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Progress and setbacks in socioeconomic inequalities in adolescent health-related behaviours in Brazil, 2009-2015.

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Progress and setbacks in socioeconomic inequalities in adolescent health-related behaviours in Brazil, 2009-2015.

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ABSTRACT

Objectives

Despite some progress, Brazil is still one of the most unequal countries, and the extent of socioeconomic inequalities in adolescent health is unclear. We assessed trends in socioeconomic inequalities in adolescent's health-related behaviours in Brazil between 2009-2015.

Design: We used cross-sectional data from the Brazilian National Survey of School Health carried out in 2009, 2012 and 2015.

Setting: Brazilian state capitals.

Participants: Students attending 9th grade from public and private schools in Brazilian state capitals in 2009 (60,973 students), 2012 (74,432 students) and 2015 (60,078 students)

Main Outcome measure:

We assessed 12 health-related behaviours under 3 broad domains (lifestyle risk behaviours, engagement in risky activities and exposure to violence). Socioeconomic status was assessed through an asset-based wealth index derived from principal components analysis. Absolute and relative inequalities in these health behaviours and inequalities trends were investigated.

Results

From 2009 to 2015, prevalence of certain harmful health-related behaviours increased, such as unsafe sex (21.5% to 33.9%), domestic violence (9.5% to 16.2%), bullying victimization (14.2% to 21.7%) and in irregular consumption of beans (37.5% to 43.7%). Other indicators decreased: alcohol use (27.1% to 23.2%), irregular physical activity (83.0% to 75.6%) and consumption of soft drinks (37.2% to 28.8%). Over the period, we found consistent evidence of decreasing health inequalities for lifestyle behaviours (fruit, bean and soft drink consumption) and alcohol use, set against increasing inequalities in violence (domestic violence, fights using guns and bullying victimization).

Conclusion

Socioeconomic inequality increased in the violence domain and decreased for lifestyle behaviours among Brazilian adolescents. Widening gaps in violence domain urge immediately policy measures in Brazil.

Key-words: Adolescent, Social inequalities, health behaviour.

Strengths and limitations of this study

- We assessed the extent of socioeconomic inequalities in adolescent health and how it has changed over time in a middle-income country;
- We used a large representative urban samples from Brazilian adolescents attending public and private schools;
- Another strength of this study was the use of complex measures of inequality;
- Although we have used validated questionnaires, the self-report of behaviours may cause some degree of classification bias;
- The period of 6 years may be too short to expect significant changes in inequalities.

INTRODUCTION

Adolescence is a critical period for promotion of human development. During adolescence, biological, cognitive, emotional, and social capabilities are founded and future patterns of adult health are established [1]. Despite its clear importance, adolescent's health has been generally overlooked in social policies. In order to guide surveillance, investments and policy actions, a broad concept of adolescent health has been proposed by The Lancet Commission on adolescent health. This concept includes aspects related to sexual and reproductive health, nutritional deficiencies, injury and violence, physical and mental health, and substance use disorders [2].

Socioeconomic factors strongly predict adolescent health [3]. Socioeconomic inequalities have consistently increased over the last decades in US and Europe [4], and this trend coincides with widening gaps in indicators of adolescent health [5]. For instance, a time-series analysis of 34 North American and European countries showed an increase in inequalities between socioeconomic groups in physical activity, body mass index, and psychological and physical symptoms between 2002 and 2010 [5].

Studies monitoring inequality in adolescent health in low- and middle-income countries are sparse in the literature. Brazil is still one of the most unequal countries worldwide [6], although considerable social protection efforts have been adopted in the last decades (*e.g.*, creation of a free public universal health system, expanding community-based primary care and providing a robust conditional cash transfer program) [7]. These social programs have had positive impacts on adult health, especially among the most deprived, with increased overall food quality and diversity [8], reduced racial inequalities in health [9] and cardiovascular disease mortality [10]. However, the extent of socioeconomic inequalities in adolescent health and how it has changes over time in Brazil is unclear.

In this study, we assessed levels and trends in socioeconomic inequalities in adolescent health in Brazil between 2009 and 2015. We used data from three large representative health surveys of adolescents living in Brazilian state capitals. We selected 12 indicators under 3 broad domains (lifestyle risk behaviours, engagement in risky activities and exposure to violence) to provide a holistic view of adolescent health inequalities in Brazil.

METHODS

We used cross-sectional data from three Brazilian National Surveys of School Health (*Pesquisa Nacional da Saude do Escolar* - PeNSE) carried out in 2009, 2012 and 2015. In order to have comparable datasets across the three surveys, we used a representative subsample of adolescents attending 9th grade (i.e., mostly aged between 14-15 years) in public and private schools from the 26 state capitals and the Federal District. Detailed information about PeNSE has been published elsewhere [11-13]. Briefly, PeNSE sampling strategy included stratification per cluster and multi-stage selection. The sampling strata were each of the 26 state capitals and Federal District. The primary sampling units (PSUs) were schools, and the secondary sampling units (SSUs) were classrooms. School selection was proportional to the total number of 9th grade classes, while the classes in each school were chosen by simple random selection. Two classrooms were selected from schools with three or more 9th grade classrooms, whereas one classroom was selected from schools with one or two 9th grade classrooms. All students enrolled in the selected classrooms were invited to participate in the study. Participants were not included in the study if they did not attend school during data collection, refuse to participate, or did not report their age and sex. The total number of students included in our analysis was 60,973 (final response rate 83.8%) for 2009,

61,145 (final response rate 82.2%) for 2012, and 51,192 (final response rate 95.2%) for 2015 surveys [11-13].

Students filled out a self-reported structured questionnaire available in a Personal Digital Assistant device (2009 survey) or smartphone application (2012 and 2015 survey) in their school classrooms during regular school hours. The questionnaire was based on the Global School-Based Student Health Survey [14] and the Youth Risk Behaviour Surveillance System[15], and was adapted to the Brazilian setting. Questions included socioeconomic variables and several risk and protective factors for adolescent health.

We estimated a wealth index specific for each survey year through Principal Component Analysis (PCA), following the steps proposed by Barros and Victora [16]. We ran PCA including the following variables: mother's educational level (incomplete middle school, complete middle school, complete high-school, complete higher education); school administrative status (public or private); self-report of having: landline, mobile phone, computer, internet access, car, bathroom inside the house and housemaid services. We retained the first component of the analysis and calculated coefficients from the expression: coefficient=loading/standard deviation x100. The individual scores were estimated from the $\sum c_i v_i$, where c_i is the coefficient and v_i is the value for the ith variable. The wealth index was assessed as quintiles of the total wealth scores. We refer to the first quintile (Q1) as the poorest quintile (poorest 20%) and the fifth quintile (Q5) as the wealthiest quintile (wealthiest 20%).

The indicators of adolescent health used in this study are defined in table 1 (full questionnaire items listed in appendix 1). We divided indicators in three domains: lifestyle risk behaviours, engagement in risky activities and exposure to violence. Alcohol and tobacco use were included as risky activities and not lifestyle behaviours,

because Brazilian law forbids the sale of these substances for younger than 18 years old. We have used the concept of "irregular consumption" (<5 times in the past week) for all food indicators, following the complementary concept of "regular consumption", which was validated using 24 hours recall[17]. We also chose to include bean consumption because of their protective health effects and importance in Brazil as an affordable traditional staple food [18]. The frequency of 2 or more times in the previous month for bullying victimization followed the concept of this type of violence, which presume repetition[19]. The unsafe sex was assessed only for those who reported had sexual relationships.

Domain	Indicator	Definition
Lifestyle risk behaviours	Irregular fruit consumption	Less than 5 times in the past week
	Irregular vegetable consumption	Less than 5 times in the past week
	Irregular bean consumption	Less than 5 times in the past week
	Regular soft drink consumption	5 or more times in the past week
	Irregular recreational physical activity	Less than 5 times in the past week
Engagement in risky activities	Alcohol use	1 or more times in previous month
	Drug use	1 or more times in previous month
	Tobacco use	1 or more times in previous month
	Unsafe sex	If not used a condom at last sexual intercourse
Exposure to violence	Involvement in gun fights	1 or more times in previous month
	Bullying victimization	2 or more times in previous month
	Domestic violence victimization	1 or more times in previous month

Table 1: Indicators of adolescent health used in the present study

To assess socioeconomic inequalities in adolescent health we used several measures of inequality. Firstly, we estimated simple measures of inequality (pairwise comparisons), such as differences and ratios of each health indicator between the wealthiest group (5th quintile) and the poorest group (1st quintile).

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Secondly, we estimated complex measures of inequality, represented by an indicator of absolute inequality, the slope index of inequality (SII), and an indicator of relative inequality, the concentration index (CIX) [20]. Both SII and CIX take into account all quintiles of the wealth index to compare a given health indicator across all wealth subgroups.

We estimated the SII using logistic regression to avoid predicting implausible values below zero or above one, considering that all health indicators were presented as proportions [21]. The SII estimates the absolute difference (i.e., in percentage points) in the prevalence of health indicator between individuals in the wealthiest and poorest quintiles. Negative values of SII indicate that prevalence of the health indicator is higher among the poorest adolescents than the wealthiest (values ranged from -100 to +100).

The CIX was also expressed on a scale ranging from −100 to +100; a value of 0 represents perfect equality, whereas negative values indicate that poor individuals have higher prevalence of a given health indicator than wealthy individuals [22]. The CIX was calculated with no corrections [21].

Linear regressions using variance-weighted least squares were performed to assess changes over time in complex measures of inequality (SII and CIX) based on the means and standard deviation for each of the three surveys.

Multiple imputation was performed using the chained equation technique due to the significant proportion of missing values for the mother's education level in the three datasets (19,36%, n=33,559). We also imputed other study variables with a smaller proportion of missing values, to create a complete dataset. The imputed data exhibited satisfactory statistical reproducibility according to Monte Carlo error analysis[23].

The sample design was taken into consideration for descriptive analyses, using survey prefix command (svy) in Stata. School clustering (random effect) and sample

weights were considered when estimating complex measures of inequality (SII and CIX). All the statistical analyses were performed using Stata 14.0.

Ethics approval

PeNSE surveys were approved by the National Commission of Research Ethics (Comissão Nacional de Ética em Pesquisa – Conep), records no. 11.537 (2009), 16.805 (2012) and 1.006.467 (2015). The surveys were performed in accordance with the Declaration of Helsinki and all participants gave their informed consent. Databases were made publicly available on an IBGE website without any information that could identify subjects.

Patient and public involvement

No patients or public were involved in the design and conceptualisation of this study.

Data Sharing

The dataset of 2009, 2012 and 2015 PeNSE are publicly available at:

https://www.ibge.gov.br/estatisticas-novoportal/sociais/educacao/9134-pesquisa-

nacional-de-saude-do-escolar.html?=&t=microdados

RESULTS

In 2015, the health-related behaviours more common among Brazilian adolescents were irregular consumption of fruits (67.2%) and vegetables (61.8%) and irregular recreational physical activity (75.6%). Less frequent were the unsafe sex in last sexual intercourse (33.9%), alcohol use (23.2%) and exposure to bullying (21.7%).

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Between 2009 and 2015, the prevalence of irregular vegetable consumption, irregular recreational physical activity, regular soft drink consumption, alcohol, tobacco and drug use decreased. On the other hand, trends for irregular bean consumption, unsafe sexual intercourse, and exposure to violence (domestic violence, fight using guns, and bullying victimization) increased (Table 2).

