

Smokers in Brazil: who are they?

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Received 3 March 2015
Accepted 4 August 2015
Published Online First
20 August 2015

ABSTRACT

Background Brazil has experienced a large decline in smoking prevalence due to several tobacco control policies that were implemented in the past 25 years. Previous population-wide studies found a consistent reduction over time in daily cigarette consumption among all socioeconomic groups.

Objective To examine changes between 2008 and 2013 in tobacco behaviours and health-related conditions of smokers.

Methods We used data obtained from two nationally-representative surveys conducted in 2008 and 2013 to estimate the prevalence of self-reported psychological and physical morbidity, and nicotine dependence markers, stratified by gender and sociodemographic groups. Generalised linear models were used to understand whether absolute differences in prevalence rates over time differed by categories of selected variables.

Results For both genders, as smoking prevalence declined in Brazil, there has been an increase in the proportion of ever smokers who have quit. In addition, remaining smokers seem to be making more quitting attempts. Among men with low educational level or younger than 25 years-old, as compared to their counterparts, cessation rate showed an even greater increase over time. Moreover, the proportion of light smokers, which represent the vast majority of smokers, did not decrease. The percentage of poor health-conditions among remaining smokers nevertheless increased, particularly among women, which can make future cessation more challenging.

Conclusions In Brazil, quitting rate is increasing, thus suggesting that tobacco control interventions implemented in Brazil in the past years seem to be effectively reaching the smoking population. This is strong evidence against the 'hardening hypothesis', which posits that remaining smokers decrease their willingness and ability to quit.

INTRODUCTION

Brazil has experienced a large decline in smoking prevalence due to several tobacco control policies that were implemented in the past 25 years (male, from 43.3% in 1989 to 27.1% in 2003, and to 18.9% in 2013; female, from 27.0% in 1989 to 18.4% in 2003, and to 11.0% in 2013).¹⁻⁴ Interventions to reduce the burden and prevalence of tobacco use included price increases, smoke-free air laws, marketing restrictions, prominent health warnings and national smoking cessation campaigns through the mass media.^{3,4} Additionally, Brazil has become one of the fastest-growing major world economies,^{5,6} thus increasing access to cognitive-behavioural and pharmacological treatment for smoking cessation.^{4,7} Brazil is also facing changes

in its population dynamics and in patterns of the relative contributions of risk factors other than smoking to chronic morbidity and mortality.^{8,9}

Based on the hypothesis that current smokers are more dependent than former smokers, as less dependent smokers could quit more easily,^{10,11} previous national studies tried understanding whether Brazil's smokers who continued to smoke, or started to smoke, increased their average daily cigarette consumption over time.^{1,12} A consistent reduction in consumption was found in all socioeconomic groups, along with a decrease in their respective smoking prevalence, as also observed in other countries.¹³ Importantly, though, while heavily addicted smokers, on average, also consume more cigarettes per day, this may not represent a valid measure of nicotine addiction and, consequently, a valid predictor of lower cessation rates in the future (ie, 'hardening of the target').^{2,14,15} For instance, a decrease in consumption may be offset by increased nicotine intake per cigarette smoked.¹⁶

In 2008, a comprehensive survey for tobacco control in Brazil was included in a national health-related survey to be conducted every 5 years.^{2,17} As stated in article 20 of the WHO Framework Convention on Tobacco Control (WHO FCTC),¹⁸ it is, indeed, essential to establish progressively a national system for the epidemiological surveillance of tobacco consumption and related social, economic and health indicators to track the evolution of the tobacco epidemic and, also, to propose new strategies to prevent smoking initiation and/or stimulate cessation. The creation of this integrated surveillance system is, therefore, also in accordance with article 14 of the WHO FCTC, which encourages the implementation of effective measures to promote smoking cessation.

The establishment of a sustained broader surveillance system in Brazil makes it possible to achieve the major aim of the present study, which is to examine changes between 2008 and 2013 in tobacco behaviours and health-related conditions of smokers, in order to understand whether current smokers are less likely to quit now than in the past. To the best of our knowledge, our study represents the first-ever detailed evaluation of this issue in an upper-middle-income country with a longer history of tobacco prevention programmes than other countries.

