educational levels, except for the one corresponding to 9 to 11 years of formal education.

All of the investigated indicators decreased in the Northern and Northeastern regions of the country, except for the prevalence of ex-smokers, which remained stable. The percentage of smokers in the North varied from 15.1% in 2006 to 8.1% in 2013, corresponding to a 0.98% mean annual decrease. The proportion of smokers in the Northeast varied from 13.1% in 2006 to 7.4% in 2013, corresponding to a 0.77% mean

**Table 3.** Smoking trend indicators, by schooling level, in Brazilian capitals, Vigitel 2006 to 2013.

Factors investigated	Years of schooling	2006	2007	2008	2009	2010	2011	2012	2013	p-value*	Inclination	Intercept
											-0.521	
Smokers	0 to 8	19.1	18.9	18.9	18.1	18.1	18.2	16.3	15	<b>0.0034<sup>#</sup></b>	-0.543	1065.6
	9 to 11	13.8	13.5	12	11.9	12.2	10.7	10	10.3	<b>&lt;0.001<sup>#</sup></b>	-0.515	1102.7
	12 and over	10.9	12.1	10.8	10.8	10	9.8	9.1	7.4	<b>0.0029<sup>#</sup></b>	0.274	1046
Ex-smokers	0 to 8	27.9	29.1	28.6	30.4	30.2	30.2	29	30.6	0.0627	0.026	-520.7
	9 to 11	17.4	17.9	18	16.7	18.1	17.4	17.3	18.2	0.7675	-0.381	-35
	12 and over	17.7	17.9	16.4	16.8	16.4	16.3	15	15.3	<b>0.0013<sup>#</sup></b>	-0.111	782
Smokers consuming 20 or more cigarettes per day	0 to 8	5.9	6.2	6.8	6	5.8	6.1	6.2	4.9	0.1979	-0.108	228.5
	9 to 11	3.9	3.7	2.9	3	3.6	2.7	3	3.1	0.1073	-0.164	220.9
	12 and over	3	3.2	3	2.5	2.9	2.7	2.5	1.6	<b>0.0162<sup>#</sup></b>	-0.71	332.8
Passive smokers in the home	0 to 8	-	-	-	12.7	11.2	10.8	10.3	9.6	<b>0.0071<sup>#</sup></b>	-0.71	1438.7
	9 to 11	-	-	-	13.9	12.8	12.8	10.7	11.4	<b>0.0457<sup>#</sup></b>	-0.29	1440.1
	12 and over	-	-	-	10.7	9.9	10	9.4	9.5	<b>0.0426<sup>#</sup></b>	-0.49	593.1
Passive smokers in the workplace	0 to 8	-	-	-	13.6	11.4	12.2	12.3	10.7	0.177	-0.5	997.4
	9 to 11	-	-	-	13.2	12.2	12.4	11.2	11.2	<b>0.0236<sup>#</sup></b>	-0.21	1017.5
	12 and over	-	-	-	7.5	6.5	7.8	6.4	6.5	0.3859		429.3

\*The calculation of the p-value is made by linear regression. <sup>#</sup>Statistically significant values with a declining trend.

annual decrease. Relative to the Center-West, the total numbers of smokers and individuals who smoked 20 or more cigarettes per day exhibited decreasing trends. In the Southeastern region, the numbers of smokers, smokers of 20 cigarettes or more per day and passive smokers in the home decreased. In the Southern region, the numbers of smokers, smokers of 20 cigarettes or more per day and passive smokers in the workplace decreased. Although the highest prevalence of smokers corresponded to the Southern region – 18.8% in 2006 and 14.6% in 2013 – the total numbers of smokers, smokers of 20 or more cigarettes per day and passive smokers in the workplace exhibited decreasing trends (Table 4).

## Discussion

The results of the present study indicate improvement in the indicators of tobacco consumption in Brazil. The prevalence rates of smokers decreased in both genders and in all categories of education and geographical areas during the investigated period. The prevalence of tobacco use decreased among men and women, as did the numbers of male ex-smokers, heavy smokers of both genders, and passive smokers at home among both females and the overall population.

As concerns the fight against smoking, Brazil is an example for the rest of the world. One comparative study conducted by the WHO showed

that among 16 countries with a total combined population of approximately three billion people, including China, Russia, Thailand, Bangladesh, Egypt, India, Mexico, Philippines, Poland, Turkey, Ukraine and Vietnam, among others, Brazil exhibited the lowest prevalence of smokers<sup>14</sup>.