Table 2 - Brazilian adolescent characteristics and health-related behaviours from PeNSE surveys 2009, 2012 and 2015.

adolescents characteristics and behaviours	PeNSE survey year					
	2009 (60,973 students)		2012 (61,145 students)		2015 (51,192 students)	
characteristics	%	CI95%	%	CI95%	%	CI95%
Sex (female)	52.5	(51.9-53.2)	50.8	(50.1-51.6)	50.8	(49.9-51.7)
Age (**mean and standard error**)	14.2	(0.02)	14.3	(0.02)	14.2	(0.02)
Wealth index (**mean and standard error**)	3.8	(0.03)	4.0	(0.06)	4.0	(0.06)
behaviours						
Irregular fruit consumption	68.5	(67.8-69.2)	70.2	(69.5-70.9)	67.2	(66.3-68.0)
Irregular vegetables consumption	68.8	(68.0-69.5)	64.1	(63.3-64.9)	61.7	(60.7-62.7)
Irregular beans consumption	37.4	(36.4-38.5)	40.0	(38.5-41.5)	43.7	(42.4-45.1)
Regular soft drinks consumption	37.2	(36.3-38.2)	35.4	(34.6-36.2)	28.8	(27.9-29.8)
Irregular recreational physical activity	83.0	(82.3-83.6)	74.2	(7.5-74.8)	75.6	(74.8-76.3)
Alcohol use (once in the last month)	27.1	(26.3-28.0)	26.8	(25.8-27.7)	23.2	(22.2-24.2)
Tobacco use (once in the last month)	6.2	(5.8-6.7)	6.1	(5.6-6.6)	5.3	(4.9-5.8)
Drug use (once in the last month)	3.3	(3.0-3.6)	3.8	(3.4-4.2)	2.5	(2.2-2.7)
Unsafe sex (in the last sexual intercourse)	21.5	(20.3-22.7)	22.5	(21.6-23.5)	33.9	(32.3-35.4)
Domestic violence (once in the last month)	9.5	(9.1-10.0)	11.6	(11.1-12.1)	16.2	(15.5-16.9)
Involvement in gun fights (once in the last month)	4.0	(3.7-4.3)	6.9	(6.6-7.3)	5.6	(5.2-6.1)
Bullying victimization (twice or more in the last month)	14.2	(13.6-14.7)	16.5	(15.9-17.1)	21.7	(21.1-22.4)

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Figure 1 (A-C) shows the trends in health indicators by wealth quintile between 2009 and 2015. The width of the bars represents the absolute inequality. For most health indicators (except bean, soft drink and alcohol use), people in the poorest group reported more adverse levels compared to the wealthiest group. In general, over the period 2009-2015, health inequalities decreased for lifestyle behaviours (fruit, vegetable, bean and soft drink consumption, and recreational physical activity), while increased for risky activities and violence (smoking, drug use, unsafe sex, domestic violence, fights using guns and bullying victimization) (Appendix 2).

INSERT FIGURE 1 HERE

Some of these trends were not statistically significant according to complex measures of inequality (table 3).

Table 3 - Complex measures of inequality in health-related behaviours among Brazilian adolescents. PeNSE surveys 2009, 2012 and 2015.

Quintiles of Wealth index (1=poorest; 5=wealthiest) Indicators	Slope Index of inequality (SII)				Concentration index of inequality (CIX)			
	2009	2012	2015	*p*-value*	2009	2012	2015	*p*-value*
Irregular fruit consumption	-13.68	-9.01	-8.88	0.015	-2.82	-2.31	-2.26	0.267
Irregular vegetables consumption	-19.02	-17.59	-17.92	0.535	-4.30	-4.48	-5.18	0.165
Irregular beans consumption	9.95	11.25	7.33	0.434	6.48	3.47	2.22	0.000
Regular soft drinks consumption	16.55	10.49	3.89	0.000	6.94	5.19	2.90	0.000
Irregular recreational physical activity	-8.66	-9.47	-7.90	0.745	-1.70	-1.91	-1.71	0.837
Alcohol use (once in the last month)	9.69	0.68	0.06	0.000	4.79	1.71	1.19	0.004
Tobacco use (once in the last month)	-1.68	-2.80	-3.15	0.125	-5.68	-6.32	-8.69	0.290
Drug use (once in the last month)	0.34	0.46	-0.98	0.048	-0.08	4.47	-4.61	0.428
Unsafe sex (in the last sexual intercourse)	-9.67	-6.88	-13.28	0.498	-6.52	-5.44	-6.56	0.914
Domestic violence (once in the last month)	-1.84	-5.24	-6.92	0.000	-2.72	-7.02	-6.57	0.014
Involvement in gun fights (once in the last month)	-0.76	-1.90	-3.30	0.002	-2.82	-4.42	-8.79	0.029
Bullying victimization (twice or more in the last month)	0.83	-0.20	-6.60	0.000	0.56	0.59	-4.41	0.000

In all years, alcohol consumption was the health indicator more equally distributed between wealth quintiles both according to absolute and relative measures. On the other hand, irregular vegetables consumption and unsafe sex had the highest absolute inequality and fights using guns and tobacco use the highest relative inequality. Over time, the absolute (SII) and relative inequalities (CIX) between wealth index quintiles became wider for all three indicators of exposure to violence, and narrower for some indicators of lifestyle behaviour (fruit, beans and soft drinks) and alcohol consumption. There was limited evidence of change in inequalities over time for the other lifestyle behaviours, such as irregular vegetables consumption and recreational physical activity, and indicators of engagement in risky activities, such as tobacco, drug use and unsafe sex (table 3, figure 2).

INSERT FIGURE 2 HERE

DISCUSSION

We showed evidence of persistent socioeconomic inequalities in adolescent health in Brazil. Between 2009 and 2015, lifestyle behaviours (fruit and soft drinks consumption) and alcohol use became more equally distributed between socioeconomic groups, while inequalities in experiencing violence were exacerbated. In this period, there was little evidence of change to inequalities in risky activities (smoking, drugs, unsafe sex).

In general, the direction of health inequalities we observed are similar to that reported in other settings, that is, poorer adolescents are more likely to report harmful health behaviours than richer [5]. For certain harmful behaviours (e.g. alcohol and drug use), however, differences between social groups were not significant or went in the

opposite direction (i.e. wealthier adolescents reported higher prevalences). These findings are consistent with results observed in other countries [24].

Looking at time-trends in these inequalities, our findings differ to existing evidence from Western Europe and North America. For some lifestyle (e.g. vegetable consumption, physical activity) and risky behaviours (drug and tobacco use), inequalities have not changed significantly between 2009 and 2015 in Brazil. Yet inequality in lifestyle and risky behaviors have increased over similar period in many other countries [5, 25]. Similarly to ours, one study found persistent inequality in vegetable consumption [26]. Despite this, comparable data for many indicators of risk behaviours are lacking. Rates of violence as well as inequalities in violence increased markedly (gun fights, domestic violence, bullying), and these trends also differ from other countries [27].

Reasons for differential socioeconomic inequality trends between lifestyle behaviours, risk behaviours and violence-related indicators in Brazilian adolescents are unclear. Reductions in lifestyle behaviour inequalities fits with the general trend of narrowing economic and health inequalities observed for adults in Brazil in that period[28, 29]. This is often attributed to rising prosperity combined with roll-out of redistributive health and social programs such as the Bolsa Familia cash transfer program [30], as well as scaled-up health promotion efforts (especially obesity prevention) [31]. Exacerbation of violence-related inequalities have also been observed in one study of adult mortality in Salvador [32]. It has been suggested that public health interventions have focussed on reducing infectious and chronic diseases but neglect, on the other hand, external causes of ill-health such as interpersonal violence. In fact, violence-related mortality has declined slower than all other causes in Brazil, and even increased in 19 of the 27 states [33].

It is worth noting that we found a shift in prevalence of alcohol use and soft drinks consumption between socioeconomic in the period studied. In 2009, these indicators were higher among the wealthiest group, but in 2015 the differences were considerably attenuated. The reduction in the consumption of these products was more pronounced among the wealthiest group than in the poorest group. Conversely, for bean consumption, poorer adolescents reported higher prevalence than wealthiest adolescences. In this regard, the reduction in disparities between wealth groups should be read with caution. In high-income countries, poorer individuals consume more alcohol, relative to wealthier individuals, while in low-middle income countries wealthier individuals are more exposed than the poorer [34]. This trend could be shifting. In fact, industries of unhealthy commodities have moved to, and are growing faster in, low- and middle-income countries comparing to high-income countries [35]. This phenomenon might explain, at least in part, the increase in consumption of ultra-processed products (e.g. sugary drinks) and alcohol, and the reduction of bean consumption in these settings [36]. Brazil seems to be moving towards patterns of health indicators and their inequalities currently observed in high-income countries. In these countries, the reduction in alcohol use and soft drinks consumption among those privileged is not necessarily followed by a reduction among those more socially deprived [5]. Although this trend is measured as a reduction in inequality, it is not desirable.

The main strength of this study is to explore a wide spectrum of health indicators, which provides information on prevalence and trends in key risk factors for adolescent health. Another positive aspect is the large representative urban samples from Brazilian adolescents attending public and private schools. In Brazil, the school coverage in this age is very high (88-97%) [37], which reduces significantly the risk of

selection bias. Despite this, is plausible to assume that students at higher risk of harmful health behaviors have higher truancy and dropout rates. Therefore, this could have masked the true extent of the inequalities. We also report a range of simple and complex measures of inequalities to allow clear interpretation of trends as well as presenting rigorous hypothesis tests which make use of all data. Concordance between the absolute and relative measures of inequality adds strength to our conclusions.

Some limitations should be acknowledged. The engagement in health-related behaviours was self-reported by adolescents, and therefore, misclassification may have occurred towards social desirable behaviors. Misclassification likely affected the prevalence of health indicators similarly over three surveys. Although, use of self-reported outcomes is a limitation, it is widely recognised as an acceptable and often the only feasible approach for monitoring adolescent health behaviours [38]. Moreover, there is evidence of validity of the dietary indicators used in the PeNSE survey [17], and a US survey on which the PeNSE survey was based demonstrated good test-retest reliability and consistency across different modes of questioning [39].

The surveys were available only for a period of 6 years, which may be too short to expect significant changes in inequalities. To continue monitoring trends in adolescent health inequality for longer periods is desirable. Also, the data analysed are representative of Brazilian state capitals, not the whole country. State Capitals are highly urbanized cities and more developed than other cities, therefore, these results may not be generalizable to small cities and rural areas. However state capitals are the most populous and unequal areas of Brazil [40], making them important settings for studying inequality trends, and meaning they can act as sentinels to the country as a whole.

Brazil is facing a huge economic recession since 2015, which deepened in 2016. Unemployment and inflation have increased and people's purchasing power has been reduced, with the poor especially affected. Therefore it will be vital to continue monitoring the trends observed in this study and take action to prevent exacerbation of existing inequalities.

Policy makers and researchers should be alert to the fact that possible reductions in health risky behaviours may be unbalanced between social groups and even be increasing in disadvantaged social groups while decreasing on average [22]. In this study, we found that the gap between poor adolescents and wealthy adolescents is reducing for lifestyle behaviours such as fruit consumption; while it is increasing for violent behaviours. For alcohol, irregular bean consumption and regular soft drink consumption we found that the gap between social groups is narrowing, although represented by a reduction in these risk behaviours among rich and an increase among poor adolescents.

Conflict of interest: None.