METHODS

This study uses data from the Global Adult Tobacco Survey (GATS-Brazil 2008 and GATS-Brazil 2013), which is part of the Global Tobacco Surveillance System established by the WHO to track the evolution of the tobacco



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To cite: Szklo AS, de Souza MC, Szklo M, et al. *Tob Control* 2016;**25**:564-570.

epidemic. Detailed methods for both surveys have been published elsewhere.^{2 17}

GATS-Brazil 2008 and 2013

GATS-Brazil cross-sectional surveys were nationally representative and conducted in 2008 and 2013. The surveys were designed to conduct individual interviews on tobacco use indicators among adults aged 18 years and above. As GATS-Brazil surveys were part of a broader national health survey, individuals also provided information on morbidity and risk factors for non-communicable diseases.

A complex probabilistic sample with four selection stages (municipalities, census tracts, households, and individuals aged 18 years and above) was chosen. A total of 39 847 households in 2008 and 62 986 in 2013 were sampled for GATS-Brazil, after excluding 11 164 and 18 781 vacant/non-existent household units and refusals in 2008 and 2013, respectively. Only one individual per household (37 317 in 2008, and 60 237 in 2013) was selected to answer questions about tobacco use, other risk factors for chronic diseases and morbidity.^{2 17}

In both surveys, participants reported the number of years of education they had attained, which were grouped into 0–7 years of education ('low') and 8 or more years of education ('high'). This cut-point reflects educational programme's efforts made by the Brazilian government in the last decade to increase the proportion of individuals who have at least 8 years of education.⁶ Participants were also grouped into '24 years-old or less' and 'older than 24 years', as around 95% of the Brazilian population starts smoking before they are 25 years-old.^{2 16} Finally, participants were dichotomised into 'urban' and 'rural' residents.

The question "Compared to persons of your age, in general, how do you rate your own health status?" was used to assess self-rated health status, and categorised as 'very good', 'good', 'fair', 'poor', or 'very poor'. We compared the categories 'very good/good' with 'fair/poor/very poor'.^{19 20}

Self-reported history of depression was assessed by the response 'yes' or 'no' to the question "Has any physician ever told you that you have or have had depression?"

Self-reported sedentary behaviour was assessed by the response to questions related to three main physical domains: (1) Leisure time/sport/recreation, "In the last 3 months, did you practice any sort of physical activity or sport?"; (2) Occupation (including household work), "In your work, are you involved in labor-intensive activities?"; (3) Transportation, "Are you involved in active transportation to and from work by foot or bike?" We compared individuals who answered 'no' for the three domains with those who answered 'yes' to at least one of the three proposed questions.²¹

Information on cigarette consumption as well as daily versus occasional status was based on two questions: (1) "Currently, do you smoke?", categorised as 'daily', 'less than daily', or 'not at all'; and, if 'daily' or 'less than daily', (2) "On average, how many (manufactured OR hand-rolled OR Clove/Bali) cigarettes do you smoke per day (OR per week)?" We divided the total number of cigarettes smoked per week by seven to obtain their daily consumption.

To assess years of daily smoking history among current daily smokers, we combined the question "How old were you when you started smoking tobacco daily?" and the information on age. Recent daily smokers were defined as "initiated smoking daily 5 years-ago or less" (versus "initiated smoking daily more than 5 years-ago").

Once respondents were defined as daily smokers, they also answered the question "How soon after you wake up do you

usually have your first cigarette?" which was used, along with average daily cigarette consumption, to create the *Heaviness of Smoking Index (HSI)*.²² Degree of dependence was stratified according to two categories: light ($HSI \leq 3$) and heavy ($4 \leq HSI \leq 6$).²³

Household passive smoking was based on the question "How often does anyone smoke inside your home?." We compared the category 'at least monthly', that is, 'daily'+ 'weekly'+ 'monthly' with the sum of 'less than monthly' and 'never'. For smokers, results were stratified by light and heavy smoking.

Recent quit attempt was assessed by a response 'yes' or 'no' to the question "During the past 12 months, have you tried to stop smoking?."

Cessation rate was based on two questions: (1) "Currently, do you smoke?", categorised as 'daily', 'less than daily', or 'not at all'; and if 'not at all', (2) "In the past, have you smoked tobacco?", ('daily', 'less than daily', or 'not at all'). We grouped past 'daily' and 'less than daily' smoking and divided by the number of ever smokers to create the cessation rate variable.