Improving the indicators of tobacco use depends on countless factors, including the regulatory measures adopted by the country, which are in agreement with the best evidence designated by the WHO as “best buy”<sup>1</sup>. The following are considered to be cost-effective measures for prevention of NCDs: a) increases in the taxes on and price of tobacco products; b) banning smoking in public areas; c) warnings on the dangers associated with tobacco use; and d) banning tobacco advertising, sponsorship and promotion. Brazil has enacted important legislation to regulate tobacco products, a process that was consolidated through Law no. 12,546/2011<sup>15</sup> on tobacco-free environments, which increased the tax on tobacco to 85% and established a minimum price for cigarettes. In addition, presidential decree no. 8,262/2014 regulated measures such as banning smoking in enclosed areas, restricting cigarette displays to points of sale only, and expanding the space occupied by sanitary warnings<sup>16</sup>. Thus, all of the “best buy” evidence was implemented in Brazil. One further factor that improved the governance of actions was Brazil’s adherence to the Framework Convention on Tobacco Control in 2005<sup>5,8</sup>.

**Table 4.** Smoking trend indicators, by Regions, Vigitel, 2006 to 2013.

	2006	2007	2008	2009	2010	2011	2012	2013	p-value*	Inclination	Intercept
<b>North</b>											
smokers	15.1	14.9	13.5	12.3	12.2	11.7	9.3	8.1	<0.001#	-0.982	1985.8
ex-smokers	25.2	24.4	24.7	25.8	25.3	24	22.1	24.4	0.1968	-0.235	495.8
consumption of 20 or more cigarettes per day	3.2	3.1	3.3	2.9	2.7	2.8	2.5	1.7	<b>0.0049#</b>	-0.181	366.4
passive smokers in the home	-	-	-	13.9	13	12.3	10.9	10.6	<b>0.0018#</b>	-0.87	1761.7
passive smokers in the workplace	-	-	-	13.3	12.5	12.9	11.2	11.1	<b>0.0367#</b>	-0.57	1158.5
<b>Northeast</b>											
smokers	13.1	12.8	10.6	11.5	10.3	9.3	8.9	7.4	<0.001#	-0.768	1553.5
ex-smokers	21.4	21.4	21.9	20.6	21.5	20.3	19.7	20.7	0.06	-0.206	434.8
consumption of 20 or more cigarettes per day	3.7	3.2	3	2.9	2.7	2.5	2.9	2.2	<b>0.0035#</b>	-0.163	330.6
passive smokers in the home	-	-	-	12.8	12.5	12.3	11.1	10.4	<b>0.0102#</b>	-0.62	1258.6
passive smokers in the workplace	-	-	-	11.9	11.3	11.3	10.4	9.7	<b>0.0074#</b>	-0.53	1076.8
<b>Mid-West</b>											
smokers	14.8	14.2	13.9	13.7	13.4	10.9	10.6	10.9	<0.001#	-0.65	1319
ex-smokers	20.8	21.7	22.1	23.4	20.9	21.2	21.2	20.1	0.3689	-0.15	322.9
consumption of 20 or more cigarettes per day	3.8	4	4.3	3.7	4.2	2.8	3.4	2.4	<b>0.0408#</b>	-0.2	405.5
passive smokers in the home	-	-	-	11.7	9.5	9.9	10.2	9.8	0.3188	-0.31	633.6
passive smokers in the workplace	-	-	-	13	10.5	11	11.5	10.2	0.2251	-0.46	936.3
<b>Southeast</b>											
smokers	16.7	17.1	17.1	15.4	16.2	15.8	14.4	13.6	<b>0.0041#</b>	-0.456	932
ex-smokers	22.3	23.6	22	22.4	22.7	22.6	21.3	22.7	0.4812	-0.079	180.3
consumption of 20 or more cigarettes per day	5.2	5.7	5.4	4.7	5.2	5	4.9	4.3	<b>0.0342#</b>	-0.131	268.2
passive smokers in the home	-	-	-	12.9	11.3	11.1	9.4	10.1	<b>0.042#</b>	-0.75	1519.2
passive smokers in the workplace	-	-	-	12.2	10	11.3	10.3	9.9	<b>0.198</b>	-0.43	875.5
<b>South</b>											
smokers	18.8	19.1	17.6	20	17.1	17.8	14.8	14.6	<b>0.0176#</b>	-0.633	1290.2
ex-smokers	23.2	23.5	22.8	23.4	24.6	24.1	22.4	21.7	0.4029	-0.13	284
consumption of 20 or more cigarettes per day	6.8	6.5	6.8	7	6.4	6.3	5.6	5.3	<b>0.0105#</b>	-0.204	415.4
passive smokers in the home	-	-	-	11.4	10.8	10.1	11.3	10.1	0.3586	-0.21	433.1
passive smokers in the workplace	-	-	-	9.4	8.9	8.8	8.4	7.7	<b>0.0058#</b>	-0.39	792.9

\*The calculation of the p-value is made by linear regression. # Statistically significant values with a declining trend.

The Program for Crop Diversification in Tobacco-Growing Areas, established in 2005, is an intersectoral initiative with great importance, which provides technical assistance for tobacco family farmers to shift to food production<sup>17</sup>.

The goals established in the Plan of Strategic Actions Against NCDs 2011-2022<sup>18-20</sup> and the Global NCD Plan<sup>21</sup> include reducing the prevalence of smokers in Brazil by 30% in 10 years. The prevalence rates analyzed here and the continuous decline in the number of smokers in Brazil indicate that this goal will be met and exceeded.