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Figure 1 - Time trends in health-related behaviours by wealthy quintile among adolescent

Figure 2- Prevalence of health-related behaviours among adolescent in 2015 and Slope Index of Inequality (SII, absolute inequality).

Figure 1 - Time trends in health-related behaviours by wealthy quintile among adolescent.

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Figure 2- Prevalence of health-related behaviours among adolescent in 2015 and Slope Index of Inequality (SII, absolute inequality).

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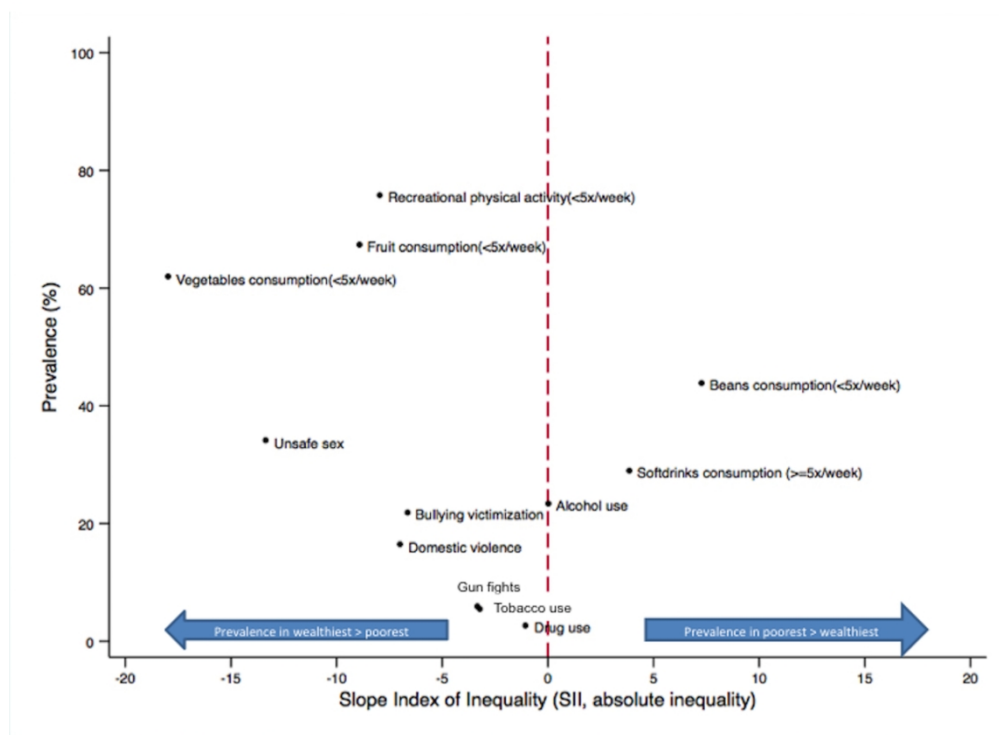Appendix 1. Description of health indicators assessed.

Health indicator	Original question
Regular dietary consumption of fruits (≥5 days) in the last week	In the 7 days, on how many days did you eat fresh fruits or fruits salad? Options: I did not eat fresh fruits or fruits salad in the last 7 days; 1 day in the last 7 days; 2 days in the last 7 days; 3 days in the last 7 days; 4 days in the last 7 days; 5 days in the last 7 days; 6 days in the last 7 days; Every day in the last 7 days
Regular dietary consumption of vegetables (≥5 days) in the last week	In the 7 days, on how many days did you eat at least one type of raw or cooked vegetable? Options: I did not eat vegetables in the last 7 days; 1 day in the last 7 days; 2 days in the last 7 days; 3 days in the last 7 days; 4 days in the last 7 days; 5 days in the last 7 days; 6 days in the last 7 days; Every day in the last 7 days
Regular dietary consumption of beans (≥5 days) in the last week	In the 7 days, on how many days did you eat beans? Options: I did not eat beans in the last 7 days; 1 day in the last 7 days; 2 days in the last 7 days; 3 days in the last 7 days; 4 days in the last 7 days; 5 days in the last 7 days; 6 days in the last 7 days; Every day in the last 7 days
Regular dietary consumption of soft drinks (≥5 days) in the last week	In the 7 days, on how many days did you drink soft drinks? Options: I did not drink soft drinks in the last 7 days; 1 day in the last 7 days; 2 days in the last 7 days; 3 days in the last 7 days; 4 days in the last 7 days; 5 days in the last 7 days; 6 days in the last 7 days; Every day in the last 7 days

Recreational physical activity at least 5 times in the last week	In the last 7 days, excluding physical education classes, on how many days did you practice any physical activity such as sports, dance, gymnastics, etc? Options: No day in the last 7 days; 1 day in the last 7 days; 2 days in the last 7 days; 3 days in the last 7 days; 4 days in the last 7 days; 5 days in the last 7 days; 6 days in the last 7 days; Every day in the last 7 days
Victim of domestic violence at least once in the previous month by some adult family member	In the last 30 days, how many times was you physically assaulted by some adult family member? Options: Not once in the last 30 days; 1 time in the last 30 days; 2 or 3 times in the last 30 days; 4 or 5 times in the last 30 days; 6 or 7 times in the last 30 days; 8 or 9 times in the last 30 days; 10 or 11 times in the last 30 days; 12 or more times in the last 30 days
Involvement in fights using guns at least one in the last month	In the last 30 days, did you get involved in any fight that someone used guns? Options: yes; no
Bullying victimization at least twice in the last month	"In the past 30 days, how often have you been mocked, teased, called names or intimidated by one of your schoolmates so much that you were hurt/annoyed/upset/offended/ashamed? Options: No day in the last 30 days; rarely in the last 30 days; sometimes in the last 30 days; most of the time in the last 30 days; always in the last 30 days
Alcohol use at least once in the previous month	In the last 30 days, on how many days did you drink at least one cup or dose of alcoholic

	beverage? Options: No day in the last 30 days; 1 or 2 days in the last 30 days; 3 to 5 days in the last 30 days; 6 to 9 days in the last 30 days; 10 to 19 days in the last 30 days; 20 to 29 days in the last 30 days; Every day in the last 30 days
Drug use at least once in the previous month	In the last 30 days, how many times did you used drugs such as marijuana, cocain, crack, glue, ecstasy, oxy, etc? Options: I have never used drugs; no day in the last 30 days; 1 or 2 days in the last 30 days; 3 to 5 days in the last 30 days; 6 to 9 days in the last 30 days; 10 or more days in the last 30 days
Smoking at least once in the previous month	In the last 30 days, on how many days did you smoke cigarettes? Options: I have never smoked; No day in the last 30 days; 1 or 2 days in the last 30 days; 3 to 5 days in the last 30 days; 6 to 9 days in the last 30 days; 10 to 19 days in the last 30 days; 20 to 29 days in the last 30 days; Every day in the last 30 days
Safe sexual behaviour (if have used condom in the last sexual intercourse)	In the last time you had sex, did you and your partner use a condom? Options: I have never had sex; yes; no; I don't know

Appendix 2

Simple measures of inequality in health-related behaviours among Brazilian adolescents from PeNSE surveys 2009, 2012 and 2015.

Indicator	PeNSE survey year	National	Q1 (poorest) %	Q5 (richest) %	Difference (quintile 5 - quintile 1) %	Difference (quintile 5 - quintile 1) 95% CI	Ratio (quintile 5/ quintile 1) %	Ratio (quintile 5/ quintile 1) 95% CI	Population Attributable risk (PAR)	Population Attributable risk percentage (PAR%)
	2009	68.49	74.34	64.00	10.34	8.06; 12.62	1.16	1.12; 1.20	-4.49	-6.56
Irregular fruit consumption	2012	70.24	75.35	66.96	8.39	6.03; 10.74	1.13	1.08; 1.16	-3.28	-4.67
	2015	67.17	72.29	64.15	8.14	5.28; 11.00	1.13	1.08; 1.18	-3.02	-4.50
	2009	68.77	76.81	61.47	15.34	13.28; 17.41	1.25	1.21; 1.29	-7.30	-10.62
Irregular vegetables consumption	2012	64.12	71.64	56.99	14.65	12.46; 16.83	1.26	1.21;1.30	-7.13	-11.12
	2015	61.73	69.97	55.14	14.83	11.66;18.01	1.27	1.20; 1.34	-6.59	-10.68
	2009	37.45	37.38	47.74	-10.36	-12.96; -7.77	0.78	0.74; 0.83	10.29	27.48
Irregular beans consumption	2012	40.00	41.09	51.74	-10.65	-13.88; -7.42	0.79	0.74; 0.85	11.74	29.35
	2015	43.74	46.27	52.07	-5.80	-9.17; -2.43	0.89	0.83; 0.95	8.33	19.04
	2009	37.21	29.67	41.59	-11.92	-14.32; -9.50	0.71	0.67; 0.76	4.38	11.77
Regular softdrinks consumption	2012	35.44	28.17	36.62	-8.45	-10.69; -6.20	0.77	0.72; 0.83	1.18	3.33
	2015	28.84	24.51	27.42	-2.91	-5.45; -0.33	0.89	0.81; 0.98	-1.42	-4.92
	2009	82.96	85.88	78.96	6.92	5.30; 8.55	1.09	1.07; 1.11	-4.00	-4.66
Irregular recreational physical activity	2012	74.15	77.97	70.27	7.70	5.82; 9.58	1.11	1.08; 1.14	-3.88	-4.98
	2015	75.58	78.58	72.36	6.22	3.93; 8.51	1.09	1.05; 1.12	-3.22	-4.10
	2009	27.13	23.57	31.02	-7.45	-9.22; -5.67	0.76	0.71; 0.81	3.89	14.33
Alcohol use (once in the last month)	2012	26.78	25.55	26.33	-0.78	-2.94; 1.37	0.97	0.89; 1.05	-0.45	-1.67
	2015	23.2	22.24	22.50	-0.26	-2.99; 2.47	0.99	0.87; 1.12	-0.70	-3.03
	2009	6.25	6.70	5.63	1.07	0.09; 2.06	1.19	1.01; 1.40	-0.62	-9.92
Tobacco use (once in the last month)	2012	6.08	7.20	4.44	2.76	1.70; 3.82	1.62	1.35; 1.95	-1.64	-26.99
	2015	5.34	7.18	4.41	2.77	1.48; 4.06	1.63	1.28; 2.08	-0.93	-17.35

	Year								
Drug use (once in the last month)	2009	3.32	3.01	3.52	-0.51	-1.29; 0.27	0.85 0.67; 1.08	0.20	6.02
	2012	3.81	3.94	3.63	0.31	-0.70; 1.32	1.09 0.83; 1.42	-0.18	-4.72
	2015	2.45	2.55	2.20	0.35	-0.52; 1.22	1.16 0.80; 1.69	-0.25	-10.20
Unsafe sex (in the last sexual intercourse)	2009	21.46	25.19	16.65	8.54	5.27; 11.82	1.51 1.27; 1.80	-4.81	-22.41
	2012	22.5	24.29	18.83	5.46	2.10; 8.81	1.29 1.10; 1.51	-3.67	-16.31
	2015	33.86	39.11	26.00	13.11	8.21; 18.01	1.50 1.28; 1.77	-7.86	-23.21
Domestic violence (once in the last month)	2009	9.54	10.13	8.79	1.34	0.06; 2.62	1.15 1.00; 1.33	-0.75	-7.86
	2012	11.6	14.08	9.87	4.21	2.82; 5.61	1.43 1.27; 1.61	-1.73	-14.91
	2015	16.17	19.33	13.11	6.22	4.48; 7.96	1.47 1.32; 1.65	-3.06	-18.92
Involvement in gun fights (in the last month)	2009	4.01	3.93	3.15	0.78	0.02; 1.53	1.25 1.00; 1.55	-0.86	-21.45
	2012	6.94	7.50	5.65	1.85	0.82; 2.88	1.33 1.13; 1.55	-1.29	-18.59
	2015	5.61	7.19	3.70	3.49	2.41; 4.58	1.94 1.56; 2.42	-1.91	-34.05
Bullying victimization (twice or more in the last month)	2009	14.16	13.71	14.54	-0.83	-2.16; 0.50	0.94 0.86; 1.04	0.38	2.68
	2012	16.5	16.90	16.73	0.17	-1.68; 2.04	1.01 0.90; 1.13	0.23	1.39
	2015	21.74	24.88	18.51	6.37	4.28; 8.45	1.34 1.22; 1.48	-3.23	-14.86