Data analysis

Measures of health-related conditions (ie, self-rated health status, self-reported history of depression, and self-reported sedentary behaviour) were stratified by gender. Differences over time were assessed by χ^2 test, with significance level at 5%.

Measures of nicotine dependence (ie, cigarette smoking prevalence, recent quitting attempts, proportion of daily smokers, proportion of recent daily smokers, years of daily smoking, proportion of heavy smokers, passive smoking among light smokers, passive smoking among heavy smokers, and cessation rate) were stratified by gender and educational level (or area of residence), as one would expect lower cessation rates among underprivileged smokers who tend to have less access to treatment and communication strategies.^{3 10 24} We also estimated measures of nicotine dependence stratified by gender and age-group, as the optimistic bias among younger people, compared to older smokers, may have produced a differential effect of stronger tobacco control implemented in Brazil.^{25–27} Differences over time in the proportions of measures of nicotine dependence by categories of selected sociodemographic variables were assessed by χ^2 test (or F test for the assessment of the continuous variable 'years of daily smoking'), with significance level at 5%. Furthermore, given the public health implications of our study,²⁸ generalised linear models using the Poisson family and Gaussian link function were specified to understand whether absolute differences in prevalence rates of selected measures of nicotine dependence between 2008 and 2013 were homogeneous by educational level (OR age-group OR area of residence), using p values ≤ 0.05 to define a significant interaction term ($time*education$ or $time*age$ or $time*residence$).²⁹ The model used the Gaussian family with the identity link function for the variable 'years of daily smoking'.

STATA 12.0 statistical application was used for the statistical analysis, taking also into account the complex sample weights.³⁰

RESULTS

A total of 24.1 million cigarette smokers in 2008 (male, 14.5 million; female, 9.6 million) and 21.1 million cigarette smokers in 2013 (male, 12.8 million; female, 8.3 million) were included in the analysis, when using the sample weights. The proportion of individuals with 8 or more years of education increased statistically significantly between 2008 and 2013 only among the male Brazilian smoking population (male, from 38.3% to 48.1%; female, from 45.6% to 48.4%). The percentage of

Table 1 Unadjusted prevalence rates (%) of health-related conditions in smokers by gender, Brazil, 2008 and 2013

Health-related conditions	Cigarette smokers		
	2008	2013	p Value*
Male			
Self-rated health status—good or very good	68.4	62.7	<0.01
Self-reported depression—no	96.1	95.6	0.42
Self-reported sedentary behaviour—no	75.7	80.3	0.01
Female			
Self-rated health status—good or very good	64.2	54.0	<0.01
Self-reported depression—no	87.9	82.2	<0.01
Self-reported sedentary behaviour—no	88.6	85.1	0.02

*Corresponds to p value for χ^2 test for differences in prevalence rates between 2008 and 2013.

those aged less than 25 years did not statistically change over time (male, from 15.3% to 13.8%; female, from 9.6% to 8.2%). A greater proportion of smokers lived in urban areas in

both surveys for both genders. Only male cigarette smokers showed a statistically significant decrease in the proportion of those living in a rural area (male, from 20.8% to 17.7%; female, from 13.6% to 11.8%).(data not shown in a table).

For both genders, a pattern of unadjusted absolute decreases in prevalence rates of very good/good self-rated health status was observed between 2008 and 2013 (table 1). Absolute declines in the proportion of self-reported absence of depression and in the proportion of self-reported absence of sedentary behaviour were also observed among female smokers.

For both genders and for all categories of selected sociodemographic variables, unadjusted cigarette smoking prevalence rates decreased over time. Except for smokers aged 24 years or less, the frequency of quitting attempts in the past 12 months increased between 2008 and 2013 (tables 2–4).

Males with low educational level showed a greater decline in smoking prevalence ($p_{\text{interaction}} \leq 0.01$) and a larger increase in years of daily smoking ($p_{\text{interaction}} = 0.04$) than smokers with high educational level between 2008 and 2013 (table 2). Moreover, males with a low educational level also increased their cessation rate over time, while their counterparts

Table 2 Unadjusted prevalence rates (%) of selected nicotine-dependent characteristics in cigarette smokers, by gender and educational level, Brazil, 2008 and 2013

