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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

ABSTRACT

Objectives: The aim of our study was to assess social inequality trends for hypertension, diabetes mellitus, smoking and obesity from 2007 to 2018 in adults from Brazilian capitals.
Setting: Data from the VIGITEL study, a cross-sectional telephone survey conducted annually from 2007 to 2018.
Participants: We used data from 578,977 Brazilian adults (≥18 years).
Design: Cross-sectional surveys conducted annually from 2007 to 2018.
Primary outcome measures: Participants responded a questionnaire about medical diagnosis of hypertension and diabetes, their smoking status, weight and height. Educational inequalities by sex and skin color were assessed trough absolute (slope index of inequality – SII) and relative measures of inequality (concentration index – CIX), and trends were tested by Prais-Winsten.
Results: All outcomes were more prevalent in the least educated. The largest absolute educational inequality was observed for hypertension (SII_{total} = -35.7 in 2018). In 12 years, the total educational disparity remained constant for hypertension, increased for diabetes (absolute) and smoking (relative), and decreased for obesity (relative). Overall, inequality was higher among women and non-whites, compared to men and whites. We found a reduction in absolute inequality for hypertension among non-whites, an increase for diabetes in all strata, and an increase for smoking in women and non-whites. The relative inequality decreased in women and whites and increased for smoking in all strata, except among men.
Conclusion: The educational inequality reduced for obesity, remained constant for hypertension and increased for diabetes and smoking from 2007 to 2018 in Brazilian adults.

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Keywords: Inequality, Hypertension, Diabetes, Smoking, Obesity, Adults.

Strengths and limitations of this study

- We assessed the extent and trend of socioeconomic inequalities in major NCD (hypertension and diabetes) and its risk factors (smoking and obesity) over 12 years in a middle-income country;

- We used large representative samples from Brazilian adults living in the 27 state Capitals in Brazil;

- We assessed educational inequalities in total sample and in subgroups of sex and race/color using complex measures of inequality.

- Using data from a telephone Survey (VIGITEL) limited our generalizability to those with landlines we would expect some small differences in the prevalence of our risk factors if we had assessed a sample that was not limited by landline access.

- The use of self-reported diseases may have affected our results underestimating inequality in hypertension and diabetes, as it may have underestimated the prevalence among least favored groups.

INTRODUCTION

Chronic non-communicable diseases (NCD) are the main cause of death in Brazil[1] and worldwide[2]. According to the Global Burden of Diseases, Injuries, and Risk Factors Study, in 2017, the four main risk factors for mortality and years of life lost due to disability in Brazil were systemic arterial hypertension, diabetes *mellitus*, obesity and smoking[3]. Importantly, these risk factors affect the less economically favored groups in a more pronounced way[4-6], in addition to reinforcing poverty and income inequality by generating an increase in direct and indirect spending and loss of productivity[7]. The synthesis of 283 studies in low- and middle-income countries showed a positive association between low income, low socioeconomic status and low educational level with the occurrence of NCDs[8]. In Brazil, adults with less education, non-whites and without health insurance had a higher prevalence of risk factors for NCD, such as smoking, leisure with physical inactivity, physical inactivity and less consumption of fruits and vegetables[9].

Trend analysis of the risk factors for NCD in Brazil showed that the prevalence of hypertension remained stable between 2006 and 2018, while diabetes and obesity grew and smoking dropped [10]. However, this trend did not occur homogeneously among social strata. Between 1998 and 2013, there was a reduction in educational inequalities for hypertension and coronary heart disease and an increase in inequality for diabetes in Brazilian adults[5]. An American study showed an increase in inequality between 1999 and 2014 for cardiovascular risk, maintaining the percentage of people at high cardiovascular risk in the low-income population and a significant reduction in those with higher income[11].

A sustained reduction in health inequities between countries is necessary[8]. However, trend studies on social inequality in the different risk factors for NCD that are essential for health planning are scarce in Brazil[5], especially assessing risk factors concomitantly and based on educational disparities, also considering sex and color strata. Therefore, our aim was to assess social inequality trends for hypertension, diabetes, smoking and obesity among adults from Brazilian state capitals, from 2007 to 2018. We also performed subgroup analysis for education inequalities for the outcomes by skin color and sex.

METHODS

Study design and source of data and sample

This study used data collected by the Surveillance of Risk and Protection Factors for Chronic Diseases by Telephone Survey (VIGITEL), coordinated by the Ministry of Health of Brazil, from 2007 to 2018. VIGITEL is a cross-sectional system for monitoring the health of the adult population – over 18 years old, residing in the Brazilian capitals and the Federal District (DF), and who have a landline telephone – carried out annually since 2006. The sample stratification took place by telephone prefix until 2011, and subsequently by postal code (CEP). In order to reduce possible biases due to the partial coverage of the population by the landline telephone system, VIGITEL assigned a final weight to each individual, considering the inverse of the number of telephone lines in the household interviewed, the number of adults living in the household and the socio-demographic composition of the sample, based on the 2000 and 2010 demographic censuses. This weighting ensured the representativeness for the general adult population of each city in all years[10].

Data from 625,070 individuals interviewed between 2007 and 2018 were initially obtained. We excluded women who were pregnant and those who had doubts if they were or were not pregnant by the time of the enterview (5,087 women); people aged 80 or older (22,234 individuals) because aging may affect self-reports[12]; people who did not want to or did not know how to respond to their skin color (20,699 respondents) and without body mass index (BMI) data (n=3). These exclusions resulted in a loss of 46,093 (7.4%) observations when compared to the original study. Thus, 578,977 participants were included in this study.

All data of the participants were self-reported. They answered about previous medical diagnosis of hypertension and diabetes (all types), if they were current smokers (yes/no) and their weight and height, used to calculate the Body Mass Index (IMC). We considered IMC≥30kg/m2 for obesity[13]. Risk factors were described according to the number of years of study (divided into 4 categories: 0-3 years of study, 4-8 years, 9-11 years and 12 or more years of study), sex (women and men) and skin color (white and non-white). Skin color also was self-reported and included the categories: white (used for white color) and black, dark, brown, mixed race, yellow, red and indigenous (used for non-white skin color).

Statistical analysis

Prevalence of the four risk factors (2007-2018) was adjusted for age based on the year 2018. We estimated complex measures of inequality such as the slope index of inequality (SII) and the concentration index (CIX) and their 95% confidance interval. Both indicators were calculated according to the World Heath Organization [14] and Barros et al. [15]. While the SII represents the absolute difference between the less (0-3 years of study) and the most favored groups (12 or more years of study), the CIX assesses the relative difference between them. Results equal to zero represent a situation of total equality. When it is equal +1 or -1, we have the grater inequality possible. Negative values indicates a higher prevalence of the risk factor in the least favored group, while positive ones represents grater prevalence in those most favored groups. The results of SII and CIX were multiplied by 100 to facilitate their visualization in tables and graphs, ranging from -100 to +100. On this scale, CIX values less than -20 or greater than 20 can be considered relevant indicators of inequality[14].

The different levels of education were used to calculate the total SII and CIX. Subsequently, the SII and CIX data for schooling were stratified by sex and skin color. The time trend of the indicators was analyzed by linear regression using the Prais-Winsten method [16]. Statistical analyses were performed using the STATA/SE® 15.1 software.

Ethical aspects

VIGITEL was approved by the National Research Ethics Commission (CONEP). The VIGITEL database is in the public domain and does not allow identification of participants. It is available at the electronic address: http://svs.aids.gov.br/download/Vigitel/. The waiver of ethical review was approved by the Research Ethics Committee of the Federal University of Uberlândia, Minas Gerais (CAAE: 2,654,271).

Role of the funding source

This research received financial support from Brazilian National Council of Scientific and Technological Development (CNPq), 404905/2016-1, awarded to Catarina Machado Azeredo. The study sponsor was not involved in the design of the study; the collection, analysis, and interpretation of data; writing the report; or the decision to submit the report for publication.

RESULTS

From 2007 to 2018, the profile of individuals evaluated remained similar, with 40 years as the mean age and similar distribution between sexes and skin color (53.2% female and 55.6% non-white in 2018). The average number of years of study showed a significant increase in the period, going from 9.4 to 10.7 years of study. The prevalence of hypertension remained constant in the period (34.1% in 2007 to 33.3% in 2018), with a reduction in smoking (from 13.0% to 7.4%), while the prevalence of diabetes (8.9% to 10.6%) and obesity increased (14.7% to 20.0%) (Table 1).

An important educational gradient was observed for all risk factors, with a higher prevalence among those with less education. The largest educational discrepancy was observed for diabetes and the smallest for smoking, with slight variations over the period (Figure 1). In 2018, for example, the prevalence of risk factors in adults with less education (0-3 years of study) was 28.4% for obesity, 60.7% for hypertension, 24.4% for diabetes and 9.0% for smoking. On the other hand, in adults with 12 years or more of study the prevalence rates were 16.8% for obesity, 23.8% for hypertension, 6.4% for diabetes and 5.6% for smoking.

Hypertension, diabetes, and obesity were more prevalent in women than in men, while smoking prevalence was higher in men. The prevalence of outcomes was higher in non-whites compared to whites for hypertension and obesity, and lower for diabetes and smoking. Supplementary tables 1 to 4 show the age-adjusted prevalence of each outcome by years of study and stratified by sex and skin color.

Table 2 shows the absolute (SII) and relative (CIX) measures of educational inequality for the four outcomes. Negative SII and CIX values for all risk factors reaffirm their higher prevalence among groups with less education.

The absolute and relative educational inequality for hypertension, diabetes and obesity was, in general, higher among women than men and higher in non-white individuals compared to whites, represented by negative and higher SII and CIX values (Figures 2 and 3). The exceptions were for the SII in smoking, as inequality was higher in men, being important to note that CIX reversed its trend of higher inequality in men in 2007, for women in 2018. Obesity showed higher absolute and relative inequality among whites (Figure 3). Over the period, there was a reduction in absolute inequality in hypertension only among non-whites (Figure 2). The relative inequality remained constant, being higher in women than in men and in non-whites in relation to whites (Figure 2). The absolute inequality in diabetes had a statistically significant increase in all strata (Figure 2). This increase was greater in men than in women, as well as in whites in relation to non-whites. The relative inequality in diabetes remained constant over the period (Figure 2). The absolute inequality for obesity remained constant, although there was a reduction in the relative inequality for the total sample, between women and non-whites (Figure 3). There was an increase in absolute inequality in smoking between whites and women in the analyzed period. The relative inequality in smoking increased in all strata, except among men, where it remained constant (Figure 3).

DISCUSSION

In our study, diabetes, hypertension, obesity, and smoking remained more prevalent in the less educated groups from 2007 to 2018 in Brazil. The absolute and relative educational inequalities were higher among women and non-whites, compared to men and whites. Hypertension was the risk factor that had the highest absolute educational inequality, which decreased only among non-whites in the period; the absolute educational inequality for diabetes increased in all strata. The absolute educational inequality remained constant for obesity, although the relative one has reduced for the total sample, among women and non-whites. There was an increase in the absolute educational inequality for smoking among women and whites and relative educational inequality for all strata, except for men where it remained constant.

Hypertension had the highest educational inequality, which remained constant in the period, except for the reduction among non-whites. On the other hand, educational inequality for diabetes increased in this period in all strata. Trend analysis of prevalence of diabetes, hypertension and heart disease from 1998 to 2013 also found an increase in diabetes disparities among a representative sample of Brazilian adults[5]. It is possible that strategies such as the Brazilian National Policy for the Comprehensive Health of the Black Population[17], could have contributed to reduce race inequality by decreasing the prevalence of hypertension among non-whites. However, if this is true, we would expect to find a reduction in race inequality for diabetes. There are several potential explanations for the increase in educational gap for diabetes. This could have been partially driven by our finding of an increase in obesity prevalence over time, and higher prevalence among those less educated. Obesity is a risk factor stronger for diabetes than for hypertension[18 19]. It is also possible that the increase in primary care coverage has provided access to health care and, consequently, increased the diagnosis of diabetes among those underprivileged (i.e., therefore, artificially increasing the diabetes inequality). The National Program for Improving Access and Quality in Primary Care and the Requalification Program for Basic Health Units (*Programa Nacional de Melhoria do Acesso e da Qualidade da Atenção Básica* -PMAQ), created in 2011, as well as the More Doctors for Brazil Project (*Mais Médicos para o Brasil*), created in 2013, increased the number of health units and physicians' access to more than 65 million people[20]. If that was the case, we would expect increase in social inequality for hypertension too[21]. Unless the requirement of fewer medical supplies for hypertension diagnosis compared to diabetes[21] causes less underreport for hypertension and, therefore, benefits less from the extension in primary care coverage not affecting the inequality.

The increase in obesity prevalence over time, especially among the less educated group, have been reported in other countries[22]. This can be explained by the lower financial access to healthy food in addition to fewer opportunities to engage in leisure physical activities[23]. Some small progress was found with a reduction on the relative educational inequality for obesity in the total sample, women and non-whites. Nonetheless, Brazil still lacks strong initiatives to protect the more vulnerable groups and tackle the social inequalities for obesity such as regulation of nutritional labelling claims and health warnings, advertising restrictions, protection of the food school environment and taxation of unhealthy food[24], jointly with a broad promotion of active commuting and availability of public spaces for physical activity[25].

Our results confirm the global decrease trend in smoking prevalence[26], with a sharper reduction among the more educated adults[27]. This explained the increase in the relative educational inequality in most strata, except among men. Several actions have been taken to halt smoking, such as the ratification of the World Health Organization Framework Convention on Tobacco Control in 2005, which resulted in the Brazilian National Tobacco Control Policy[28]. These policies may have had less impact on less educated people[29], increasing social inequality. Although actions, such as the taxation of tobacco products, immediately affect low-income individuals, over time they resort to the illegal market, maintaining the cigarette use. Recent work shows that, in Brazil, the illegal cigarette market grew from 28.6% in 2012 to 42.8% in 2016[30]. Moreover, most actions aimed at changing behavior in favor of smoking cessation are educational, requiring cognitive skills for better understanding and, thus, more educated people will benefit more from these interventions[31]. In addition, tobacco companies have intensified marketing strategies to reach vulnerable populations, such as women[32], which may also justify the higher inequality in this group.

Educational inequality for risk factors for NCDs has disproportionately affected women and non-whites in Brazil. Although women have had more schooling than men in Brazil, their average income has been lower[33]. Illiteracy among women aged 15 years and over non-white was more than double that of white women (10.2% and 4.9%, respectively). Although there was an improvement in the education of the non-white adult population with 12 or more years of study between 1995 and 2015 (from 3.3 to 12%), this percentage among whites was more than two-fold higher in 2015 (25.9%)[33]. In Brazil, unlike other countries, social inequality drives racial disparities[34]. Black people have less access to health care, less quality of health care and are less informed about health promotion and disease prevention[35].

We found punctual reduction in the disparities for hypertension and obesity, and an increase in disparities for diabetes and smoking, that are all modifiable risk factors sensitive to strategies promoting health lifestyle[36]. Accordingly, policies targeting the vulnerable groups, such as income redistribution[37], a strong and broad social security system and health education and promotion, would avoid the reinforcement of the current inequalities[8] and bring better health outcomes for Brazilians. In the last decades, Brazil has adopted several policies that could mitigate socioeconomic inequalities, with the potential to alter the prevalence of risk factors for NCDs, such as the expansion of primary health care, through the Family Health Strategy, and conditional cash transfer, through Bolsa Família Program. These policies increased the access of the low-income population to health promotion and disease prevention actions [38 39]. Launched in 2011 by the Minister of Health of Brazil, the Strategic Action Plan for Trackling Chronic Non-Communicable Diseases in Brazil has made advances in survaillance (eg. national surveys and monitoring of mortality and risk factor reduction targets); health promotion (eg. encouragement of physical activity, adequate nutrition and health promotion through the creation of the Health Gym Program); regulation (eg. legislation on tobacco-free environments); and health care (eg. free of charge drugs for hypertension, diabetes, and asthma; organization of the emergency service network for cardiovascular diseases) [40]. Despite efforts, limited advances have been achieved. Health inequality is a persistent phenomenon [41]. Moreover, since 2014, Brazil has been facing an economic crisis and recently adopted austerity policies that could negatively impact health inequality trends[42].

Our results may serve as a starting point for new studies that can deepen into the causes that led to the reductions in educational inequalities observed for hypertension and obesity. Future studies also need to understand the reasons for an increase in educational inequality for diabetes and smoking.

Our study has some limitations. VIGITEL survey collected data only from the population that has landlines and included only the adults living in Brazilian capitals and the federal district. Despite using weighting measures for the general population, we would expect some small differences in the prevalence of our risk factors if we had assessed a sample that was not limited by landline access[43]. Over time, the acess to landlines has reduced, and older and wealthier households are more likely to have and retain a landline in addition to a mobile phone. Therefore, the set of those contacted in a landline-only survey will increasingly skew towards those older/ wealthier groups. This may have underestimated the prevalence of NCDs risk factors in those places with less landlines acess [44]. Future studies need to assess social inequality for NCDs in rural areas[8]. In addition, risk factors were self-reported and may be underestimated, especially medical diagnosis of diabetes and hypertension. This may have affected our results underestimating inequality in hypertension and diabetes, as it may have underestimated the prevalence among least favored groups.

In conclusion, we observed a reduction in educational gap for hypertension and obesity and an increase for diabetes mellitus and smoking from 2007 to 2018. Absolute educational inequality for hypertension decreased between non-whites, and relative inequality decreased for obesity in general and among women and non-whites. The absolute educational inequality increased for diabetes in all strata and increased for smoking in almost all strata, in relative and absolute forms.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

CONTRIBUTION STATEMENT

P.T.D. contributed to data analysis and interpretation and to drafting and revising the manuscript and figures. C.M.A., L.S.S., A.E.M.R. L.F.M.R. and E.S.M. contributed to study concept and design, data interpretation, revising the manuscript and figures, and final approval of the version submitted.

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Table 1: Sociodemographic characteristics and risk factor prevalence, according to survey year of VIGITEL (2007-2018).

Characteristics	Survey year											
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Individuals (n)	54,271	52,641	52,726	52,628	51,656	40,374	45,889	34,991	49,919	46,488	48,931	48,463
Mean age (years)	39.8	39.9	40.2	40.3	40.4	40.1	40.2	40.2	40.9	40.7	41.4	41.7
Education (years)	9.4	9.4	9.6	9.8	9.9	10.3	10.4	10.6	10.5	10.8	10.6	10.7
Sex (%)												
Female	53.2	53.3	53.3	53.2	53.2	53.3	53.4	53.4	53.1	53.3	53.3	53.2
Male	46.8	46.7	46.7	46.8	46.8	46.7	46.6	46.6	46.9	46.7	46.7	46.8
Skin color (%)												
White	40.8	39.0	39.1	39.8	43.9	43.5	45.0	43.6	41.2	46.2	45.0	44.4
Non-white	59.2	61.0	60.9	60.2	56.1	56.5	55.0	56.4	58.8	53.8	55.0	55.6
Risk factors (%) +												
Hypertension	34.1	35.5	35.4	35.6	34.9	33.6	33.1	33.8	33.7	33.6	33.2	33.3
Diabetes	8.9	9.3	10.0	10.3	10.2	9.9	9.5	10.9	10.2	12.0	10.4	10.6
Smoking	13.0	12.3	11.9	11.2	11.0	10.0	8.8	8.7	8.1	7.9	7.6	7.4
Obesity	14.7	15.5	15.9	16.8	17.7	18.2	18.1	18.8	19.0	19.1	19.1	20.0

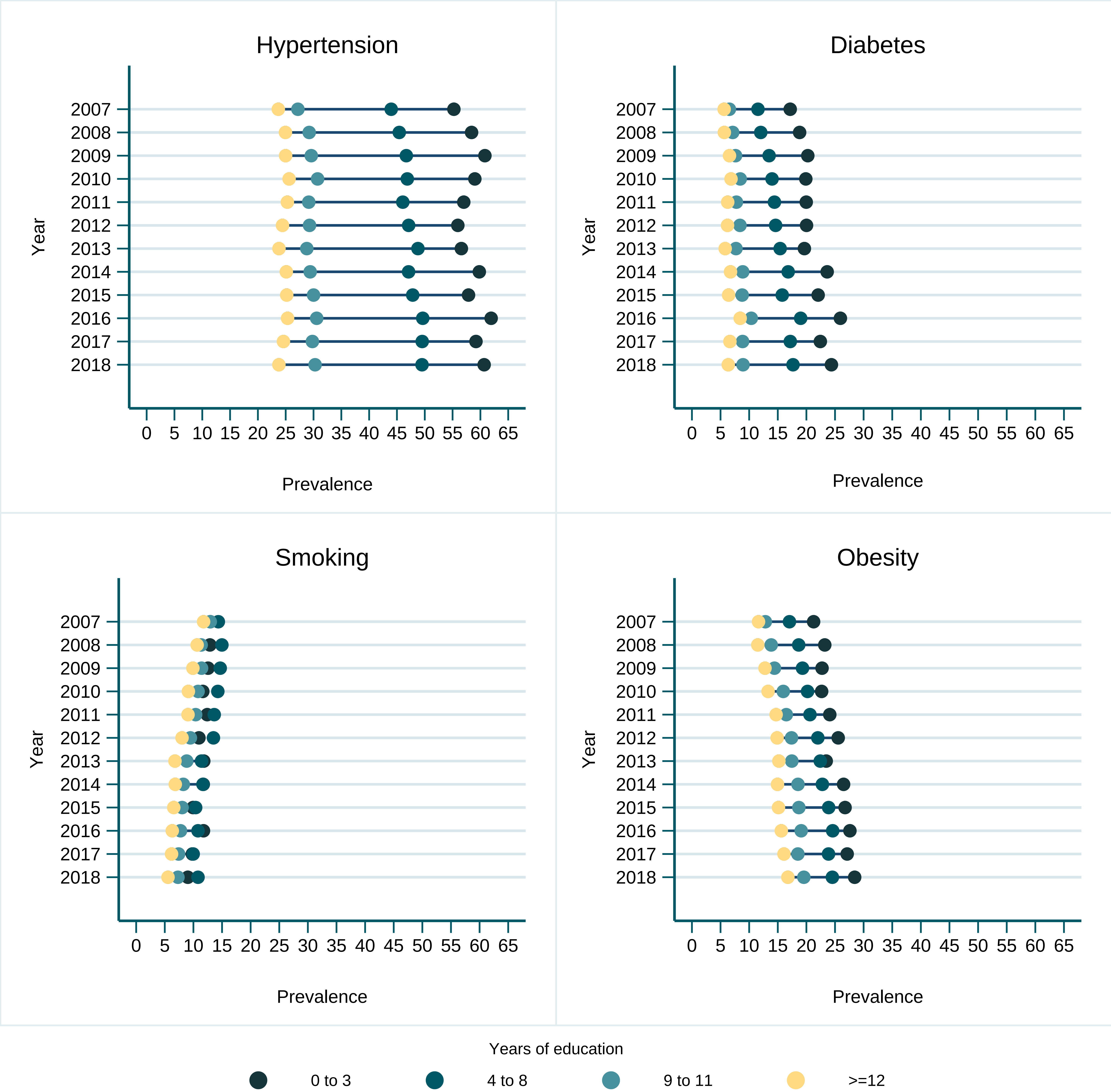
+ Age-standardized prevalence;

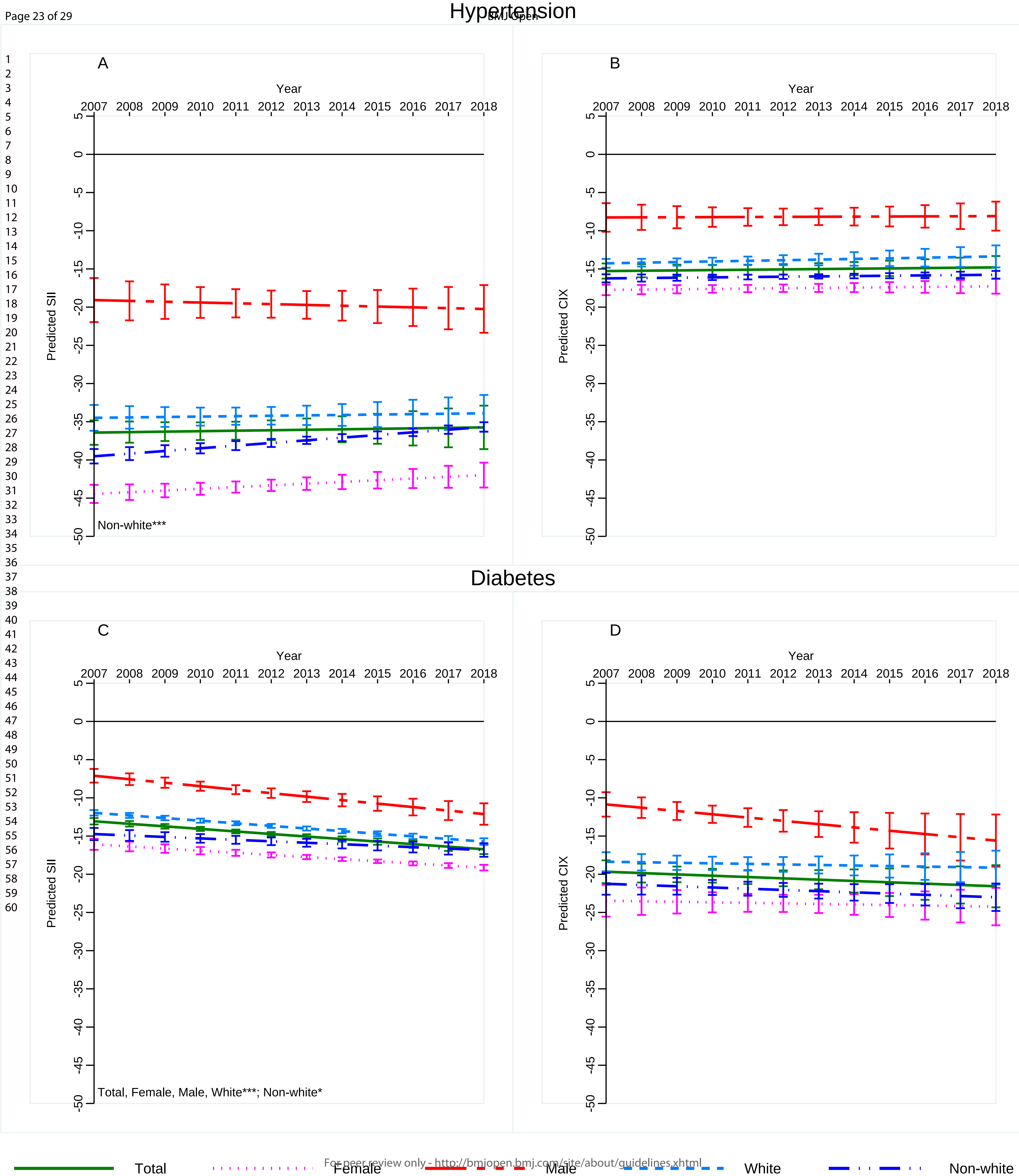
Table 2: Absolute (SII) and relative (CIX) education inequality in hypertension, diabetes, smoking and obesity* for the total population.

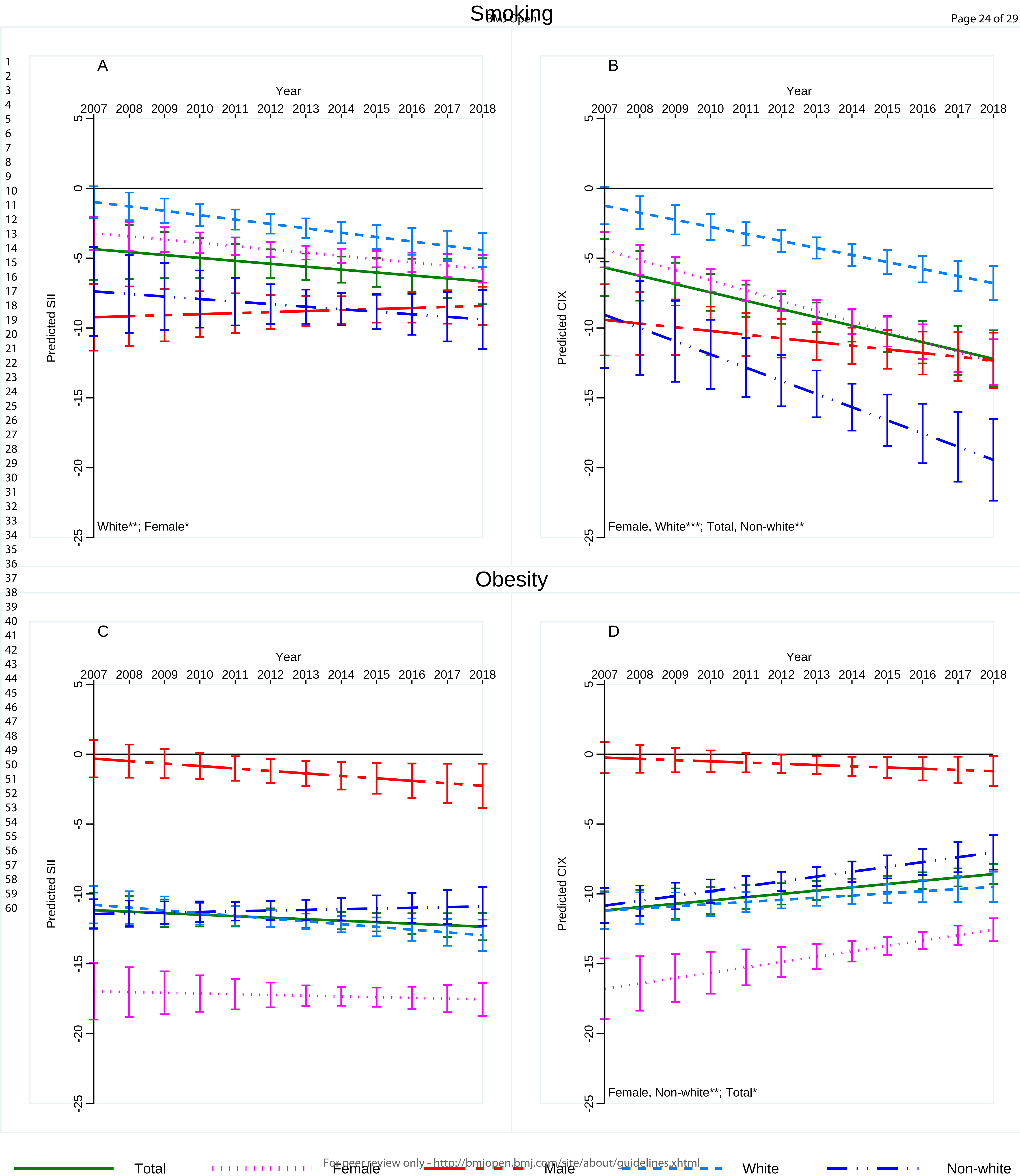
Risk factor	SII (95% CI)		CIX (95% CI)	
	2007	2018	2007	2018
Hypertension	-36.4 (-38.0; -34.8)	-35.7 (-38.6; -32.9)	-15.3 (-16.3; -14.3)	-14.8 (-16.3; -13.3)
Diabetes	-13.1 (-13.5; -12.6)	-16.7 (-17.4; -16.1)	-19.7 (-21.2; -18.2)	-21.6 (-24.3; -18.8)
Smoking	-4.4 (-6.6; -2.2)	-6.7 (-8.3; -5.0)	-5.7 (-7.7; -3.6)	-12.2 (-14.2; -10.2)
Obesity	-11.2 (-12.4; -9.9)	-12.3 (-13.3; -11.4)	-11.2 (-12.5; -9.8)	-8.6 (-9.3; -7.9)

VIGITEL, 2007 and 2018.

*Age-standardized prevalence; SII: Slope index of inequality; CIX: Concentration index of inequality.


Hypertension
Diabetes
Smoking
Obesity
Year
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Prevalence
Years of education
0 to 3
4 to 8
9 to 11
>=12


Hypertension
A
Year
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Predicted SII
5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
Non-white***
B
Year
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Predicted CIX
5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
Diabetes
C
Year
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Predicted SII
5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
Total, Female, Male, White***; Non-white*
D
Year
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Predicted CIX
5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
Total
Female
Male
White
Non-white


Smoking
A
Year
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Predicted SII
5 0 -5 -10 -15 -20 -25
White**; Female*
B
Predicted CIX
Female, White***; Total, Non-white**
Obesity
C
D
Female, Non-white**; Total*
Total
Female
Male
White
Non-white

Supplementary table 1: Age-standardized prevalence of hypertension by years of education, sex and skin color, VIGITEL 2007-2018.