According to studies conducted in Brazil<sup>5,6</sup> and worldwide<sup>14</sup>, the frequency of smokers is higher among males compared to females, as also found in the present study. This higher prevalence of male smokers has historical reasons, as in the beginning of the 20<sup>th</sup> century, smoking was associated with virility, strength and power<sup>8,22</sup>. Later on, the spread of smoking to women

during the 1960s and 1970s was associated with the myths of independence, freedom and self-affirmation<sup>23-26</sup>. These cultural influences account for the lower prevalence of smokers among females, along with its slower reduction rate due to its later introduction<sup>26,27</sup>. In other countries, as reported by the Global Adults Tobacco Survey, the frequency of smokers tends to be lower among females. In countries such as Egypt and Bangladesh, as a function of strong religious and cultural influences, the prevalence of smokers is less than 2% among women versus approximately 30% among men<sup>14</sup>.

The present study is the first to report decreasing trends in the prevalence of smokers from both genders, albeit faster among males. Vigitel first detected the decline in the prevalence of female smokers in 2013; this finding makes the current scenario quite favorable for the goal of reducing the prevalence of smokers by 30% in 10 years<sup>18-20</sup>.

According to the literature, low income and low educational levels are associated with higher prevalence rates of tobacco use in Brazil<sup>6,28</sup> and other countries<sup>14</sup>. This association was confirmed in the present study, as the prevalence of smokers among the interviewees with the lowest educational level (eight or fewer years of formal education) was approximately twice as high compared to the ones with the highest educational level (12 or more years). Nevertheless, the results of the present study showed not only that the prevalence of smokers decreased in all educational levels, but that the rate of reduction was similar in all of them – approximately 0.5% per year.

Analysis per geographical area revealed that the prevalence of smokers exhibited a decreasing trend in all of the Brazilian regions, though with differences in magnitude, as the frequency of smokers is highest in the South and Southeast. The higher prevalence of smokers in the South has been associated with the fact that this Brazilian region concentrates most of the tobacco production<sup>29</sup>. Cultural issues also control these numbers, such as the strong influence of immigrant populations from Europe and bordering countries, such as Argentina and Uruguay, where the prevalence of smoking is over 30%<sup>30</sup>. In turn, the lower prevalence of smokers in the North and Northeast has been associated with cultural issues and local market characteristics, such as the smaller role the tobacco industry plays.

Passive smoking, which is another global concern, may result in high risks for the exposed population and can cause the same types of diseases as direct smoking<sup>22</sup>. Data from PETab 2008 show that 24.4% of the adult population was exposed to passive smoking in the workplace<sup>6</sup>. Vigitel detected decreased prevalence rates of passive smoking at home among females and in the overall population, while the exposure to passive smoking at the workplace remained stable, affecting almost one-tenth of the Brazilian population. As a function of the decree that bans smoking in public places, the decrease in the prevalence of passive smoking in the workplace is expected to intensify in the next few years<sup>16</sup>.

The prevalence of heavy smoking (20 or more cigarettes per day) decreased in both gen-

ders. Although the prevalence of heavy smokers was almost twice as high among males compared to females, the reduction rate was larger among the former. Some studies showed that heavy smoking is associated with a higher risk of lung cancer among individuals who are more exposed, exhibiting a dose-response gradient<sup>31</sup>.

Due to the methods used by Vigitel, one of the limitations of the present study is the fact that the population interviewed was restricted to adults residing in state capitals and the Federal District with access to landlines, as it made the sample representativeness limited. However, that problem was minimized by the use of weighting factors to equate the demographic composition of the Vigitel sample to the ones of the overall adult population according to the 2010 Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE) census data<sup>10</sup>.

Starting in 2012, Vigitel updated the post-stratification data using the 2010 census; thus, the full trend analysis relative to the set of indicators of tobacco use was performed again with those novel data. Additionally, the “raking” technique was used, which represented an advancement that further approximated the population-based estimates<sup>9,12</sup>.

## Conclusion

The results described here indicate significant improvement of the indicators of tobacco use in Brazil both as a whole and categorized per educational level, age range, gender and geographical area. These results point to the relevance of measures against smoking in public policies, such as the Plan to Combat Chronic Diseases and the Policy of Health Promotion<sup>32</sup>, on the improvement of the indicators of tobacco use among the adult and the adolescent population<sup>33</sup>. Thus, the relevance of Vigitel’s annual monitoring of the indicators of tobacco use for the combat of NCD is reaffirmed, and it can be concluded that Brazil made significant advances towards the accomplishment of the globally agreed goals of tobacco use reduction.

## Collaborators

DC Malta designed the study, analyzed the data, wrote the initial version and approved the final version of the manuscript. T Porto, M Luz, SR Stopa, J Barbosa Silva Júnior and AA Chioro made substantial contributions to the manuscript and approved its final version.

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