Nicotine-dependent Characteristics	Total			Educational level			p Value for additive interaction†			
	2008	2013	p Value*	0–7 years		p Value*	Eight or more years		p Value*	
				2008	2013		2008	2013		
Male										
Prevalence of smokers	22.8	18.7	<0.01	30.0	24.3	<0.01	16.6	14.9	0.03	<0.01
Current smokers										
Quitting attempt in the past 12 months	38.9	43.6	<0.01	39.2	43.4	0.04	38.4	43.8	0.03	0.72
Daily smokers	87.9	85.9	0.06	90.0	87.6	0.08	84.5	84.1	0.82	0.37
Current daily smokers										
Recent daily smoker	11.2	7.4	<0.01	7.1	3.7	0.01	18.1	11.6	<0.01	0.20
Years of daily smoking‡	25.2	27.1	<0.01	28.5	32.2	<0.01	19.7	21.4	0.03	0.04
Heavy smokers§	20.2	20.1	0.92	19.4	20.2	0.65	21.8	20.0	0.42	0.35
Passive smoking inside household§										
Among heavy smokers	74.2	79.9	0.05	75.7	77.9	0.56	71.8	82.1	0.02	0.16
Among light smokers	65.2	57.7	<0.001	70.5	62.2	<0.01	55.6	52.6	0.38	0.20
Ever smokers										
Cessation rate¶	50.0	53.0	0.01	48.6	53.8	<0.01	52.2	52.0	0.91	0.02
Female										
Prevalence of smokers	13.8	10.8	<0.01	16.7	14.6	<0.01	11.4	8.4	<0.01	0.38
Current smokers										
Quitting attempt in the past 12 months	45.1	53.0	<0.01	47.7	56.3	<0.01	42.1	49.3	0.01	0.69
Daily smokers	87.9	88.3	0.72	90.5	88.8	0.23	84.9	87.8	0.12	0.10
Current daily smokers										
Recent daily smoker	9.7	6.1	<0.01	5.3	3.4	0.09	15.1	9.1	<0.01	0.04
Years of daily smoking‡	24.9	28.8	<0.01	28.2	32.4	<0.01	20.7	25.0	<0.01	0.92
Heavy smokers§	17.2	17.4	0.91	16.8	18.0	0.56	17.8	16.8	0.66	0.48
Passive smoking inside household§										
Among heavy smokers	82.8	79.2	0.37	79.3	80.8	0.79	86.8	77.4	0.09	0.17
Among light smokers	69.3	62.4	<0.01	72.2	65.0	0.01	65.5	59.7	0.05	0.74
Ever smokers										
Cessation rate¶	53.7	56.2	0.04	55.3	57.0	0.29	51.5	55.3	0.04	0.41

*Corresponds to p value for χ^2 test for differences in prevalence rates between 2008 and 2013.

†Generalised linear models (GLM) using the Poisson family and Gaussian link function were specified to understand whether absolute differences in prevalence rates between 2008 and 2013 were homogeneous by educational level.

‡GLM using the Gaussian family were specified to understand whether absolute differences in means between 2008 and 2013 were homogeneous by educational level; p value for F test was used to assess unadjusted differences in means over time.

§Light smokers: Heaviness of Smoking Index (HSI) ≤ 3 ; heavy smokers: HSI ≥ 4 .

¶Cessation rate: past daily and occasional smokers divided by the number of ever smokers.

Table 3 Unadjusted prevalence rates (%) of selected nicotine-dependent characteristics in cigarette smokers, by gender and age-group, Brazil, 2008 and 2013