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract abstract; page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found page 1
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Page2
Objectives	3	State specific objectives, including any prespecified hypotheses Page 3
Methods		
Study design	4	Present key elements of study design early in the paper Page 3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Page 3
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up NA *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls NA *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants –Page3 and first para page 4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed NA *Case-control study*—For matched studies, give matching criteria and the number of controls per case NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Page 4 and page 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 Table 1 – page 5 and Supplementary material
Bias	9	Describe any efforts to address potential sources of bias Page 4 (response rate – selection bias); page 5 (validation of measures – information bias)
Study size	10	Explain how the study size was arrived at . Page 3 and Reference: Oliveira et al. 2017
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Page 6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Page 6
		(*b*) Describe any methods used to examine subgroups and interactions NA
		(*c*) Explain how missing data were addressed Pages 6-7

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(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed NA

Case-control study—If applicable, explain how matching of cases and controls was addressed NA

Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy Page 7

(*e*) Describe any sensitivity analyses NA

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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
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
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion

Key results	18	Summarise key results with reference to study objectives
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
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results

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

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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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Progress and setbacks in socioeconomic inequalities in adolescent health-related behaviours in Brazil, 2009-2015.

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Progress and setbacks in socioeconomic inequalities in adolescent health-related behaviours in Brazil, 2009-2015.

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Words count: 2849

Authorship statement: CMA, LFMR, RBL and AJDB conceptualized the study and were involved in the analysis and interpretation of the results. CZR was involved in data preparation, designed and prepared the tables. SK and PACM were involved in the interpretation and discussion of results. The initial draft of the paper was prepared by CMA following extensive discussions and inputs from the other co-authors. All authors have reviewed, revised the manuscript and approved the final version.

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ABSTRACT

Objectives
Despite some progress, Brazil is still one of the most unequal countries, and the extent of socioeconomic inequalities in adolescent health is unclear. We assessed trends in socioeconomic inequalities in adolescent's health-related behaviours in Brazil between 2009-2015.

Design: We used cross-sectional data from the Brazilian National Survey of School Health carried out in 2009, 2012 and 2015.
Setting: Brazilian state capitals.
Participants: Students attending 9th grade from public and private schools in Brazilian state capitals in 2009 (60,973 students), 2012 (74,432 students) and 2015 (60,078 students)
Main Outcome measure:
We assessed 12 health-related behaviours (irregular fruit, vegetables and bean consumption; regular soft drinks consumption; irregular physical activity; alcohol, drug and tobacco use; unsafe sex; involvement in gun fights; bullying victimization and domestic violence victimization), under the broad domains of lifestyle risk behaviours, engagement in risky activities and exposure to violence. Socioeconomic status was assessed through an asset-based wealth index derived from principal components analysis. Absolute and relative inequalities in these health behaviours and inequalities trends were investigated.
Results
From 2009 to 2015, prevalence of certain harmful health-related behaviours increased, such as unsafe sex (21.5% to 33.9%), domestic violence (9.5% to 16.2%), bullying victimization (14.2% to 21.7%) and in irregular consumption of beans (37.5% to 43.7%). Other indicators decreased: alcohol use (27.1% to 23.2%), irregular physical activity (83.0% to 75.6%) and consumption of soft drinks (37.2% to 28.8%). Over the period, we found consistent evidence of decreasing health inequalities for lifestyle behaviours (fruit, bean and soft drink consumption) and alcohol use, set against increasing inequalities in violence (domestic violence, fights using guns and bullying victimization).
Conclusion
Socioeconomic inequality increased in the violence domain and decreased for lifestyle behaviours among Brazilian adolescents. Widening gaps in violence domain urge immediately policy measures in Brazil.
Key-words: Adolescent, Social inequalities, health behaviour.

Strengths and limitations of this study

- We assessed the extent of socioeconomic inequalities in adolescent health and how it has changed over time in a middle-income country;
- We used a large representative urban samples from Brazilian adolescents attending public and private schools;
- Another strength of this study was the use of complex measures of inequality;
- Although we have used validated questionnaires, the self-report of behaviours may cause some degree of classification bias;
- The period of 6 years may be too short to expect significant changes in inequalities.

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INTRODUCTION

Adolescence is a critical period for promotion of human development. During adolescence, biological, cognitive, emotional, and social capabilities are founded and future patterns of adult health are established [1]. Despite its clear importance, adolescent's health has been generally overlooked in social policies. In order to guide surveillance, investments and policy actions, a broad concept of adolescent health has been proposed by The Lancet Commission on adolescent health. This concept includes aspects related to sexual and reproductive health, nutritional deficiencies, injury and violence, physical and mental health, and substance use disorders [2].

Socioeconomic factors strongly predict adolescent health [3]. Socioeconomic inequalities have consistently increased over the last decades in US and Europe [4], and this trend coincides with widening gaps in indicators of adolescent health [5]. For instance, a time-series analysis of 34 North American and European countries showed an increase in inequalities between socioeconomic groups in physical activity, body mass index, and psychological and physical symptoms between 2002 and 2010 [5].

Studies monitoring inequality in adolescent health in low- and middle-income countries are sparse in the literature. Brazil is still one of the most unequal countries worldwide [6], although considerable social protection efforts have been adopted in the last decades (*e.g.*, creation of a free public universal health system, expanding community-based primary care and providing a robust conditional cash transfer program) [7]. These social programs have had positive impacts on adult health, especially among the most deprived, with increased overall food quality and diversity [8], reduced racial inequalities in health [9] and cardiovascular disease mortality [10]. However, the extent of socioeconomic inequalities in adolescent health and how it has changes over time in Brazil is unclear.

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In this study, we assessed levels and trends in socioeconomic inequalities in adolescent health in Brazil between 2009 and 2015, addressing absolute and relative measures of inequality. We used data from three large representative health surveys of adolescents living in Brazilian state capitals. We selected 12 indicators under 3 broad domains (lifestyle risk behaviours, engagement in risky activities and exposure to violence) to provide a holistic view of adolescent health inequalities in Brazil.

METHODS

We used cross-sectional data from three Brazilian National Surveys of School Health (*Pesquisa Nacional da Saude do Escolar* - PeNSE) carried out in 2009, 2012 and 2015. In order to have comparable datasets across the three surveys, we used a representative subsample of adolescents attending 9th grade (i.e., mostly aged between 14-15 years) in public and private schools from the 26 state capitals and the Federal District. Detailed information about PeNSE has been published elsewhere [11-13]. Briefly, PeNSE sampling strategy included stratification per cluster and multi-stage selection. The sampling strata were each of the 26 state capitals and Federal District. The primary sampling units (PSUs) were schools, and the secondary sampling units (SSUs) were classrooms. School selection was proportional to the total number of 9th grade classes, while the classes in each school were chosen by simple random selection. Two classrooms were selected from schools with three or more 9th grade classrooms, whereas one classroom was selected from schools with one or two 9th grade classrooms. All students enrolled in the selected classrooms were invited to participate in the study. Participants were not included in the study if they did not attend school during data collection, refuse to participate, or did not report their age and sex. The total number of students included in our analysis was 60,973 (final response rate 83.8%) for 2009,

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61,145 (final response rate 82.2%) for 2012, and 51,192 (final response rate 85.2%) for 2015 surveys [11-13].

Students filled out a self-reported structured questionnaire available in a Personal Digital Assistant device (2009 survey) or smartphone application (2012 and 2015 survey) in their school classrooms during regular school hours. The questionnaire was based on the Global School-Based Student Health Survey [14] and the Youth Risk Behaviour Surveillance System[15], and was adapted to the Brazilian setting. Questions included socioeconomic variables and several risk and protective factors for adolescent health.

We estimated a wealth index specific for each survey year through Principal Component Analysis (PCA), following the steps proposed by Barros and Victora [16]. We ran PCA including the following variables: mother's educational level (incomplete middle school, complete middle school, complete high-school, complete higher education); school administrative status (public or private); self-report of having: landline, mobile phone, computer, internet access, car, bathroom inside the house and housemaid services. We retained the first component of the analysis and calculated coefficients from the expression: coefficient=loading/standard deviation x100. The individual scores were estimated from the $\sum c_i v_i$, where c_i is the coefficient and v_i is the value for the ith variable. The wealth index was assessed as quintiles of the total wealth scores. We refer to the first quintile (Q1) as the poorest quintile (poorest 20%) and the fifth quintile (Q5) as the wealthiest quintile (wealthiest 20%).

The indicators of adolescent health used in this study are defined in table 1. We divided indicators in three domains: lifestyle risk behaviours, engagement in risky activities and exposure to violence. Alcohol and tobacco use were included as risky activities and not lifestyle behaviours, because Brazilian law forbids the sale of these

substances for younger than 18 years old. We have used the concept of "irregular consumption" (<5 times in the past week) for all food indicators, following the complementary concept of "regular consumption", which was validated using 24 hours recall[17]. We also chose to include bean consumption because of their protective health effects and importance in Brazil as an affordable traditional staple food [18]. The frequency of 2 or more times in the previous month for bullying victimization followed the concept of this type of violence, which presume repetition[19]. The unsafe sex was assessed only for those who reported had sexual relationships.

Table 1: Indicators of adolescent health used in the present study

Domain	Health indicator	Original question
Lifestyle risk behaviours	Regular dietary consumption of fruits (≥5 days) in the last week	In the 7 days, on how many days did you eat fresh fruits or fruits salad? Options: I did not eat fresh fruits or fruits salad in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Regular dietary consumption of vegetables (≥5 days) in the last week	In the 7 days, on how many days did you eat at least one type of raw or cooked vegetable? Options: I did not eat vegetables in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Regular dietary consumption of beans (≥5 days) in the last week	In the 7 days, on how many days did you eat beans? Options: I did not eat beans in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Regular dietary consumption of soft drinks (≥5 days) in the last week	In the 7 days, on how many days did you drink soft drinks? Options: I did not drink soft drinks in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Recreational physical activity at least 5 times in the last week	In the last 7 days, excluding physical education classes, on how many days did you practice any physical activity such as sports, dance, gymnastics, etc? Options: No day in the last 7 days; other

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		options ranged from 1 day in the last 7 days to every day in the last 7 days.
Exposure to violence	Victim of domestic violence at least once in the previous month by some adult family member	In the last 30 days, how many times was you physically assaulted by some adult family member? Options: Not once in the last 30 days; 1 time in the last 30 days; other options ranged from 2 or 3 times in the last 30 days to 12 or more times in the last 30 days.
	Involvement in fights using guns at least one in the last month	In the last 30 days, did you get involved in any fight that someone used guns? Options: yes; no
	Bullying victimization at least sometimes in the last month	"In the past 30 days, how often have you been mocked, teased, called names or intimidated by one of your schoolmates so much that you were hurt/annoyed/upset/offended/ashamed? Options: No day in the last 30 days; rarely in the last 30 days; sometimes in the last 30 days; most of the time in the last 30 days; always in the last 30 days
Engagement in risky activities	Alcohol use at least once in the previous month	In the last 30 days, on how many days did you drink at least one cup or dose of alcoholic beverage? Options: No day in the last 30 days; Other options ranged from 1 or 2 days in the last 30 days to every day in the last 30 days.
	Drug use at least once in the previous month	In the last 30 days, how many times did you used drugs such as marijuana, cocain, crack, glue, ecstasy, oxy, etc? Options: I have never used drugs; no day in the last 30 days; Other options ranged from 1 or 2 days in the last 30 days to 10 or more days in the last 30 days.
	Smoking at least once in the previous month	In the last 30 days, on how many days did you smoke cigarettes? Options: I have never smoked; No day in the last 30 days; Other options ranged from 1 or 2 days in the last 30 days to every day in the last 30 days.
	Safe sexual behaviour (have used condom in the last sexual intercourse)	In the last time you had sex, did you and your partner use a condom? Options: I have never had sex; yes; no; I don't know.