Years of education Sex and skin color (%)	Hypertension % (95% CI) 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0-3 years												
Total	55.2 (53.3; 57.2)	58.4 (56.5; 60.3)	60.8 (58.8; 62.8)	59.0 (57.0; 61.0)	57.0 (55.1; 58.9)	56.0 (53.5; 58.4)	56.6 (54.3; 58.9)	59.8 (57.3; 62.4)	57.9 (55.9; 59.9)	61.9 (59.7; 64.1)	59.2 (57.2; 61.2)	60.7 (58.8; 62.6)
Female	58.9 (-115.4; 115.4)	62.4 (-122.2; 122.2)	64.6 (-126.6; 126.6)	63.0 (-123.5; 123.5)	62.1 (-121.8; 121.8)	60.0 (-117.6; 117.6)	62.2 (-121.9; 121.9)	62.5 (-122.6; 122.6)	62.5 (-122.5; 122.5)	66.7 (-130.8; 130.8)	62.6 (-122.8; 122.8)	63.6 (-124.7; 124.7)
Male	46.2 (-89.3; 91.7)	48.3 (-93.6; 95.9)	50.7 (-98.2; 100.6)	48.8 (-94.5; 96.9)	43.3 (-83.8; 86.1)	45.1 (-86.9; 89.9)	43.3 (-83.4; 86.2)	52.6 (-101.6; 104.7)	45.3 (-87.6; 90.0)	50.4 (-97.4; 100.1)	50.5 (-97.8; 100.2)	52.9 (-102.6; 104.9)
White	54.6 (-105.3; 108.7)	57.6 (-111.2; 114.7)	59.0 (-113.9; 117.5)	61.5 (-118.7; 122.3)	58.9 (-113.7; 117.1)	55.8 (-107.1; 111.5)	56.9 (-109.6; 113.6)	56.6 (-108.6; 113.2)	57.2 (-110.3; 113.9)	61.5 (-118.6; 122.5)	58.6 (-113.2; 116.7)	61.6 (-118.9; 122.4)
Non-white	55.5 (-107.0; 110.7)	58.8 (-113.3; 117.0)	61.5 (-118.5; 122.5)	57.9 (-111.6; 115.4)	55.9 (-108.1; 111.3)	56.1 (-108.0; 111.9)	56.3 (-108.6; 112.1)	62.5 (-120.4; 124.4)	58.2 (-112.3; 115.9)	62.3 (-120.4; 123.8)	60.5 (-117.0; 120.4)	58.5 (-113.0; 116.2)
4-8 years												
Total***	44.0 (42.8; 45.2)	45.4 (44.2; 46.6)	46.7 (45.5; 47.9)	46.9 (45.7; 48.0)	46.1 (44.9; 47.2)	47.1 (45.8; 48.4)	48.8 (47.6; 50.0)	47.1 (45.8; 48.4)	47.8 (46.7; 48.9)	49.6 (48.4; 50.9)	49.5 (48.4; 50.7)	49.5 (48.4; 50.6)
Female***	48.3 (-94.7; 94.7)	50.6 (-99.3; 99.3)	50.4 (-98.8; 98.8)	50.9 (-99.8; 99.8)	51.0 (-100.0; 100.0)	52.1 (-102.2; 102.2)	53.4 (-104.7; 104.7)	51.3 (-100.5; 100.5)	52.7 (-103.4; 103.4)	54.1 (-106.1; 106.1)	53.6 (-105.0; 105.0)	53.5 (-104.9; 104.9)
Male***	35.3 (-68.3; 69.9)	34.6 (-66.9; 68.5)	38.8 (-75.3; 76.9)	38.2 (-74.1; 75.7)	36.2 (-70.2; 71.7)	36.7 (-71.0; 72.7)	38.5 (-74.7; 76.2)	37.9 (-73.3; 75.0)	37.7 (-73.2; 74.6)	40.5 (-78.5; 80.1)	40.9 (-79.5; 80.9)	40.6 (-78.9; 80.4)
White***	45.7 (-88.6; 90.5)	48.2 (-93.5; 95.4)	47.2 (-91.5; 93.5)	48.5 (-94.1; 96.0)	47.8 (-92.8; 94.6)	48.9 (-94.9; 97.0)	51.8 (-100.5; 102.4)	48.0 (-92.9; 95.1)	48.9 (-94.9; 96.7)	50.7 (-98.3; 100.3)	51.4 (-99.8; 101.7)	50.1 (-97.2; 99.1)
Non-white**	43.0 (-83.1; 85.3)	43.9 (-84.9; 87.1)	46.4 (-89.9; 92.1)	45.9 (-89.0; 91.1)	44.8 (-86.9; 88.8)	45.6 (-88.3; 90.4)	46.1 (-89.5; 91.3)	46.4 (-89.9; 92.0)	47.2 (-91.6; 93.5)	48.7 (-94.6; 96.4)	47.4 (-92.0; 93.9)	47.5 (-92.1; 94.0)
9-11 years												
Total	27.2 (26.3; 28.1)	29.2 (28.3; 30.1)	29.6 (28.7; 30.5)	30.7 (29.9; 31.6)	29.2 (28.3; 30.0)	29.3 (28.4; 30.2)	28.8 (28.0; 29.6)	29.4 (28.5; 30.3)	30.0 (29.3; 30.8)	30.6 (29.8; 31.4)	29.8 (29.0; 30.6)	30.3 (29.5; 31.1)
Female*	29.0 (-56.8; 56.8)	31.4 (-61.6; 61.6)	31.6 (-61.9; 61.9)	32.7 (-64.1; 64.1)	31.0 (-60.8; 60.8)	31.5 (-61.7; 61.7)	31.0 (-60.7; 60.7)	31.3 (-61.4; 61.4)	32.9 (-64.6; 64.6)	32.6 (-63.9; 63.9)	32.0 (-62.8; 62.8)	33.1 (-64.8; 64.8)
Male	24.1 (-46.7; 47.9)	25.5 (-49.3; 50.6)	26.2 (-50.7; 51.9)	27.1 (-52.6; 53.7)	26.1 (-50.7; 51.8)	25.5 (-49.3; 50.5)	25.2 (-48.9; 50.0)	26.2 (-50.8; 52.0)	25.2 (-48.8; 49.8)	27.2 (-52.9; 53.9)	26.0 (-50.5; 51.5)	25.5 (-49.4; 50.5)
White	27.9 (-54.0; 55.3)	31.4 (-60.9; 62.2)	31.3 (-60.6; 61.9)	33.1 (-64.2; 65.5)	32.4 (-62.9; 64.1)	33.3 (-64.5; 65.8)	31.1 (-60.3; 61.5)	31.8 (-61.7; 63.1)	31.4 (-61.1; 62.2)	33.4 (-65.0; 66.2)	32.0 (-62.1; 63.3)	31.9 (-61.9; 63.0)
Non-white	26.7 (-51.6; 53.1)	27.8 (-53.7; 55.3)	28.5 (-55.1; 56.7)	29.3 (-56.6; 58.1)	26.8 (-51.9; 53.3)	26.3 (-50.8; 52.3)	27.1 (-52.4; 53.7)	27.7 (-53.5; 55.0)	29.2 (-56.5; 57.8)	28.6 (-55.3; 56.7)	27.4 (-53.0; 54.3)	27.6 (-53.5; 54.8)
12 or more years												
Total	23.7 (22.7; 24.6)	25.0 (24.0; 25.9)	25.0 (24.1; 25.9)	25.6 (24.7; 26.5)	25.3 (24.4; 26.2)	24.4 (23.5; 25.3)	23.8 (23.0; 24.6)	25.1 (24.2; 26.0)	25.2 (24.5; 25.9)	25.3 (24.6; 26.0)	24.6 (23.9; 25.3)	23.8 (23.1; 24.4)
Female	22.4 (-43.8; 43.8)	23.9 (-46.9; 46.9)	24.3 (-47.7; 47.7)	25.4 (-49.8; 49.8)	24.3 (-47.7; 47.7)	23.9 (-46.7; 46.7)	23.0 (-45.0; 45.0)	25.0 (-49.1; 49.1)	25.2 (-49.3; 49.3)	24.7 (-48.5; 48.5)	24.0 (-47.1; 47.1)	23.6 (-46.3; 46.3)
Male	25.7 (-49.8; 51.0)	26.6 (-51.5; 52.8)	26.0 (-50.4; 51.6)	26.0 (-50.3; 51.5)	26.9 (-52.1; 53.3)	25.4 (-49.2; 50.4)	25.2 (-48.9; 49.9)	25.3 (-48.9; 50.1)	25.2 (-49.0; 49.9)	26.3 (-51.2; 52.1)	25.6 (-49.7; 50.5)	24.0 (-46.6; 47.5)
White	24.7 (-47.7; 49.2)	25.2 (-48.6; 50.0)	24.7 (-47.8; 49.2)	26.7 (-51.7; 53.1)	26.4 (-51.1; 52.4)	25.4 (-49.0; 50.4)	25.9 (-50.2; 51.4)	26.7 (-51.5; 53.0)	26.8 (-52.0; 53.2)	27.1 (-52.5; 53.6)	26.0 (-50.5; 51.6)	25.0 (-48.4; 49.4)
Non-white	22.3 (-43.0; 44.4)	24.7 (-47.8; 49.1)	25.3 (-48.9; 50.2)	24.2 (-46.9; 48.1)	23.8 (-46.0; 47.3)	23.2 (-44.8; 46.1)	21.1 (-40.7; 41.9)	23.3 (-45.0; 46.3)	23.2 (-45.0; 46.0)	23.2 (-45.0; 46.0)	22.0 (-42.7; 43.7)	21.7 (-42.0; 43.0)

*p<0.05; **p<0.01; ***p<0.001.

Supplementary table 2: Age-standardized prevalence of diabetes by years of education, sex and skin color, VIGITEL 2007-2018.

Years of education	Diabetes % (95% CI)											
Sex and skin color (%)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0-3 years												
Total***	17.2 (15.6; 18.7)	18.8 (17.2; 20.4)	20.3 (18.5; 22.0)	19.9 (18.2; 21.6)	20.0 (18.4; 21.6)	20.0 (18.0; 22.0)	19.7 (17.8; 21.5)	23.6 (21.4; 25.9)	22.1 (20.3; 23.8)	25.9 (23.9; 28.0)	22.4 (20.8; 24.1)	24.4 (22.7; 26.0)
Female***	18.2 (-35.7; 35.7)	20.1 (-39.4; 39.4)	21.4 (-42.0; 42.0)	20.8 (-40.7; 40.7)	21.7 (-42.6; 42.6)	21.8 (-42.8; 42.8)	21.7 (-42.6; 42.6)	25.6 (-50.1; 50.1)	23.7 (-46.5; 46.5)	28.1 (-55.1; 55.1)	24.0 (-47.0; 47.0)	25.8 (-50.6; 50.6)
Male**	14.6 (-27.6; 29.6)	15.6 (-29.5; 31.5)	17.2 (-32.5; 34.8)	17.7 (-33.5; 35.7)	15.3 (-28.9; 30.9)	15.2 (-28.6; 31.1)	14.8 (-27.7; 30.2)	18.6 (-34.9; 37.8)	17.5 (-33.2; 35.4)	20.7 (-39.3; 41.9)	18.5 (-35.2; 37.3)	20.6 (-39.4; 41.5)
White*	15.7 (-29.6; 32.0)	18.3 (-34.6; 37.0)	20.2 (-38.1; 41.0)	20.3 (-38.3; 41.1)	18.1 (-34.1; 36.6)	18.0 (-33.6; 36.9)	19.4 (-36.6; 39.4)	23.2 (-43.8; 47.3)	22.5 (-42.8; 45.6)	25.2 (-47.8; 50.9)	21.7 (-41.1; 43.9)	21.5 (-40.8; 43.6)
Non-white***	17.8 (-33.6; 36.3)	19.1 (-35.9; 38.8)	20.3 (-38.0; 41.5)	19.7 (-37.0; 40.4)	21.1 (-40.1; 42.6)	21.5 (-40.7; 43.7)	19.9 (-37.5; 40.4)	24.0 (-45.3; 48.7)	21.8 (-41.2; 44.3)	26.6 (-50.7; 53.7)	22.4 (-42.5; 45.4)	24.2 (-46.0; 48.7)
4-8 years												
Total***	11.5 (10.7; 12.4)	12.0 (11.2; 12.9)	13.5 (12.6; 14.4)	14.0 (13.1; 14.9)	14.4 (13.5; 15.3)	14.6 (13.7; 15.6)	15.4 (14.5; 16.3)	16.8 (15.8; 17.9)	15.8 (15.0; 16.6)	19.0 (18.0; 20.0)	17.2 (16.3; 18.0)	17.7 (16.8; 18.5)
Female***	12.4 (-24.3; 24.3)	13.1 (-25.7; 25.7)	13.8 (-27.1; 27.1)	14.7 (-28.8; 28.8)	15.8 (-31.0; 31.0)	15.0 (-29.4; 29.4)	16.0 (-31.4; 31.4)	17.3 (-34.0; 34.0)	16.6 (-32.6; 32.6)	20.2 (-39.5; 39.5)	17.7 (-34.7; 34.7)	18.0 (-35.4; 35.4)
Male***	9.8 (-18.7; 19.9)	9.8 (-18.6; 19.8)	12.7 (-24.4; 25.6)	12.5 (-24.0; 25.2)	11.7 (-22.3; 23.5)	13.8 (-26.5; 27.7)	14.1 (-27.1; 28.3)	15.7 (-30.2; 31.5)	14.0 (-26.9; 28.0)	16.7 (-32.0; 33.3)	16.1 (-31.0; 32.1)	16.8 (-32.4; 33.5)
White***	12.3 (-23.4; 24.7)	12.7 (-24.4; 25.6)	13.9 (-26.4; 27.9)	15.5 (-29.8; 31.2)	15.3 (-29.4; 30.7)	14.1 (-26.9; 28.5)	16.5 (-31.5; 33.0)	17.0 (-32.4; 34.1)	15.8 (-30.4; 31.7)	20.6 (-39.5; 41.0)	17.6 (-33.9; 35.3)	18.3 (-35.1; 36.5)
Non-white***	11.1 (-21.1; 22.5)	11.6 (-22.0; 23.6)	13.3 (-25.2; 26.9)	13.1 (-24.9; 26.6)	13.8 (-26.3; 27.7)	15.0 (-28.7; 30.2)	14.5 (-27.7; 29.1)	16.7 (-31.9; 33.6)	15.7 (-30.2; 31.5)	17.6 (-33.8; 35.3)	16.4 (-31.3; 32.8)	16.1 (-30.8; 32.2)
9-11 years												
Total***	6.5 (6.0; 7.1)	7.1 (6.6; 7.7)	7.6 (7.1; 8.2)	8.4 (7.9; 9.0)	7.8 (7.3; 8.3)	8.4 (7.8; 9.0)	7.7 (7.2; 8.2)	8.9 (8.3; 9.5)	8.8 (8.3; 9.3)	10.4 (9.8; 10.9)	8.9 (8.4; 9.3)	8.9 (8.5; 9.4)
Female**	6.7 (-13.2; 13.2)	7.3 (-14.3; 14.3)	7.8 (-15.2; 15.2)	8.9 (-17.4; 17.4)	7.9 (-15.5; 15.5)	8.6 (-16.9; 16.9)	7.9 (-15.6; 15.6)	9.1 (-17.8; 17.8)	9.4 (-18.4; 18.4)	11.0 (-21.5; 21.5)	8.9 (-17.4; 17.4)	9.1 (-17.9; 17.9)
Male***	6.3 (-11.9; 12.6)	6.8 (-13.0; 13.8)	7.4 (-14.1; 14.8)	7.6 (-14.5; 15.3)	7.6 (-14.4; 15.2)	8.0 (-15.3; 16.0)	7.3 (-14.0; 14.7)	8.6 (-16.4; 17.2)	7.7 (-14.9; 15.5)	9.4 (-18.0; 18.7)	8.8 (-17.0; 17.6)	8.6 (-16.6; 17.2)
White**	6.9 (-13.1; 13.9)	8.3 (-15.9; 16.7)	8.0 (-15.3; 16.2)	9.8 (-18.8; 19.6)	9.1 (-17.4; 18.2)	9.3 (-17.8; 18.6)	8.6 (-16.6; 17.3)	9.7 (-18.6; 19.5)	9.5 (-18.3; 19.0)	11.5 (-22.1; 22.9)	9.8 (-18.9; 19.6)	9.5 (-18.3; 19.0)
Non-white**	6.3 (-11.9; 12.8)	6.4 (-11.9; 13.0)	7.4 (-13.9; 14.9)	7.6 (-14.3; 15.4)	6.8 (-12.9; 13.9)	7.7 (-14.7; 15.6)	7.0 (-13.2; 14.1)	8.3 (-15.7; 16.7)	8.3 (-15.9; 16.7)	9.6 (-18.3; 19.2)	7.7 (-14.6; 15.5)	8.0 (-15.3; 16.1)
12 or more years												
Total	5.6 (5.1; 6.2)	5.7 (5.1; 6.2)	6.6 (6.0; 7.1)	6.8 (6.3; 7.4)	6.3 (5.7; 6.8)	6.2 (5.7; 6.8)	5.8 (5.4; 6.2)	6.7 (6.2; 7.3)	6.4 (6.0; 6.8)	8.4 (8.0; 8.9)	6.6 (6.2; 7.0)	6.4 (6.0; 6.7)
Female*	4.7 (-9.1; 9.1)	4.7 (-9.2; 9.2)	5.9 (-11.5; 11.5)	6.5 (-12.7; 12.7)	5.6 (-11.0; 11.0)	6.0 (-11.7; 11.7)	5.4 (-10.5; 10.5)	6.7 (-13.2; 13.2)	6.1 (-12.0; 12.0)	7.9 (-15.6; 15.6)	6.1 (-11.9; 11.9)	6.1 (-11.9; 11.9)
Male	7.1 (-13.6; 14.3)	7.2 (-13.7; 14.4)	7.7 (-14.7; 15.4)	7.4 (-14.2; 14.9)	7.4 (-14.1; 14.7)	6.6 (-12.7; 13.4)	6.6 (-12.6; 13.2)	6.7 (-12.9; 13.6)	6.9 (-13.2; 13.7)	9.3 (-17.9; 18.5)	7.6 (-14.6; 15.1)	6.9 (-13.2; 13.7)
White*	5.7 (-10.6; 11.6)	5.6 (-10.5; 11.5)	6.7 (-12.6; 13.6)	7.1 (-13.5; 14.3)	6.7 (-12.8; 13.7)	6.3 (-11.9; 12.7)	6.4 (-12.2; 13.0)	7.3 (-13.9; 14.8)	7.0 (-13.3; 14.0)	9.3 (-17.8; 18.5)	7.2 (-13.8; 14.5)	6.8 (-13.0; 13.6)
Non-white	5.6 (-10.6; 11.3)	5.7 (-10.9; 11.6)	6.4 (-12.2; 13.0)	6.5 (-12.4; 13.2)	5.6 (-10.6; 11.3)	6.2 (-11.7; 12.4)	5.0 (-9.5; 10.2)	6.1 (-11.5; 12.3)	5.8 (-11.0; 11.6)	7.4 (-14.2; 14.9)	5.7 (-10.9; 11.5)	5.6 (-10.7; 11.2)

*p<0.05; **p<0.01; ***p<0.001.

Supplementary table 3: Age-standardized prevalence of smoking by years of education, sex and skin color, VIGITEL 2007-2018

Years of education	Smoking % (95% CI)											
Sex and skin color (%)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0-3 years												
Total***	13.0 (11.7; 14.2)	12.9 (11.6; 14.1)	12.6 (11.3; 13.9)	11.6 (10.4; 12.9)	12.4 (11.2; 13.6)	11.0 (9.5; 12.4)	11.8 (10.3; 13.3)	11.7 (10.1; 13.4)	9.9 (8.7; 11.1)	11.8 (10.2; 13.3)	9.8 (8.6; 11.0)	9.0 (7.9; 10.2)
Female***	10.7 (-21.0; 21.0)	11.1 (-21.8; 21.8)	10.9 (-21.3; 21.3)	10.9 (-21.3; 21.3)	10.1 (-19.9; 19.9)	9.5 (-18.7; 18.7)	9.7 (-19.1; 19.1)	10.4 (-20.3; 20.3)	8.3 (-16.4; 16.4)	10.3 (-20.2; 20.2)	8.5 (-16.6; 16.6)	9.0 (-17.6; 17.6)
Male**	18.6 (-35.8; 37.2)	17.4 (-33.4; 34.9)	17.1 (-32.7; 34.2)	13.6 (-25.9; 27.4)	18.5 (-35.5; 36.9)	14.8 (-28.1; 29.8)	16.7 (-32.0; 33.7)	15.3 (-29.0; 31.0)	14.3 (-27.3; 28.7)	15.3 (-29.1; 30.9)	13.3 (-25.3; 26.7)	9.1 (-17.1; 18.5)
White*	10.4 (-18.9; 21.6)	9.9 (-18.1; 20.6)	10.9 (-20.1; 22.7)	9.7 (-17.9; 20.2)	11.4 (-21.0; 23.6)	11.4 (-20.9; 24.0)	10.2 (-18.6; 21.6)	10.7 (-19.3; 22.6)	8.2 (-14.7; 17.3)	9.4 (-16.9; 19.9)	8.2 (-14.8; 17.2)	8.1 (-14.8; 16.9)
Non-white**	14.1 (-26.6; 28.8)	14.2 (-26.7; 28.8)	13.2 (-24.6; 27.1)	12.5 (-23.4; 25.6)	13.0 (-24.5; 26.5)	10.6 (-19.6; 22.1)	13.1 (-24.6; 26.7)	12.6 (-23.4; 25.9)	10.9 (-20.4; 22.3)	13.8 (-26.1; 28.1)	10.4 (-19.4; 21.3)	9.2 (-17.0; 18.9)
4-8 years												
Total***	14.4 (13.6; 15.1)	15.0 (14.2; 15.8)	14.7 (13.9; 15.5)	14.3 (13.5; 15.1)	13.6 (12.9; 14.4)	13.5 (12.6; 14.4)	11.4 (10.7; 12.2)	11.7 (10.8; 12.5)	10.4 (9.7; 11.1)	10.8 (10.1; 11.6)	10.0 (9.3; 10.7)	10.8 (10.1; 11.5)
Female***	11.6 (-22.7; 22.7)	12.6 (-24.8; 24.8)	12.7 (-24.8; 24.8)	12.2 (-24.0; 24.0)	10.9 (-21.4; 21.4)	11.3 (-22.1; 22.1)	9.5 (-18.6; 18.6)	9.9 (-19.3; 19.3)	8.8 (-17.2; 17.2)	8.7 (-17.1; 17.1)	8.0 (-15.6; 15.6)	9.1 (-17.8; 17.8)
Male***	19.9 (-38.6; 39.6)	19.9 (-38.4; 39.4)	19.0 (-36.7; 37.8)	18.6 (-36.0; 37.0)	19.0 (-36.8; 37.7)	18.1 (-35.0; 36.1)	15.7 (-30.3; 31.2)	15.7 (-30.2; 31.2)	13.7 (-26.5; 27.4)	15.1 (-29.2; 30.1)	14.2 (-27.5; 28.3)	14.6 (-28.2; 29.1)
White***	13.7 (-26.2; 27.6)	13.2 (-25.1; 26.6)	13.4 (-25.5; 27.0)	12.7 (-24.1; 25.5)	12.7 (-24.2; 25.6)	12.1 (-23.0; 24.6)	10.8 (-20.4; 21.8)	10.4 (-19.6; 21.3)	10.5 (-20.0; 21.3)	10.5 (-19.8; 21.3)	9.8 (-18.6; 20.0)	10.0 (-18.9; 20.3)
Non-white***	14.7 (-28.2; 29.6)	16.0 (-30.7; 32.0)	15.4 (-29.5; 30.9)	15.2 (-29.1; 30.4)	14.3 (-27.5; 28.7)	14.6 (-28.0; 29.3)	12.0 (-22.9; 24.1)	12.7 (-24.2; 25.5)	10.3 (-19.6; 20.8)	11.1 (-21.2; 22.3)	10.3 (-19.6; 20.7)	11.3 (-21.7; 22.8)
9-11 years												
Total***	12.9 (12.3; 13.6)	11.4 (10.8; 11.9)	11.4 (10.9; 12.0)	10.8 (10.3; 11.4)	10.4 (9.9; 10.9)	9.5 (8.9; 10.0)	8.8 (8.3; 9.3)	8.2 (7.7; 8.8)	8.0 (7.6; 8.5)	7.7 (7.3; 8.2)	7.4 (7.0; 7.9)	7.3 (6.9; 7.7)
Female***	11.2 (-22.0; 22.0)	9.6 (-18.8; 18.8)	9.4 (-18.5; 18.5)	9.7 (-19.1; 19.1)	8.9 (-17.4; 17.4)	8.0 (-15.7; 15.7)	7.1 (-14.0; 14.0)	7.1 (-13.8; 13.8)	6.4 (-12.6; 12.6)	6.7 (-13.1; 13.1)	6.1 (-11.9; 11.9)	5.9 (-11.6; 11.6)
Male***	15.9 (-30.7; 31.5)	14.4 (-27.8; 28.5)	14.9 (-28.8; 29.5)	12.8 (-24.8; 25.5)	12.9 (-24.9; 25.5)	12.0 (-23.2; 23.9)	11.6 (-22.4; 23.1)	10.2 (-19.6; 20.3)	10.7 (-20.8; 21.3)	9.5 (-18.4; 18.9)	9.7 (-18.7; 19.3)	9.7 (-18.7; 19.3)
White***	13.3 (-25.6; 26.6)	12.1 (-23.2; 24.2)	12.2 (-23.4; 24.4)	12.4 (-23.8; 24.7)	11.3 (-21.6; 22.5)	10.9 (-21.0; 21.9)	9.6 (-18.5; 19.3)	9.4 (-18.0; 18.9)	9.3 (-17.8; 18.6)	8.6 (-16.4; 17.2)	8.8 (-16.8; 17.6)	8.5 (-16.3; 17.1)
Non-white***	12.7 (-24.3; 25.3)	10.9 (-20.8; 21.8)	10.9 (-20.9; 21.9)	9.8 (-18.8; 19.8)	9.8 (-18.7; 19.6)	8.4 (-15.9; 16.9)	8.2 (-15.7; 16.5)	7.4 (-14.1; 15.0)	7.3 (-13.9; 14.7)	7.2 (-13.7; 14.5)	6.6 (-12.6; 13.4)	6.4 (-12.2; 13.0)
12 or more years												
Total***	11.8 (11.1; 12.4)	10.7 (10.0; 11.3)	9.9 (9.3; 10.5)	9.1 (8.6; 9.7)	9.1 (8.5; 9.6)	8.0 (7.4; 8.6)	6.8 (6.3; 7.2)	6.8 (6.3; 7.4)	6.6 (6.2; 7.0)	6.3 (5.9; 6.7)	6.2 (5.8; 6.6)	5.6 (5.2; 5.9)
Female***	10.1 (-19.8; 19.8)	9.4 (-18.4; 18.4)	9.1 (-17.9; 17.9)	8.1 (-15.9; 15.9)	8.2 (-16.1; 16.1)	6.8 (-13.4; 13.4)	6.0 (-11.7; 11.7)	6.1 (-11.9; 11.9)	5.6 (-11.0; 11.0)	5.0 (-9.8; 9.8)	5.2 (-10.2; 10.2)	4.5 (-8.9; 8.9)
Male***	14.3 (-27.7; 28.5)	12.7 (-24.4; 25.2)	11.2 (-21.5; 22.2)	10.9 (-21.0; 21.7)	10.5 (-20.2; 20.9)	10.0 (-19.3; 20.0)	8.2 (-15.7; 16.3)	8.1 (-15.6; 16.3)	8.2 (-15.8; 16.3)	8.5 (-16.4; 16.9)	7.9 (-15.3; 15.7)	7.3 (-14.1; 14.6)
White***	12.3 (-23.5; 24.6)	12.0 (-23.0; 24.1)	11.4 (-21.8; 22.8)	10.3 (-19.7; 20.6)	10.0 (-19.2; 20.2)	9.4 (-17.9; 18.9)	7.8 (-14.9; 15.7)	8.7 (-16.5; 17.5)	8.0 (-15.2; 16.0)	7.2 (-13.8; 14.5)	7.4 (-14.1; 14.8)	6.6 (-12.6; 13.3)
Non-white***	11.1 (-21.4; 22.3)	9.0 (-17.2; 18.1)	8.1 (-15.5; 16.4)	7.7 (-14.7; 15.5)	7.7 (-14.7; 15.5)	6.2 (-11.8; 12.7)	5.5 (-10.4; 11.1)	4.6 (-8.7; 9.5)	4.9 (-9.3; 10.0)	5.2 (-9.9; 10.5)	4.6 (-8.8; 9.4)	4.2 (-7.8; 8.4)

*p<0.05; **p<0.01; ***p<0.001.

Supplementary table 4: Age-standardized prevalence of obesity by years of education, sex and skin color,VIGITEL 2007-2018.