Nicotine-dependent characteristics	Age-group						p Value for additive interaction†
	18–24 years			Twenty five or more years			
	2008	2013	p Value*	2008	2013	p Value*	
<i>Male</i>							
Prevalence of smokers	18.9	15.4	0.02	23.7	19.3	<0.01	0.55
Current smokers							
Quitting attempt in the past 12 months	42.8	44.9	0.68	38.1	43.4	<0.01	0.57
Daily smokers	78.3	74.4	0.34	89.7	87.8	0.06	0.64
Current daily smokers							
Recent daily smoker	64.0	47.0	<0.01	2.8	2.1	0.19	<0.01
Years of daily smoking‡	4.7	5.6	<0.01	28.5	30.0	<0.01	0.30
Heavy smokers§	15.1	17.0	0.62	21.1	20.5	0.73	0.56
Passive smoking inside household§							
Among heavy smokers	74.3	89.9	0.05	74.2	78.8	0.14	0.20
Among light smokers	62.0	63.7	0.78	65.7	56.9	<0.01	0.11
Ever smokers							
Cessation rate¶	24.8	32.6	0.02	52.9	55.1	0.06	0.04
<i>Female</i>							
Prevalence of smokers	8.2	5.8	0.01	14.8	11.7	<0.01	0.44
Current smokers							
Quitting attempt in the past 12 months	44.0	54.1	0.15	45.2	52.9	<0.01	0.74
Daily smokers	78.3	83.9	0.27	88.9	88.7	0.87	0.24
Current daily smokers							
Recent daily smoker	64.2	54.0	0.19	4.6	2.1	<0.01	0.32
Years of daily smoking‡	4.9	5.8	0.11	26.7	30.8	<0.01	<0.01
Heavy smokers§	7.3	15.7	0.08	18.1	17.5	0.71	0.08
Passive smoking inside household§							
Among heavy smokers	86.8	100.0	0.11	82.6	77.7	0.23	0.11
Among light smokers	71.4	73.5	0.77	69.1	61.5	<0.01	0.20
Ever smokers							
Cessation rate¶	40.8	39.8	0.83	54.7	57.2	0.05	0.47

*Corresponds to p value for χ^2 test for differences in prevalence rates between 2008 and 2013.

†Generalised linear models (GLM) using the Poisson family and Gaussian link function were specified to understand whether absolute differences in prevalence rates between 2008 and 2013 were homogeneous by age-groups.

‡GLM using the Gaussian family were specified to understand whether absolute differences in means between 2008 and 2013 were homogeneous by age-groups; p value for F test was used to assess unadjusted differences in means over time.

§Light smokers: Heaviness of Smoking Index (HSI) ≤ 3 ; heavy smokers: HSI ≥ 4 .

¶Cessation rate: past daily and occasional smokers divided by the number of ever smokers.

experienced no changes ($p_{\text{interaction}}=0.02$). The already low proportions of recent daily smokers among male current daily smokers in the 25+ age-group remained unaltered between the two surveys, as compared to younger male smokers, who experienced a decline in these proportions ($p_{\text{interaction}}\leq 0.01$) (table 3). An increase over time in the cessation rate was more evident among younger male smokers than in the older ones ($p_{\text{interaction}}=0.04$).

The decrease in the proportion of recent daily smokers was more pronounced among females with high educational level (versus low educational level) ($p_{\text{interaction}}=0.04$), as the latter already have low baseline proportions of recent daily initiation (table 2). Furthermore, in older female smokers, but not in the younger ones, an increase in their years of daily smoking was observed ($p_{\text{interaction}}\leq 0.01$) (table 3). Cigarette female smokers living in rural areas experienced an absolute reduction in the proportion of daily smokers among current smokers, but this result was not observed in those living in the urban area ($p_{\text{interaction}}=0.02$) (table 4).

For both genders, the proportions of heavy smokers among current daily smokers remained unaltered, irrespective of

sociodemographic variables. Moreover, heavy smokers, who already have high proportions of household passive smoking exposure, did not experience a decline in these proportions. Among light smokers, except for young individuals and for males with a high educational level or living in a rural area, unadjusted prevalence rates of household passive smoking decreased between surveys (tables 2–4).

When we assessed interactions between time of survey and selected sociodemographic variables while adjusting simultaneously by the other sociodemographic variables presented in tables 2–4, the main conclusions remained virtually unchanged.

DISCUSSION

Our results demonstrate that, as smoking prevalence declined in Brazil, there has been an increase in cessation rates and in the proportion of quitting attempts in the past 12 months for males and females. Moreover, among men with low educational level or younger than 25 years-old, as compared to their counterparts, the proportion of ex-smokers among ever smokers showed an even greater increase between 2008 and 2013 (smoking prevalence also showed a larger decrease among males

Table 4 Unadjusted prevalence rates (%) of selected nicotine-dependent characteristics in cigarette smokers, by gender and area of residence, Brazil, 2008 and 2013