To assess socioeconomic inequalities in adolescent health we used several measures of inequality. Firstly, we estimated simple measures of inequality (pairwise comparisons), such as differences and ratios of each health indicator between the wealthiest group (5th quintile) and the poorest group (1st quintile).

Secondly, we estimated complex measures of inequality, represented by an indicator of absolute inequality, the slope index of inequality (SII), and an indicator of relative inequality, the concentration index (CIX) [20]. Both SII and CIX take into account all quintiles of the wealth index to compare a given health indicator across all wealth subgroups.

We estimated the SII using logistic regression to avoid predicting implausible values below zero or above one, considering that all health indicators were presented as proportions [21]. The SII estimates the absolute difference (i.e., in percentage points) in the prevalence of health indicator between individuals in the wealthiest and poorest quintiles. Negative values of SII indicate that prevalence of the health indicator is higher among the poorest adolescents than the wealthiest (values ranged from -100 to +100).

The CIX was also expressed on a scale ranging from −100 to +100; a value of 0 represents perfect equality, whereas negative values indicate that poor individuals have higher prevalence of a given health indicator than wealthy individuals [22]. The CIX was calculated with no corrections [21].

Linear regressions using variance-weighted least squares were performed to assess changes over time in complex measures of inequality (SII and CIX) based on the means and standard deviation for each of the three surveys.

Multiple imputation was performed using the chained equation technique due to the significant proportion of missing values for the mother's education level in the three datasets (19,36%, n=33,559). We also imputed other study variables with a smaller

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proportion of missing values, to create a complete dataset. The imputed data exhibited

satisfactory statistical reproducibility according to Monte Carlo error analysis[23].

The sample design was taken into consideration for descriptive analyses, using

survey prefix command (svy) in Stata. School clustering (random effect) and sample

weights were considered when estimating complex measures of inequality (SII and

CIX). All the statistical analyses were performed using Stata 14.0.

Ethics approval

PeNSE surveys were approved by the National Commission of Research Ethics

(Comissão Nacional de Ética em Pesquisa – Conep), records no. 11.537 (2009), 16.805

(2012) and 1.006.467 (2015). The surveys were performed in accordance with the

Declaration of Helsinki and all participants gave their informed consent. Databases were

made publicly available on an IBGE website without any information that could

identify subjects.

Patient and public involvement

No patients or public were involved in the design and conceptualisation of this

study.

Data Sharing

The dataset of 2009, 2012 and 2015 PeNSE are publicly available at:

https://www.ibge.gov.br/estatisticas-novoportal/sociais/educacao/9134-pesquisa-

nacional-de-saude-do-escolar.html?=&t=microdados

RESULTS

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In 2015, the health-related behaviours more common among Brazilian adolescents were irregular consumption of fruits (67.2%) and vegetables (61.8%) and irregular recreational physical activity (75.6%). Less frequent were the unsafe sex in last sexual intercourse (33.9%), alcohol use (23.2%) and exposure to bullying (21.7%). Between 2009 and 2015, the prevalence of irregular vegetable consumption, irregular recreational physical activity, regular soft drink consumption, alcohol, tobacco and drug use decreased. On the other hand, trends for irregular bean consumption, unsafe sexual intercourse, and exposure to violence (domestic violence, fight using guns, and bullying victimization) increased (Table 2).

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Table 2 - Brazilian adolescent characteristics and health-related behaviours from PeNSE surveys 2009, 2012 and 2015.

adolescents characteristics and behaviours	PeNSE survey year					
	2009 (60,973 students)		2012 (61,145 students)		2015 (51,192 students)	
Characteristics	%	CI95%	%	CI95%	%	CI95%
Sex (female)	52.5	(51.9-53.2)	50.8	(50.1-51.6)	50.8	(49.9-51.7)
Age (**mean and standard error)**	14.2	(0.02)	14.3	(0.02)	14.2	(0.02)
Wealth index (**mean and standard error)**	3.8	(0.03)	4.0	(0.06)	4.0	(0.06)
Behaviours						
Irregular fruit consumption	68.5	(67.8-69.2)	70.2	(69.5-70.9)	67.2	(66.3-68.0)
Irregular vegetables consumption	68.8	(68.0-69.5)	64.1	(63.3-64.9)	61.7	(60.7-62.7)
Irregular beans consumption	37.4	(36.4-38.5)	40.0	(38.5-41.5)	43.7	(42.4-45.1)
Regular soft drinks consumption	37.2	(36.3-38.2)	35.4	(34.6-36.2)	28.8	(27.9-29.8)
Irregular recreational physical activity	83.0	(82.3-83.6)	74.2	(7.5-74.8)	75.6	(74.8-76.3)
Alcohol use (once in the last month)	27.1	(26.3-28.0)	26.8	(25.8-27.7)	23.2	(22.2-24.2)
Tobacco use (once in the last month)	6.2	(5.8-6.7)	6.1	(5.6-6.6)	5.3	(4.9-5.8)
Drug use (once in the last month)	3.3	(3.0-3.6)	3.8	(3.4-4.2)	2.5	(2.2-2.7)
Unsafe sex (in the last sexual intercourse)	21.5	(20.3-22.7)	22.5	(21.6-23.5)	33.9	(32.3-35.4)
Domestic violence (once in the last month)	9.5	(9.1-10.0)	11.6	(11.1-12.1)	16.2	(15.5-16.9)
Involvement in gun fights (once in the last month)	4.0	(3.7-4.3)	6.9	(6.6-7.3)	5.6	(5.2-6.1)
Bullying victimization (twice or more in the last month)	14.2	(13.6-14.7)	16.5	(15.9-17.1)	21.7	(21.1-22.4)

Figure 1 (A-C) shows the trends in health indicators by wealth quintile between 2009 and 2015. The width of the bars represents the absolute inequality. For most health indicators (except bean, soft drink and alcohol use), people in the poorest group reported more adverse levels compared to the wealthiest group. In general, over the period 2009-2015, health inequalities decreased for lifestyle behaviours (fruit, vegetable, bean and soft drink consumption, and recreational physical activity), while increased for risky activities and violence (smoking, drug use, unsafe sex, domestic violence, fights using guns and bullying victimization) (Appendix 1).

INSERT FIGURE 1 HERE

Some of these trends were not statistically significant according to complex measures of inequality (table 3).

Table 3 - Complex measures of inequality in health-related behaviours among Brazilian adolescents. PeNSE surveys 2009, 2012 and 2015.

Quintiles of Wealth index (1=poorest; 5=wealthiest)	Slope Index of inequality (SII)				Concentration index of inequality (CIX)			
Indicators	2009	2012	2015	*p*-value*	2009	2012	2015	*p*-value*
Irregular fruit consumption	-13.68	-9.01	-8.88	0.015	-2.82	-2.31	-2.26	0.267
Irregular vegetables consumption	-19.02	-17.59	-17.92	0.535	-4.30	-4.48	-5.18	0.165
Irregular beans consumption	9.95	11.25	7.33	0.434	6.48	3.47	2.22	<0.001
Regular soft drinks consumption	16.55	10.49	3.89	<0.001	6.94	5.19	2.90	<0.001
Irregular recreational physical activity	-8.66	-9.47	-7.90	0.745	-1.70	-1.91	-1.71	0.837
Alcohol use (once in the last month)	9.69	0.68	0.06	0.000	4.79	1.71	1.19	0.004
Tobacco use (once in the last month)	-1.68	-2.80	-3.15	0.125	-5.68	-6.32	-8.69	0.290
Drug use (once in the last month)	0.34	0.46	-0.98	0.048	-0.08	4.47	-4.61	0.428
Unsafe sex (in the last sexual intercourse)	-9.67	-6.88	-13.28	0.498	-6.52	-5.44	-6.56	0.914
Domestic violence (once in the last month)	-1.84	-5.24	-6.92	<0.001	-2.72	-7.02	-6.57	0.014
Involvement in gun fights (once in the last month)	-0.76	-1.90	-3.30	0.002	-2.82	-4.42	-8.79	0.029
Bullying victimization (twice or more in the last month)	0.83	-0.20	-6.60	<0.001	0.56	0.59	-4.41	<0.001

In all years, alcohol consumption was the health indicator more equally distributed between wealth quintiles both according to absolute and relative measures. On the other hand, irregular vegetables consumption and unsafe sex had the highest absolute inequality and fights using guns and tobacco use the highest relative inequality. Over time, the absolute (SII) and relative inequalities (CIX) between wealth index quintiles became wider for all three indicators of exposure to violence, and narrower for some indicators of lifestyle behaviour (fruit, beans and soft drinks) and alcohol consumption. There was limited evidence of change in inequalities over time for the other lifestyle behaviours, such as irregular vegetables consumption and recreational physical activity, and indicators of engagement in risky activities, such as tobacco, drug use and unsafe sex (table 3, figure 2).

INSERT FIGURE 2 HERE

DISCUSSION

We showed evidence of persistent socioeconomic inequalities in adolescent health in Brazil. Between 2009 and 2015, lifestyle behaviours (fruit and soft drinks consumption) and alcohol use became more equally distributed between socioeconomic groups, while inequalities in experiencing violence were exacerbated. In this period, there was little evidence of change to inequalities in risky activities (smoking, drugs, unsafe sex).

In general, the direction of health inequalities we observed are similar to that reported in other settings, that is, poorer adolescents are more likely to report harmful health behaviours than richer [5]. For certain harmful behaviours (e.g. alcohol and drug use), however, differences between social groups were not significant or went in the

opposite direction (i.e. wealthier adolescents reported higher prevalences). These findings are consistent with results observed in other countries [24].

Looking at time-trends in these inequalities, our findings differ to existing evidence from Western Europe and North America. For some lifestyle (e.g. vegetable consumption, physical activity) and risky behaviours (drug and tobacco use), inequalities have not changed significantly between 2009 and 2015 in Brazil. Yet inequality in lifestyle and risky behaviors have increased over similar period in many other countries [5, 25]. Similarly to ours, one study found persistent inequality in vegetable consumption [26]. Despite this, comparable data for many indicators of risk behaviours are lacking. Rates of violence as well as inequalities in violence increased markedly (gun fights, domestic violence, bullying), and these trends also differ from other countries [27].