Years of education	Obesity - Year (95% CI)											
Sex and skin color (%)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
0-3 years												
Total***	21.3 (19.6; 22.9)	23.2 (21.5; 24.9)	22.7 (21.0; 24.5)	22.7 (20.9; 24.4)	24.1 (22.4; 25.7)	25.6 (23.4; 27.7)	23.5 (21.5; 25.4)	26.5 (24.2; 28.8)	26.8 (24.9; 28.6)	27.6 (25.6; 29.6)	27.1 (25.3; 28.9)	28.4 (26.7; 30.2)
Female***	23.8 (-46.6; 46.6)	26.8 (-52.5; 52.5)	25.2 (-49.3; 49.3)	25.3 (-49.7; 49.7)	27.1 (-53.2; 53.2)	28.9 (-56.5; 56.5)	26.2 (-51.4; 51.4)	29.6 (-58.0; 58.0)	29.4 (-57.7; 57.7)	30.3 (-59.3; 59.3)	29.6 (-58.1; 58.1)	31.2 (-61.2; 61.2)
Male***	15.0 (-28.4; 30.5)	14.1 (-26.5; 28.6)	16.2 (-30.7; 33.0)	15.9 (-30.0; 32.2)	16.0 (-30.2; 32.3)	16.8 (-31.4; 34.2)	17.0 (-31.9; 34.5)	18.4 (-34.5; 37.5)	19.5 (-37.0; 39.3)	21.2 (-40.3; 42.9)	20.8 (-39.6; 41.9)	21.1 (-40.3; 42.5)
White***	20.5 (-39.0; 41.4)	23.3 (-44.4; 46.7)	20.3 (-38.4; 41.1)	21.4 (-40.7; 43.3)	24.6 (-46.9; 49.4)	24.5 (-46.4; 49.6)	24.3 (-46.1; 49.0)	26.3 (-49.9; 53.4)	25.9 (-49.3; 52.2)	28.2 (-53.7; 56.8)	26.7 (-50.9; 53.7)	26.6 (-50.8; 53.6)
Non-white***	21.6 (-40.9; 43.9)	23.2 (-43.9; 47.1)	23.7 (-44.8; 48.1)	23.2 (-43.9; 47.1)	23.8 (-45.2; 48.1)	26.3 (-49.9; 53.3)	22.8 (-43.1; 46.3)	26.6 (-50.4; 54.0)	27.2 (-51.8; 55.0)	27.1 (-51.6; 54.7)	26.2 (-49.8; 52.8)	28.7 (-54.7; 57.7)
4-8 years												
Total***	17.0 (16.2; 17.9)	18.7 (17.7; 19.6)	19.3 (18.4; 20.3)	20.2 (19.3; 21.1)	20.6 (19.7; 21.6)	22.0 (20.9; 23.1)	22.4 (21.4; 23.4)	22.8 (21.7; 23.9)	23.9 (22.9; 24.8)	24.6 (23.6; 25.6)	23.9 (22.9; 24.8)	24.5 (23.6; 25.5)
Female***	17.9 (-35.0; 35.0)	20.4 (-40.1; 40.1)	20.5 (-40.2; 40.2)	21.3 (-41.8; 41.8)	22.1 (-43.3; 43.3)	23.8 (-46.6; 46.6)	23.6 (-46.3; 46.3)	24.7 (-48.4; 48.4)	25.7 (-50.3; 50.3)	25.9 (-50.7; 50.7)	24.5 (-48.0; 48.0)	26.4 (-51.7; 51.7)
Male***	15.4 (-29.6; 30.8)	15.0 (-28.7; 29.9)	16.9 (-32.4; 33.7)	17.9 (-34.4; 35.6)	17.8 (-34.2; 35.4)	18.3 (-35.2; 36.6)	19.8 (-38.2; 39.5)	18.6 (-35.7; 37.2)	20.2 (-39.0; 40.3)	22.0 (-42.5; 43.9)	22.5 (-43.6; 44.8)	20.5 (-39.5; 40.8)
White***	16.7 (-32.0; 33.3)	19.3 (-37.2; 38.5)	19.4 (-37.3; 38.7)	20.4 (-39.2; 40.7)	20.3 (-39.2; 40.5)	22.0 (-42.4; 44.0)	21.9 (-42.2; 43.8)	22.8 (-43.8; 45.5)	23.8 (-45.9; 47.4)	24.6 (-47.4; 49.0)	23.5 (-45.1; 46.8)	24.4 (-47.1; 48.7)
Non-white***	17.3 (-33.0; 34.6)	18.3 (-35.0; 36.7)	19.3 (-36.9; 38.7)	20.1 (-38.5; 40.3)	20.8 (-40.1; 41.6)	22.0 (-42.2; 44.0)	22.9 (-44.0; 45.6)	22.8 (-43.8; 45.6)	24.0 (-46.2; 47.8)	24.6 (-47.5; 49.0)	24.4 (-47.1; 48.6)	24.5 (-47.2; 48.7)
9-11 years												
Total***	12.8 (12.2; 13.4)	13.9 (13.2; 14.5)	14.4 (13.8; 15.1)	16.0 (15.3; 16.6)	16.5 (15.9; 17.1)	17.4 (16.7; 18.1)	17.5 (16.8; 18.1)	18.5 (17.8; 19.3)	18.7 (18.1; 19.3)	19.1 (18.4; 19.8)	18.5 (17.9; 19.2)	19.6 (18.9; 20.2)
Female***	12.2 (-23.8; 23.8)	13.5 (-26.4; 26.4)	14.2 (-27.9; 27.9)	15.6 (-30.6; 30.6)	16.2 (-31.7; 31.7)	17.5 (-34.3; 34.3)	17.2 (-33.7; 33.7)	18.8 (-36.8; 36.8)	19.1 (-37.4; 37.4)	19.3 (-37.9; 37.9)	18.6 (-36.4; 36.4)	19.9 (-38.9; 38.9)
Male***	14.0 (-27.0; 27.8)	14.5 (-28.0; 28.9)	14.8 (-28.5; 29.3)	16.6 (-32.1; 33.0)	17.0 (-32.9; 33.7)	17.2 (-33.3; 34.3)	17.9 (-34.7; 35.5)	18.1 (-35.0; 36.0)	18.0 (-34.8; 35.7)	18.7 (-36.2; 37.1)	18.5 (-35.7; 36.6)	19.0 (-36.9; 37.7)
White***	12.8 (-24.6; 25.5)	14.0 (-26.9; 27.9)	14.3 (-27.5; 28.4)	15.8 (-30.4; 31.4)	16.9 (-32.6; 33.6)	18.1 (-34.9; 35.9)	16.9 (-32.7; 33.7)	18.5 (-35.7; 36.8)	18.1 (-35.0; 36.0)	18.4 (-35.6; 36.6)	17.6 (-34.0; 35.0)	18.9 (-36.5; 37.6)
Non-white***	12.9 (-24.7; 25.7)	13.8 (-26.5; 27.6)	14.5 (-27.9; 29.0)	16.1 (-31.0; 32.1)	16.2 (-31.2; 32.3)	16.9 (-32.6; 33.7)	17.9 (-34.5; 35.5)	18.6 (-35.8; 37.0)	19.0 (-36.8; 37.8)	19.6 (-37.8; 38.9)	18.9 (-36.5; 37.6)	19.6 (-37.8; 38.9)
12 or more years												
Total***	11.6 (11.0; 12.3)	11.5 (10.9; 12.1)	12.8 (12.1; 13.4)	13.3 (12.7; 13.9)	14.7 (14.1; 15.4)	14.9 (14.2; 15.6)	15.2 (14.6; 15.8)	15.0 (14.2; 15.7)	15.1 (14.6; 15.7)	15.6 (15.1; 16.2)	16.1 (15.5; 16.7)	16.8 (16.2; 17.4)
Female***	9.4 (-18.5; 18.5)	9.4 (-18.4; 18.4)	11.3 (-22.2; 22.2)	12.0 (-23.5; 23.5)	13.0 (-25.4; 25.4)	13.7 (-26.8; 26.8)	12.7 (-24.9; 24.9)	13.5 (-26.4; 26.4)	13.5 (-26.5; 26.5)	13.8 (-27.1; 27.1)	14.3 (-28.0; 28.0)	15.1 (-29.5; 29.5)
Male***	15.1 (-29.1; 29.9)	14.9 (-28.8; 29.6)	15.0 (-29.0; 29.9)	15.6 (-30.2; 31.0)	17.6 (-34.1; 34.9)	17.0 (-32.8; 33.7)	19.5 (-37.8; 38.5)	17.5 (-33.8; 34.7)	17.8 (-34.6; 35.3)	18.6 (-36.1; 36.8)	19.2 (-37.2; 37.9)	19.7 (-38.2; 38.9)
White***	11.2 (-21.5; 22.6)	11.1 (-21.2; 22.3)	12.2 (-23.4; 24.4)	12.8 (-24.6; 25.6)	14.1 (-27.1; 28.2)	14.4 (-27.7; 28.9)	14.9 (-28.7; 29.8)	14.5 (-27.8; 29.0)	14.7 (-28.3; 29.3)	15.1 (-29.0; 30.0)	14.9 (-28.7; 29.7)	16.1 (-31.0; 32.0)
Non-white***	12.2 (-23.4; 24.3)	12.0 (-23.1; 24.0)	13.5 (-26.0; 26.9)	13.9 (-26.9; 27.7)	15.5 (-30.0; 30.9)	15.5 (-29.8; 30.8)	15.6 (-30.1; 30.9)	15.5 (-29.9; 30.9)	15.6 (-30.2; 31.0)	16.3 (-31.6; 32.4)	17.4 (-33.6; 34.4)	17.3 (-33.4; 34.2)

*p<0.05; **p<0.01; ***p<0.001.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	Indicate the study's design with a commonly used term in the title or the abstract Page 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Page 3
Objectives	3	State specific objectives, including any prespecified hypotheses Page3
Methods		
Study design	4	Present key elements of study design early in the paper Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Page 4
Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants Page 4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Pages 4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Pages 4-5
Bias	9	Describe any efforts to address potential sources of bias pages 4-5
Study size	10	Explain how the study size was arrived at page4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Page 5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Page 5
		(*b*) Describe any methods used to examine subgroups and interactions Page 5
		(*c*) Explain how missing data were addressed Page 5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy Page 5
		(*e*) Describe any sensitivity analyses Page 5
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Page 4
		(b) Give reasons for non-participation at each stage Page 4
		(c) Consider use of a flow diagram NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Table 1
		(b) Indicate number of participants with missing data for each variable of interest

		page 4
Outcome data	15*	Report numbers of outcome events or summary measures Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Figures 1, 2 and 3
		(*b*) Report category boundaries when continuous variables were categorized NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Figure 1
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Figures 2 and 3
Discussion		
Key results	18	Summarise key results with reference to study objectives Page 8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Page 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Page 11
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 11
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based page 6

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

ABSTRACT

Objectives: Our study aimed to assess social inequality trends for hypertension, diabetes mellitus, smoking and obesity from 2007 to 2018 in adults from Brazilian capitals.

Setting: Data from the VIGITEL study, a cross-sectional telephone survey conducted annually from 2007 to 2018.

Participants: We used data from 578,977 Brazilian adults (≥18 years).

Design: Cross-sectional surveys conducted annually from 2007 to 2018.

Primary outcome measures: Participants responded to a questionnaire about medical diagnosis of hypertension and diabetes, smoking status, weight and height. Educational inequalities (0-3, 4-8, 9-11 and 12 or more years of study) by sex and skin color were assessed trough absolute (slope index of inequality – SII) and relative measures of inequality (concentration index – CIX), and trends were tested by Prais-Winsten.

Results: All outcomes were more prevalent in the least educated. The largest absolute educational inequality was observed for hypertension (SII_{total} = -37.8 in 2018). During 2007-2018, the total educational disparity remained constant for hypertension, increased for diabetes and smoking, and decreased for obesity. Overall, inequality was higher among women and non-whites, compared to men and whites. We found a reduction in absolute inequality for hypertension among non-whites, an increase for diabetes in all strata, and an increase for smoking in women and non-whites. The relative inequality decreased in women and whites and increased for smoking in all strata, except among men.

Conclusion: The educational inequality reduced for obesity, remained constant for hypertension and increased for diabetes and smoking from 2007 to 2018 in Brazilian adults.

Funding: Brazilian National Council of Scientific and Technological Development (CNPq), 404905/2016-1.

Keywords: Inequality, Hypertension, Diabetes, Smoking, Obesity, Adults.

Strengths and limitations of this study

- We assessed the extent and trend of socioeconomic inequalities in major non-communicable diseases (hypertension and diabetes) and its risk factors (smoking and obesity) over 12 years in a middle-income country;

- We used large samples from Brazilian adults living in the 27 state Capitals in Brazil;

- We assessed educational inequalities in total sample and in subgroups of sex and race/skin color using complex measures of inequality.

- Using data from a telephone Survey (VIGITEL) limited our generalizability to those with landlines.

- The use of self-reported diseases may have affected our results underestimating inequality in hypertension and diabetes, as it may have underestimated the prevalence among least favored groups.

INTRODUCTION

Non-communicable diseases (NCD) are the main cause of death in Brazil[1] and worldwide[2]. According to the Global Burden of Diseases, Injuries, and Risk Factors Study, in 2017, the four main risk factors for mortality and years of life lost due to disability in Brazil were systemic arterial hypertension, diabetes *mellitus*, obesity and smoking[3]. Importantly, these risk factors affect the less economically favored groups in a more pronounced way[4-6], in addition to reinforcing poverty and income inequality by generating an increase in direct and indirect spending and loss of productivity[7]. A synthesis of 283 studies in low- and middle-income countries showed a positive association between low income, low socioeconomic status and low educational level with the occurrence of NCD[8]. In Brazil, adults with less education, non-whites and without health insurance had a higher prevalence of risk factors for NCD, such as smoking, leisure time physical inactivity, and lower consumption of fruits and vegetables[9].

Trend analysis of the risk factors for NCD in Brazil showed that the prevalence of hypertension remained stable between 2006 and 2018, while diabetes and obesity grew and smoking dropped [10]. However, this trend did not occur homogeneously among social strata. Between 1998 and 2013, there was a reduction in educational inequalities for hypertension and coronary heart disease and an increase in inequality for diabetes in Brazilian adults[5].

A sustained reduction in health inequities between countries is necessary[8]. However, trend studies on social inequality in the different risk factors for NCD that are essential for health planning are scarce in Brazil[5], especially assessing risk factors concomitantly and based on educational disparities, also considering sex and color strata. Therefore, our aim was to assess social inequality trends for hypertension, diabetes, smoking and obesity among adults from Brazilian state capitals, from 2007 to 2018. We also performed subgroup analysis for education inequalities by skin color and sex.

METHODS

Study design and source of data and sample

This study used data collected by the Surveillance of Risk and Protection Factors for Chronic Diseases by Telephone Survey (VIGITEL), coordinated by the Ministry of Health of Brazil, from 2007 to 2018. VIGITEL is a cross-sectional system for monitoring the health of the adult population – over 18 years old, residing in the Brazilian capitals and the Federal District (DF), and who have a landline telephone – carried out annually since 2006. The sample stratification took place by telephone prefix until 2011, and subsequently by postal code (CEP). In order to reduce selection bias due to the partial coverage of the population by the landline telephone system, VIGITEL assigned a final weight to each individual, considering the inverse of the number of telephone lines in the household interviewed, the number of adults living in the household and the socio-demographic composition of the sample, based on the 2000 and 2010 demographic censuses. This weighting aimed to achieve representativeness for population aged 18 years and over of each state capital in Brazil, including DF in all years[10], but it cannot be used as a representative sample of the whole country. However, it had limitations previously described[11].

Data from 625,070 individuals interviewed between 2007 and 2018 were initially obtained. We excluded women who were pregnant and those who had doubts if they were or were not pregnant by the time of the interview (5,087 women); people aged 80 or older (22,234 individuals) because aging may affect self-reports[12]; people who did not want to or did not know how to respond to their skin color (20,699 respondents), corresponding to a loss of 46,093 (7.4%) observations compared to the original study. Thus, 578,977 participants were included in this study. During the analysis, there were 2 additional missing for skin color e 3 missing for obesity.

All data of the participants were self-reported. They answered about previous medical diagnosis of hypertension and diabetes (all types), if they were current smokers (yes/no) and their weight and height, used to calculate the Body Mass Index (BMI). We considered

BMI≥30kg/m^2 for obesity[13]. Risk factors were described according educational level (i.e., years of study number: 0-3, 4-8, 9-11 and 12 or more study years), sex (women and men) and skin color (white and non-white). Skin color also was self-reported and included the categories: white (used for white color) and black, brown, mixed race, yellow (Asian), red (i.e. indigenous) and indigenous (used for non-white skin color).

Statistical analysis

Prevalence of hypertension, diabetes, smoking and obesity (2007-2018) was age-standardized using the age distribution of the year 2018. We estimated absolute and relative complex measures of inequality, namely the slope index of inequality (SII) and the concentration index (CIX), respectively, and its 95% confidence interval. These measures of inequality are complementary and were calculated according to the World Health Organization [14] and Barros et al. [15]. The SII results from a linear regression of the cumulative population proportional distribution in each one of the four educational groups in this study and represents the absolute difference, in predicted values, on disease prevalence between the least and the most favored person, with no education and the highest possible education, taking into consideration the entire distribution of the stratification variable. The CIX assesses the relative difference between them and shows how concentrated are the diseases towards the least or most favored groups. CIX values should be read with caution because it can overestimate inequalities when the outcome of interest has a low frequency and may not be able to identify important inequalities when the outcome prevalence is high[16].

The results of SII and CIX were multiplied by 100 to facilitate their visualization in tables and graphs, ranging from -100 to +100. On this scale, CIX values less than -20 or greater than 20 can be considered relevant indicators of inequality[14]. Results equal to zero represent a situation of total equality. When it is equal +100 or -100, we have the grater inequality possible.

Negative values indicate a higher prevalence of the risk factor in the least educated group, while positive ones represents grater prevalence in those most educated groups.

The different levels of education were used to calculate the total SII and CIX. Subsequently, the SII and CIX data for educational level schooling were stratified by sex and skin color. The time trend of the indicators was analyzed using the Prais-Winsten method modified by Durbin and Watson instead of traditional linear regression to avoid the autoregressive problem common in this social serial trend analysis[17]. Statistical analyses were performed using the STATA/SE® 15.1 software.

Ethical aspects

VIGITEL was approved by the National Research Ethics Commission (CONEP). The VIGITEL database is in the public domain and does not allow identification of participants. It is available at the electronic address: http://svs.aids.gov.br/download/Vigitel/. The waiver of ethical review was approved by the Research Ethics Committee of the Federal University of Uberlândia, Minas Gerais (CAAE: 2,654,271).

Patient and public involvement

No patients or public were involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

From 2007 to 2018, the profile of individuals evaluated remained similar, with a slight increase in the average of age (from 39.8 to 41.7 years) and similar distribution between sexes and skin color (53.2% female and 58.6% non-white in 2018). The average number of years of study showed a significant increase in the period, from 9.4 to 10.7 years of study. The prevalence of hypertension remained constant in the period (34.1% in 2007 to 33.3% in 2018), with a reduction in smoking (from 13.0% to 7.4%), while the prevalence of diabetes (8.9% to 10.6%) and obesity increased (14.7% to 20.0%) (Table 1).

An educational gradient was observed for all four outcomes, with a higher prevalence among the least educated group. The largest prevalence discrepancy in 2018, between the least and the most educated groups, was observed for diabetes (24.4% and 6.4%) resulting in a difference of 281.3%, and the smallest for smoking (9.0% and 5.6%), where the prevalence difference between groups was 60,7%, with slight variations over the period (Figure 1 and Supplementary tables 1 to 4). For hypertension and obesity, these prevalence differences were: 60.7% versus 23.8% and 28.4% versus 16.8%, respectively.

Hypertension, diabetes, and obesity were more prevalent in women than in men, while smoking prevalence was higher in men. The prevalence of outcomes was higher in non-whites compared to whites for hypertension and obesity, and lower for diabetes and smoking. Supplementary Figures 1 and 2 and supplementary Tables 1 to 4 show the age-standardized prevalence of each outcome by years of study and stratified by sex, skin color and education.

Table 2 shows the absolute (SII) and relative (CIX) measures of educational inequality for the four outcomes and also by sex and skin color. Negative SII and CIX values for all outcomes reaffirm their higher prevalence among least educated group.

The absolute and relative educational inequality for hypertension, diabetes and obesity was, in general, higher among women than men and higher in non-white individuals compared to whites, represented by negative and higher SII and CIX values (Figures 2, 3 and 4). The exception was smoking, where SII and CIX were higher in men. Obesity showed higher absolute and relative inequality among whites (Figure 4). Over the period, relative inequality remained constant in hypertension (Figure 2), being higher in women than in men (Figure 3) and in non-whites in relation to whites (Figure 4). The absolute inequality in diabetes had a statistically significant increase in all strata (Figures 2, 3 and 4). This increase was greater in men than in women, as well as in whites in relation to non-whites. The relative inequality in diabetes remained constant over the period. The absolute inequality for obesity remained constant, although there was a reduction in the relative inequality for the total sample and between women and non-whites (Figures 2, 3 and 4). There was an increase in absolute inequality in smoking between whites and women during the analyzed period. The relative inequality in smoking increased in all strata, except among men, where it remained constant (Figures 2, 3 and 4).

DISCUSSION

In our study, diabetes, hypertension, obesity, and smoking remained more prevalent in the least educated groups from 2007 to 2018 in Brazil. The absolute and relative educational inequalities were higher among women and non-whites, compared to men and whites. Hypertension was the outcome that had the highest absolute educational inequality, which remained constant in the period; the absolute educational inequality for diabetes increased in all strata. The absolute educational inequality remained constant for obesity, although the relative one has reduced for the total sample, among women and non-whites. There was an increase in the absolute educational inequality for smoking among women and whites and relative educational inequality for all strata, except for men where it remained constant.

Hypertension had higher prevalence (33.3% in 2018) and the highest absolute educational inequality (-37.8 in 2018). The prevalence in the least educated group was 60.7%. A study carried out with Brazilian adults found that aging, black skin color, low education, obesity, being a former smoker, self-reported diabetes, high cholesterol and high salt intake were associated with a higher prevalence of hypertension[18]. In addition to individual factors, a study conducted with the North American population indicated that states with greater socioeconomic vulnerability, such as low family income and high percentages of the population below the poverty line were significantly associated with a high prevalence of self-reported hypertension[19], which corroborates with the inequality findings in our study. However, although we found the highest educational inequality for hypertension, it remained constant in the period. On the other hand, educational inequality for diabetes increased in this period in all strata. Diabetes had the highest relative inequity in 2018 (-24.0). Trend analysis of the prevalence of diabetes, hypertension and heart disease from 1998 to 2013 also found an increase in diabetes disparities among a representative sample of Brazilian adults[5]. It is possible that strategies such as the Brazilian National Policy for the Comprehensive Health of the Black Population[20], could have contributed to reduce race inequality by decreasing the prevalence of hypertension among non-whites. However, if this is true, we would expect to find a reduction in race inequality for diabetes. There are several potential explanations for the increase in educational inequalities for diabetes. This could have been partially driven by our finding of an increase in obesity prevalence over time, and higher prevalence among those less educated. Obesity is a stronger risk factor for diabetes than for hypertension[21 22]. It is also possible that the increase in primary care coverage has provided access to health care and, consequently, increased the diagnosis of diabetes among those underprivileged (i.e., therefore, artificially increasing the diabetes inequality). The National Program for Improving Access and Quality in Primary Care and the Requalification Program for Basic Health Units (*Programa Nacional de Melhoria do Acesso e da Qualidade da Atenção Básica* -PMAQ), created in 2011, as well as the More Doctors for Brazil Project (*Mais Médicos para o Brasil*), created in 2013, increased the number of health units and physicians' access to more than 65 million people[23]. If that was the case, we would expect increase in social inequality for hypertension too[24]. Unless the requirement of fewer medical supplies for hypertension diagnosis compared to diabetes[24] causes less underreport for hypertension and, therefore, benefits less from the extension in primary care coverage not affecting the inequality.

The increase in obesity prevalence over time, especially among the least educated group, have been reported in other countries[25]. This can be explained by the lower financial access to healthy food in addition to fewer opportunities to engage in leisure physical activities[26]. The gap in obesity prevalence between least and the most educated groups reduced over time, but it was not sufficient to impact SII indicator. However, due to an increase in obesity prevalence in all education groups, especially in those with 9 to 11 study years (53,1% while prevalence raised 33,3% in people with less than 4 years of study), relative inequality reduced. This reduction in relative inequality is an artificial change that should not be read as an achievement because does not reflect a beneficial change in inequality, but rather a worsening scenario for all strata of education. Brazil still lacks strong initiatives to protect the more vulnerable groups and tackle the social inequalities for obesity such as regulation of nutritional labelling claims and health warnings, advertising restrictions, protection of the food school environment and taxation of unhealthy food[27], jointly with a broad promotion of active commuting and availability of public spaces for physical activity[28].

Our results confirm the global decrease trend in smoking prevalence[29], with a sharper reduction among the most educated adults[30]. This explained the increase in the relative educational inequality in most strata, except among men. Several actions have been taken to halt smoking, such as the ratification of the World Health Organization Framework Convention on Tobacco Control in 2005, which resulted in the Brazilian National Tobacco Control Policy[31]. These policies may have had less impact the least educated people[32], increasing social inequality. Although actions, such as the taxation of tobacco products, immediately affect low-income individuals, over time they resort to the illegal market, maintaining the cigarette use. Recent work shows that, in Brazil, the illegal cigarette market grew from 28.6% in 2012 to

42.8% in 2016[33]. Moreover, most actions aimed at changing behavior in favor of smoking cessation are educational, requiring cognitive skills for better understanding and, thus, more educated people will benefit more from these interventions[34]. In addition, tobacco companies have intensified marketing strategies to reach vulnerable populations, such as women[35], which may also justify the higher inequality in this group.

Educational inequality has disproportionately affected women and non-whites in Brazil. Although women have had more schooling than men in Brazil, their average income has been lower[36]. Illiteracy among women aged 15 years and over non-white was more than double that of white women (10.2% and 4.9%, respectively). Although there was an improvement in the education of the non-white adult population with 12 or more years of study between 1995 and 2015 (from 3.3 to 12%), this percentage among whites was more than two-fold higher in 2015 (25.9%)[36]. In Brazil, unlike other countries, social inequality drives racial disparities[37]. Black people have less access to health care, less quality of health care and are less informed about health promotion and disease prevention[38].

We found punctual reduction in the disparities for obesity, and an increase in disparities for diabetes and smoking, that are all modifiable risk factors sensitive to strategies promoting health lifestyle[39]. Accordingly, policies targeting the vulnerable groups, such as income redistribution[40], a strong and broad social security system and health education and promotion, would avoid the reinforcement of the current inequalities[8] and bring better health outcomes for Brazilians. In the last decades, Brazil has adopted several policies that could mitigate socioeconomic inequalities, with the potential to alter the prevalence of risk factors for NCDs, such as the expansion of primary health care, through the Family Health Strategy, and conditional cash transfer, through Bolsa Família Program. These policies increased the access of the low-income population to health promotion and disease prevention actions [41] [42]. Launched in 2011 by the Minister of Health of Brazil, the Strategic Action Plan for Tackling

Chronic Non-Communicable Diseases in Brazil has made advances in surveillance (eg. national surveys and monitoring of mortality and risk factor reduction targets); health promotion (eg. encouragement of physical activity, adequate nutrition and health promotion through the creation of the Health Gym Program); regulation (eg. legislation on tobacco-free environments); and health care (eg. free of charge drugs for hypertension, diabetes, and asthma; organization of the emergency service network for cardiovascular diseases) [43]. More recently, a new plan for Tackling NCD in Brazil from 2021 to 2030 has been launched by the Minister of Health of Brazil, and it is guided to prevent NCD, promote health, while reducing health inequalities[44]. Despite efforts, limited advances have been achieved. Health inequality is a persistent phenomenon [45]. Moreover, since 2014, Brazil has been facing an economic crisis and recently adopted austerity policies that could negatively impact health inequality trends[46].

Our results may serve as a starting point for new studies that can deepen into the causes that led to the reductions in educational inequalities observed for hypertension and obesity. Future studies also need to understand the reasons for an increase in educational inequality for diabetes and smoking.

Our study has some limitations. VIGITEL survey collected data only from the population with landlines and included only the adults living in Brazilian capitals and the federal district. Despite using weighting measures for the general population, we would expect some small differences in the prevalence of our outcomes if we had assessed a sample that was not limited by landline access[11]. Over time, the access to landlines has reduced, and older and wealthier households are more likely to have and retain a landline in addition to a mobile phone. Therefore, the set of those contacted in a landline-only survey will increasingly skew towards those older/ wealthier groups. This may have underestimated the prevalence of NCD in those places with less landlines access [47]. Future studies need to assess social inequality for NCD in rural areas[8]. In addition, risk factors were self-reported and may be underestimated, especially medical diagnosis of diabetes and hypertension. This may have affected our results underestimating inequality in hypertension and diabetes, as it may have underestimated the prevalence among the least favored groups.

In conclusion, we observed maintenance in the educational gap for hypertension and decreased relative inequity in general obesity and among female and non-whites. The reduction in inequality for obesity should be read with caution because it reflects increases in obesity prevalence in all groups. The absolute educational inequality increased for diabetes in all strata and increased in absolute and relative forms for smoking in almost all strata.

CONTRIBUTION STATEMENT

P.T.D. contributed to data analysis and interpretation and to drafting and revising the manuscript and figures. C.M.A., L.S.S., A.E.M.R. L.F.M.R. and E.S.M. contributed to study concept and design, data interpretation, revising the manuscript and figures, and final approval of the version submitted.

COMPETING INTERESTS

The authors declare no competing interests.

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DATA SHARING STATEMENT

All datasets of VIGITEL are publicly available at: http://svs.aids.gov.br/download/Vigitel/

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Table 1: Sociodemographic characteristics and risk factor prevalence, according to survey year of VIGITEL (2007-2018).

Characteristics	Survey year and Standard Error												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	p value
Individuals (n)	54,271	52,641	52,726	52,628	51,656	40,374	45,889	34,991	49,919	46,488	48,931	48,463	-
Mean age (years)	39.8 ± 0.1	39.9 ± 0.1	40.2 ± 0.1	40.3 ± 0.1	40.4 ± 0.1	40.1 ± 0.1	40.2 ± 0.1	40.2 ± 0.2	40.9 ± 0.1	40.7 ± 0.1	41.4 ± 0.1	41.7 ± 0.1	0.001
Education (years)	9.4 ± 0.0	9.4 ± 0.0	9.6 ± 0.0	9.8 ± 0.0	9.9 ± 0.0	10.3 ± 0.0	10.4 ± 0.0	10.6 ± 0.1	10.5 ± 0.0	10.8 ± 0.0	10.6 ± 0.0	10.7 ± 0.0	<0.001
Sex (%)													
Female	53.2 ± 0.4	53.3 ± 0.4	53.3 ± 0.5	53.2 ± 0.5	53.2 ± 0.4	53.3 ± 0.5	53.4 ± 0.5	53.4 ± 0.6	53.1 ± 0.5	53.3 ± 0.5	53.3 ± 0.5	53.2 ± 0.5	0.858
Male	46.8 ± 0.4	46.7 ± 0.4	46.7 ± 0.5	46.8 ± 0.5	46.8 ± 0.4	46.7 ± 0.5	46.6 ± 0.5	46.6 ± 0.6	46.9 ± 0.5	46.7 ± 0.5	46.7 ± 0.5	46.8 ± 0.5	0.858
Skin color (%)													
White	40.8 ± 0.4	39.0 ± 0.4	39.1 ± 0.4	39.8 ± 0.5	43.9 ± 0.4	43.5 ± 0.5	45.0 ± 0.5	43.6 ± 0.5	41.2 ± 0.5	46.2 ± 0.5	42.1 ± 0.5	41.4 ± 0.5	0.154
Non-white	59.2 ± 0.4	61.0 ± 0.4	60.9 ± 0.4	60.2 ± 0.5	56.1 ± 0.4	56.5 ± 0.5	55.0 ± 0.5	56.4 ± 0.5	58.8 ± 0.5	53.8 ± 0.5	57.9 ± 0.5	58.6 ± 0.5	0.154
Risk factors (%) [+]													
Hypertension	34.1 ± 0.3	35.5 ± 0.3	35.4 ± 0.3	35.6 ± 0.3	34.9 ± 0.3	33.6 ± 0.3	33.1 ± 0.3	33.8 ± 0.3	33.7 ± 0.2	33.6 ± 0.2	33.2 ± 0.2	33.3 ± 0.2	0.065
Diabetes	8.9 ± 0.2	9.3 ± 0.2	10.0 ± 0.2	10.3 ± 0.2	10.2 ± 0.2	9.9 ± 0.2	9.5 ± 0.2	10.9 ± 0.2	10.2 ± 0.2	12.0 ± 0.2	10.4 ± 0.2	10.6 ± 0.2	0.004
Smoking	13.0 ± 0.2	12.3 ± 0.2	11.9 ± 0.2	11.2 ± 0.2	11.0 ± 0.2	10.0 ± 0.2	8.8 ± 0.2	8.7 ± 0.2	8.1 ± 0.1	7.9 ± 0.1	7.6 ± 0.1	7.4 ± 0.1	<0.001
Obesity	14.7 ± 0.2	15.5 ± 0.2	15.9 ± 0.2	16.8 ± 0.2	17.7 ± 0.2	18.2 ± 0.2	18.1 ± 0.2	18.8 ± 0.2	19.0 ± 0.2	19.1 ± 0.2	19.1 ± 0.2	20.0 ± 0.2	<0.001

[+] Age standardized according to 2018 age distribution.

Table 2: Age standardized Slope Index of Inequality (SII) and Concentration Index (CIX) in hypertension, diabetes, smoking and obesity.

Risck factor	SII (95% CI)		CIX (95% CI)	
	2007	2018	2007	2018
Hypertension	-36.8 (-38.8; -34.9)	-37.8 (-39.3; -36.2)	-15.9 (-16.9; -14.9)	-16.0 (-16.8; -15.2)
Female	-44.5 (-46.9; -42.0)	-44.1 (-45.9; -42.2)	-18.3 (-19.5; -17.1)	-18.2 (-19.2; -17.3)
Male	-20.2 (-23.3; -17.0)	-23.5 (-26.0; -21.0)	-9.2 (-11.0; -7.5)	-9.9 (-11.4; -8.4)
White	-33.5 (-36.6; -30.4)	-35.5 (-37.8; -33.2)	-14.3 (-15.9; -12.7)	-14.3 (-15.6; -13.0)
Non-white	-39.6 (-42.1; -37.1)	-40.3 (-42.3; -38.3)	-17.0 (-18.2; -15.7)	-17.5 (-18.6; -16.4)
Diabetes	-12.8 (-14.3; -11.3)	-17.7 (-18.9; -16.5)	-20.3 (-22.8; -17.9)	-24.0 (-25.7; -22.3)
Female	-15.9 (-17.9; -13.9)	-19.9 (-21.5; -18.4)	-24.6 (-27.5; -21.7)	-26.9 (-29.0; -24.8)
Male	-6.8 (-8.9; -4.6)	-13.4 (-15.3; -11.6)	-10.8 (-15.0; -6.7)	-17.7 (-20.6; -14.9)
White	-11.1 (-13.4; -8.9)	-15.7 (-17.5; -14.0)	-19.0 (-22.8; -15.1)	-21.1 (-23.7; -18.4)
Non-white	-14.0 (-16.1; -12.0)	-19.7 (-21.3; -18.1)	-21.2 (-24.3; -18.1)	-26.4 (-28.6; -24.2)
Smoking	-2.7 (-4.1; -1.3)	-6.4 (-7.4; -5.4)	-3.5 (-5.3; -1.8)	-12.1 (-14.2; -10.0)
Female	-1.3 (-2.9; 0.4)	-6.2 (-7.4; -5.1)	-2.0 (-4.4; 0.4)	-14.4 (-17.4; -11.5)
Male	-7.2 (-9.7; -4.8)	-7.6 (-9.3; -5.9)	-7.1 (-9.5; -4.7)	-10.4 (-13.4; -7.5)
White	-0.4 (-2.6; 1.7)	-4.3 (-5.8; -2.8)	-1.0 (-3.7; 1.7)	-6.6 (-9.7; -3.5)
Non-white	-4.4 (-6.2; -2.6)	-8.7 (-10.0; -7.4)	-5.4 (-7.6; -3.2)	-18.2 (-20.9; -15.4)
Obesity	-10.8 (-12.4; -9.2)	-12.2 (-13.6; -10.7)	-11.3 (-13.0; -9.6)	-8.6 (-9.8; -7.4)
Female	-16.6 (-18.7; -14.5)	-18.0 (-19.8; -16.2)	-17.4 (-19.5; -15.2)	-12.9 (-14.4; -11.5)

Male	-0.4 (-2.7; 1.9)	-0.8 (-3.1; 1.5)	-0.5 (-3.0; 2.0)	-0.2 (-2.0; 1.7)
White	-9.7 (-12.1; -7.3)	-11.9 (-14.0; -9.8)	-11.0 (-13.7; -8.2)	-8.4 (-10.3; -6.6)
Non-white	-11.2 (-13.3; -9.1)	-11.9 (-13.8; -10.0)	-10.9 (-13.0; -8.8)	-8.1 (-9.6; -6.6)

Figure 1: Age-standardized prevalence of hypertension, diabetes, smoking and obesity by years of education and survey year from 2007 to 2018. VIGITEL, 2007-2018.

Figure 2: Trends in total slope index of inequality (SII) and concentration index (CIX) for age-standardized prevalence of hypertension, diabetes, smoking and obesity, VIGITEL 2007-2018.