Nicotine-dependent characteristics	Area of residence						p Value for interaction†
	Rural			Urban			
	2008	2013	p Value*	2008	2013	p Value*	
<i>Male</i>							
Prevalence of smokers	28.2	22.1	<0.01	21.7	18.1	<0.01	0.13
Current smokers							
Quitting attempt in the past 12 months	36.4	41.6	0.06	39.5	44.0	0.01	0.84
Daily smokers	88.8	85.1	0.08	87.7	86.1	0.19	0.40
Current daily smokers							
Recent daily smoker	7.8	2.3	<0.01	12.2	8.5	0.01	0.88
Years of daily smoking‡	28.5	30.8	0.03	24.3	26.3	<0.01	0.06
Heavy smokers§	15.6	19.4	0.17	21.5	20.3	0.42	0.11
Passive smoking inside household§							
Among heavy smokers	77.6	78.5	0.88	73.6	80.2	0.04	0.43
Among light smokers	76.6	72.1	0.16	61.8	54.6	<0.01	0.51
Ever smokers							
Cessation rate¶	44.9	51.2	0.01	51.2	53.3	0.10	0.53
<i>Female</i>							
Prevalence of smokers	14.1	10.1	<0.01	13.7	10.9	<0.01	0.31
Current smokers							
Quitting attempt in the past 12 months	47.2	56.9	0.03	44.8	52.4	<0.01	0.69
Daily smokers	88.6	80.8	0.03	87.8	89.3	0.21	0.02
Current daily smokers							
Recent daily smoker	6.2	4.2	0.36	10.2	6.4	<0.01	0.46
Years of daily smoking‡	28.0	31.1	0.04	24.4	28.5	<0.01	0.51
Heavy smokers§	10.2	10.8	0.83	18.4	18.2	0.91	0.81
Passive smoking inside household§							
Among heavy smokers	88.0	75.9	0.25	82.3	79.5	0.50	0.40
Among light smokers	79.0	69.1	0.03	67.5	61.6	0.01	0.45
Ever smokers							
Cessation rate¶	54.1	58.2	0.18	53.6	55.9	0.09	0.47

*Corresponds to p value for χ^2 test for differences in prevalence rates between 2008 and 2013.

†Generalised linear models (GLM) using the Poisson family and Gaussian link function were specified to understand whether absolute differences in prevalence rates between 2008 and 2013 were homogeneous by area of residence.

‡GLM using the Gaussian family were specified to understand whether absolute differences in means between 2008 and 2013 were homogeneous by area of residence; p value for F test was used to assess unadjusted differences in means over time.

§Light smokers: Heaviness of Smoking Index (HSI) ≤ 3 ; Heavy smokers: HSI ≥ 4 .

¶Cessation rate: past daily and occasional smokers divided by the number of ever smokers.

with low educational level). These findings are strong evidence that the Brazilian smoking population has been ‘softening’ (versus ‘hardening’),^{10 15} that is, remaining smokers do not seem unwilling or unable to quit.

Recent studies conducted among the remaining smoking population of developed countries that are in a similar tobacco epidemic stage as Brazil, such as Canada, Australia and the USA, also revealed no overall evidence of the ‘hardening hypothesis’, that is, no increase in use/dependence.^{13 31–34} However, differently from what we observed in Brazil, some of these studies found an increase over time in the proportion of highly dependent smokers among individuals that experience greater difficulties in accessing health services,^{6 10 24} that is, low-income and low-educational level smokers. These findings suggest that the broad set of legislative, healthcare, educational and economic interventions implemented in Brazil in the past years aimed at promoting smoking cessation/reducing initiation likely reached different population subgroups with the same level of effectiveness.⁴ For example, price increases and the third set of emotionally powerful pictorial health warnings launched in 2009, combined with the free telephone counselling service, probably

had a great impact in Brazilian smokers with lower educational and income levels.^{4 35 36}

On the other hand, our results suggest that health needs arising from demographic, epidemiological and economic transitions in Brazil should be taken into consideration when planning tobacco control policies.^{2 8 9 37} Particularly among remaining female smokers, the efficiency and quality of healthcare will likely need to be improved to accommodate their worse general health status. Experiencing more depression symptoms and poorer self-rated health status now than in the past, which are proxy variables for limitations in physical and mental functioning,^{14 19 20 38} can make quitting more challenging. The increase in self-reported sedentary behaviour could be also considered a ‘hardening of the target’, as physical activity may be protective against smoking initiation and may also help smoking cessation.^{10 15 39} In short, the burden of non-communicable conditions in the general population and, therefore, also among smokers in Brazil, requires the adoption of creative therapeutic models. The United Nations’ Human Development Report (HDR) shows, indeed, that there is still room for improvement in general healthcare delivery in Brazil.⁶