Reasons for differential socioeconomic inequality trends between lifestyle behaviours, risk behaviours and violence-related indicators in Brazilian adolescents are unclear. Reductions in lifestyle behaviour inequalities fits with the general trend of narrowing economic and health inequalities observed for adults in Brazil in that period[28, 29]. This is often attributed to rising prosperity combined with roll-out of redistributive health and social programs such as the Bolsa Familia cash transfer program [30], as well as scaled-up health promotion efforts (especially obesity prevention) [31]. Exacerbation of violence-related inequalities have also been observed in one study of adult mortality in Salvador [32]. It has been suggested that public health interventions have focussed on reducing infectious and chronic diseases but neglect, on the other hand, external causes of ill-health such as interpersonal violence. In fact, violence-related mortality has declined slower than all other causes in Brazil, and even increased in 19 of the 27 states [33].

It is worth noting that we found a shift in prevalence of alcohol use and soft drinks consumption between socioeconomic in the period studied. In 2009, these indicators were higher among the wealthiest group, but in 2015 the differences were considerably attenuated. The reduction in the consumption of these products was more pronounced among the wealthiest group than in the poorest group. Conversely, for bean consumption, poorer adolescents reported higher prevalence than wealthiest adolescences. In this regard, the reduction in disparities between wealth groups should be read with caution. In high-income countries, poorer individuals consume more alcohol, relative to wealthier individuals, while in low-middle income countries wealthier individuals are more exposed than the poorer [34]. This trend could be shifting. In fact, industries of unhealthy commodities have moved to, and are growing faster in, low- and middle-income countries comparing to high-income countries [35]. This phenomenon might explain, at least in part, the increase in consumption of ultra-processed products (e.g. sugary drinks) and alcohol, and the reduction of bean consumption in these settings [36]. Brazil seems to be moving towards patterns of health indicators and their inequalities currently observed in high-income countries. In these countries, the reduction in alcohol use and soft drinks consumption among those privileged is not necessarily followed by a reduction among those more socially deprived [5]. Although this trend is measured as a reduction in inequality, it is not desirable.

The main strength of this study is to explore a wide spectrum of health indicators, which provides information on prevalence and trends in key risk factors for adolescent health. Another positive aspect is the large representative urban samples from Brazilian adolescents attending public and private schools. In Brazil, the school coverage in this age is very high (88-97%) [37], which reduces significantly the risk of

selection bias. Despite this, is plausible to assume that students at higher risk of harmful health behaviors have higher truancy and dropout rates. Therefore, this could have masked the true extent of the inequalities. We also report a range of simple and complex measures of inequalities to allow clear interpretation of trends as well as presenting rigorous hypothesis tests which make use of all data. Concordance between the absolute and relative measures of inequality adds strength to our conclusions.

Some limitations should be acknowledged. The engagement in health-related behaviours was self-reported by adolescents, and therefore, misclassification may have occurred towards social desirable behaviors. Misclassification likely affected the prevalence of health indicators similarly over three surveys. Although, use of self-reported outcomes is a limitation, it is widely recognised as an acceptable and often the only feasible approach for monitoring adolescent health behaviours [38]. Moreover, there is evidence of validity of the dietary indicators used in the PeNSE survey [17], and a US survey on which the PeNSE survey was based demonstrated good test-retest reliability and consistency across different modes of questioning [39].

The surveys were available only for a period of 6 years, which may be too short to expect significant changes in inequalities. To continue monitoring trends in adolescent health inequality for longer periods is desirable. Also, the data analysed are representative of Brazilian state capitals, not the whole country. State Capitals are highly urbanized cities and more developed than other cities, therefore, these results may not be generalizable to small cities and rural areas. However state capitals are the most populous and unequal areas of Brazil [40], making them important settings for studying inequality trends, and meaning they can act as sentinels to the country as a whole.

Brazil is facing a huge economic recession since 2015, which deepened in 2016. Unemployment and inflation have increased and people's purchasing power has been reduced, with the poor especially affected. Therefore it will be vital to continue monitoring the trends observed in this study and take action to prevent exacerbation of existing inequalities.

Policy makers and researchers should be alert to the fact that possible reductions in health risky behaviours may be unbalanced between social groups and even be increasing in disadvantaged social groups while decreasing on average [22]. In this study, we found that the gap between poor adolescents and wealthy adolescents is reducing for lifestyle behaviours such as fruit consumption; while it is increasing for violent behaviours. For alcohol, irregular bean consumption and regular soft drink consumption we found that the gap between social groups is narrowing, although represented by a reduction in these risk behaviours among rich and an increase among poor adolescents.

Conflict of interest: None.

Data Sharing Statement: The dataset of 2009, 2012 and 2015 PeNSE are publicly available at: https://www.ibge.gov.br/estatisticas-novoportal/sociais/educacao/9134-pesquisa-nacional-de-saude-do-escolar.html?=&t=microdados

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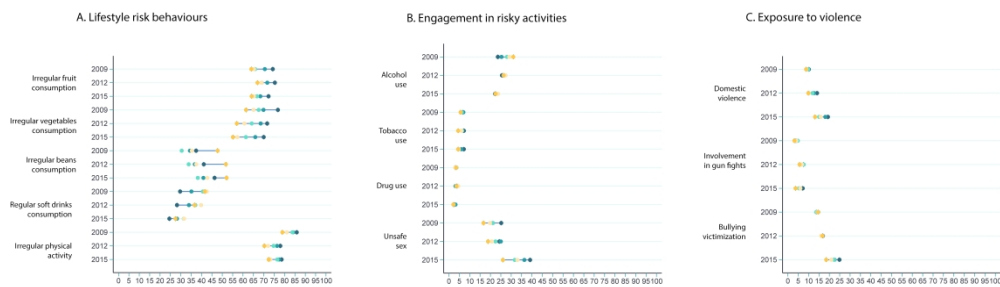40   IBGE. Síntese de Indicadores Sociais, uma análise das condições de vida. Rio de Janeiro: IBGE, Coordenação de População e Indicadores Sociais 2017:147.

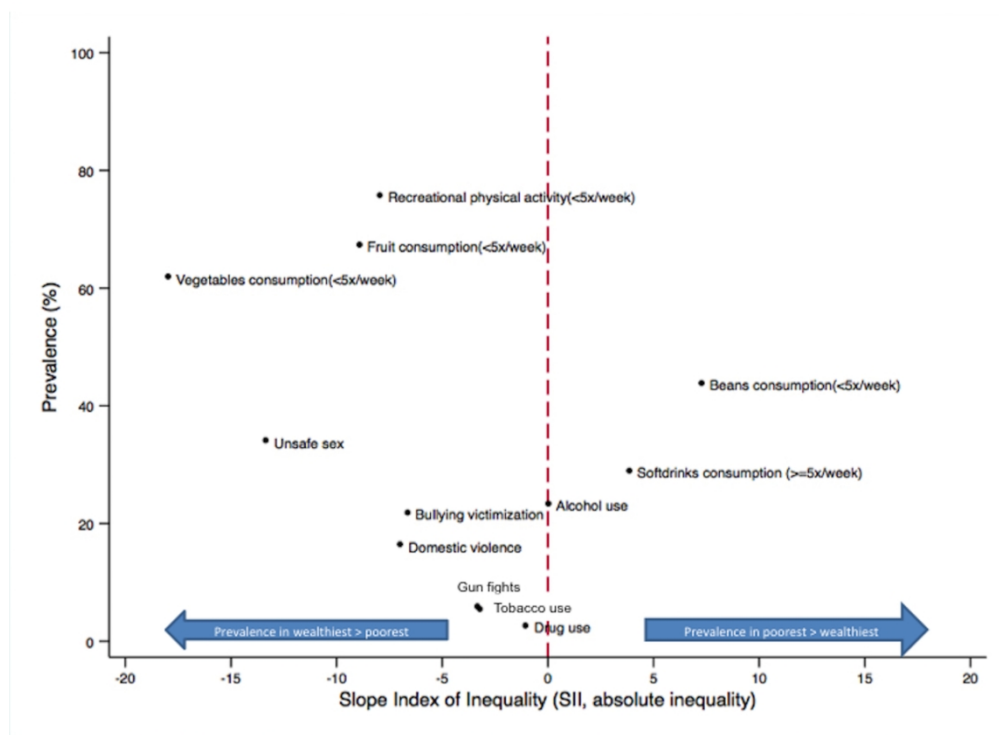Figure 1 - Time trends in health-related behaviours by wealthy quintile among adolescent

Figure 2- Prevalence of health-related behaviours among adolescent in 2015 and Slope Index of Inequality (SII, absolute inequality).

Figure 1 - Time trends in health-related behaviours by wealthy quintile among adolescent.

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Figure 2- Prevalence of health-related behaviours among adolescent in 2015 and Slope Index of Inequality (SII, absolute inequality).

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Appendix 1

Simple measures of inequality in health-related behaviours among Brazilian adolescents from PeNSE surveys 2009, 2012 and 2015.

Indicator	PeNSE survey year	National	Q1 (poorest) %	Q5 (richest) %	Difference (quintile 5 - quintile 1) %	Difference (quintile 5 - quintile 1) 95% CI	Ratio (quintile 5/ quintile 1) %	Ratio (quintile 5/ quintile 1) 95% CI	Population Attributable risk (PAR)	Population Attributable risk percentage (PAR%)
	2009	68.49	74.34	64.00	10.34	8.06; 12.62	1.16	1.12; 1.20	-4.49	-6.56
Irregular fruit consumption	2012	70.24	75.35	66.96	8.39	6.03; 10.74	1.13	1.08; 1.16	-3.28	-4.67
	2015	67.17	72.29	64.15	8.14	5.28; 11.00	1.13	1.08; 1.18	-3.02	-4.50
	2009	68.77	76.81	61.47	15.34	13.28; 17.41	1.25	1.21; 1.29	-7.30	-10.62
Irregular vegetables consumption	2012	64.12	71.64	56.99	14.65	12.46; 16.83	1.26	1.21;1.30	-7.13	-11.12
	2015	61.73	69.97	55.14	14.83	11.66;18.01	1.27	1.20; 1.34	-6.59	-10.68
	2009	37.45	37.38	47.74	-10.36	-12.96; -7.77	0.78	0.74; 0.83	10.29	27.48
Irregular beans consumption	2012	40.00	41.09	51.74	-10.65	-13.88; -7.42	0.79	0.74; 0.85	11.74	29.35
	2015	43.74	46.27	52.07	-5.80	-9.17; -2.43	0.89	0.83; 0.95	8.33	19.04
	2009	37.21	29.67	41.59	-11.92	-14.32; -9.50	0.71	0.67; 0.76	4.38	11.77
Regular softdrinks consumption	2012	35.44	28.17	36.62	-8.45	-10.69; -6.20	0.77	0.72; 0.83	1.18	3.33
	2015	28.84	24.51	27.42	-2.91	-5.45; -0.33	0.89	0.81; 0.98	-1.42	-4.92
	2009	82.96	85.88	78.96	6.92	5.30; 8.55	1.09	1.07; 1.11	-4.00	-4.66
Irregular recreational physical activity	2012	74.15	77.97	70.27	7.70	5.82; 9.58	1.11	1.08; 1.14	-3.88	-4.98
	2015	75.58	78.58	72.36	6.22	3.93; 8.51	1.09	1.05; 1.12	-3.22	-4.10
	2009	27.13	23.57	31.02	-7.45	-9.22; -5.67	0.76	0.71; 0.81	3.89	14.33
Alcohol use (once in the last month)	2012	26.78	25.55	26.33	-0.78	-2.94; 1.37	0.97	0.89; 1.05	-0.45	-1.67
	2015	23.2	22.24	22.50	-0.26	-2.99; 2.47	0.99	0.87; 1.12	-0.70	-3.03
	2009	6.25	6.70	5.63	1.07	0.09; 2.06	1.19	1.01; 1.40	-0.62	-9.92
Tobacco use (once in the last month)	2012	6.08	7.20	4.44	2.76	1.70; 3.82	1.62	1.35; 1.95	-1.64	-26.99
	2015	5.34	7.18	4.41	2.77	1.48; 4.06	1.63	1.28; 2.08	-0.93	-17.35