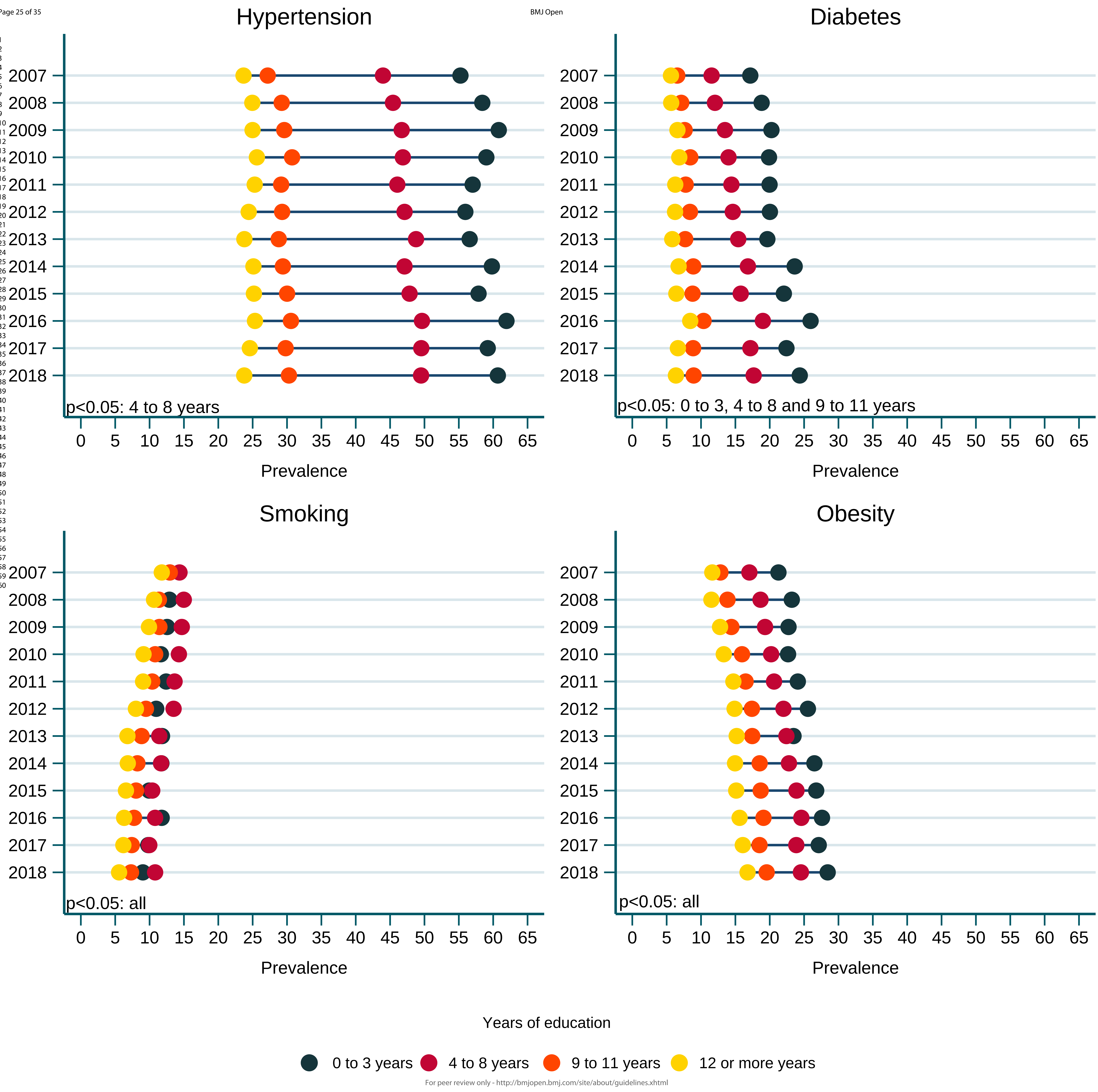
c: annual change of index; p= p-value.

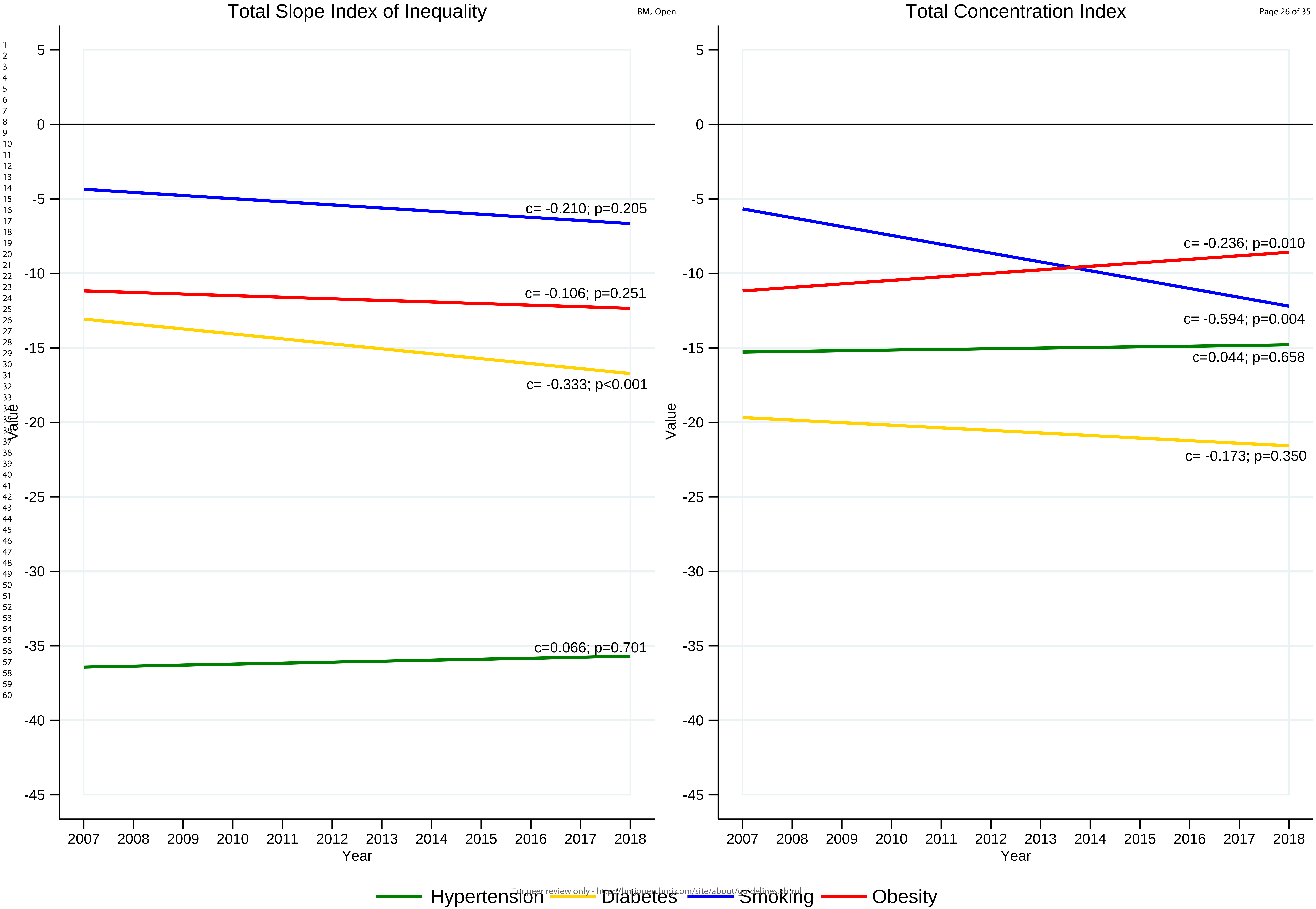
Figure 3: Trends in slope index of inequality (SII) and concentration index (CIX) for age-standardized prevalence of hypertension, diabetes, smoking and obesity by sex, VIGITEL 2007-2018.

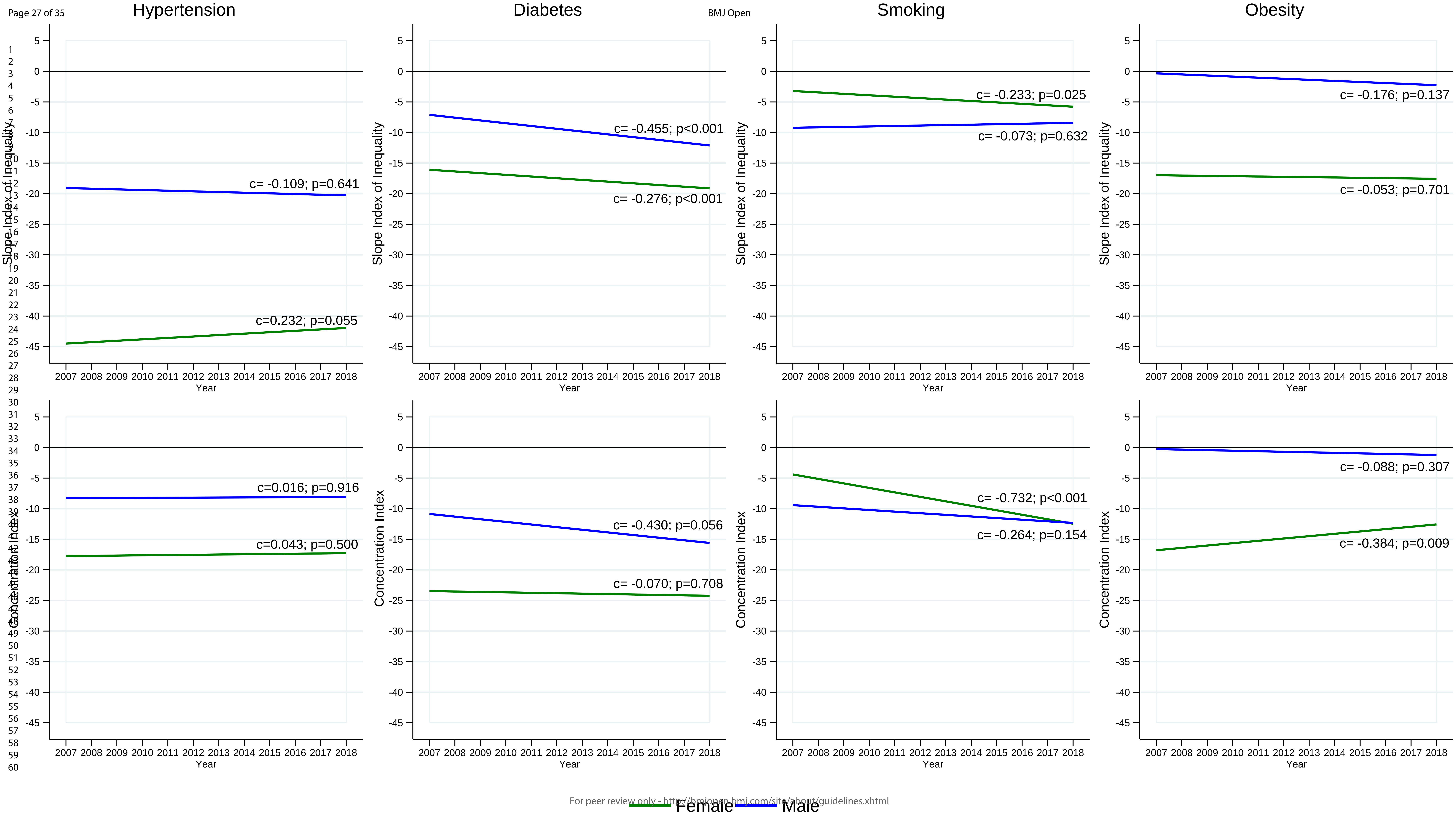
c: annual change of index; p= p-value.

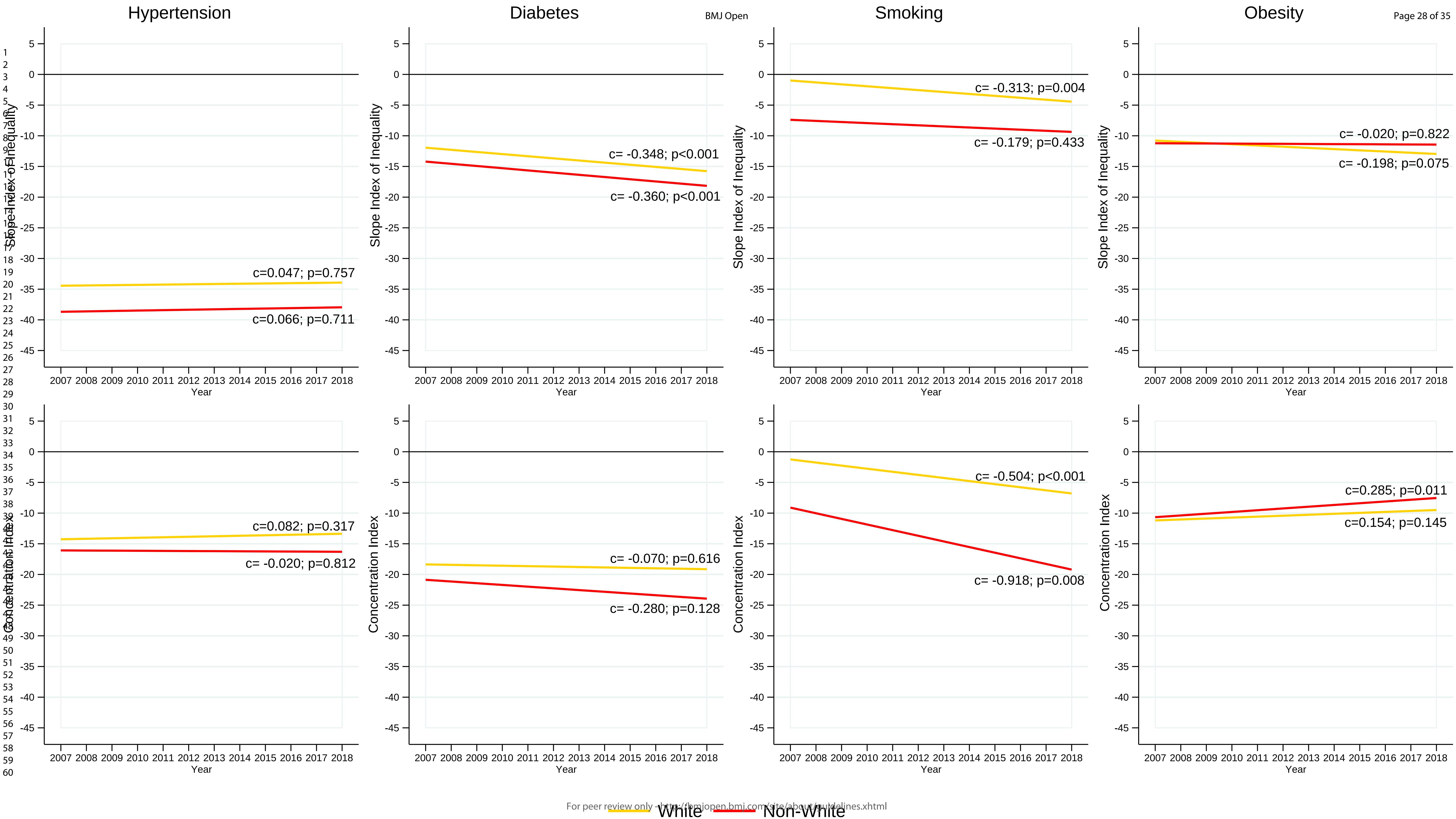
Figure 4: Trends in slope index of inequality (SII) and concentration index (CIX) for age-standardized prevalence of hypertension, diabetes, smoking and obesity by skin color, VIGITEL 2007-2018.

c: annual change of index; p= p-value.

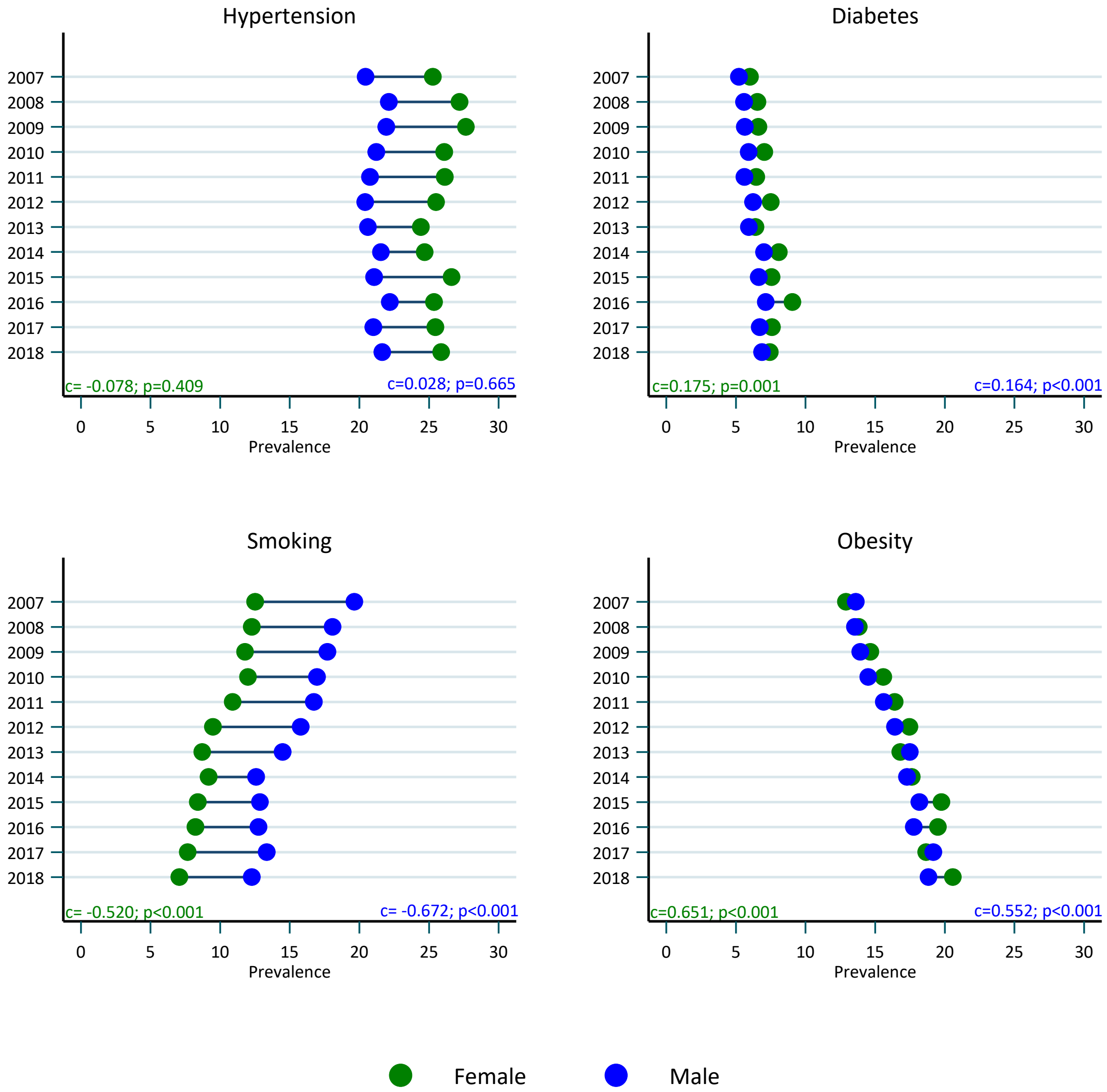

Hypertension
Diabetes
Smoking
Obesity
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
p<0.05: 4 to 8 years
p<0.05: 0 to 3, 4 to 8 and 9 to 11 years
p<0.05: all
p<0.05: all
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Prevalence
Years of education
0 to 3 years
4 to 8 years
9 to 11 years
12 or more years


Total Slope Index of Inequality
Total Concentration Index
Value
Year
c= -0.210; p=0.205
c= -0.106; p=0.251
c= -0.333; p<0.001
c=0.066; p=0.701
c= -0.236; p=0.010
c= -0.594; p=0.004
c=0.044; p=0.658
c= -0.173; p=0.350
Hypertension
Diabetes
Smoking
Obesity


Hypertension
Diabetes
Smoking
Obesity
Slope Index of Inequality
Concentration Index
Year
c= -0.109; p=0.641
c=0.232; p=0.055
c= -0.455; p<0.001
c= -0.276; p<0.001
c= -0.233; p=0.025
c= -0.073; p=0.632
c= -0.176; p=0.137
c= -0.053; p=0.701
c=0.016; p=0.916
c=0.043; p=0.500
c= -0.430; p=0.056
c= -0.070; p=0.708
c= -0.732; p<0.001
c= -0.264; p=0.154
c= -0.088; p=0.307
c= -0.384; p=0.009
Female
Male

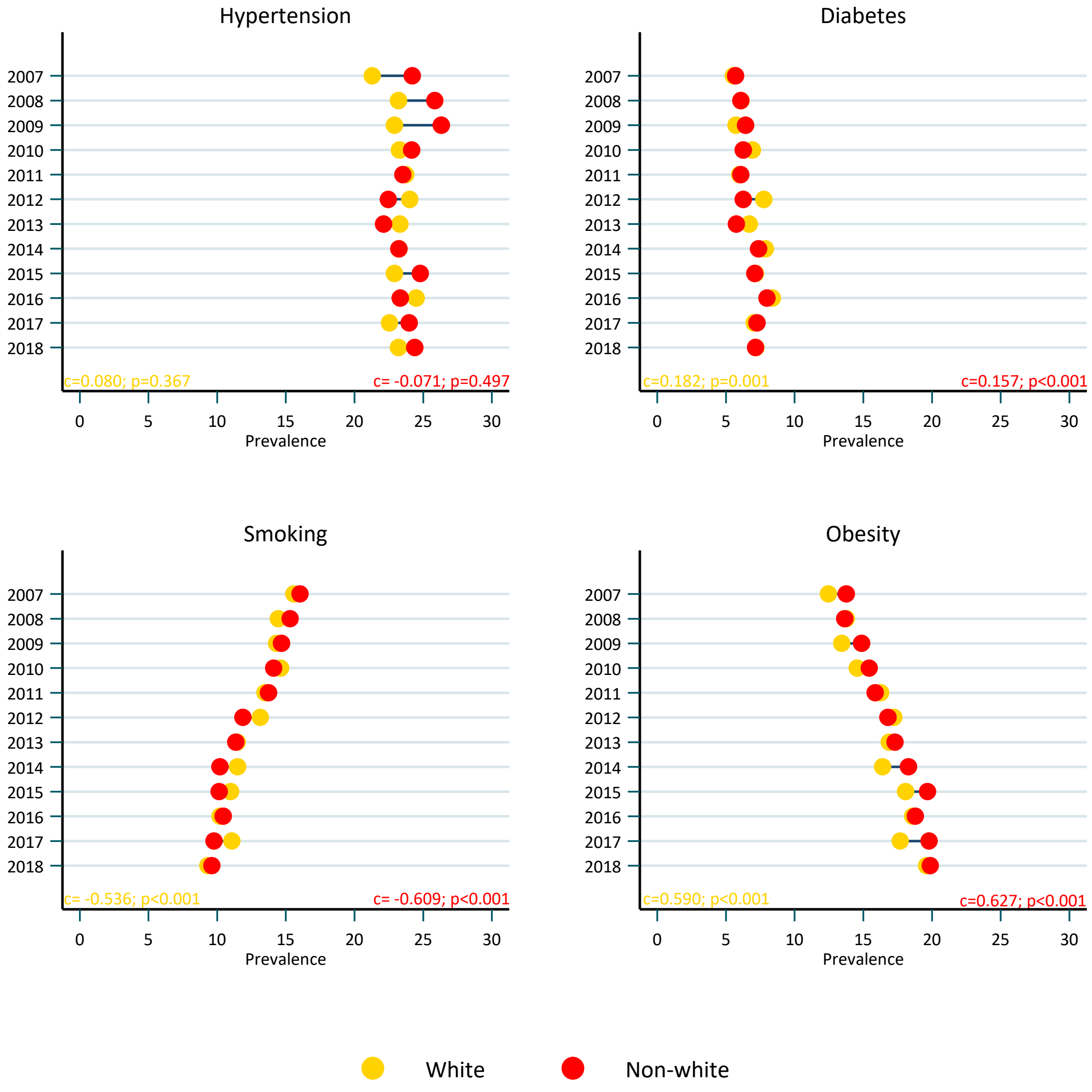

Hypertension
Diabetes
Smoking
Obesity
Slope Index of Inequality
Concentration Index
Year
c=0.047; p=0.757
c=0.066; p=0.711
c= -0.348; p<0.001
c= -0.360; p<0.001
c= -0.313; p=0.004
c= -0.179; p=0.433
c= -0.020; p=0.822
c= -0.198; p=0.075
c=0.082; p=0.317
c= -0.020; p=0.812
c= -0.070; p=0.616
c= -0.280; p=0.128
c= -0.504; p<0.001
c= -0.918; p=0.008
c=0.285; p=0.011
c=0.154; p=0.145
White
Non-White

Supplementary figure 1: Age-standardized prevalence of hypertension, diabetes, smoking and obesity by sex, VIGITEL 2007-2018.



c: annual change (%); p= p-value

Supplementary figure 2: Age-standardized prevalence of hypertension, diabetes, smoking and obesity by skin color, VIGITEL 2007-2018.



c: annual change (%); p= p-value

Supplementary table 1: Age-standardized prevalence of hypertension by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education Sex and skin color (%)	Survey year (95% CI) 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual change (%)	p value
0-3 years														
Total	55.2 (53.3; 57.2)	58.4 (56.5; 60.3)	60.8 (58.8; 62.8)	59.0 (57.0; 61.0)	57.0 (55.1; 58.9)	56.0 (53.5; 58.4)	56.6 (54.3; 58.9)	59.8 (57.3; 62.4)	57.9 (55.9; 59.9)	61.9 (59.7; 64.1)	59.2 (57.2; 61.2)	60.7 (58.8; 62.6)	0.29	0.112
Female	58.9 (56.5; 61.2)	62.4 (60.1; 64.7)	64.6 (62.2; 67.0)	63.0 (60.6; 65.4)	62.1 (59.9; 64.4)	60.0 (57.1; 62.9)	62.2 (59.5; 64.9)	62.5 (59.5; 65.6)	62.5 (60.1; 64.9)	66.7 (64.1; 69.3)	62.6 (60.3; 65.0)	63.6 (61.4; 65.9)	0.25	0.179
Male	46.2 (42.8; 49.5)	48.3 (45.0; 51.7)	50.7 (47.1; 54.3)	48.8 (45.2; 52.4)	43.3 (40.0; 46.7)	45.1 (40.8; 49.4)	43.3 (39.3; 47.2)	52.6 (48.2; 57.1)	45.3 (41.8; 48.9)	50.4 (46.5; 54.2)	50.5 (47.0; 54.0)	52.9 (49.5; 56.4)	0.35	0.112
White	54.6 (50.9; 58.2)	57.6 (54.0; 61.3)	59.0 (55.1; 63.0)	61.5 (57.7; 65.2)	58.9 (55.7; 62.0)	55.8 (51.9; 59.6)	56.9 (53.4; 60.4)	56.6 (52.7; 60.5)	57.2 (53.7; 60.7)	61.5 (58.2; 64.8)	58.6 (55.3; 62.0)	61.6 (58.3; 64.8)	0.34	0.156
Non-white	55.5 (53.2; 57.9)	58.8 (56.5; 61.0)	61.5 (59.2; 63.8)	57.9 (55.5; 60.3)	55.9 (53.6; 58.3)	56.1 (53.0; 59.2)	56.3 (53.3; 59.3)	62.5 (59.1; 65.8)	58.2 (55.8; 60.7)	62.3 (59.4; 65.2)	59.5 (57.1; 62.0)	60.2 (57.9; 62.5)	0.30	0.083
4-8 years														
Total	44.0 (42.8; 45.2)	45.4 (44.2; 46.6)	46.7 (45.5; 47.9)	46.9 (45.7; 48.0)	46.1 (44.9; 47.2)	47.1 (45.8; 48.4)	48.8 (47.6; 50.0)	47.1 (45.8; 48.4)	47.8 (46.7; 48.9)	49.6 (48.4; 50.9)	49.5 (48.4; 50.7)	49.5 (48.4; 50.6)	0.45	<0.001
Female	48.3 (46.8; 49.9)	50.6 (49.1; 52.2)	50.4 (48.9; 51.9)	50.9 (49.4; 52.4)	51.0 (49.6; 52.5)	52.1 (50.4; 53.8)	53.4 (51.9; 54.9)	51.3 (49.6; 53.0)	52.7 (51.3; 54.1)	54.1 (52.6; 55.7)	53.6 (52.2; 55.0)	53.5 (52.1; 54.9)	0.42	<0.001
Male	35.3 (33.4; 37.1)	34.6 (32.7; 36.4)	38.8 (36.9; 40.7)	38.2 (36.4; 40.1)	36.2 (34.5; 37.9)	36.7 (34.6; 38.7)	38.5 (36.6; 40.4)	37.9 (35.7; 40.0)	37.7 (36.0; 39.4)	40.5 (38.5; 42.4)	40.9 (39.0; 42.8)	40.6 (38.8; 42.5)	0.46	0.001
White	45.7 (43.6; 47.8)	48.2 (46.1; 50.3)	47.2 (45.0; 49.3)	48.5 (46.4; 50.6)	47.8 (45.9; 49.7)	48.9 (46.9; 51.0)	51.8 (49.9; 53.6)	48.0 (45.9; 50.0)	48.9 (47.0; 50.7)	50.7 (48.9; 52.5)	51.4 (49.6; 53.2)	50.1 (48.3; 51.9)	0.37	<0.001
Non-white	43.0 (41.5; 44.4)	43.9 (42.4; 45.3)	46.4 (44.9; 47.9)	45.9 (44.5; 47.4)	44.8 (43.3; 46.3)	45.6 (43.8; 47.3)	46.1 (44.5; 47.7)	46.4 (44.6; 48.2)	47.2 (45.8; 48.6)	48.7 (47.1; 50.4)	48.3 (46.8; 49.7)	49.1 (47.7; 50.6)	0.48	<0.001
9-11 years														
Total	27.2 (26.3; 28.1)	29.2 (28.3; 30.1)	29.6 (28.7; 30.5)	30.7 (29.9; 31.6)	29.2 (28.3; 30.0)	29.3 (28.4; 30.2)	28.8 (28.0; 29.6)	29.4 (28.5; 30.3)	30.0 (29.3; 30.8)	30.6 (29.8; 31.4)	29.8 (29.0; 30.6)	30.3 (29.5; 31.1)	0.17	0.112
Female	29.0 (27.8; 30.2)	31.4 (30.2; 32.6)	31.6 (30.4; 32.7)	32.7 (31.6; 33.9)	31.0 (29.9; 32.1)	31.5 (30.3; 32.6)	31.0 (29.9; 32.1)	31.3 (30.1; 32.5)	32.9 (31.9; 33.9)	32.6 (31.5; 33.7)	32.0 (31.0; 33.1)	33.1 (32.0; 34.1)	0.22	0.043
Male	24.1 (22.8; 25.4)	25.5 (24.2; 26.7)	26.2 (24.9; 27.5)	27.1 (25.8; 28.4)	26.1 (24.9; 27.3)	25.5 (24.2; 26.8)	25.2 (24.1; 26.4)	26.2 (24.9; 27.6)	25.2 (24.1; 26.3)	27.2 (26.1; 28.4)	26.0 (24.9; 27.2)	25.5 (24.3; 26.6)	0.07	0.496
White	27.9 (26.4; 29.4)	31.4 (29.9; 32.9)	31.3 (29.8; 32.7)	33.1 (31.6; 34.6)	32.4 (31.0; 33.8)	33.3 (31.8; 34.7)	31.1 (29.8; 32.4)	31.8 (30.4; 33.3)	31.4 (30.2; 32.7)	33.4 (32.2; 34.7)	32.0 (30.7; 33.3)	31.9 (30.6; 33.1)	0.21	0.276
Non-white	26.7 (25.6; 27.8)	27.8 (26.7; 28.9)	28.5 (27.5; 29.6)	29.3 (28.2; 30.3)	26.8 (25.8; 27.8)	26.3 (25.2; 27.4)	27.1 (26.0; 28.1)	27.7 (26.5; 28.8)	29.2 (28.2; 30.1)	28.6 (27.6; 29.6)	28.5 (27.5; 29.4)	29.3 (28.3; 30.2)	0.16	0.040
12 or more years														
Total	23.7 (22.7; 24.6)	25.0 (24.0; 25.9)	25.0 (24.1; 25.9)	25.6 (24.7; 26.5)	25.3 (24.4; 26.2)	24.4 (23.5; 25.3)	23.8 (23.0; 24.6)	25.1 (24.2; 26.0)	25.2 (24.5; 25.9)	25.3 (24.6; 26.0)	24.6 (23.9; 25.3)	23.8 (23.1; 24.4)	-0.01	0.954
Female	22.4 (21.1; 23.6)	23.9 (22.7; 25.1)	24.3 (23.2; 25.5)	25.4 (24.3; 26.5)	24.3 (23.2; 25.5)	23.9 (22.7; 25.0)	23.0 (22.0; 24.0)	25.0 (23.8; 26.2)	25.2 (24.2; 26.1)	24.7 (23.8; 25.6)	24.0 (23.2; 24.9)	23.6 (22.8; 24.5)	0.08	0.504
Male	25.7 (24.3; 27.1)	26.6 (25.2; 28.0)	26.0 (24.6; 27.4)	26.0 (24.6; 27.3)	26.9 (25.6; 28.2)	25.4 (24.0; 26.8)	25.2 (24.0; 26.4)	25.3 (23.8; 26.7)	25.2 (24.1; 26.4)	26.3 (25.2; 27.4)	25.6 (24.5; 26.6)	24.0 (23.0; 25.1)	-0.12	0.092
White	24.7 (23.4; 26.0)	25.2 (23.9; 26.4)	24.7 (23.5; 26.0)	26.7 (25.5; 27.9)	26.4 (25.2; 27.6)	25.4 (24.1; 26.6)	25.9 (24.8; 27.0)	26.7 (25.4; 27.9)	26.8 (25.8; 27.9)	27.1 (26.1; 28.0)	26.0 (25.1; 27.0)	25.0 (24.0; 25.9)	0.08	0.424
Non-white	22.3 (21.0; 23.6)	24.7 (23.4; 26.0)	25.3 (24.0; 26.6)	24.2 (23.0; 25.5)	23.8 (22.5; 25.0)	23.2 (21.9; 24.5)	21.1 (20.0; 22.1)	23.3 (22.0; 24.6)	23.2 (22.2; 24.2)	23.2 (22.2; 24.2)	23.0 (22.0; 23.9)	22.5 (21.5; 23.4)	-0.11	0.357