For both genders, the cessation rate increased and the proportion of daily smokers among current smokers remained unaltered between 2008 and 2013 or, in some cases, even decreased (eg, women living in rural vs urban areas). Moreover, the proportion of light smokers, which represent about 80% of current daily smokers, did not decline. Considering that less addicted smokers, measured by a low frequency of cigarette use, are more likely to quit,^{10 27} these findings suggest that quitting will continue at present rates in Brazil in the future. However, the increase in years of daily smoking for most sociodemographic groups indicates that Brazil's remaining daily smokers may need an intervention programme tailored to its specific needs.

Brazil's 1996 smoke-free law prohibited the use of tobacco products in all enclosed public places, except in designated smoking areas. Starting in 2009, several States began implementing 100% smoke-free air restrictions, and the 2011 federal law was fully enforced in 2014.^{7 40} These environmental changes over time may have inconvenienced heavy smokers, thus leading to smoking cessation or to a reduction of the degree of addiction of those who continued to smoke.^{1 10 12 41} We found, indeed, that, among current daily smokers, the proportion of heavy smokers did not increase over time, although the 'hardening hypothesis' posits that these smokers would increasingly comprise the remaining smoking population.^{10 11 15} Moreover, although Brazil does not have a law to prevent secondhand smoking inside the home, the proportion of household passive smoking among light smokers, that is, the largest group of smokers, strongly declined between 2008 and 2013. This finding also suggests that remaining smokers in Brazil are likely being replaced by individuals who are less resistant to increasing social disapproval, which can help quitting in the future.

Limitations

Although in both cross-sectional population-based household surveys the samples were probabilistic and nationally representative, these data are subject to survival bias (eg, there may be a higher mortality among heavier and older smokers) and biases resulting from self-reporting health-conditions and tobacco behaviours (eg, there may be an increasing tendency over time to under-report cigarette consumption due to the growing stigma associated with smoking).^{34 42} However, data from other national health surveys and from legal and illegal markets suggest, respectively, an increase over time in non-communicable conditions and a temporal decrease in cigarette consumption.^{5 43 44} Given the public health implications of our study, we only assessed additive interactions,²⁸ as it measures the absolute impact in terms of increase/decrease in the number of smokers. When we also assessed multiplicative interactions, main conclusions against the 'hardening hypothesis' remained unaltered (data not shown). Finally, due to the variability in definitions of 'hardcore' smokers currently used in the literature, researchers need to be cautious when describing remaining smoking population as 'hardcore'.^{10 15}

CONCLUSION

In Brazil, for both genders, as smoking prevalence rates decreased, the proportion of ever smokers who have quit increased. In addition, remaining smokers seem to be making more quitting attempts. These findings suggest that tobacco control interventions implemented in Brazil in the past years seem to be effectively reaching the smoking population to either increase their willingness or ability to quit. Our results strongly

argue against the 'hardening hypothesis' which posits that, as prevalence declines, the smokers that remain will find quitting more challenging.

What this paper adds

- ▶ It has been argued that remaining smokers are less willing and less likely to quit now than in the past. Previous population-wide studies conducted in Brazil have found a consistent reduction over time in daily cigarette consumption among all socioeconomic groups. Our study expands this assessment to other tobacco behaviours and health-related conditions, and represents the first-ever detailed evaluation of the Brazilian remaining smoking population.
- ▶ In Brazil, for males and females, smoking prevalence rates declined, cessation rates increased, and remaining smokers seem to be making more quitting attempts. These findings suggest that the broad set of legislative, healthcare, education and economic interventions implemented in the past years seem to be effectively reaching the smoking population.
- ▶ Our findings are strong evidence against the 'hardening hypothesis' which posits that, as smoking prevalence decreases, the smokers that remain will find quitting more challenging.

Contributors ASS participated in the data processing, data analysis and as lead author in the elaboration/preparation of the article. MCDs participated in the data processing, data analysis and in the elaboration/preparation of the article as co-author. LMDa and MS participated in the consultancy for data analysis and elaboration/preparation of the article as co-authors.

Funding The GATS-Brazil was funded by the Brazilian Ministry of Health and the Bloomberg Foundation.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

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