	Year								
Drug use (once in the last month)	2009	3.32	3.01	3.52	-0.51	-1.29; 0.27	0.85	0.67; 1.08	0.20	6.02
	2012	3.81	3.94	3.63	0.31	-0.70; 1.32	1.09	0.83; 1.42	-0.18	-4.72
	2015	2.45	2.55	2.20	0.35	-0.52; 1.22	1.16	0.80; 1.69	-0.25	-10.20
Unsafe sex (in the last sexual intercourse)	2009	21.46	25.19	16.65	8.54	5.27; 11.82	1.51	1.27; 1.80	-4.81	-22.41
	2012	22.5	24.29	18.83	5.46	2.10; 8.81	1.29	1.10; 1.51	-3.67	-16.31
	2015	33.86	39.11	26.00	13.11	8.21; 18.01	1.50	1.28; 1.77	-7.86	-23.21
Domestic violence (once in the last month)	2009	9.54	10.13	8.79	1.34	0.06; 2.62	1.15	1.00; 1.33	-0.75	-7.86
	2012	11.6	14.08	9.87	4.21	2.82; 5.61	1.43	1.27; 1.61	-1.73	-14.91
	2015	16.17	19.33	13.11	6.22	4.48; 7.96	1.47	1.32; 1.65	-3.06	-18.92
Involvement in gun fights (in the last month)	2009	4.01	3.93	3.15	0.78	0.02; 1.53	1.25	1.00; 1.55	-0.86	-21.45
	2012	6.94	7.50	5.65	1.85	0.82; 2.88	1.33	1.13; 1.55	-1.29	-18.59
	2015	5.61	7.19	3.70	3.49	2.41; 4.58	1.94	1.56; 2.42	-1.91	-34.05
Bullying victimization (twice or more in the last month)	2009	14.16	13.71	14.54	-0.83	-2.16; 0.50	0.94	0.86; 1.04	0.38	2.68
	2012	16.5	16.90	16.73	0.17	-1.68; 2.04	1.01	0.90; 1.13	0.23	1.39
	2015	21.74	24.88	18.51	6.37	4.28; 8.45	1.34	1.22; 1.48	-3.23	-14.86

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract 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 Page3
Objectives	3	State specific objectives, including any prespecified hypotheses Page 4
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 and 5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up NA *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls NA *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants –Page4 and first para page 5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed NA *Case-control study*—For matched studies, give matching criteria and the number of controls per case NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Page 5 and 6
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 Table 1 – page 6
Bias	9	Describe any efforts to address potential sources of bias Last para Page 4 and first para page 5 (response rate – selection bias); page 5 (validation of measures – information bias)
Study size	10	Explain how the study size was arrived at . Page 4 and Reference: Oliveira et al. 2017
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Pages 8 and 9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Pages 8 and 9
		(*b*) Describe any methods used to examine subgroups and interactions NA

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(*c*) Explain how missing data were addressed Page 9

(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed NA

Case-control study—If applicable, explain how matching of cases and controls was addressed NA

Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy Page 9 last para

(*e*) Describe any sensitivity analyses NA

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 Table 2
		(b) Give reasons for non-participation at each stage Response rate 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 2
		(b) Indicate number of participants with missing data for each variable of interest Page 9 (we used multiple imputation)
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure NA
		Cross-sectional study—Report numbers of outcome events or summary measures Table 2
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 Table 3, figures 1 and 2.
		(*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 NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses NA

Discussion

Key results	18	Summarise key results with reference to study objectives Page 15
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 18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Pages 15-18
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 17 last para

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 19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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.

BMJ Open

Progress and setbacks in socioeconomic inequalities in adolescent health-related behaviours in Brazil: results from three cross-sectional surveys 2009-2015.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-025338.R2
Article Type:	Research
Date Submitted by the Author:	05-Jan-2019
Complete List of Authors:	Azeredo, Catarina; Universidade Federal de Uberlandia, Faculdade de Medicina Rezende, Leandro; Departamento de Medicina Preventiva, Faculdade de Medicina FMUSP, Universidade de Sao Paulo, SP, BR, Mallinson, Poppy; London School of Hygiene and Tropical Medicine Faculty of Epidemiology and Population Health, Department of Non-Communicable Disease Epidemiology Ricardo, Camila; Universidade de Sao Paulo Faculdade de Medicina, Departamento de Medicina Preventiva Kinra, Sanjay; LSHTM, Levy, Renata; University of Sao Paulo, Medicine Barros, A; Federal University of Pelotas (UFPel), Postgraduate Programme in Epidemiology
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Global health, Paediatrics
Keywords:	Adolescent, Health Behavior, Health Inequality, EPIDEMIOLOGY

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Progress and setbacks in socioeconomic inequalities in adolescent health-related behaviours in Brazil: results from three cross-sectional surveys 2009-2015

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Words count: 2849

Authorship statement: CMA, LFMR, RBL and AJDB conceptualized the study and were involved in the analysis and interpretation of the results. CZR was involved in data preparation, designed and prepared the tables. SK and PACM were involved in the interpretation and discussion of results. The initial draft of the paper was prepared by CMA following extensive discussions and inputs from the other co-authors. All authors have reviewed, revised the manuscript and approved the final version.

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ABSTRACT

Objectives
Despite some progress, Brazil is still one of the most unequal countries, and the extent of socioeconomic inequalities in adolescent health is unclear. We assessed trends in socioeconomic inequalities in adolescent's health-related behaviours in Brazil between 2009-2015.

Design: We used cross-sectional data from the Brazilian National Survey of School Health carried out in 2009, 2012 and 2015.
Setting: Brazilian state capitals.
Participants: Students attending 9th grade from public and private schools in Brazilian state capitals in 2009 (60,973 students), 2012 (74,432 students) and 2015 (60,078 students)
Main Outcome measure:
We assessed 12 health-related behaviours (irregular fruit, vegetables and bean consumption; regular soft drinks consumption; irregular physical activity; alcohol, drug and tobacco use; unsafe sex; involvement in gun fights; bullying victimization and domestic violence victimization), under the broad domains of lifestyle risk behaviours, engagement in risky activities and exposure to violence. Socioeconomic status was assessed through an asset-based wealth index derived from principal components analysis. Absolute and relative inequalities in these health behaviours and inequalities trends were investigated.
Results
From 2009 to 2015, prevalence of certain harmful health-related behaviours increased, such as unsafe sex (21.5% to 33.9%), domestic violence (9.5% to 16.2%), bullying victimization (14.2% to 21.7%) and in irregular consumption of beans (37.5% to 43.7%). Other indicators decreased: alcohol use (27.1% to 23.2%), irregular physical activity (83.0% to 75.6%) and consumption of soft drinks (37.2% to 28.8%). Over the period, we found consistent evidence of decreasing health inequalities for lifestyle behaviours (fruit, bean and soft drink consumption) and alcohol use, set against increasing inequalities in violence (domestic violence, fights using guns and bullying victimization).
Conclusion
Socioeconomic inequality increased in the violence domain and decreased for lifestyle behaviours among Brazilian adolescents. Widening gaps in violence domain urge immediately policy measures in Brazil.
Key-words: Adolescent, Social inequalities, health behaviour.

Strengths and limitations of this study

- We assessed the extent of socioeconomic inequalities in adolescent health and how it has changed over time in a middle-income country;
- We used a large representative urban samples from Brazilian adolescents attending public and private schools;
- Another strength of this study was the use of complex measures of inequality;
- Although we have used validated questionnaires, the self-report of behaviours may cause some degree of classification bias;
- The period of 6 years may be too short to expect significant changes in inequalities.

INTRODUCTION

Adolescence is a critical period for promotion of human development. During adolescence, biological, cognitive, emotional, and social capabilities are founded and future patterns of adult health are established [1]. Despite its clear importance, adolescent's health has been generally overlooked in social policies. In order to guide surveillance, investments and policy actions, a broad concept of adolescent health has been proposed by The Lancet Commission on adolescent health. This concept includes aspects related to sexual and reproductive health, nutritional deficiencies, injury and violence, physical and mental health, and substance use disorders [2].

Socioeconomic factors strongly predict adolescent health [3]. Socioeconomic inequalities have consistently increased over the last decades in US and Europe [4], and this trend coincides with widening gaps in indicators of adolescent health [5]. For instance, a time-series analysis of 34 North American and European countries showed an increase in inequalities between socioeconomic groups in physical activity, body mass index, and psychological and physical symptoms between 2002 and 2010 [5].

Studies monitoring inequality in adolescent health in low- and middle-income countries are sparse in the literature. Brazil is still one of the most unequal countries worldwide [6], although considerable social protection efforts have been adopted in the last decades (*e.g.*, creation of a free public universal health system, expanding community-based primary care and providing a robust conditional cash transfer program) [7]. These social programs have had positive impacts on adult health, especially among the most deprived, with increased overall food quality and diversity [8], reduced racial inequalities in health [9] and cardiovascular disease mortality [10]. However, the extent of socioeconomic inequalities in adolescent health and how it has changes over time in Brazil is unclear.

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In this study, we assessed levels and trends in socioeconomic inequalities in adolescent health in Brazil between 2009 and 2015, addressing absolute and relative measures of inequality. We used data from three large representative health surveys of adolescents living in Brazilian state capitals. We selected 12 indicators under 3 broad domains (lifestyle risk behaviours, engagement in risky activities and exposure to violence) to provide a holistic view of adolescent health inequalities in Brazil.

METHODS

We used cross-sectional data from three Brazilian National Surveys of School Health (*Pesquisa Nacional da Saude do Escolar* - PeNSE) carried out in 2009, 2012 and 2015. In order to have comparable datasets across the three surveys, we used a representative subsample of adolescents attending 9th grade (i.e., mostly aged between 14-15 years) in public and private schools from the 26 state capitals and the Federal District. Detailed information about PeNSE has been published elsewhere [11-13]. Briefly, PeNSE sampling strategy included stratification per cluster and multi-stage selection. The sampling strata were each of the 26 state capitals and Federal District. The primary sampling units (PSUs) were schools, and the secondary sampling units (SSUs) were classrooms. School selection was proportional to the total number of 9th grade classes, while the classes in each school were chosen by simple random selection. Two classrooms were selected from schools with three or more 9th grade classrooms, whereas one classroom was selected from schools with one or two 9th grade classrooms. All students enrolled in the selected classrooms were invited to participate in the study. Participants were not included in the study if they did not attend school during data collection, refuse to participate, or did not report their age and sex. The total number of students included

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in our analysis was 60,973 (final response rate 83.8%) for 2009, 61,145 (final response rate 82.2%) for 2012, and 51,192 (final response rate 85.2%) for 2015 surveys [11-13].

Students filled out a self-reported structured questionnaire available in a Personal Digital Assistant device (2009 survey) or smartphone application (2012 and 2015 survey) in their school classrooms during regular school hours. The questionnaire was based on the Global School-Based Student Health Survey [14] and the Youth Risk Behaviour Surveillance System[15], and was adapted to the Brazilian setting. Questions included socioeconomic variables and several risk and protective factors for adolescent health.