Supplementary table 2: Age-standardized prevalence of diabetes by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education / Sex and skin color (%)	Survey year (95% CI) 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual change (%)	p value
0-3 years														
Total	17.2 (15.6; 18.7)	18.8 (17.2; 20.4)	20.3 (18.5; 22.0)	19.9 (18.2; 21.6)	20.0 (18.4; 21.6)	20.0 (18.0; 22.0)	19.7 (17.8; 21.5)	23.6 (21.4; 25.9)	22.1 (20.3; 23.8)	25.9 (23.9; 28.0)	22.4 (20.8; 24.1)	24.4 (22.7; 26.0)	0.60	<0.001
Female	18.2 (16.3; 20.1)	20.1 (18.1; 22.1)	21.4 (19.2; 23.6)	20.8 (18.6; 22.9)	21.7 (19.8; 23.7)	21.8 (19.3; 24.3)	21.7 (19.3; 24.1)	25.6 (22.7; 28.4)	23.7 (21.6; 25.9)	28.1 (25.6; 30.6)	24.0 (22.0; 26.1)	25.8 (23.8; 27.9)	0.67	<0.001
Male	14.6 (12.3; 16.9)	15.6 (13.1; 18.0)	17.2 (14.3; 20.1)	17.7 (14.9; 20.4)	15.3 (12.8; 17.7)	15.2 (12.0; 18.4)	14.8 (12.0; 17.5)	18.6 (15.1; 22.0)	17.5 (14.8; 20.2)	20.7 (17.6; 23.8)	18.5 (15.8; 21.2)	20.6 (17.9; 23.4)	0.45	0.001
White	15.7 (13.1; 18.4)	18.3 (15.4; 21.1)	20.2 (16.8; 23.6)	20.3 (16.9; 23.6)	18.1 (15.6; 20.5)	18.0 (15.1; 20.9)	19.4 (16.5; 22.2)	23.2 (19.8; 26.6)	22.5 (19.5; 25.5)	25.2 (22.2; 28.1)	21.7 (18.9; 24.5)	21.5 (18.8; 24.2)	0.55	0.014
Non-white	17.8 (16.0; 19.7)	19.1 (17.2; 21.0)	20.3 (18.2; 22.3)	19.7 (17.7; 21.7)	21.1 (19.1; 23.1)	21.5 (18.8; 24.3)	19.9 (17.4; 22.4)	24.0 (20.9; 27.0)	21.8 (19.7; 23.9)	26.6 (23.9; 29.4)	22.9 (20.8; 24.9)	25.9 (23.8; 28.0)	0.62	<0.001
4-8 years														
Total	11.5 (10.7; 12.4)	12.0 (11.2; 12.9)	13.5 (12.6; 14.4)	14.0 (13.1; 14.9)	14.4 (13.5; 15.3)	14.6 (13.7; 15.6)	15.4 (14.5; 16.3)	16.8 (15.8; 17.9)	15.8 (15.0; 16.6)	19.0 (18.0; 20.0)	17.2 (16.3; 18.0)	17.7 (16.8; 18.5)	0.60	<0.001
Female	12.4 (11.3; 13.5)	13.1 (12.0; 14.2)	13.8 (12.7; 15.0)	14.7 (13.6; 15.8)	15.8 (14.7; 17.0)	15.0 (13.8; 16.3)	16.0 (14.8; 17.2)	17.3 (16.0; 18.6)	16.6 (15.6; 17.7)	20.2 (18.9; 21.4)	17.7 (16.6; 18.8)	18.0 (17.0; 19.1)	0.58	<0.001
Male	9.8 (8.7; 11.0)	9.8 (8.6; 11.0)	12.7 (11.3; 14.1)	12.5 (11.2; 13.9)	11.7 (10.5; 12.9)	13.8 (12.3; 15.3)	14.1 (12.7; 15.6)	15.7 (14.1; 17.4)	14.0 (12.8; 15.2)	16.7 (15.2; 18.1)	16.1 (14.7; 17.5)	16.8 (15.4; 18.2)	0.63	<0.001
White	12.3 (10.8; 13.7)	12.7 (11.2; 14.2)	13.9 (12.3; 15.4)	15.5 (13.9; 17.1)	15.3 (13.9; 16.8)	14.1 (12.7; 15.6)	16.5 (15.0; 17.9)	17.0 (15.4; 18.5)	15.8 (14.5; 17.2)	20.6 (19.1; 22.0)	17.6 (16.3; 19.0)	18.3 (16.9; 19.7)	0.58	<0.001
Non-white	11.1 (10.1; 12.1)	11.6 (10.6; 12.6)	13.3 (12.2; 14.4)	13.1 (12.1; 14.2)	13.8 (12.7; 14.9)	15.0 (13.7; 16.3)	14.5 (13.3; 15.7)	16.7 (15.4; 18.1)	15.7 (14.7; 16.8)	17.6 (16.4; 18.9)	16.9 (15.8; 18.0)	17.3 (16.2; 18.4)	0.59	<0.001
9-11 years														
Total	6.5 (6.0; 7.1)	7.1 (6.6; 7.7)	7.6 (7.1; 8.2)	8.4 (7.9; 9.0)	7.8 (7.3; 8.3)	8.4 (7.8; 9.0)	7.7 (7.2; 8.2)	8.9 (8.3; 9.5)	8.8 (8.3; 9.3)	10.4 (9.8; 10.9)	8.9 (8.4; 9.3)	8.9 (8.5; 9.4)	0.23	0.001
Female	6.7 (6.0; 7.4)	7.3 (6.5; 8.0)	7.8 (7.0; 8.5)	8.9 (8.1; 9.6)	7.9 (7.2; 8.6)	8.6 (7.9; 9.4)	7.9 (7.3; 8.6)	9.1 (8.3; 9.9)	9.4 (8.7; 10.0)	11.0 (10.3; 11.7)	8.9 (8.3; 9.5)	9.1 (8.5; 9.7)	0.24	0.003
Male	6.3 (5.5; 7.0)	6.8 (6.0; 7.7)	7.4 (6.6; 8.2)	7.6 (6.8; 8.4)	7.6 (6.8; 8.3)	8.0 (7.1; 8.8)	7.3 (6.6; 8.1)	8.6 (7.7; 9.5)	7.7 (7.1; 8.4)	9.4 (8.6; 10.1)	8.8 (8.1; 9.5)	8.6 (7.9; 9.4)	0.21	<0.001
White	6.9 (6.0; 7.8)	8.3 (7.3; 9.4)	8.0 (7.1; 9.0)	9.8 (8.8; 10.8)	9.1 (8.2; 10.0)	9.3 (8.4; 10.2)	8.6 (7.8; 9.5)	9.7 (8.8; 10.7)	9.5 (8.7; 10.3)	11.5 (10.6; 12.4)	9.8 (9.0; 10.6)	9.5 (8.7; 10.3)	0.23	0.009
Non-white	6.3 (5.6; 7.0)	6.4 (5.7; 7.0)	7.4 (6.7; 8.0)	7.6 (6.9; 8.2)	6.8 (6.2; 7.5)	7.7 (7.0; 8.4)	7.0 (6.4; 7.6)	8.3 (7.5; 9.0)	8.3 (7.7; 8.9)	9.6 (8.9; 10.3)	8.3 (7.7; 8.8)	8.6 (8.0; 9.2)	0.23	<0.001
12 or more years														
Total	5.6 (5.1; 6.2)	5.7 (5.1; 6.2)	6.6 (6.0; 7.1)	6.8 (6.3; 7.4)	6.3 (5.7; 6.8)	6.2 (5.7; 6.8)	5.8 (5.4; 6.2)	6.7 (6.2; 7.3)	6.4 (6.0; 6.8)	8.4 (8.0; 8.9)	6.6 (6.2; 7.0)	6.4 (6.0; 6.7)	0.10	0.094
Female	4.7 (4.0; 5.3)	4.7 (4.1; 5.3)	5.9 (5.1; 6.6)	6.5 (5.8; 7.2)	5.6 (5.0; 6.2)	6.0 (5.3; 6.7)	5.4 (4.8; 5.9)	6.7 (6.0; 7.5)	6.1 (5.6; 6.7)	7.9 (7.4; 8.5)	6.1 (5.6; 6.6)	6.1 (5.6; 6.5)	0.15	0.028
Male	7.1 (6.2; 8.1)	7.2 (6.3; 8.1)	7.7 (6.8; 8.6)	7.4 (6.6; 8.3)	7.4 (6.5; 8.2)	6.6 (5.8; 7.5)	6.6 (5.9; 7.3)	6.7 (5.9; 7.6)	6.9 (6.2; 7.5)	9.3 (8.5; 10.0)	7.6 (6.9; 8.2)	6.9 (6.2; 7.5)	0.02	0.748
White	5.7 (4.9; 6.4)	5.6 (4.9; 6.3)	6.7 (5.9; 7.5)	7.1 (6.4; 7.8)	6.7 (6.0; 7.5)	6.3 (5.6; 7.0)	6.4 (5.8; 7.1)	7.3 (6.5; 8.1)	7.0 (6.4; 7.6)	9.3 (8.6; 9.9)	7.2 (6.7; 7.8)	6.8 (6.2; 7.3)	0.16	0.041
Non-white	5.6 (4.8; 6.4)	5.7 (5.0; 6.5)	6.4 (5.6; 7.2)	6.5 (5.8; 7.3)	5.6 (4.9; 6.3)	6.2 (5.4; 6.9)	5.0 (4.4; 5.6)	6.1 (5.3; 6.8)	5.8 (5.2; 6.3)	7.4 (6.8; 8.0)	6.0 (5.4; 6.5)	5.9 (5.3; 6.4)	0.03	0.447

Supplementary table 3: Age-standardized prevalence of smoking by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education	Survey year (95% CI)													
Sex and skin color (%)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual change (%)	p value
0-3 years														
Total	13.0 (11.7; 14.2)	12.9 (11.6; 14.1)	12.6 (11.3; 13.9)	11.6 (10.4; 12.9)	12.4 (11.2; 13.6)	11.0 (9.5; 12.4)	11.8 (10.3; 13.3)	11.7 (10.1; 13.4)	9.9 (8.7; 11.1)	11.8 (10.2; 13.3)	9.8 (8.6; 11.0)	9.0 (7.9; 10.2)	-0.29	<0.001
Female	10.7 (9.3; 12.1)	11.1 (9.7; 12.6)	10.9 (9.4; 12.4)	10.9 (9.3; 12.4)	10.1 (8.8; 11.5)	9.5 (7.9; 11.2)	9.7 (8.1; 11.4)	10.4 (8.4; 12.3)	8.3 (7.0; 9.7)	10.3 (8.5; 12.1)	8.5 (7.0; 9.9)	9.0 (7.6; 10.4)	-0.22	<0.001
Male	18.6 (16.0; 21.2)	17.4 (15.0; 19.8)	17.1 (14.5; 19.6)	13.6 (11.3; 15.9)	18.5 (15.9; 21.0)	14.8 (11.8; 17.8)	16.7 (13.8; 19.7)	15.3 (12.1; 18.5)	14.3 (11.8; 16.8)	15.3 (12.4; 18.2)	13.3 (10.9; 15.6)	9.1 (7.1; 11.1)	-0.54	0.005
White	10.4 (8.2; 12.5)	9.9 (7.8; 11.9)	10.9 (8.5; 13.3)	9.7 (7.5; 11.9)	11.4 (9.4; 13.3)	11.4 (9.0; 13.9)	10.2 (8.2; 12.3)	10.7 (8.2; 13.1)	8.2 (6.3; 10.0)	9.4 (7.4; 11.4)	8.2 (6.3; 10.0)	8.1 (6.2; 10.0)	-0.21	0.013
Non-white	14.1 (12.6; 15.7)	14.2 (12.6; 15.7)	13.2 (11.6; 14.7)	12.5 (10.9; 14.0)	13.0 (11.5; 14.6)	10.6 (8.8; 12.4)	13.1 (11.0; 15.2)	12.6 (10.3; 14.8)	10.9 (9.3; 12.4)	13.8 (11.6; 16.1)	10.8 (9.2; 12.3)	9.5 (8.1; 11.0)	-0.28	0.004
4-8 years														
Total	14.4 (13.6; 15.1)	15.0 (14.2; 15.8)	14.7 (13.9; 15.5)	14.3 (13.5; 15.1)	13.6 (12.9; 14.4)	13.5 (12.6; 14.4)	11.4 (10.7; 12.2)	11.7 (10.8; 12.5)	10.4 (9.7; 11.1)	10.8 (10.1; 11.6)	10.0 (9.3; 10.7)	10.8 (10.1; 11.5)	-0.47	<0.001
Female	11.6 (10.6; 12.5)	12.6 (11.7; 13.6)	12.7 (11.7; 13.6)	12.2 (11.3; 13.2)	10.9 (10.0; 11.8)	11.3 (10.2; 12.3)	9.5 (8.6; 10.4)	9.9 (8.9; 10.8)	8.8 (8.0; 9.6)	8.7 (7.8; 9.6)	8.0 (7.2; 8.8)	9.1 (8.2; 9.9)	-0.40	0.001
Male	19.9 (18.5; 21.3)	19.9 (18.4; 21.3)	19.0 (17.6; 20.4)	18.6 (17.2; 20.0)	19.0 (17.6; 20.4)	18.1 (16.6; 19.7)	15.7 (14.2; 17.1)	15.7 (14.1; 17.3)	13.7 (12.5; 15.0)	15.1 (13.7; 16.5)	14.2 (12.9; 15.6)	14.6 (13.2; 16.0)	-0.59	<0.001
White	13.7 (12.4; 15.1)	13.2 (11.9; 14.5)	13.4 (12.0; 14.8)	12.7 (11.3; 14.0)	12.7 (11.5; 13.9)	12.1 (10.8; 13.4)	10.8 (9.7; 11.9)	10.4 (9.2; 11.7)	10.5 (9.4; 11.7)	10.5 (9.4; 11.6)	9.8 (8.7; 11.0)	10.0 (8.9; 11.1)	-0.38	<0.001
Non-white	14.7 (13.8; 15.7)	16.0 (15.0; 17.0)	15.4 (14.4; 16.4)	15.2 (14.2; 16.1)	14.3 (13.3; 15.3)	14.6 (13.5; 15.8)	12.0 (11.0; 13.0)	12.7 (11.5; 13.8)	10.3 (9.5; 11.2)	11.1 (10.1; 12.1)	10.1 (9.2; 10.9)	11.3 (10.4; 12.3)	-0.54	<0.001
9-11 years														
Total	12.9 (12.3; 13.6)	11.4 (10.8; 11.9)	11.4 (10.9; 12.0)	10.8 (10.3; 11.4)	10.4 (9.9; 10.9)	9.5 (8.9; 10.0)	8.8 (8.3; 9.3)	8.2 (7.7; 8.8)	8.0 (7.6; 8.5)	7.7 (7.3; 8.2)	7.4 (7.0; 7.9)	7.3 (6.9; 7.7)	-0.51	<0.001
Female	11.2 (10.5; 12.0)	9.6 (8.9; 10.3)	9.4 (8.7; 10.1)	9.7 (9.1; 10.4)	8.9 (8.2; 9.5)	8.0 (7.4; 8.7)	7.1 (6.5; 7.7)	7.1 (6.4; 7.7)	6.4 (5.9; 7.0)	6.7 (6.1; 7.2)	6.1 (5.5; 6.6)	5.9 (5.4; 6.4)	-0.47	<0.001
Male	15.9 (14.9; 16.9)	14.4 (13.4; 15.3)	14.9 (13.9; 15.9)	12.8 (11.9; 13.7)	12.9 (12.0; 13.7)	12.0 (11.1; 13.0)	11.6 (10.8; 12.5)	10.2 (9.3; 11.0)	10.7 (9.9; 11.5)	9.5 (8.7; 10.3)	9.7 (8.9; 10.5)	9.7 (8.9; 10.5)	-0.58	<0.001
White	13.3 (12.3; 14.3)	12.1 (11.1; 13.1)	12.2 (11.3; 13.2)	12.4 (11.4; 13.3)	11.3 (10.4; 12.2)	10.9 (10.0; 11.9)	9.6 (8.8; 10.4)	9.4 (8.5; 10.3)	9.3 (8.5; 10.1)	8.6 (7.8; 9.3)	8.8 (8.0; 9.6)	8.5 (7.7; 9.3)	-0.46	<0.001
Non-white	12.7 (11.9; 13.4)	10.9 (10.2; 11.6)	10.9 (10.2; 11.6)	9.8 (9.2; 10.5)	9.8 (9.1; 10.4)	8.4 (7.7; 9.0)	8.2 (7.6; 8.8)	7.4 (6.7; 8.1)	7.3 (6.8; 7.8)	7.2 (6.6; 7.8)	6.6 (6.1; 7.1)	6.5 (6.0; 7.1)	-0.54	<0.001
12 or more years														
Total	11.8 (11.1; 12.4)	10.7 (10.0; 11.3)	9.9 (9.3; 10.5)	9.1 (8.6; 9.7)	9.1 (8.5; 9.6)	8.0 (7.4; 8.6)	6.8 (6.3; 7.2)	6.8 (6.3; 7.4)	6.6 (6.2; 7.0)	6.3 (5.9; 6.7)	6.2 (5.8; 6.6)	5.6 (5.2; 5.9)	-0.55	<0.001
Female	10.1 (9.3; 10.9)	9.4 (8.6; 10.2)	9.1 (8.4; 9.9)	8.1 (7.4; 8.8)	8.2 (7.5; 8.9)	6.8 (6.1; 7.6)	6.0 (5.4; 6.5)	6.1 (5.4; 6.8)	5.6 (5.1; 6.1)	5.0 (4.5; 5.5)	5.2 (4.7; 5.7)	4.5 (4.1; 5.0)	-0.51	<0.001
Male	14.3 (13.3; 15.4)	12.7 (11.6; 13.7)	11.2 (10.2; 12.1)	10.9 (9.9; 11.8)	10.5 (9.6; 11.4)	10.0 (9.1; 11.0)	8.2 (7.4; 8.9)	8.1 (7.2; 9.1)	8.2 (7.4; 8.9)	8.5 (7.8; 9.2)	7.9 (7.2; 8.6)	7.3 (6.7; 8.0)	-0.60	<0.001
White	12.3 (11.4; 13.1)	12.0 (11.1; 12.9)	11.4 (10.5; 12.2)	10.3 (9.5; 11.1)	10.0 (9.3; 10.8)	9.4 (8.5; 10.2)	7.8 (7.1; 8.5)	8.7 (7.8; 9.5)	8.0 (7.3; 8.6)	7.2 (6.6; 7.8)	7.4 (6.8; 8.0)	6.6 (6.1; 7.2)	-0.52	<0.001
Non-white	11.1 (10.2; 12.1)	9.0 (8.2; 9.8)	8.1 (7.4; 8.9)	7.7 (6.9; 8.4)	7.7 (6.9; 8.5)	6.2 (5.5; 7.0)	5.5 (4.9; 6.0)	4.6 (4.0; 5.3)	4.9 (4.4; 5.5)	5.2 (4.7; 5.7)	4.8 (4.3; 5.3)	4.4 (3.9; 4.9)	-0.58	<0.001

Supplementary table 4: Age-standardized prevalence of obesity by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education / Sex and skin color (%)	Survey year (95% CI) 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual change (%)	p value
0-3 years														
Total	21.3 (19.6; 22.9)	23.2 (21.5; 24.9)	22.7 (21.0; 24.5)	22.7 (20.9; 24.4)	24.1 (22.4; 25.7)	25.6 (23.4; 27.7)	23.5 (21.5; 25.4)	26.5 (24.2; 28.8)	26.8 (24.9; 28.6)	27.6 (25.6; 29.6)	27.1 (25.3; 28.9)	28.4 (26.7; 30.2)	0.60	<0.001
Female	23.8 (21.7; 25.8)	26.8 (24.7; 28.9)	25.2 (23.0; 27.4)	25.3 (23.2; 27.5)	27.1 (25.1; 29.2)	28.9 (26.1; 31.6)	26.2 (23.7; 28.7)	29.6 (26.7; 32.5)	29.4 (27.2; 31.7)	30.3 (27.7; 32.8)	29.6 (27.4; 31.9)	31.2 (29.1; 33.4)	0.57	<0.001
Male	15.0 (12.7; 17.3)	14.1 (11.8; 16.3)	16.2 (13.6; 18.9)	15.9 (13.4; 18.4)	16.0 (13.5; 18.4)	16.8 (13.6; 19.9)	17.0 (14.1; 19.8)	18.4 (15.0; 21.7)	19.5 (16.7; 22.3)	21.2 (18.1; 24.3)	20.8 (18.0; 23.6)	21.1 (18.4; 23.8)	0.65	<0.001
White	20.5 (17.6; 23.4)	23.3 (20.1; 26.4)	20.3 (17.0; 23.6)	21.4 (18.3; 24.6)	24.6 (21.8; 27.4)	24.5 (21.1; 27.9)	24.3 (21.2; 27.4)	26.3 (22.8; 29.9)	25.9 (22.8; 29.0)	28.2 (25.1; 31.2)	26.7 (23.7; 29.7)	26.6 (23.7; 29.6)	0.64	<0.001
Non-white	21.6 (19.7; 23.6)	23.2 (21.2; 25.2)	23.7 (21.6; 25.8)	23.2 (21.2; 25.3)	23.8 (21.8; 25.8)	26.3 (23.5; 29.2)	22.8 (20.3; 25.4)	26.6 (23.6; 29.7)	27.2 (25.0; 29.5)	27.1 (24.4; 29.8)	27.4 (25.1; 29.6)	29.4 (27.2; 31.6)	0.58	<0.001
4-8 years														
Total	17.0 (16.2; 17.9)	18.7 (17.7; 19.6)	19.3 (18.4; 20.3)	20.2 (19.3; 21.1)	20.6 (19.7; 21.6)	22.0 (20.9; 23.1)	22.4 (21.4; 23.4)	22.8 (21.7; 23.9)	23.9 (22.9; 24.8)	24.6 (23.6; 25.6)	23.9 (22.9; 24.8)	24.5 (23.6; 25.5)	0.67	<0.001
Female	17.9 (16.7; 19.0)	20.4 (19.2; 21.7)	20.5 (19.2; 21.7)	21.3 (20.1; 22.5)	22.1 (20.8; 23.3)	23.8 (22.3; 25.2)	23.6 (22.3; 24.9)	24.7 (23.3; 26.2)	25.7 (24.5; 26.9)	25.9 (24.5; 27.2)	24.5 (23.3; 25.7)	26.4 (25.1; 27.6)	0.70	<0.001
Male	15.4 (14.1; 16.7)	15.0 (13.7; 16.2)	16.9 (15.4; 18.3)	17.9 (16.5; 19.2)	17.8 (16.5; 19.1)	18.3 (16.8; 19.9)	19.8 (18.3; 21.4)	18.6 (16.9; 20.3)	20.2 (18.8; 21.6)	22.0 (20.4; 23.6)	22.5 (20.9; 24.1)	20.5 (19.0; 22.0)	0.62	<0.001
White	16.7 (15.1; 18.2)	19.3 (17.6; 21.0)	19.4 (17.7; 21.1)	20.4 (18.7; 22.1)	20.3 (18.8; 21.8)	22.0 (20.3; 23.7)	21.9 (20.4; 23.5)	22.8 (21.0; 24.5)	23.8 (22.2; 25.4)	24.6 (23.0; 26.1)	23.5 (21.9; 25.0)	24.4 (22.9; 26.0)	0.65	<0.001
Non-white	17.3 (16.2; 18.3)	18.3 (17.2; 19.5)	19.3 (18.1; 20.4)	20.1 (19.0; 21.2)	20.8 (19.7; 22.0)	22.0 (20.6; 23.4)	22.9 (21.5; 24.2)	22.8 (21.4; 24.3)	24.0 (22.8; 25.1)	24.6 (23.2; 26.0)	24.1 (22.9; 25.4)	24.6 (23.4; 25.9)	0.68	<0.001
9-11 years														
Total	12.8 (12.2; 13.4)	13.9 (13.2; 14.5)	14.4 (13.8; 15.1)	16.0 (15.3; 16.6)	16.5 (15.9; 17.1)	17.4 (16.7; 18.1)	17.5 (16.8; 18.1)	18.5 (17.8; 19.3)	18.7 (18.1; 19.3)	19.1 (18.4; 19.8)	18.5 (17.9; 19.2)	19.6 (18.9; 20.2)	0.60	<0.001
Female	12.2 (11.3; 13.0)	13.5 (12.6; 14.3)	14.2 (13.4; 15.1)	15.6 (14.8; 16.5)	16.2 (15.3; 17.0)	17.5 (16.6; 18.4)	17.2 (16.3; 18.0)	18.8 (17.8; 19.8)	19.1 (18.3; 19.9)	19.3 (18.5; 20.2)	18.6 (17.7; 19.4)	19.9 (19.0; 20.7)	0.68	<0.001
Male	14.0 (13.1; 14.9)	14.5 (13.6; 15.4)	14.8 (13.8; 15.7)	16.6 (15.6; 17.6)	17.0 (16.0; 17.9)	17.2 (16.2; 18.3)	17.9 (16.9; 18.9)	18.1 (17.0; 19.2)	18.0 (17.0; 18.9)	18.7 (17.7; 19.7)	18.5 (17.4; 19.5)	19.0 (18.0; 20.1)	0.46	<0.001
White	12.8 (11.7; 13.8)	14.0 (12.9; 15.1)	14.3 (13.2; 15.3)	15.8 (14.7; 16.9)	16.9 (15.8; 18.0)	18.1 (16.9; 19.2)	16.9 (15.9; 18.0)	18.5 (17.3; 19.7)	18.1 (17.1; 19.2)	18.4 (17.4; 19.5)	17.6 (16.6; 18.6)	18.9 (17.8; 20.0)	0.52	0.001
Non-white	12.9 (12.1; 13.6)	13.8 (13.0; 14.6)	14.5 (13.8; 15.3)	16.1 (15.3; 16.9)	16.2 (15.4; 17.0)	16.9 (16.0; 17.8)	17.9 (17.0; 18.7)	18.6 (17.6; 19.5)	19.0 (18.2; 19.8)	19.6 (18.7; 20.4)	19.1 (18.3; 19.9)	20.0 (19.1; 20.8)	0.64	<0.001
12 or more years														
Total	11.6 (11.0; 12.3)	11.5 (10.9; 12.1)	12.8 (12.1; 13.4)	13.3 (12.7; 13.9)	14.7 (14.1; 15.4)	14.9 (14.2; 15.6)	15.2 (14.6; 15.8)	15.0 (14.2; 15.7)	15.1 (14.6; 15.7)	15.6 (15.1; 16.2)	16.1 (15.5; 16.7)	16.8 (16.2; 17.4)	0.46	<0.001
Female	9.4 (8.6; 10.2)	9.4 (8.6; 10.1)	11.3 (10.5; 12.2)	12.0 (11.2; 12.8)	13.0 (12.1; 13.8)	13.7 (12.8; 14.6)	12.7 (12.0; 13.5)	13.5 (12.6; 14.4)	13.5 (12.8; 14.2)	13.8 (13.1; 14.5)	14.3 (13.6; 15.0)	15.1 (14.3; 15.8)	0.48	<0.001
Male	15.1 (14.0; 16.1)	14.9 (13.8; 16.0)	15.0 (14.0; 16.1)	15.6 (14.6; 16.6)	17.6 (16.6; 18.7)	17.0 (15.9; 18.1)	19.5 (18.4; 20.5)	17.5 (16.3; 18.7)	17.8 (16.8; 18.8)	18.6 (17.6; 19.6)	19.2 (18.2; 20.1)	19.7 (18.7; 20.7)	0.45	<0.001
White	11.2 (10.4; 12.1)	11.1 (10.3; 12.0)	12.2 (11.3; 13.1)	12.8 (12.0; 13.7)	14.1 (13.2; 15.0)	14.4 (13.5; 15.4)	14.9 (14.1; 15.7)	14.5 (13.5; 15.5)	14.7 (13.9; 15.5)	15.1 (14.3; 15.8)	14.9 (14.1; 15.7)	16.1 (15.3; 16.9)	0.43	<0.001
Non-white	12.2 (11.2; 13.2)	12.0 (11.1; 12.9)	13.5 (12.5; 14.5)	13.9 (13.0; 14.8)	15.5 (14.5; 16.5)	15.5 (14.4; 16.5)	15.6 (14.7; 16.5)	15.5 (14.5; 16.6)	15.6 (14.8; 16.4)	16.3 (15.5; 17.2)	17.4 (16.6; 18.3)	17.6 (16.7; 18.4)	0.48	<0.001

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	Indicate the study's design with a commonly used term in the title or the abstract Page 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Page 3
Objectives	3	State specific objectives, including any prespecified hypotheses Page3
Methods		
Study design	4	Present key elements of study design early in the paper Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Page 4
Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants Page 4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Pages 4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Pages 4-5
Bias	9	Describe any efforts to address potential sources of bias pages 4-5
Study size	10	Explain how the study size was arrived at page4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Page 5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Page 5
		(*b*) Describe any methods used to examine subgroups and interactions Page 5
		(*c*) Explain how missing data were addressed Page 5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy Page 5
		(*e*) Describe any sensitivity analyses Page 5
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Page 4
		(b) Give reasons for non-participation at each stage Page 4
		(c) Consider use of a flow diagram NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Table 1
		(b) Indicate number of participants with missing data for each variable of interest

		page 4
Outcome data	15*	Report numbers of outcome events or summary measures Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Figures 1, 2 and 3
		(*b*) Report category boundaries when continuous variables were categorized NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Figure 1
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Figures 2 and 3
Discussion		
Key results	18	Summarise key results with reference to study objectives Page 8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Page 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Page 11
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 11
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based page 6

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

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EDUCATIONAL DISPARITIES IN HYPERTENSION, DIABETES, OBESITY AND SMOKING IN BRAZIL: A TREND ANALYSIS OF 578,977 ADULTS FROM A NATIONAL SURVEY, 2007 TO 2018.

ABSTRACT

Objectives: Our study aimed to assess social inequality trends for hypertension, diabetes mellitus, smoking and obesity from 2007 to 2018 in adults from Brazilian capitals.

Setting: Data from the VIGITEL study, a cross-sectional telephone survey conducted annually from 2007 to 2018.

Participants: We used data from 578,977 Brazilian adults (≥18 years).

Design: Cross-sectional surveys conducted annually from 2007 to 2018.

Primary outcome measures: Participants responded to a questionnaire about medical diagnosis of hypertension and diabetes, smoking status, weight and height. Educational inequalities (0-3, 4-8, 9-11 and 12 or more years of study) by sex and skin color were assessed trough absolute (slope index of inequality – SII) and relative measures of inequality (concentration index – CIX), and trends were tested by Prais-Winsten.

Results: All outcomes were more prevalent in the least educated. The largest absolute educational inequality was observed for hypertension (SII_{total} = -37.8 in 2018). During 2007-2018, the total educational disparity remained constant for hypertension, increased for diabetes and smoking, and decreased for obesity. Overall, inequality was higher among women and non-whites, compared to men and whites. We found a reduction in absolute inequality for hypertension among non-whites, an increase for diabetes in all strata, and an increase for smoking in women and non-whites. The relative inequality decreased in women and whites and increased for smoking in all strata, except among men.

Conclusion: The educational inequality reduced for obesity, remained constant for hypertension and increased for diabetes and smoking from 2007 to 2018 in Brazilian adults.

Funding: Brazilian National Council of Scientific and Technological Development (CNPq), 404905/2016-1.

Keywords: Inequality, Hypertension, Diabetes, Smoking, Obesity, Adults.

Strengths and limitations of this study

- We assessed the extent and trend of socioeconomic inequalities in major non-communicable diseases (hypertension and diabetes) and its risk factors (smoking and obesity) over 12 years in a middle-income country;

- We used large samples from Brazilian adults living in the 27 state Capitals in Brazil;

- We assessed educational inequalities in total sample and in subgroups of sex and race/skin color using complex measures of inequality.

- Using data from a telephone Survey (VIGITEL) limited our generalizability to those with landlines.

- The use of self-reported diseases may have affected our results underestimating inequality in hypertension and diabetes, as it may have underestimated the prevalence among least favored groups.

INTRODUCTION

Non-communicable diseases (NCD) are the main cause of death in Brazil[1] and worldwide[2]. According to the Global Burden of Diseases, Injuries, and Risk Factors Study, in 2017, the four main risk factors for mortality and years of life lost due to disability in Brazil were systemic arterial hypertension, diabetes *mellitus*, obesity and smoking[3]. Importantly, these risk factors affect the less economically favored groups in a more pronounced way[4-6], in addition to reinforcing poverty and income inequality by generating an increase in direct and indirect spending and loss of productivity[7]. A synthesis of 283 studies in low- and middle-income countries showed a positive association between low income, low socioeconomic status and low educational level with the occurrence of NCD[8]. In Brazil, adults with less education, non-whites and without health insurance had a higher prevalence of risk factors for NCD, such as smoking, leisure time physical inactivity, and lower consumption of fruits and vegetables[9].

Trend analysis of the risk factors for NCD in Brazil showed that the prevalence of hypertension remained stable between 2006 and 2018, while diabetes and obesity grew and smoking dropped [10]. However, this trend did not occur homogeneously among social strata. Between 1998 and 2013, there was a reduction in educational inequalities for hypertension and coronary heart disease and an increase in inequality for diabetes in Brazilian adults[5].

A sustained reduction in health inequities between countries is necessary[8]. However, trend studies on social inequality in the different risk factors for NCD that are essential for health planning are scarce in Brazil[5], especially assessing risk factors concomitantly and based on educational disparities, also considering sex and color strata. Therefore, our aim was to assess social inequality trends for hypertension, diabetes, smoking and obesity among adults from Brazilian state capitals, from 2007 to 2018. We also performed subgroup analysis for education inequalities by skin color and sex.

METHODS

Study design and source of data and sample

This study used data collected by the Surveillance of Risk and Protection Factors for Chronic Diseases by Telephone Survey (VIGITEL), coordinated by the Ministry of Health of Brazil, from 2007 to 2018. VIGITEL is a cross-sectional system for monitoring the health of the adult population – over 18 years old, residing in the Brazilian capitals and the Federal District (DF), and who have a landline telephone – carried out annually since 2006. The sample stratification took place by telephone prefix until 2011, and subsequently by postal code (CEP). In order to reduce selection bias due to the partial coverage of the population by the landline telephone system, VIGITEL assigned a final weight to each individual, considering the inverse of the number of telephone lines in the household interviewed, the number of adults living in the household and the socio-demographic composition of the sample, based on the 2000 and 2010 demographic censuses. This weighting aimed to achieve representativeness for population aged 18 years and over of each state capital in Brazil, including DF in all years[10], but it cannot be used as a representative sample of the whole country. However, it had limitations previously described[11].

Data from 625,070 individuals interviewed between 2007 and 2018 were initially obtained. We excluded women who were pregnant and those who had doubts if they were or were not pregnant by the time of the interview (5,087 women); people aged 80 or older (22,234 individuals) because aging may affect self-reports[12]; people who did not want to or did not know how to respond to their skin color (20,699 respondents), corresponding to a loss of 46,093 (7.4%) observations compared to the original study. Thus, 578,977 participants were included in this study. During the analysis, there were 2 additional missing for skin color e 3 missing for obesity.

All data of the participants were self-reported. They answered about previous medical diagnosis of hypertension and diabetes (all types), if they were current smokers (yes/no) and their weight and height, used to calculate the Body Mass Index (BMI). We considered BMI≥30kg/m^2 for obesity[13]. Risk factors were described according educational level (i.e., years of study number: 0-3, 4-8, 9-11 and 12 or more study years), sex (women and men) and skin color (white and non-white). Skin color also was self-reported and included the categories: white (used for white color) and black, brown, mixed race, yellow (Asian), red (i.e. indigenous) and indigenous (used for non-white skin color).

Statistical analysis

Prevalence of hypertension, diabetes, smoking and obesity (2007-2018) was age-standardized using the age distribution of the year 2018. We estimated absolute and relative complex measures of inequality, namely the slope index of inequality (SII) and the concentration index (CIX), respectively, and its 95% confidence interval. These measures of inequality are complementary and were calculated according to the World Health Organization [14] and Barros et al. [15]. The SII results from a linear regression of the cumulative population proportional distribution in each one of the four educational groups in this study and represents the absolute difference, in predicted values, on disease prevalence between the least and the most favored person, with no education and the highest possible education, taking into consideration the entire distribution of the stratification variable. The CIX assesses the relative difference between them and shows how concentrated are the diseases towards the least or most favored groups. CIX values should be read with caution because it can overestimate inequalities when the outcome of interest has a low frequency and may not be able to identify important inequalities when the outcome prevalence is high[16].

The results of SII and CIX were multiplied by 100 to facilitate their visualization in tables and graphs, ranging from -100 to +100. On this scale, CIX values less than -20 or greater than 20 can be considered relevant indicators of inequality[14]. Results equal to zero represent a situation of total equality. When it is equal +100 or -100, we have the grater inequality possible. Negative values indicate a higher prevalence of the risk factor in the least educated group, while positive ones represents grater prevalence in those most educated groups.

The different levels of education were used to calculate the total SII and CIX. Subsequently, the SII and CIX data for educational level schooling were stratified by sex and skin color. The time trend of the indicators was analyzed using the Prais-Winsten method modified by Durbin and Watson instead of traditional linear regression to avoid the autoregressive problem common in this social serial trend analysis[17]. Statistical analyses were performed using the STATA/SE® 15.1 software.

Ethical aspects

VIGITEL was approved by the National Research Ethics Commission (CONEP). The VIGITEL database is in the public domain and does not allow identification of participants. It is available at the electronic address: http://svs.aids.gov.br/download/Vigitel/. The waiver of ethical review was approved by the Research Ethics Committee of the Federal University of Uberlândia, Minas Gerais (CAAE: 2,654,271).

Patient and public involvement

No patients or public were involved in the design, or conduct, or reporting, or dissemination plans of our research.

RESULTS

From 2007 to 2018, the profile of individuals evaluated remained similar, with a slight increase (p=0.001) in the average of age (from 39.8 to 41.7 years) and similar distribution between sexes (p=0.858 – 53.2% female) and skin color (p=0.154 – 58.6% non-white) in 2018. The average number of years of study showed a significant increase in the period, from 9.4 to

10.7 years of study (p=0.001). The prevalence of hypertension remained constant in the period (34.1% in 2007 to 33.3% in 2018 – p=0.065), with a reduction in smoking (from 13.0% to 7.4% – p=0.001), while the prevalence of diabetes (8.9% to 10.6% – p=0.004) and obesity increased (14.7% to 20.0% – p=0.001) (Table 1). Descriptive data stratified by sex and skin color can be found in Supplementary Table 1.

An educational gradient was observed for all four outcomes, with a higher prevalence among the least educated group. The largest prevalence discrepancy in 2018, between the least and the most educated groups, was observed for diabetes (24.4% and 6.4%) resulting in a difference of 18.0 percentage points. The smallest for smoking (9.0% and 5.6%), where the prevalence difference between groups was 3.4 percentage points. Detailed data can be found in Figure 1 and Supplementary Tables 2 to 5. For hypertension and obesity, these prevalence differences were: 60.7% versus 23.8% and 28.4% versus 16.8%, respectively.

Hypertension, diabetes, and obesity were more prevalent in women than in men, while smoking prevalence was higher in men. The prevalence of outcomes was higher in non-whites compared to whites for hypertension and obesity, and lower for diabetes and smoking. Supplementary Figures 1 and 2 and Supplementary Tables 2 to 5 show the age-standardized prevalence of each outcome by years of study and stratified by sex, skin color and education.

Table 2 shows the absolute (SII) and relative (CIX) measures of educational inequality for the four outcomes and also by sex and skin color. Negative SII and CIX values for all outcomes reaffirm their higher prevalence among least educated group.

The absolute and relative educational inequality for hypertension, diabetes and obesity was, in general, higher among women than men and higher in non-white individuals compared to whites, represented by negative and higher SII and CIX values (Figures 2, 3 and 4). The exception was smoking, where SII and CIX were higher in men. Obesity showed higher absolute and relative inequality among whites (Figure 4). Over the period, absolute and relative inequality remained constant in hypertension (Figure 2; p=0.701 and 0.658, respectively), being higher in women than in men (Figure 3) and in non-whites in relation to whites (Figure 4). The absolute inequality in diabetes had a statistically significant increase in all strata (Figures 2, 3 and 4; p<0.05). This increase was greater in men than in women, as well as in whites in relation to non-whites. The relative inequality in diabetes remained constant over the period (p=0.350). The absolute inequality for obesity remained constant (p=0.251), although there was a reduction in the relative inequality for the total sample and between women and non-whites (Figures 2, 3 and 4; p=0.010, 0.009 and 0.011, respectively). There was an increase in absolute inequality in smoking between whites (p=0.004) and women (p=0.025) during the analyzed period. The relative inequality in smoking increased in all strata (p<0.05), except among men, where it remained constant (Figures 2, 3 and 4).

DISCUSSION

In our study, diabetes, hypertension, obesity, and smoking remained more prevalent in the least educated groups from 2007 to 2018 in Brazil. The absolute and relative educational inequalities were higher among women and non-whites, compared to men and whites. Hypertension was the outcome that had the highest absolute educational inequality, which remained constant in the period; the absolute educational inequality for diabetes increased in all strata. The absolute educational inequality remained constant for obesity, although the relative one has reduced for the total sample, among women and non-whites. There was an increase in the absolute educational inequality for smoking among women and whites and relative educational inequality for all strata, except for men where it remained constant.

Hypertension had higher prevalence (33.3% in 2018) and the highest absolute educational inequality (-37.8 in 2018). The prevalence in the least educated group was 60.7%. A study carried out with Brazilian adults found that aging, black skin color, low education, obesity, being a former smoker, self-reported diabetes, high cholesterol and high salt intake were associated with a higher prevalence of hypertension[18]. In addition to individual factors, a study conducted with the North American population indicated that states with greater socioeconomic vulnerability, such as low family income and high percentages of the population below the poverty line were significantly associated with a high prevalence of self-reported hypertension[19], which corroborates with the inequality findings in our study. However, although we found the highest educational inequality for hypertension, it remained constant in the period. On the other hand, educational inequality for diabetes increased in this period in all strata. Diabetes had the highest relative inequity in 2018 (-24.0). Trend analysis of the prevalence of diabetes, hypertension and heart disease from 1998 to 2013 also found an increase in diabetes disparities among a representative sample of Brazilian adults[5]. It is possible that strategies such as the Brazilian National Policy for the Comprehensive Health of the Black Population[20], could have contributed to reduce race inequality by decreasing the prevalence of hypertension among non-whites. However, if this is true, we would expect to find a reduction in race inequality for diabetes. There are several potential explanations for the increase in educational inequalities for diabetes. This could have been partially driven by our finding of an increase in obesity prevalence over time, and higher prevalence among those less educated. Obesity is a stronger risk factor for diabetes than for hypertension[21 22]. It is also possible that the increase in primary care coverage has provided access to health care and, consequently, increased the diagnosis of diabetes among those underprivileged (i.e., therefore, artificially increasing the diabetes inequality). The National Program for Improving Access and Quality in Primary Care and the Requalification Program for Basic Health Units (*Programa Nacional de Melhoria do Acesso e da Qualidade da Atenção Básica* -PMAQ), created in 2011, as well as the More Doctors for Brazil Project (*Mais Médicos para o Brasil*), created in 2013, increased the number of health units and physicians' access to more than 65 million people[23]. If that was the case, we would expect increase in social inequality for hypertension too[24]. Unless the requirement of fewer medical supplies for hypertension diagnosis compared to diabetes[24] causes less underreport for hypertension and, therefore, benefits less from the extension in primary care coverage not affecting the inequality.

The increase in obesity prevalence over time, especially among the least educated group, have been reported in other countries[25]. This can be explained by the lower financial access to healthy food in addition to fewer opportunities to engage in leisure physical activities[26]. The gap in obesity prevalence between least and the most educated groups reduced over time, but it was not sufficient to impact SII indicator. However, due to an increase in obesity prevalence in all education groups, especially in those with 9 to 11 study years (53,1% while prevalence raised 33,3% in people with less than 4 years of study), relative inequality reduced. This reduction in relative inequality is an artificial change that should not be read as an achievement because does not reflect a beneficial change in inequality, but rather a worsening scenario for all strata of education. Brazil still lacks strong initiatives to protect the more vulnerable groups and tackle the social inequalities for obesity such as regulation of nutritional labelling claims and health warnings, advertising restrictions, protection of the food school environment and taxation of unhealthy food[27], jointly with a broad promotion of active commuting and availability of public spaces for physical activity[28].

Our results confirm the global decrease trend in smoking prevalence[29], with a sharper reduction among the most educated adults[30]. This explained the increase in the relative educational inequality in most strata, except among men. Several actions have been taken to halt smoking, such as the ratification of the World Health Organization Framework Convention on Tobacco Control in 2005, which resulted in the Brazilian National Tobacco Control Policy[31]. These policies may have had less impact the least educated people[32], increasing social inequality. Although actions, such as the taxation of tobacco products, immediately affect low-income individuals, over time they resort to the illegal market, maintaining the cigarette use. Recent work shows that, in Brazil, the illegal cigarette market grew from 28.6% in 2012 to 42.8% in 2016[33]. Moreover, most actions aimed at changing behavior in favor of smoking cessation are educational, requiring cognitive skills for better understanding and, thus, more educated people will benefit more from these interventions[34]. In addition, tobacco companies have intensified marketing strategies to reach vulnerable populations, such as women[35], which may also justify the higher inequality in this group.

Educational inequality has disproportionately affected women and non-whites in Brazil. Although women have had more schooling than men in Brazil, their average income has been lower[36]. Illiteracy among women aged 15 years and over non-white was more than double that of white women (10.2% and 4.9%, respectively). Although there was an improvement in the education of the non-white adult population with 12 or more years of study between 1995 and 2015 (from 3.3 to 12%), this percentage among whites was more than two-fold higher in 2015 (25.9%)[36]. In Brazil, unlike other countries, social inequality drives racial disparities[37]. Black people have less access to health care, less quality of health care and are less informed about health promotion and disease prevention[38].

We found punctual reduction in the disparities for obesity, and an increase in disparities for diabetes and smoking, that are all modifiable risk factors sensitive to strategies promoting health lifestyle[39]. Accordingly, policies targeting the vulnerable groups, such as income redistribution[40], a strong and broad social security system and health education and promotion, would avoid the reinforcement of the current inequalities[8] and bring better health outcomes for Brazilians. In the last decades, Brazil has adopted several policies that could mitigate socioeconomic inequalities, with the potential to alter the prevalence of risk factors for NCDs, such as the expansion of primary health care, through the Family Health Strategy, and conditional cash transfer, through Bolsa Família Program. These policies increased the access of the low-income population to health promotion and disease prevention actions [41] [42]. Launched in 2011 by the Minister of Health of Brazil, the Strategic Action Plan for Tackling Chronic Non-Communicable Diseases in Brazil has made advances in surveillance (eg. national surveys and monitoring of mortality and risk factor reduction targets); health promotion (eg. encouragement of physical activity, adequate nutrition and health promotion through the creation of the Health Gym Program); regulation (eg. legislation on tobacco-free environments); and health care (eg. free of charge drugs for hypertension, diabetes, and asthma; organization of the emergency service network for cardiovascular diseases) [43]. More recently, a new plan for Tackling NCD in Brazil from 2021 to 2030 has been launched by the Minister of Health of Brazil, and it is guided to prevent NCD, promote health, while reducing health inequalities[44]. Despite efforts, limited advances have been achieved. Health inequality is a persistent phenomenon [45]. Moreover, since 2014, Brazil has been facing an economic crisis and recently adopted austerity policies that could negatively impact health inequality trends[46].

Our results may serve as a starting point for new studies that can deepen into the causes that led to the reductions in educational inequalities observed for hypertension and obesity. Future studies also need to understand the reasons for an increase in educational inequality for diabetes and smoking.

Our study has some limitations. VIGITEL survey collected data only from the population with landlines and included only the adults living in Brazilian capitals and the federal district. Despite using weighting measures for the general population, we would expect some small differences in the prevalence of our outcomes if we had assessed a sample that was not limited by landline access[11]. Over time, the access to landlines has reduced, and older and wealthier households are more likely to have and retain a landline in addition to a mobile phone. Therefore, the set of those contacted in a landline-only survey will increasingly skew towards those older/ wealthier groups. This may have underestimated the prevalence of NCD in those places with less landlines access [47]. Future studies need to assess social inequality for NCD in rural areas[8]. In addition, risk factors were self-reported and may be underestimated, especially medical diagnosis of diabetes and hypertension. This may have affected our results underestimating inequality in hypertension and diabetes, as it may have underestimated the prevalence among the least favored groups.

In conclusion, we observed maintenance in the educational gap for hypertension and decreased relative inequity in general obesity and among female and non-whites. The reduction in inequality for obesity should be read with caution because it reflects increases in obesity prevalence in all groups. The absolute educational inequality increased for diabetes in all strata and increased in absolute and relative forms for smoking in almost all strata.

CONTRIBUTION STATEMENT

P.T.D. contributed to data analysis and interpretation and to drafting and revising the manuscript and figures. C.M.A., L.S.S., A.E.M.R. L.F.M.R. and E.S.M. contributed to study concept and design, data interpretation, revising the manuscript and figures, and final approval of the version submitted.

COMPETING INTERESTS

The authors declare no competing interests.

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The study sponsor was not involved in the study's design; the collection, analysis, and interpretation of data; writing the report; or the decision to submit the report for publication.

DATA SHARING STATEMENT

All datasets of VIGITEL are publicly available at: http://svs.aids.gov.br/download/Vigitel/

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Table 1: Sociodemographic characteristics and risk factor prevalence, according to survey year of VIGITEL (2007-2018).

Characteristics	Survey year and Standard Error												
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	p value
Individuals (n)	54,271	52,641	52,726	52,628	51,656	40,374	45,889	34,991	49,919	46,488	48,931	48,463	-
Mean age (years)	39.8 ± 0.1	39.9 ± 0.1	40.2 ± 0.1	40.3 ± 0.1	40.4 ± 0.1	40.1 ± 0.1	40.2 ± 0.1	40.2 ± 0.2	40.9 ± 0.1	40.7 ± 0.1	41.4 ± 0.1	41.7 ± 0.1	0.001
Education (years)	9.4 ± 0.0	9.4 ± 0.0	9.6 ± 0.0	9.8 ± 0.0	9.9 ± 0.0	10.3 ± 0.0	10.4 ± 0.0	10.6 ± 0.1	10.5 ± 0.0	10.8 ± 0.0	10.6 ± 0.0	10.7 ± 0.0	<0.001
Sex (%)													
Female	53.2 ± 0.4	53.3 ± 0.4	53.3 ± 0.5	53.2 ± 0.5	53.2 ± 0.4	53.3 ± 0.5	53.4 ± 0.5	53.4 ± 0.6	53.1 ± 0.5	53.3 ± 0.5	53.3 ± 0.5	53.2 ± 0.5	0.858
Male	46.8 ± 0.4	46.7 ± 0.4	46.7 ± 0.5	46.8 ± 0.5	46.8 ± 0.4	46.7 ± 0.5	46.6 ± 0.5	46.6 ± 0.6	46.9 ± 0.5	46.7 ± 0.5	46.7 ± 0.5	46.8 ± 0.5	0.858
Skin color (%)													
White	40.8 ± 0.4	39.0 ± 0.4	39.1 ± 0.4	39.8 ± 0.5	43.9 ± 0.4	43.5 ± 0.5	45.0 ± 0.5	43.6 ± 0.5	41.2 ± 0.5	46.2 ± 0.5	42.1 ± 0.5	41.4 ± 0.5	0.154
Non-white	59.2 ± 0.4	61.0 ± 0.4	60.9 ± 0.4	60.2 ± 0.5	56.1 ± 0.4	56.5 ± 0.5	55.0 ± 0.5	56.4 ± 0.5	58.8 ± 0.5	53.8 ± 0.5	57.9 ± 0.5	58.6 ± 0.5	0.154
Risk factors (%) $^{+}$													
Hypertension	34.1 ± 0.3	35.5 ± 0.3	35.4 ± 0.3	35.6 ± 0.3	34.9 ± 0.3	33.6 ± 0.3	33.1 ± 0.3	33.8 ± 0.3	33.7 ± 0.2	33.6 ± 0.2	33.2 ± 0.2	33.3 ± 0.2	0.065
Diabetes	8.9 ± 0.2	9.3 ± 0.2	10.0 ± 0.2	10.3 ± 0.2	10.2 ± 0.2	9.9 ± 0.2	9.5 ± 0.2	10.9 ± 0.2	10.2 ± 0.2	12.0 ± 0.2	10.4 ± 0.2	10.6 ± 0.2	0.004
Smoking	13.0 ± 0.2	12.3 ± 0.2	11.9 ± 0.2	11.2 ± 0.2	11.0 ± 0.2	10.0 ± 0.2	8.8 ± 0.2	8.7 ± 0.2	8.1 ± 0.1	7.9 ± 0.1	7.6 ± 0.1	7.4 ± 0.1	<0.001
Obesity	14.7 ± 0.2	15.5 ± 0.2	15.9 ± 0.2	16.8 ± 0.2	17.7 ± 0.2	18.2 ± 0.2	18.1 ± 0.2	18.8 ± 0.2	19.0 ± 0.2	19.1 ± 0.2	19.1 ± 0.2	20.0 ± 0.2	<0.001

$^{+}$ Age standardized according to 2018 age distribution.

Table 2: Age standardized Slope Index of Inequality (SII) and Concentration Index (CIX) in hypertension, diabetes, smoking and obesity.

Risck factor	SII (95% CI)			CIX (95% CI)		
	2007	2018	p-value	2007	2018	p-value
Hypertension	-36.8 (-38.8; -34.9)	-37.8 (-39.3; -36.2)	0.701	-15.9 (-16.9; -14.9)	-16.0 (-16.8; -15.2)	0.658
Female	-44.5 (-46.9; -42.0)	-44.1 (-45.9; -42.2)	0.055	-18.3 (-19.5; -17.1)	-18.2 (-19.2; -17.3)	0.500
Male	-20.2 (-23.3; -17.0)	-23.5 (-26.0; -21.0)	0.641	-9.2 (-11.0; -7.5)	-9.9 (-11.4; -8.4)	0.916
White	-33.5 (-36.6; -30.4)	-35.5 (-37.8; -33.2)	0.757	-14.3 (-15.9; -12.7)	-14.3 (-15.6; -13.0)	0.317
Non-white	-39.6 (-42.1; -37.1)	-40.3 (-42.3; -38.3)	0.711	-17.0 (-18.2; -15.7)	-17.5 (-18.6; -16.4)	0.812
Diabetes	-12.8 (-14.3; -11.3)	-17.7 (-18.9; -16.5)	0.001	-20.3 (-22.8; -17.9)	-24.0 (-25.7; -22.3)	0.350
Female	-15.9 (-17.9; -13.9)	-19.9 (-21.5; -18.4)	0.001	-24.6 (-27.5; -21.7)	-26.9 (-29.0; -24.8)	0.708
Male	-6.8 (-8.9; -4.6)	-13.4 (-15.3; -11.6)	0.001	-10.8 (-15.0; -6.7)	-17.7 (-20.6; -14.9)	0.056
White	-11.1 (-13.4; -8.9)	-15.7 (-17.5; -14.0)	0.001	-19.0 (-22.8; -15.1)	-21.1 (-23.7; -18.4)	0.616
Non-white	-14.0 (-16.1; -12.0)	-19.7 (-21.3; -18.1)	0.001	-21.2 (-24.3; -18.1)	-26.4 (-28.6; -24.2)	0.128
Smoking	-2.7 (-4.1; -1.3)	-6.4 (-7.4; -5.4)	0.205	-3.5 (-5.3; -1.8)	-12.1 (-14.2; -10.0)	0.004
Female	-1.3 (-2.9; 0.4)	-6.2 (-7.4; -5.1)	0.025	-2.0 (-4.4; 0.4)	-14.4 (-17.4; -11.5)	0.001
Male	-7.2 (-9.7; -4.8)	-7.6 (-9.3; -5.9)	0.632	-7.1 (-9.5; -4.7)	-10.4 (-13.4; -7.5)	0.154
White	-0.4 (-2.6; 1.7)	-4.3 (-5.8; -2.8)	0.004	-1.0 (-3.7; 1.7)	-6.6 (-9.7; -3.5)	0.001
Non-white	-4.4 (-6.2; -2.6)	-8.7 (-10.0; -7.4)	0.433	-5.4 (-7.6; -3.2)	-18.2 (-20.9; -15.4)	0.008
Obesity	-10.8 (-12.4; -9.2)	-12.2 (-13.6; -10.7)	0.251	-11.3 (-13.0; -9.6)	-8.6 (-9.8; -7.4)	0.010
Female	-16.6 (-18.7; -14.5)	-18.0 (-19.8; -16.2)	0.701	-17.4 (-19.5; -15.2)	-12.9 (-14.4; -11.5)	0.009
Male	-0.4 (-2.7; 1.9)	-0.8 (-3.1; 1.5)	0.137	-0.5 (-3.0; 2.0)	-0.2 (-2.0; 1.7)	0.307
White	-9.7 (-12.1; -7.3)	-11.9 (-14.0; -9.8)	0.075	-11.0 (-13.7; -8.2)	-8.4 (-10.3; -6.6)	0.145
Non-white	-11.2 (-13.3; -9.1)	-11.9 (-13.8; -10.0)	0.822	-10.9 (-13.0; -8.8)	-8.1 (-9.6; -6.6)	0.011

Figure 1: Age-standardized prevalence of hypertension, diabetes, smoking and obesity by years of education and survey year from 2007 to 2018. VIGITEL, 2007-2018.

Figure 2: Trends in total slope index of inequality (SII) and concentration index (CIX) for age-standardized prevalence of hypertension, diabetes, smoking and obesity, VIGITEL 2007-2018.

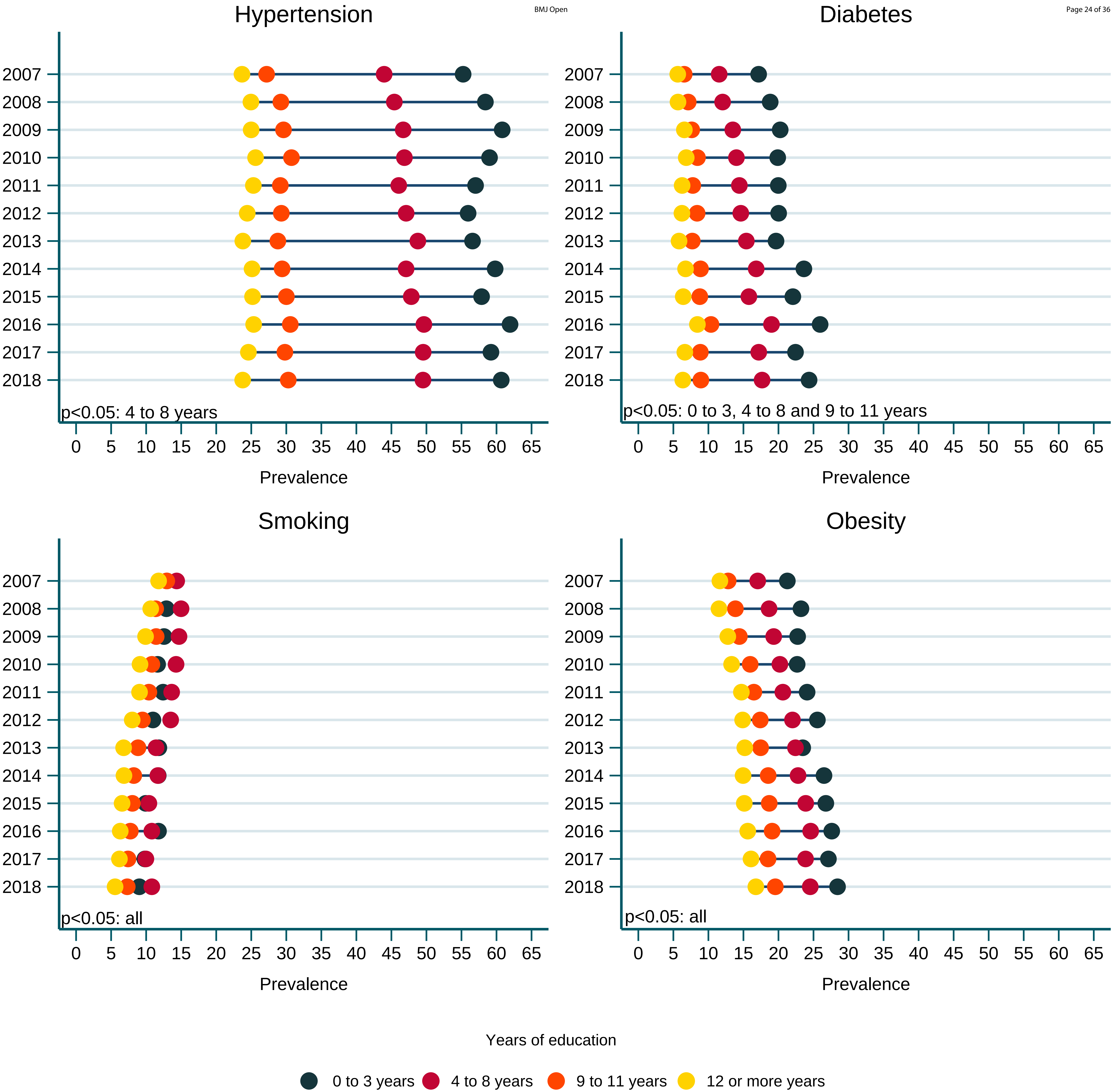
c: annual change of index; p= p-value.

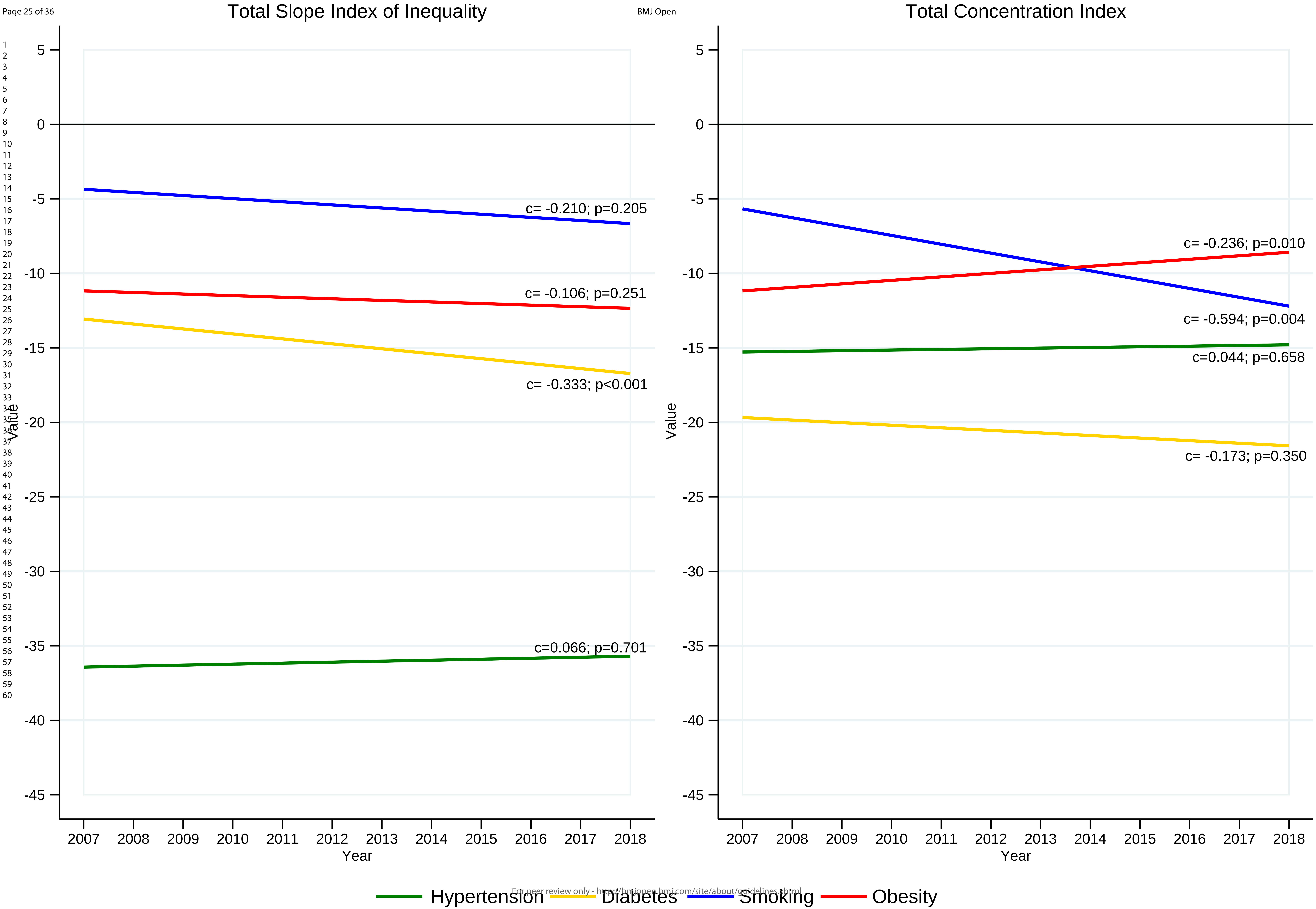
Figure 3: Trends in slope index of inequality (SII) and concentration index (CIX) for age-standardized prevalence of hypertension, diabetes, smoking and obesity by sex, VIGITEL 2007-2018.

c: annual change of index; p= p-value.

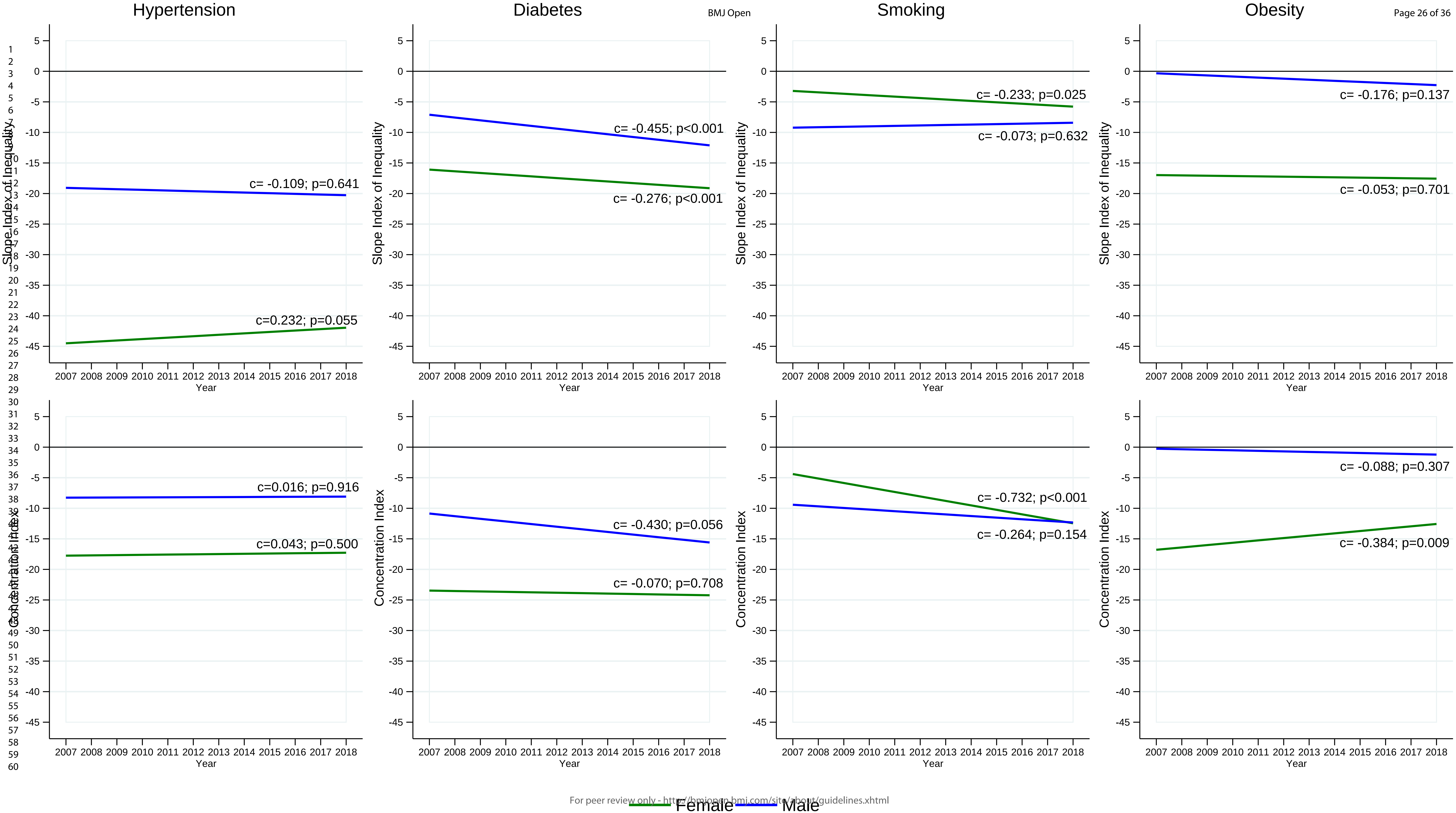
Figure 4: Trends in slope index of inequality (SII) and concentration index (CIX) for age-standardized prevalence of hypertension, diabetes, smoking and obesity by skin color, VIGITEL 2007-2018.

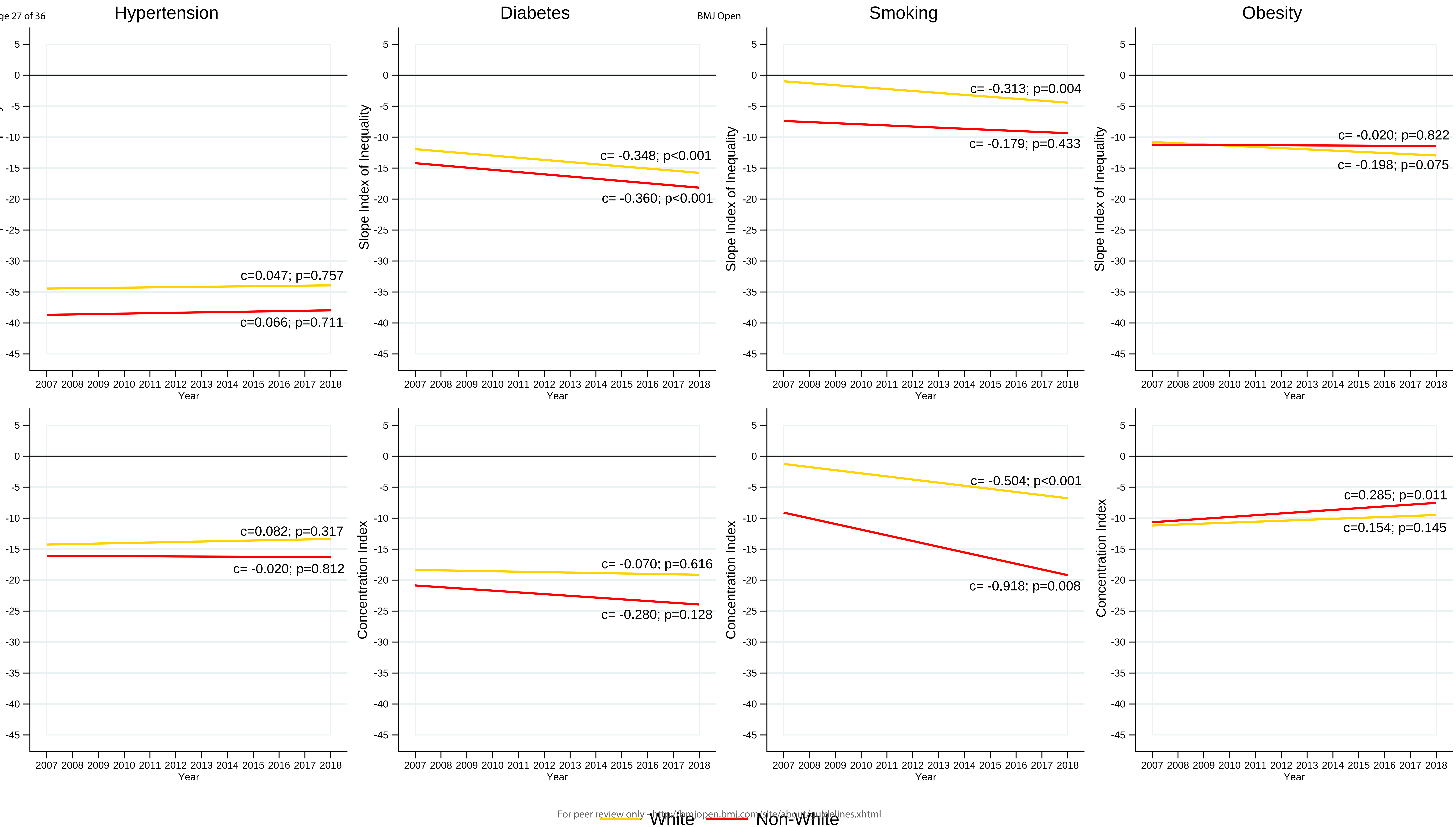
c: annual change of index; p= p-value.


Hypertension
p<0.05: 4 to 8 years
Diabetes
p<0.05: 0 to 3, 4 to 8 and 9 to 11 years
Smoking
p<0.05: all
Obesity
p<0.05: all
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
0 5 10 15 20 25 30 35 40 45 50 55 60 65
Prevalence
Years of education
0 to 3 years
4 to 8 years
9 to 11 years
12 or more years

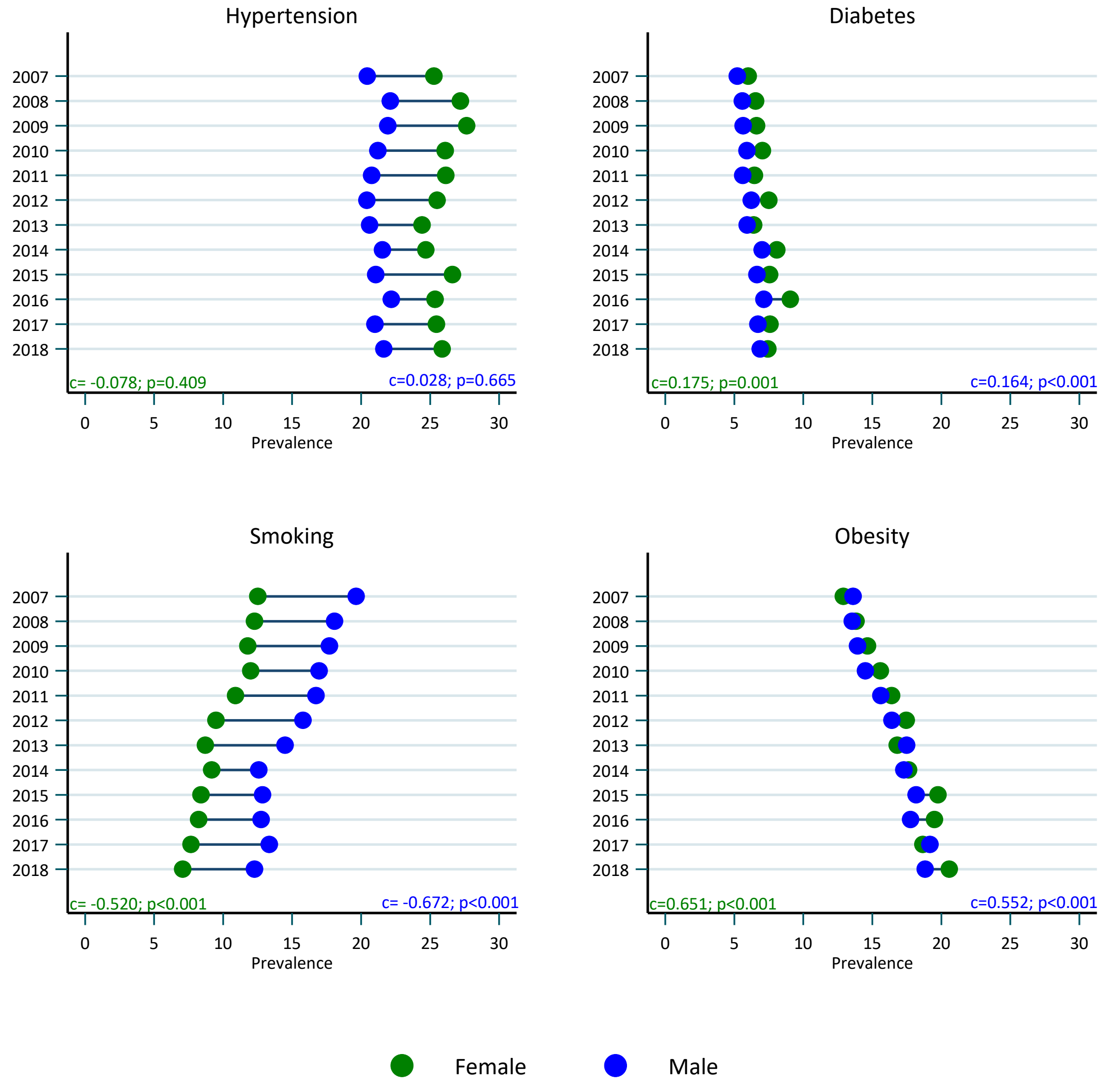


Total Slope Index of Inequality
Total Concentration Index
Value
Year
c= -0.210; p=0.205
c= -0.106; p=0.251
c= -0.333; p<0.001
c=0.066; p=0.701
c= -0.236; p=0.010
c= -0.594; p=0.004
c=0.044; p=0.658
c= -0.173; p=0.350
Hypertension
Diabetes
Smoking
Obesity


Hypertension
Diabetes
Smoking
Obesity
Slope Index of Inequality
Concentration Index
Year
c= -0.109; p=0.641
c=0.232; p=0.055
c= -0.455; p<0.001
c= -0.276; p<0.001
c= -0.233; p=0.025
c= -0.073; p=0.632
c= -0.176; p=0.137
c= -0.053; p=0.701
c=0.016; p=0.916
c=0.043; p=0.500
c= -0.430; p=0.056
c= -0.070; p=0.708
c= -0.732; p<0.001
c= -0.264; p=0.154
c= -0.088; p=0.307
c= -0.384; p=0.009
Female
Male

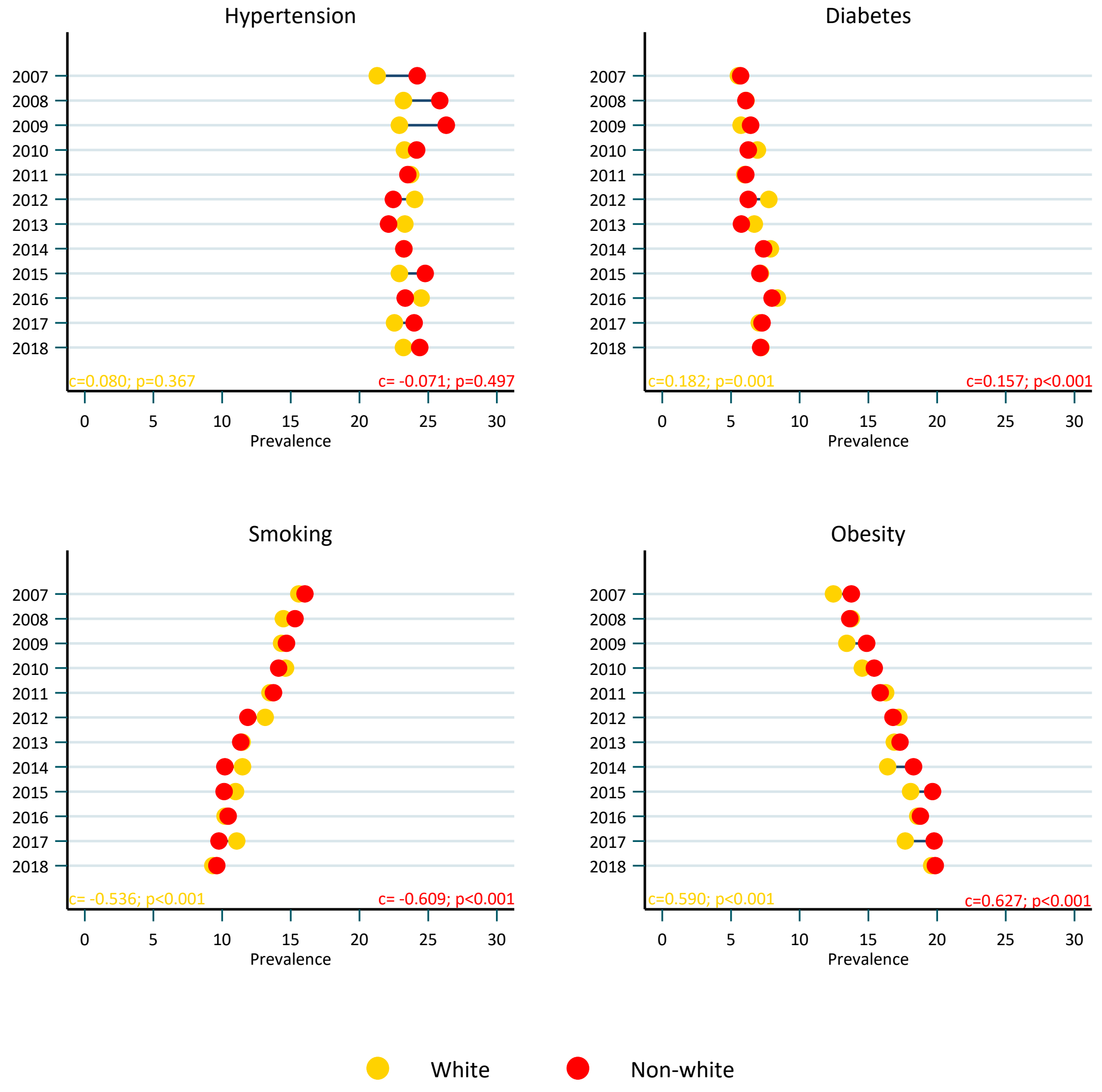

Hypertension
Diabetes
Smoking
Obesity
Slope Index of Inequality
Concentration Index
Year
c=0.047; p=0.757
c=0.066; p=0.711
c= -0.348; p<0.001
c= -0.360; p<0.001
c= -0.313; p=0.004
c= -0.179; p=0.433
c= -0.020; p=0.822
c= -0.198; p=0.075
c=0.082; p=0.317
c= -0.020; p=0.812
c= -0.070; p=0.616
c= -0.280; p=0.128
c= -0.504; p<0.001
c= -0.918; p=0.008
c=0.285; p=0.011
c=0.154; p=0.145
White
Non-White

Supplementary figure 1: Age-standardized prevalence of hypertension, diabetes, smoking and obesity by sex, VIGITEL 2007-2018.



c: annual change (%); p= p-value

Supplementary figure 2: Age-standardized prevalence of hypertension, diabetes, smoking and obesity by skin color, VIGITEL 2007-2018.



c: annual change (%); p= p-value

Supplementary Table 1: VIGITEL sociodemographic characteristics and risk factor prevalence by sex, skin and survey year.

Characteristics by sex and skin color		Survey year and Standard Error											
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mean age (years)													
	Female	40.6 ± 0.2	40.9 ± 0.2	41.2 ± 0.2	41.4 ± 0.2	41.3 ± 0.2	41.2 ± 0.2	41.4 ± 0.2	41.3 ± 0.2	42.3 ± 0.2	42.1 ± 0.2	42.7 ± 0.2	43.0 ± 0.2
	Male	38.9 ± 0.2	38.7 ± 0.2	39.1 ± 0.2	39.1 ± 0.2	39.3 ± 0.2	38.8 ± 0.2	38.8 ± 0.2	39.0 ± 0.3	39.4 ± 0.2	39.2 ± 0.2	40.0 ± 0.2	40.3 ± 0.2
	White	40.4 ± 0.2	40.5 ± 0.2	40.8 ± 0.2	41.2 ± 0.2	41.8 ± 0.2	42.1 ± 0.2	41.9 ± 0.2	42.1 ± 0.2	42.1 ± 0.2	42.3 ± 0.2	42.8 ± 0.2	42.8 ± 0.2
	Non-white	39.3 ± 0.2	39.6 ± 0.2	39.9 ± 0.2	39.8 ± 0.2	39.3 ± 0.2	38.6 ± 0.2	38.8 ± 0.2	38.8 ± 0.2	40.1 ± 0.2	39.4 ± 0.2	40.4 ± 0.2	40.9 ± 0.2
Education (years)													
	Female	9.4 ± 0.1	9.4 ± 0.1	9.7 ± 0.1	9.9 ± 0.1	9.9 ± 0.1	10.4 ± 0.1	10.5 ± 0.1	10.7 ± 0.1	10.6 ± 0.1	10.9 ± 0.1	10.8 ± 0.1	10.9 ± 0.1
	Male	9.3 ± 0.1	9.4 ± 0.1	9.6 ± 0.1	9.7 ± 0.1	9.8 ± 0.1	10.2 ± 0.1	10.3 ± 0.1	10.5 ± 0.1	10.3 ± 0.1	10.7 ± 0.1	10.5 ± 0.1	10.5 ± 0.1
	White	10.6 ± 0.1	10.6 ± 0.1	10.8 ± 0.1	11.0 ± 0.1	10.8 ± 0.1	11.1 ± 0.1	11.1 ± 0.1	11.3 ± 0.1	11.5 ± 0.1	11.4 ± 0.1	11.4 ± 0.1	11.7 ± 0.1
	Non-white	8.5 ± 0.0	8.7 ± 0.0	8.9 ± 0.1	9.0 ± 0.1	9.1 ± 0.1	9.7 ± 0.1	9.9 ± 0.1	10.1 ± 0.1	9.7 ± 0.1	10.3 ± 0.1	10.1 ± 0.1	10.0 ± 0.1
Hypertension+													
	Female	25.3 ± 0.5	27.2 ± 0.5	27.7 ± 0.5	26.1 ± 0.5	26.1 ± 0.5	25.5 ± 0.5	24.4 ± 0.5	24.7 ± 0.6	26.6 ± 0.5	25.4 ± 0.5	25.5 ± 0.5	25.9 ± 0.5
	Male	20.5 ± 0.6	22.1 ± 0.6	21.9 ± 0.6	21.2 ± 0.6	20.8 ± 0.5	20.4 ± 0.6	20.6 ± 0.6	21.6 ± 0.7	21.1 ± 0.6	22.2 ± 0.6	21 ± 0.6	21.6 ± 0.6
	White	21.3 ± 0.6	23.2 ± 0.6	22.9 ± 0.6	23.3 ± 0.6	23.7 ± 0.6	24 ± 0.6	23.3 ± 0.6	23.2 ± 0.6	22.9 ± 0.6	24.5 ± 0.6	22.6 ± 0.6	23.2 ± 0.6
	Non-white	24.2 ± 0.5	25.8 ± 0.5	26.3 ± 0.5	24.2 ± 0.5	23.5 ± 0.5	22.5 ± 0.5	22.1 ± 0.5	23.2 ± 0.6	24.8 ± 0.6	23.3 ± 0.5	24 ± 0.5	24.4 ± 0.5
Diabetes+													
	Female	6 ± 0.3	6.5 ± 0.3	6.6 ± 0.3	7 ± 0.3	6.4 ± 0.3	7.5 ± 0.3	6.4 ± 0.3	8.1 ± 0.4	7.6 ± 0.3	9.1 ± 0.4	7.6 ± 0.3	7.4 ± 0.3
	Male	5.2 ± 0.3	5.6 ± 0.3	5.6 ± 0.3	5.9 ± 0.3	5.6 ± 0.3	6.2 ± 0.4	5.9 ± 0.4	7 ± 0.4	6.6 ± 0.4	7.1 ± 0.4	6.7 ± 0.3	6.9 ± 0.3
	White	5.5 ± 0.3	6.1 ± 0.3	5.7 ± 0.4	6.9 ± 0.4	6 ± 0.3	7.7 ± 0.4	6.7 ± 0.3	7.9 ± 0.4	7.2 ± 0.4	8.4 ± 0.4	7.1 ± 0.3	7.2 ± 0.3
	Non-white	5.7 ± 0.3	6.1 ± 0.3	6.4 ± 0.3	6.3 ± 0.3	6.1 ± 0.3	6.3 ± 0.3	5.8 ± 0.3	7.4 ± 0.4	7.1 ± 0.3	8 ± 0.3	7.3 ± 0.3	7.2 ± 0.3
Smoking+													
	Female	12.5 ± 0.4	12.3 ± 0.4	11.8 ± 0.4	12 ± 0.4	10.9 ± 0.4	9.5 ± 0.4	8.7 ± 0.4	9.2 ± 0.5	8.4 ± 0.4	8.2 ± 0.4	7.7 ± 0.4	7.1 ± 0.3
	Male	19.6 ± 0.6	18.1 ± 0.6	17.7 ± 0.6	17 ± 0.6	16.7 ± 0.6	15.8 ± 0.7	14.5 ± 0.6	12.6 ± 0.6	12.9 ± 0.6	12.8 ± 0.6	13.3 ± 0.6	12.3 ± 0.6
	White	15.6 ± 0.5	14.5 ± 0.5	14.3 ± 0.5	14.6 ± 0.6	13.5 ± 0.5	13.1 ± 0.6	11.5 ± 0.5	11.5 ± 0.6	11 ± 0.5	10.2 ± 0.5	11.1 ± 0.6	9.3 ± 0.5
	Non-white	16 ± 0.5	15.3 ± 0.5	14.7 ± 0.5	14.1 ± 0.5	13.7 ± 0.4	11.9 ± 0.5	11.4 ± 0.5	10.2 ± 0.5	10.1 ± 0.5	10.4 ± 0.5	9.8 ± 0.4	9.6 ± 0.5
Obesity+													
	Female	12.9 ± 0.4	13.8 ± 0.4	14.6 ± 0.4	15.6 ± 0.4	16.4 ± 0.4	17.5 ± 0.5	16.8 ± 0.4	17.6 ± 0.5	19.8 ± 0.5	19.5 ± 0.5	18.7 ± 0.5	20.6 ± 0.5
	Male	13.6 ± 0.5	13.6 ± 0.5	13.9 ± 0.5	14.5 ± 0.5	15.6 ± 0.5	16.4 ± 0.6	17.5 ± 0.6	17.3 ± 0.6	18.2 ± 0.6	17.8 ± 0.6	19.2 ± 0.6	18.8 ± 0.6
	White	12.5 ± 0.5	13.8 ± 0.5	13.4 ± 0.5	14.6 ± 0.5	16.3 ± 0.5	17.2 ± 0.6	16.9 ± 0.5	16.4 ± 0.6	18.1 ± 0.6	18.6 ± 0.6	17.7 ± 0.6	19.6 ± 0.6
	Non-white	13.8 ± 0.4	13.6 ± 0.4	14.9 ± 0.4	15.4 ± 0.4	15.9 ± 0.4	16.8 ± 0.5	17.3 ± 0.5	18.3 ± 0.6	19.7 ± 0.5	18.8 ± 0.5	19.8 ± 0.5	19.9 ± 0.5

+ Age standardized according to 2018 age distribution.

Supplementary table 2: Age-standardized prevalence of hypertension by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education Sex and skin color (%)	Survey year (95% CI) 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual change (%)	p value
0-3 years														
Total	55.2 (53.3; 57.2)	58.4 (56.5; 60.3)	60.8 (58.8; 62.8)	59.0 (57.0; 61.0)	57.0 (55.1; 58.9)	56.0 (53.5; 58.4)	56.6 (54.3; 58.9)	59.8 (57.3; 62.4)	57.9 (55.9; 59.9)	61.9 (59.7; 64.1)	59.2 (57.2; 61.2)	60.7 (58.8; 62.6)	0.29	0.112
Female	58.9 (56.5; 61.2)	62.4 (60.1; 64.7)	64.6 (62.2; 67.0)	63.0 (60.6; 65.4)	62.1 (59.9; 64.4)	60.0 (57.1; 62.9)	62.2 (59.5; 64.9)	62.5 (59.5; 65.6)	62.5 (60.1; 64.9)	66.7 (64.1; 69.3)	62.6 (60.3; 65.0)	63.6 (61.4; 65.9)	0.25	0.179
Male	46.2 (42.8; 49.5)	48.3 (45.0; 51.7)	50.7 (47.1; 54.3)	48.8 (45.2; 52.4)	43.3 (40.0; 46.7)	45.1 (40.8; 49.4)	43.3 (39.3; 47.2)	52.6 (48.2; 57.1)	45.3 (41.8; 48.9)	50.4 (46.5; 54.2)	50.5 (47.0; 54.0)	52.9 (49.5; 56.4)	0.35	0.112
White	54.6 (50.9; 58.2)	57.6 (54.0; 61.3)	59.0 (55.1; 63.0)	61.5 (57.7; 65.2)	58.9 (55.7; 62.0)	55.8 (51.9; 59.6)	56.9 (53.4; 60.4)	56.6 (52.7; 60.5)	57.2 (53.7; 60.7)	61.5 (58.2; 64.8)	58.6 (55.3; 62.0)	61.6 (58.3; 64.8)	0.34	0.156
Non-white	55.5 (53.2; 57.9)	58.8 (56.5; 61.0)	61.5 (59.2; 63.8)	57.9 (55.5; 60.3)	55.9 (53.6; 58.3)	56.1 (53.0; 59.2)	56.3 (53.3; 59.3)	62.5 (59.1; 65.8)	58.2 (55.8; 60.7)	62.3 (59.4; 65.2)	59.5 (57.1; 62.0)	60.2 (57.9; 62.5)	0.30	0.083
4-8 years														
Total	44.0 (42.8; 45.2)	45.4 (44.2; 46.6)	46.7 (45.5; 47.9)	46.9 (45.7; 48.0)	46.1 (44.9; 47.2)	47.1 (45.8; 48.4)	48.8 (47.6; 50.0)	47.1 (45.8; 48.4)	47.8 (46.7; 48.9)	49.6 (48.4; 50.9)	49.5 (48.4; 50.7)	49.5 (48.4; 50.6)	0.45	<0.001
Female	48.3 (46.8; 49.9)	50.6 (49.1; 52.2)	50.4 (48.9; 51.9)	50.9 (49.4; 52.4)	51.0 (49.6; 52.5)	52.1 (50.4; 53.8)	53.4 (51.9; 54.9)	51.3 (49.6; 53.0)	52.7 (51.3; 54.1)	54.1 (52.6; 55.7)	53.6 (52.2; 55.0)	53.5 (52.1; 54.9)	0.42	<0.001
Male	35.3 (33.4; 37.1)	34.6 (32.7; 36.4)	38.8 (36.9; 40.7)	38.2 (36.4; 40.1)	36.2 (34.5; 37.9)	36.7 (34.6; 38.7)	38.5 (36.6; 40.4)	37.9 (35.7; 40.0)	37.7 (36.0; 39.4)	40.5 (38.5; 42.4)	40.9 (39.0; 42.8)	40.6 (38.8; 42.5)	0.46	0.001
White	45.7 (43.6; 47.8)	48.2 (46.1; 50.3)	47.2 (45.0; 49.3)	48.5 (46.4; 50.6)	47.8 (45.9; 49.7)	48.9 (46.9; 51.0)	51.8 (49.9; 53.6)	48.0 (45.9; 50.0)	48.9 (47.0; 50.7)	50.7 (48.9; 52.5)	51.4 (49.6; 53.2)	50.1 (48.3; 51.9)	0.37	<0.001
Non-white	43.0 (41.5; 44.4)	43.9 (42.4; 45.3)	46.4 (44.9; 47.9)	45.9 (44.5; 47.4)	44.8 (43.3; 46.3)	45.6 (43.8; 47.3)	46.1 (44.5; 47.7)	46.4 (44.6; 48.2)	47.2 (45.8; 48.6)	48.7 (47.1; 50.4)	48.3 (46.8; 49.7)	49.1 (47.7; 50.6)	0.48	<0.001
9-11 years														
Total	27.2 (26.3; 28.1)	29.2 (28.3; 30.1)	29.6 (28.7; 30.5)	30.7 (29.9; 31.6)	29.2 (28.3; 30.0)	29.3 (28.4; 30.2)	28.8 (28.0; 29.6)	29.4 (28.5; 30.3)	30.0 (29.3; 30.8)	30.6 (29.8; 31.4)	29.8 (29.0; 30.6)	30.3 (29.5; 31.1)	0.17	0.112
Female	29.0 (27.8; 30.2)	31.4 (30.2; 32.6)	31.6 (30.4; 32.7)	32.7 (31.6; 33.9)	31.0 (29.9; 32.1)	31.5 (30.3; 32.6)	31.0 (29.9; 32.1)	31.3 (30.1; 32.5)	32.9 (31.9; 33.9)	32.6 (31.5; 33.7)	32.0 (31.0; 33.1)	33.1 (32.0; 34.1)	0.22	0.043
Male	24.1 (22.8; 25.4)	25.5 (24.2; 26.7)	26.2 (24.9; 27.5)	27.1 (25.8; 28.4)	26.1 (24.9; 27.3)	25.5 (24.2; 26.8)	25.2 (24.1; 26.4)	26.2 (24.9; 27.6)	25.2 (24.1; 26.3)	27.2 (26.1; 28.4)	26.0 (24.9; 27.2)	25.5 (24.3; 26.6)	0.07	0.496
White	27.9 (26.4; 29.4)	31.4 (29.9; 32.9)	31.3 (29.8; 32.7)	33.1 (31.6; 34.6)	32.4 (31.0; 33.8)	33.3 (31.8; 34.7)	31.1 (29.8; 32.4)	31.8 (30.4; 33.3)	31.4 (30.2; 32.7)	33.4 (32.2; 34.7)	32.0 (30.7; 33.3)	31.9 (30.6; 33.1)	0.21	0.276
Non-white	26.7 (25.6; 27.8)	27.8 (26.7; 28.9)	28.5 (27.5; 29.6)	29.3 (28.2; 30.3)	26.8 (25.8; 27.8)	26.3 (25.2; 27.4)	27.1 (26.0; 28.1)	27.7 (26.5; 28.8)	29.2 (28.2; 30.1)	28.6 (27.6; 29.6)	28.5 (27.5; 29.4)	29.3 (28.3; 30.2)	0.16	0.040
12 or more years														
Total	23.7 (22.7; 24.6)	25.0 (24.0; 25.9)	25.0 (24.1; 25.9)	25.6 (24.7; 26.5)	25.3 (24.4; 26.2)	24.4 (23.5; 25.3)	23.8 (23.0; 24.6)	25.1 (24.2; 26.0)	25.2 (24.5; 25.9)	25.3 (24.6; 26.0)	24.6 (23.9; 25.3)	23.8 (23.1; 24.4)	-0.01	0.954
Female	22.4 (21.1; 23.6)	23.9 (22.7; 25.1)	24.3 (23.2; 25.5)	25.4 (24.3; 26.5)	24.3 (23.2; 25.5)	23.9 (22.7; 25.0)	23.0 (22.0; 24.0)	25.0 (23.8; 26.2)	25.2 (24.2; 26.1)	24.7 (23.8; 25.6)	24.0 (23.2; 24.9)	23.6 (22.8; 24.5)	0.08	0.504
Male	25.7 (24.3; 27.1)	26.6 (25.2; 28.0)	26.0 (24.6; 27.4)	26.0 (24.6; 27.3)	26.9 (25.6; 28.2)	25.4 (24.0; 26.8)	25.2 (24.0; 26.4)	25.3 (23.8; 26.7)	25.2 (24.1; 26.4)	26.3 (25.2; 27.4)	25.6 (24.5; 26.6)	24.0 (23.0; 25.1)	-0.12	0.092
White	24.7 (23.4; 26.0)	25.2 (23.9; 26.4)	24.7 (23.5; 26.0)	26.7 (25.5; 27.9)	26.4 (25.2; 27.6)	25.4 (24.1; 26.6)	25.9 (24.8; 27.0)	26.7 (25.4; 27.9)	26.8 (25.8; 27.9)	27.1 (26.1; 28.0)	26.0 (25.1; 27.0)	25.0 (24.0; 25.9)	0.08	0.424
Non-white	22.3 (21.0; 23.6)	24.7 (23.4; 26.0)	25.3 (24.0; 26.6)	24.2 (23.0; 25.5)	23.8 (22.5; 25.0)	23.2 (21.9; 24.5)	21.1 (20.0; 22.1)	23.3 (22.0; 24.6)	23.2 (22.2; 24.2)	23.2 (22.2; 24.2)	23.0 (22.0; 23.9)	22.5 (21.5; 23.4)	-0.11	0.357

Supplementary table 3: Age-standardized prevalence of diabetes by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education / Sex and skin color (%)	Survey year (95% CI) 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual change (%)	p value
0-3 years														
Total	17.2 (15.6; 18.7)	18.8 (17.2; 20.4)	20.3 (18.5; 22.0)	19.9 (18.2; 21.6)	20.0 (18.4; 21.6)	20.0 (18.0; 22.0)	19.7 (17.8; 21.5)	23.6 (21.4; 25.9)	22.1 (20.3; 23.8)	25.9 (23.9; 28.0)	22.4 (20.8; 24.1)	24.4 (22.7; 26.0)	0.60	<0.001
Female	18.2 (16.3; 20.1)	20.1 (18.1; 22.1)	21.4 (19.2; 23.6)	20.8 (18.6; 22.9)	21.7 (19.8; 23.7)	21.8 (19.3; 24.3)	21.7 (19.3; 24.1)	25.6 (22.7; 28.4)	23.7 (21.6; 25.9)	28.1 (25.6; 30.6)	24.0 (22.0; 26.1)	25.8 (23.8; 27.9)	0.67	<0.001
Male	14.6 (12.3; 16.9)	15.6 (13.1; 18.0)	17.2 (14.3; 20.1)	17.7 (14.9; 20.4)	15.3 (12.8; 17.7)	15.2 (12.0; 18.4)	14.8 (12.0; 17.5)	18.6 (15.1; 22.0)	17.5 (14.8; 20.2)	20.7 (17.6; 23.8)	18.5 (15.8; 21.2)	20.6 (17.9; 23.4)	0.45	0.001
White	15.7 (13.1; 18.4)	18.3 (15.4; 21.1)	20.2 (16.8; 23.6)	20.3 (16.9; 23.6)	18.1 (15.6; 20.5)	18.0 (15.1; 20.9)	19.4 (16.5; 22.2)	23.2 (19.8; 26.6)	22.5 (19.5; 25.5)	25.2 (22.2; 28.1)	21.7 (18.9; 24.5)	21.5 (18.8; 24.2)	0.55	0.014
Non-white	17.8 (16.0; 19.7)	19.1 (17.2; 21.0)	20.3 (18.2; 22.3)	19.7 (17.7; 21.7)	21.1 (19.1; 23.1)	21.5 (18.8; 24.3)	19.9 (17.4; 22.4)	24.0 (20.9; 27.0)	21.8 (19.7; 23.9)	26.6 (23.9; 29.4)	22.9 (20.8; 24.9)	25.9 (23.8; 28.0)	0.62	<0.001
4-8 years														
Total	11.5 (10.7; 12.4)	12.0 (11.2; 12.9)	13.5 (12.6; 14.4)	14.0 (13.1; 14.9)	14.4 (13.5; 15.3)	14.6 (13.7; 15.6)	15.4 (14.5; 16.3)	16.8 (15.8; 17.9)	15.8 (15.0; 16.6)	19.0 (18.0; 20.0)	17.2 (16.3; 18.0)	17.7 (16.8; 18.5)	0.60	<0.001
Female	12.4 (11.3; 13.5)	13.1 (12.0; 14.2)	13.8 (12.7; 15.0)	14.7 (13.6; 15.8)	15.8 (14.7; 17.0)	15.0 (13.8; 16.3)	16.0 (14.8; 17.2)	17.3 (16.0; 18.6)	16.6 (15.6; 17.7)	20.2 (18.9; 21.4)	17.7 (16.6; 18.8)	18.0 (17.0; 19.1)	0.58	<0.001
Male	9.8 (8.7; 11.0)	9.8 (8.6; 11.0)	12.7 (11.3; 14.1)	12.5 (11.2; 13.9)	11.7 (10.5; 12.9)	13.8 (12.3; 15.3)	14.1 (12.7; 15.6)	15.7 (14.1; 17.4)	14.0 (12.8; 15.2)	16.7 (15.2; 18.1)	16.1 (14.7; 17.5)	16.8 (15.4; 18.2)	0.63	<0.001
White	12.3 (10.8; 13.7)	12.7 (11.2; 14.2)	13.9 (12.3; 15.4)	15.5 (13.9; 17.1)	15.3 (13.9; 16.8)	14.1 (12.7; 15.6)	16.5 (15.0; 17.9)	17.0 (15.4; 18.5)	15.8 (14.5; 17.2)	20.6 (19.1; 22.0)	17.6 (16.3; 19.0)	18.3 (16.9; 19.7)	0.58	<0.001
Non-white	11.1 (10.1; 12.1)	11.6 (10.6; 12.6)	13.3 (12.2; 14.4)	13.1 (12.1; 14.2)	13.8 (12.7; 14.9)	15.0 (13.7; 16.3)	14.5 (13.3; 15.7)	16.7 (15.4; 18.1)	15.7 (14.7; 16.8)	17.6 (16.4; 18.9)	16.9 (15.8; 18.0)	17.3 (16.2; 18.4)	0.59	<0.001
9-11 years														
Total	6.5 (6.0; 7.1)	7.1 (6.6; 7.7)	7.6 (7.1; 8.2)	8.4 (7.9; 9.0)	7.8 (7.3; 8.3)	8.4 (7.8; 9.0)	7.7 (7.2; 8.2)	8.9 (8.3; 9.5)	8.8 (8.3; 9.3)	10.4 (9.8; 10.9)	8.9 (8.4; 9.3)	8.9 (8.5; 9.4)	0.23	0.001
Female	6.7 (6.0; 7.4)	7.3 (6.5; 8.0)	7.8 (7.0; 8.5)	8.9 (8.1; 9.6)	7.9 (7.2; 8.6)	8.6 (7.9; 9.4)	7.9 (7.3; 8.6)	9.1 (8.3; 9.9)	9.4 (8.7; 10.0)	11.0 (10.3; 11.7)	8.9 (8.3; 9.5)	9.1 (8.5; 9.7)	0.24	0.003
Male	6.3 (5.5; 7.0)	6.8 (6.0; 7.7)	7.4 (6.6; 8.2)	7.6 (6.8; 8.4)	7.6 (6.8; 8.3)	8.0 (7.1; 8.8)	7.3 (6.6; 8.1)	8.6 (7.7; 9.5)	7.7 (7.1; 8.4)	9.4 (8.6; 10.1)	8.8 (8.1; 9.5)	8.6 (7.9; 9.4)	0.21	<0.001
White	6.9 (6.0; 7.8)	8.3 (7.3; 9.4)	8.0 (7.1; 9.0)	9.8 (8.8; 10.8)	9.1 (8.2; 10.0)	9.3 (8.4; 10.2)	8.6 (7.8; 9.5)	9.7 (8.8; 10.7)	9.5 (8.7; 10.3)	11.5 (10.6; 12.4)	9.8 (9.0; 10.6)	9.5 (8.7; 10.3)	0.23	0.009
Non-white	6.3 (5.6; 7.0)	6.4 (5.7; 7.0)	7.4 (6.7; 8.0)	7.6 (6.9; 8.2)	6.8 (6.2; 7.5)	7.7 (7.0; 8.4)	7.0 (6.4; 7.6)	8.3 (7.5; 9.0)	8.3 (7.7; 8.9)	9.6 (8.9; 10.3)	8.3 (7.7; 8.8)	8.6 (8.0; 9.2)	0.23	<0.001
12 or more years														
Total	5.6 (5.1; 6.2)	5.7 (5.1; 6.2)	6.6 (6.0; 7.1)	6.8 (6.3; 7.4)	6.3 (5.7; 6.8)	6.2 (5.7; 6.8)	5.8 (5.4; 6.2)	6.7 (6.2; 7.3)	6.4 (6.0; 6.8)	8.4 (8.0; 8.9)	6.6 (6.2; 7.0)	6.4 (6.0; 6.7)	0.10	0.094
Female	4.7 (4.0; 5.3)	4.7 (4.1; 5.3)	5.9 (5.1; 6.6)	6.5 (5.8; 7.2)	5.6 (5.0; 6.2)	6.0 (5.3; 6.7)	5.4 (4.8; 5.9)	6.7 (6.0; 7.5)	6.1 (5.6; 6.7)	7.9 (7.4; 8.5)	6.1 (5.6; 6.6)	6.1 (5.6; 6.5)	0.15	0.028
Male	7.1 (6.2; 8.1)	7.2 (6.3; 8.1)	7.7 (6.8; 8.6)	7.4 (6.6; 8.3)	7.4 (6.5; 8.2)	6.6 (5.8; 7.5)	6.6 (5.9; 7.3)	6.7 (5.9; 7.6)	6.9 (6.2; 7.5)	9.3 (8.5; 10.0)	7.6 (6.9; 8.2)	6.9 (6.2; 7.5)	0.02	0.748
White	5.7 (4.9; 6.4)	5.6 (4.9; 6.3)	6.7 (5.9; 7.5)	7.1 (6.4; 7.8)	6.7 (6.0; 7.5)	6.3 (5.6; 7.0)	6.4 (5.8; 7.1)	7.3 (6.5; 8.1)	7.0 (6.4; 7.6)	9.3 (8.6; 9.9)	7.2 (6.7; 7.8)	6.8 (6.2; 7.3)	0.16	0.041
Non-white	5.6 (4.8; 6.4)	5.7 (5.0; 6.5)	6.4 (5.6; 7.2)	6.5 (5.8; 7.3)	5.6 (4.9; 6.3)	6.2 (5.4; 6.9)	5.0 (4.4; 5.6)	6.1 (5.3; 6.8)	5.8 (5.2; 6.3)	7.4 (6.8; 8.0)	6.0 (5.4; 6.5)	5.9 (5.3; 6.4)	0.03	0.447

Supplementary table 4: Age-standardized prevalence of smoking by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education	Survey year (95% CI)												Annual change (%)	p value
Sex and skin color (%)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
0-3 years														
Total	13.0 (11.7; 14.2)	12.9 (11.6; 14.1)	12.6 (11.3; 13.9)	11.6 (10.4; 12.9)	12.4 (11.2; 13.6)	11.0 (9.5; 12.4)	11.8 (10.3; 13.3)	11.7 (10.1; 13.4)	9.9 (8.7; 11.1)	11.8 (10.2; 13.3)	9.8 (8.6; 11.0)	9.0 (7.9; 10.2)	-0.29	<0.001
Female	10.7 (9.3; 12.1)	11.1 (9.7; 12.6)	10.9 (9.4; 12.4)	10.9 (9.3; 12.4)	10.1 (8.8; 11.5)	9.5 (7.9; 11.2)	9.7 (8.1; 11.4)	10.4 (8.4; 12.3)	8.3 (7.0; 9.7)	10.3 (8.5; 12.1)	8.5 (7.0; 9.9)	9.0 (7.6; 10.4)	-0.22	<0.001
Male	18.6 (16.0; 21.2)	17.4 (15.0; 19.8)	17.1 (14.5; 19.6)	13.6 (11.3; 15.9)	18.5 (15.9; 21.0)	14.8 (11.8; 17.8)	16.7 (13.8; 19.7)	15.3 (12.1; 18.5)	14.3 (11.8; 16.8)	15.3 (12.4; 18.2)	13.3 (10.9; 15.6)	9.1 (7.1; 11.1)	-0.54	0.005
White	10.4 (8.2; 12.5)	9.9 (7.8; 11.9)	10.9 (8.5; 13.3)	9.7 (7.5; 11.9)	11.4 (9.4; 13.3)	11.4 (9.0; 13.9)	10.2 (8.2; 12.3)	10.7 (8.2; 13.1)	8.2 (6.3; 10.0)	9.4 (7.4; 11.4)	8.2 (6.3; 10.0)	8.1 (6.2; 10.0)	-0.21	0.013
Non-white	14.1 (12.6; 15.7)	14.2 (12.6; 15.7)	13.2 (11.6; 14.7)	12.5 (10.9; 14.0)	13.0 (11.5; 14.6)	10.6 (8.8; 12.4)	13.1 (11.0; 15.2)	12.6 (10.3; 14.8)	10.9 (9.3; 12.4)	13.8 (11.6; 16.1)	10.8 (9.2; 12.3)	9.5 (8.1; 11.0)	-0.28	0.004
4-8 years														
Total	14.4 (13.6; 15.1)	15.0 (14.2; 15.8)	14.7 (13.9; 15.5)	14.3 (13.5; 15.1)	13.6 (12.9; 14.4)	13.5 (12.6; 14.4)	11.4 (10.7; 12.2)	11.7 (10.8; 12.5)	10.4 (9.7; 11.1)	10.8 (10.1; 11.6)	10.0 (9.3; 10.7)	10.8 (10.1; 11.5)	-0.47	<0.001
Female	11.6 (10.6; 12.5)	12.6 (11.7; 13.6)	12.7 (11.7; 13.6)	12.2 (11.3; 13.2)	10.9 (10.0; 11.8)	11.3 (10.2; 12.3)	9.5 (8.6; 10.4)	9.9 (8.9; 10.8)	8.8 (8.0; 9.6)	8.7 (7.8; 9.6)	8.0 (7.2; 8.8)	9.1 (8.2; 9.9)	-0.40	0.001
Male	19.9 (18.5; 21.3)	19.9 (18.4; 21.3)	19.0 (17.6; 20.4)	18.6 (17.2; 20.0)	19.0 (17.6; 20.4)	18.1 (16.6; 19.7)	15.7 (14.2; 17.1)	15.7 (14.1; 17.3)	13.7 (12.5; 15.0)	15.1 (13.7; 16.5)	14.2 (12.9; 15.6)	14.6 (13.2; 16.0)	-0.59	<0.001
White	13.7 (12.4; 15.1)	13.2 (11.9; 14.5)	13.4 (12.0; 14.8)	12.7 (11.3; 14.0)	12.7 (11.5; 13.9)	12.1 (10.8; 13.4)	10.8 (9.7; 11.9)	10.4 (9.2; 11.7)	10.5 (9.4; 11.7)	10.5 (9.4; 11.6)	9.8 (8.7; 11.0)	10.0 (8.9; 11.1)	-0.38	<0.001
Non-white	14.7 (13.8; 15.7)	16.0 (15.0; 17.0)	15.4 (14.4; 16.4)	15.2 (14.2; 16.1)	14.3 (13.3; 15.3)	14.6 (13.5; 15.8)	12.0 (11.0; 13.0)	12.7 (11.5; 13.8)	10.3 (9.5; 11.2)	11.1 (10.1; 12.1)	10.1 (9.2; 10.9)	11.3 (10.4; 12.3)	-0.54	<0.001
9-11 years														
Total	12.9 (12.3; 13.6)	11.4 (10.8; 11.9)	11.4 (10.9; 12.0)	10.8 (10.3; 11.4)	10.4 (9.9; 10.9)	9.5 (8.9; 10.0)	8.8 (8.3; 9.3)	8.2 (7.7; 8.8)	8.0 (7.6; 8.5)	7.7 (7.3; 8.2)	7.4 (7.0; 7.9)	7.3 (6.9; 7.7)	-0.51	<0.001
Female	11.2 (10.5; 12.0)	9.6 (8.9; 10.3)	9.4 (8.7; 10.1)	9.7 (9.1; 10.4)	8.9 (8.2; 9.5)	8.0 (7.4; 8.7)	7.1 (6.5; 7.7)	7.1 (6.4; 7.7)	6.4 (5.9; 7.0)	6.7 (6.1; 7.2)	6.1 (5.5; 6.6)	5.9 (5.4; 6.4)	-0.47	<0.001
Male	15.9 (14.9; 16.9)	14.4 (13.4; 15.3)	14.9 (13.9; 15.9)	12.8 (11.9; 13.7)	12.9 (12.0; 13.7)	12.0 (11.1; 13.0)	11.6 (10.8; 12.5)	10.2 (9.3; 11.0)	10.7 (9.9; 11.5)	9.5 (8.7; 10.3)	9.7 (8.9; 10.5)	9.7 (8.9; 10.5)	-0.58	<0.001
White	13.3 (12.3; 14.3)	12.1 (11.1; 13.1)	12.2 (11.3; 13.2)	12.4 (11.4; 13.3)	11.3 (10.4; 12.2)	10.9 (10.0; 11.9)	9.6 (8.8; 10.4)	9.4 (8.5; 10.3)	9.3 (8.5; 10.1)	8.6 (7.8; 9.3)	8.8 (8.0; 9.6)	8.5 (7.7; 9.3)	-0.46	<0.001
Non-white	12.7 (11.9; 13.4)	10.9 (10.2; 11.6)	10.9 (10.2; 11.6)	9.8 (9.2; 10.5)	9.8 (9.1; 10.4)	8.4 (7.7; 9.0)	8.2 (7.6; 8.8)	7.4 (6.7; 8.1)	7.3 (6.8; 7.8)	7.2 (6.6; 7.8)	6.6 (6.1; 7.1)	6.5 (6.0; 7.1)	-0.54	<0.001
12 or more years														
Total	11.8 (11.1; 12.4)	10.7 (10.0; 11.3)	9.9 (9.3; 10.5)	9.1 (8.6; 9.7)	9.1 (8.5; 9.6)	8.0 (7.4; 8.6)	6.8 (6.3; 7.2)	6.8 (6.3; 7.4)	6.6 (6.2; 7.0)	6.3 (5.9; 6.7)	6.2 (5.8; 6.6)	5.6 (5.2; 5.9)	-0.55	<0.001
Female	10.1 (9.3; 10.9)	9.4 (8.6; 10.2)	9.1 (8.4; 9.9)	8.1 (7.4; 8.8)	8.2 (7.5; 8.9)	6.8 (6.1; 7.6)	6.0 (5.4; 6.5)	6.1 (5.4; 6.8)	5.6 (5.1; 6.1)	5.0 (4.5; 5.5)	5.2 (4.7; 5.7)	4.5 (4.1; 5.0)	-0.51	<0.001
Male	14.3 (13.3; 15.4)	12.7 (11.6; 13.7)	11.2 (10.2; 12.1)	10.9 (9.9; 11.8)	10.5 (9.6; 11.4)	10.0 (9.1; 11.0)	8.2 (7.4; 8.9)	8.1 (7.2; 9.1)	8.2 (7.4; 8.9)	8.5 (7.8; 9.2)	7.9 (7.2; 8.6)	7.3 (6.7; 8.0)	-0.60	<0.001
White	12.3 (11.4; 13.1)	12.0 (11.1; 12.9)	11.4 (10.5; 12.2)	10.3 (9.5; 11.1)	10.0 (9.3; 10.8)	9.4 (8.5; 10.2)	7.8 (7.1; 8.5)	8.7 (7.8; 9.5)	8.0 (7.3; 8.6)	7.2 (6.6; 7.8)	7.4 (6.8; 8.0)	6.6 (6.1; 7.2)	-0.52	<0.001
Non-white	11.1 (10.2; 12.1)	9.0 (8.2; 9.8)	8.1 (7.4; 8.9)	7.7 (6.9; 8.4)	7.7 (6.9; 8.5)	6.2 (5.5; 7.0)	5.5 (4.9; 6.0)	4.6 (4.0; 5.3)	4.9 (4.4; 5.5)	5.2 (4.7; 5.7)	4.8 (4.3; 5.3)	4.4 (3.9; 4.9)	-0.58	<0.001

Supplementary table 5: Age-standardized prevalence of obesity by years of education, sex and skin color, VIGITEL 2007-2018.

Years fo education Sex and skin color (%)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual change (%)	p value
	Survey year (95% CI)													
0-3 years														
Total	21.3 (19.6; 22.9)	23.2 (21.5; 24.9)	22.7 (21.0; 24.5)	22.7 (20.9; 24.4)	24.1 (22.4; 25.7)	25.6 (23.4; 27.7)	23.5 (21.5; 25.4)	26.5 (24.2; 28.8)	26.8 (24.9; 28.6)	27.6 (25.6; 29.6)	27.1 (25.3; 28.9)	28.4 (26.7; 30.2)	0.60	<0.001
Female	23.8 (21.7; 25.8)	26.8 (24.7; 28.9)	25.2 (23.0; 27.4)	25.3 (23.2; 27.5)	27.1 (25.1; 29.2)	28.9 (26.1; 31.6)	26.2 (23.7; 28.7)	29.6 (26.7; 32.5)	29.4 (27.2; 31.7)	30.3 (27.7; 32.8)	29.6 (27.4; 31.9)	31.2 (29.1; 33.4)	0.57	<0.001
Male	15.0 (12.7; 17.3)	14.1 (11.8; 16.3)	16.2 (13.6; 18.9)	15.9 (13.4; 18.4)	16.0 (13.5; 18.4)	16.8 (13.6; 19.9)	17.0 (14.1; 19.8)	18.4 (15.0; 21.7)	19.5 (16.7; 22.3)	21.2 (18.1; 24.3)	20.8 (18.0; 23.6)	21.1 (18.4; 23.8)	0.65	<0.001
White	20.5 (17.6; 23.4)	23.3 (20.1; 26.4)	20.3 (17.0; 23.6)	21.4 (18.3; 24.6)	24.6 (21.8; 27.4)	24.5 (21.1; 27.9)	24.3 (21.2; 27.4)	26.3 (22.8; 29.9)	25.9 (22.8; 29.0)	28.2 (25.1; 31.2)	26.7 (23.7; 29.7)	26.6 (23.7; 29.6)	0.64	<0.001
Non-white	21.6 (19.7; 23.6)	23.2 (21.2; 25.2)	23.7 (21.6; 25.8)	23.2 (21.2; 25.3)	23.8 (21.8; 25.8)	26.3 (23.5; 29.2)	22.8 (20.3; 25.4)	26.6 (23.6; 29.7)	27.2 (25.0; 29.5)	27.1 (24.4; 29.8)	27.4 (25.1; 29.6)	29.4 (27.2; 31.6)	0.58	<0.001
4-8 years														
Total	17.0 (16.2; 17.9)	18.7 (17.7; 19.6)	19.3 (18.4; 20.3)	20.2 (19.3; 21.1)	20.6 (19.7; 21.6)	22.0 (20.9; 23.1)	22.4 (21.4; 23.4)	22.8 (21.7; 23.9)	23.9 (22.9; 24.8)	24.6 (23.6; 25.6)	23.9 (22.9; 24.8)	24.5 (23.6; 25.5)	0.67	<0.001
Female	17.9 (16.7; 19.0)	20.4 (19.2; 21.7)	20.5 (19.2; 21.7)	21.3 (20.1; 22.5)	22.1 (20.8; 23.3)	23.8 (22.3; 25.2)	23.6 (22.3; 24.9)	24.7 (23.3; 26.2)	25.7 (24.5; 26.9)	25.9 (24.5; 27.2)	24.5 (23.3; 25.7)	26.4 (25.1; 27.6)	0.70	<0.001
Male	15.4 (14.1; 16.7)	15.0 (13.7; 16.2)	16.9 (15.4; 18.3)	17.9 (16.5; 19.2)	17.8 (16.5; 19.1)	18.3 (16.8; 19.9)	19.8 (18.3; 21.4)	18.6 (16.9; 20.3)	20.2 (18.8; 21.6)	22.0 (20.4; 23.6)	22.5 (20.9; 24.1)	20.5 (19.0; 22.0)	0.62	<0.001
White	16.7 (15.1; 18.2)	19.3 (17.6; 21.0)	19.4 (17.7; 21.1)	20.4 (18.7; 22.1)	20.3 (18.8; 21.8)	22.0 (20.3; 23.7)	21.9 (20.4; 23.5)	22.8 (21.0; 24.5)	23.8 (22.2; 25.4)	24.6 (23.0; 26.1)	23.5 (21.9; 25.0)	24.4 (22.9; 26.0)	0.65	<0.001
Non-white	17.3 (16.2; 18.3)	18.3 (17.2; 19.5)	19.3 (18.1; 20.4)	20.1 (19.0; 21.2)	20.8 (19.7; 22.0)	22.0 (20.6; 23.4)	22.9 (21.5; 24.2)	22.8 (21.4; 24.3)	24.0 (22.8; 25.1)	24.6 (23.2; 26.0)	24.1 (22.9; 25.4)	24.6 (23.4; 25.9)	0.68	<0.001
9-11 years														
Total	12.8 (12.2; 13.4)	13.9 (13.2; 14.5)	14.4 (13.8; 15.1)	16.0 (15.3; 16.6)	16.5 (15.9; 17.1)	17.4 (16.7; 18.1)	17.5 (16.8; 18.1)	18.5 (17.8; 19.3)	18.7 (18.1; 19.3)	19.1 (18.4; 19.8)	18.5 (17.9; 19.2)	19.6 (18.9; 20.2)	0.60	<0.001
Female	12.2 (11.3; 13.0)	13.5 (12.6; 14.3)	14.2 (13.4; 15.1)	15.6 (14.8; 16.5)	16.2 (15.3; 17.0)	17.5 (16.6; 18.4)	17.2 (16.3; 18.0)	18.8 (17.8; 19.8)	19.1 (18.3; 19.9)	19.3 (18.5; 20.2)	18.6 (17.7; 19.4)	19.9 (19.0; 20.7)	0.68	<0.001
Male	14.0 (13.1; 14.9)	14.5 (13.6; 15.4)	14.8 (13.8; 15.7)	16.6 (15.6; 17.6)	17.0 (16.0; 17.9)	17.2 (16.2; 18.3)	17.9 (16.9; 18.9)	18.1 (17.0; 19.2)	18.0 (17.0; 18.9)	18.7 (17.7; 19.7)	18.5 (17.4; 19.5)	19.0 (18.0; 20.1)	0.46	<0.001
White	12.8 (11.7; 13.8)	14.0 (12.9; 15.1)	14.3 (13.2; 15.3)	15.8 (14.7; 16.9)	16.9 (15.8; 18.0)	18.1 (16.9; 19.2)	16.9 (15.9; 18.0)	18.5 (17.3; 19.7)	18.1 (17.1; 19.2)	18.4 (17.4; 19.5)	17.6 (16.6; 18.6)	18.9 (17.8; 20.0)	0.52	0.001
Non-white	12.9 (12.1; 13.6)	13.8 (13.0; 14.6)	14.5 (13.8; 15.3)	16.1 (15.3; 16.9)	16.2 (15.4; 17.0)	16.9 (16.0; 17.8)	17.9 (17.0; 18.7)	18.6 (17.6; 19.5)	19.0 (18.2; 19.8)	19.6 (18.7; 20.4)	19.1 (18.3; 19.9)	20.0 (19.1; 20.8)	0.64	<0.001
12 or more years														
Total	11.6 (11.0; 12.3)	11.5 (10.9; 12.1)	12.8 (12.1; 13.4)	13.3 (12.7; 13.9)	14.7 (14.1; 15.4)	14.9 (14.2; 15.6)	15.2 (14.6; 15.8)	15.0 (14.2; 15.7)	15.1 (14.6; 15.7)	15.6 (15.1; 16.2)	16.1 (15.5; 16.7)	16.8 (16.2; 17.4)	0.46	<0.001
Female	9.4 (8.6; 10.2)	9.4 (8.6; 10.1)	11.3 (10.5; 12.2)	12.0 (11.2; 12.8)	13.0 (12.1; 13.8)	13.7 (12.8; 14.6)	12.7 (12.0; 13.5)	13.5 (12.6; 14.4)	13.5 (12.8; 14.2)	13.8 (13.1; 14.5)	14.3 (13.6; 15.0)	15.1 (14.3; 15.8)	0.48	<0.001
Male	15.1 (14.0; 16.1)	14.9 (13.8; 16.0)	15.0 (14.0; 16.1)	15.6 (14.6; 16.6)	17.6 (16.6; 18.7)	17.0 (15.9; 18.1)	19.5 (18.4; 20.5)	17.5 (16.3; 18.7)	17.8 (16.8; 18.8)	18.6 (17.6; 19.6)	19.2 (18.2; 20.1)	19.7 (18.7; 20.7)	0.45	<0.001
White	11.2 (10.4; 12.1)	11.1 (10.3; 12.0)	12.2 (11.3; 13.1)	12.8 (12.0; 13.7)	14.1 (13.2; 15.0)	14.4 (13.5; 15.4)	14.9 (14.1; 15.7)	14.5 (13.5; 15.5)	14.7 (13.9; 15.5)	15.1 (14.3; 15.8)	14.9 (14.1; 15.7)	16.1 (15.3; 16.9)	0.43	<0.001
Non-white	12.2 (11.2; 13.2)	12.0 (11.1; 12.9)	13.5 (12.5; 14.5)	13.9 (13.0; 14.8)	15.5 (14.5; 16.5)	15.5 (14.4; 16.5)	15.6 (14.7; 16.5)	15.5 (14.5; 16.6)	15.6 (14.8; 16.4)	16.3 (15.5; 17.2)	17.4 (16.6; 18.3)	17.6 (16.7; 18.4)	0.48	<0.001

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	Indicate the study's design with a commonly used term in the title or the abstract Page 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Page 3
Objectives	3	State specific objectives, including any prespecified hypotheses Page3
Methods		
Study design	4	Present key elements of study design early in the paper Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Page 4
Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants Page 4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Pages 4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Pages 4-5
Bias	9	Describe any efforts to address potential sources of bias pages 4-5
Study size	10	Explain how the study size was arrived at page4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Page 5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Page 5
		(*b*) Describe any methods used to examine subgroups and interactions Page 5
		(*c*) Explain how missing data were addressed Page 5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy Page 5
		(*e*) Describe any sensitivity analyses Page 5
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Page 4
		(b) Give reasons for non-participation at each stage Page 4
		(c) Consider use of a flow diagram NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Table 1
		(b) Indicate number of participants with missing data for each variable of interest

		page 4
Outcome data	15*	Report numbers of outcome events or summary measures Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Figures 1, 2 and 3
		(*b*) Report category boundaries when continuous variables were categorized NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Figure 1
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Figures 2 and 3
Discussion		
Key results	18	Summarise key results with reference to study objectives Page 8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Page 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Page 11
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 11
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based page 6

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.