We estimated a wealth index specific for each survey year through Principal Component Analysis (PCA), following the steps proposed by Barros and Victora [16]. We ran PCA including the following variables: mother's educational level (incomplete middle school, complete middle school, complete high-school, complete higher education); school administrative status (public or private); self-report of having: landline, mobile phone, computer, internet access, car, bathroom inside the house and housemaid services. We retained the first component of the analysis and calculated coefficients from the expression: coefficient=loading/standard deviation x100. The individual scores were estimated from the $\sum c_i v_i$, where c_i is the coefficient and v_i is the value for the ith variable. The wealth index was assessed as quintiles of the total wealth scores. We refer to the first quintile (Q1) as the poorest quintile (poorest 20%) and the fifth quintile (Q5) as the wealthiest quintile (wealthiest 20%).

The indicators of adolescent health used in this study are defined in table 1. We divided indicators in three domains: lifestyle risk behaviours, engagement in risky activities and exposure to violence. Alcohol and tobacco use were included as risky activities and not lifestyle behaviours, because Brazilian law forbids the sale of these substances for younger than 18 years old. We have used the concept of "irregular

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consumption" (<5 times in the past week) for all food indicators, following the complementary concept of "regular consumption", which was validated using 24 hours recall[17]. We also chose to include bean consumption because of their protective health effects and importance in Brazil as an affordable traditional staple food [18]. The frequency of 2 or more times in the previous month for bullying victimization followed the concept of this type of violence, which presume repetition[19]. The unsafe sex was assessed only for those who reported had sexual relationships.

Table 1: Indicators of adolescent health used in the present study

Domain	Health indicator	Original question
Lifestyle risk behaviours	Regular dietary consumption of fruits (≥5 days) in the last week	In the 7 days, on how many days did you eat fresh fruits or fruits salad? Options: I did not eat fresh fruits or fruits salad in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Regular dietary consumption of vegetables (≥5 days) in the last week	In the 7 days, on how many days did you eat at least one type of raw or cooked vegetable? Options: I did not eat vegetables in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Regular dietary consumption of beans (≥5 days) in the last week	In the 7 days, on how many days did you eat beans? Options: I did not eat beans in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Regular dietary consumption of soft drinks (≥5 days) in the last week	In the 7 days, on how many days did you drink soft drinks? Options: I did not drink soft drinks in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.
	Recreational physical activity at least 5 times in the last week	In the last 7 days, excluding physical education classes, on how many days did you practice any physical activity such as sports, dance, gymnastics, etc? Options: No day in the last 7 days; other options ranged from 1 day in the last 7 days to every day in the last 7 days.

Exposure to violence	Victim of domestic violence at least once in the previous month by some adult family member	In the last 30 days, how many times was you physically assaulted by some adult family member? Options: Not once in the last 30 days; 1 time in the last 30 days; other options ranged from 2 or 3 times in the last 30 days to 12 or more times in the last 30 days.
	Involvement in fights using guns at least one in the last month	In the last 30 days, did you get involved in any fight that someone used guns? Options: yes; no
	Bullying victimization at least sometimes in the last month	"In the past 30 days, how often have you been mocked, teased, called names or intimidated by one of your schoolmates so much that you were hurt/annoyed/upset/offended/ashamed? Options: No day in the last 30 days; rarely in the last 30 days; sometimes in the last 30 days; most of the time in the last 30 days; always in the last 30 days
Engagement in risky activities	Alcohol use at least once in the previous month	In the last 30 days, on how many days did you drink at least one cup or dose of alcoholic beverage? Options: No day in the last 30 days; Other options ranged from 1 or 2 days in the last 30 days to every day in the last 30 days.
	Drug use at least once in the previous month	In the last 30 days, how many times did you used drugs such as marijuana, cocain, crack, glue, ecstasy, oxy, etc? Options: I have never used drugs; no day in the last 30 days; Other options ranged from 1 or 2 days in the last 30 days to 10 or more days in the last 30 days.
	Smoking at least once in the previous month	In the last 30 days, on how many days did you smoke cigarettes? Options: I have never smoked; No day in the last 30 days; Other options ranged from 1 or 2 days in the last 30 days to every day in the last 30 days.
	Safe sexual behaviour (have used condom in the last sexual intercourse)	In the last time you had sex, did you and your partner use a condom? Options: I have never had sex; yes; no; I don't know.

To assess socioeconomic inequalities in adolescent health we used several

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measures of inequality. Firstly, we estimated simple measures of inequality (pairwise comparisons), such as differences and ratios of each health indicator between the wealthiest group (5th quintile) and the poorest group (1st quintile).

Secondly, we estimated complex measures of inequality, represented by an indicator of absolute inequality, the slope index of inequality (SII), and an indicator of relative inequality, the concentration index (CIX) [20]. Both SII and CIX take into account all quintiles of the wealth index to compare a given health indicator across all wealth subgroups.

We estimated the SII using logistic regression to avoid predicting implausible values below zero or above one, considering that all health indicators were presented as proportions [21]. The SII estimates the absolute difference (i.e., in percentage points) in the prevalence of health indicator between individuals in the wealthiest and poorest quintiles. Negative values of SII indicate that prevalence of the health indicator is higher among the poorest adolescents than the wealthiest (values ranged from -100 to +100).

The CIX was also expressed on a scale ranging from −100 to +100; a value of 0 represents perfect equality, whereas negative values indicate that poor individuals have higher prevalence of a given health indicator than wealthy individuals [22]. The CIX was calculated with no corrections [21].

Linear regressions using variance-weighted least squares were performed to assess changes over time in complex measures of inequality (SII and CIX) based on the means and standard deviation for each of the three surveys.

Multiple imputation was performed using the chained equation technique due to the significant proportion of missing values for the mother's education level in the three datasets (19,36%, n=33,559). We also imputed other study variables with a smaller proportion of missing values, to create a complete dataset. The imputed data exhibited

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satisfactory statistical reproducibility according to Monte Carlo error analysis[23].

The sample design was taken into consideration for descriptive analyses, using survey prefix command (svy) in Stata. School clustering (random effect) and sample weights were considered when estimating complex measures of inequality (SII and CIX). All the statistical analyses were performed using Stata 14.0.

Ethics approval

PeNSE surveys were approved by the National Commission of Research Ethics (Comissão Nacional de Ética em Pesquisa – Conep), records no. 11.537 (2009), 16.805 (2012) and 1.006.467 (2015). The surveys were performed in accordance with the Declaration of Helsinki and all participants gave their informed consent. Databases were made publicly available on an IBGE website without any information that could identify subjects.

Patient and public involvement

No patients or public were involved in the design and conceptualisation of this study.

Data Sharing

The dataset of 2009, 2012 and 2015 PeNSE are publicly available at:

https://www.ibge.gov.br/estatisticas-novoportal/sociais/educacao/9134-pesquisa-

nacional-de-saude-do-escolar.html?=&t=microdados

RESULTS

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In 2015, the health-related behaviours more common among Brazilian adolescents were irregular consumption of fruits (67.2%) and vegetables (61.8%) and irregular recreational physical activity (75.6%). Less frequent were the unsafe sex in last sexual intercourse (33.9%), alcohol use (23.2%) and exposure to bullying (21.7%). Between 2009 and 2015, the prevalence of irregular vegetable consumption, irregular recreational physical activity, regular soft drink consumption, alcohol, tobacco and drug use decreased. On the other hand, trends for irregular bean consumption, unsafe sexual intercourse, and exposure to violence (domestic violence, fight using guns, and bullying victimization) increased (Table 2).

Table 2 - Brazilian adolescent characteristics and health-related behaviours from PeNSE surveys 2009, 2012 and 2015.

adolescents characteristics and behaviours	PeNSE survey year					
	2009 (60,973 students)		2012 (61,145 students)		2015 (51,192 students)	
Characteristics	%	CI95%	%	CI95%	%	CI95%
Sex (female)	52.5	(51.9-53.2)	50.8	(50.1-51.6)	50.8	(49.9-51.7)
Age (**mean and standard error**)	14.2	(0.02)	14.3	(0.02)	14.2	(0.02)
Wealth index (**mean and standard error**)	3.8	(0.03)	4.0	(0.06)	4.0	(0.06)
Behaviours						
Irregular fruit consumption	68.5	(67.8-69.2)	70.2	(69.5-70.9)	67.2	(66.3-68.0)
Irregular vegetables consumption	68.8	(68.0-69.5)	64.1	(63.3-64.9)	61.7	(60.7-62.7)
Irregular beans consumption	37.4	(36.4-38.5)	40.0	(38.5-41.5)	43.7	(42.4-45.1)
Regular soft drinks consumption	37.2	(36.3-38.2)	35.4	(34.6-36.2)	28.8	(27.9-29.8)
Irregular recreational physical activity	83.0	(82.3-83.6)	74.2	(7.5-74.8)	75.6	(74.8-76.3)
Alcohol use (once in the last month)	27.1	(26.3-28.0)	26.8	(25.8-27.7)	23.2	(22.2-24.2)
Tobacco use (once in the last month)	6.2	(5.8-6.7)	6.1	(5.6-6.6)	5.3	(4.9-5.8)
Drug use (once in the last month)	3.3	(3.0-3.6)	3.8	(3.4-4.2)	2.5	(2.2-2.7)
Unsafe sex (in the last sexual intercourse)	21.5	(20.3-22.7)	22.5	(21.6-23.5)	33.9	(32.3-35.4)
Domestic violence (once in the last month)	9.5	(9.1-10.0)	11.6	(11.1-12.1)	16.2	(15.5-16.9)
Involvement in gun fights (once in the last month)	4.0	(3.7-4.3)	6.9	(6.6-7.3)	5.6	(5.2-6.1)
Bullying victimization (twice or more in the last month)	14.2	(13.6-14.7)	16.5	(15.9-17.1)	21.7	(21.1-22.4)

Figure 1 (A-C) shows the trends in health indicators by wealth quintile between 2009 and 2015. The width of the bars represents the absolute inequality. For most health indicators (except bean, soft drink and alcohol use), people in the poorest group reported more adverse levels compared to the wealthiest group. In general, over the period 2009-2015, health inequalities decreased for lifestyle behaviours (fruit, vegetable, bean and soft drink consumption, and recreational physical activity), while increased for risky activities and violence (smoking, drug use, unsafe sex, domestic violence, fights using guns and bullying victimization) (Appendix 1).

INSERT FIGURE 1 HERE

Some of these trends were not statistically significant according to complex measures of inequality (table 3).

Table 3 - Complex measures of inequality in health-related behaviours among Brazilian adolescents. PeNSE surveys 2009, 2012 and 2015.

Quintiles of Wealth index (1=poorest; 5=wealthiest)	Slope Index of inequality (SII)				Concentration index of inequality (CIX)			
Indicators	2009	2012	2015	*p*-value*	2009	2012	2015	*p*-value*
Irregular fruit consumption	-13.68	-9.01	-8.88	0.015	-2.82	-2.31	-2.26	0.267
Irregular vegetables consumption	-19.02	-17.59	-17.92	0.535	-4.30	-4.48	-5.18	0.165
Irregular beans consumption	9.95	11.25	7.33	0.434	6.48	3.47	2.22	<0.001
Regular soft drinks consumption	16.55	10.49	3.89	<0.001	6.94	5.19	2.90	<0.001
Irregular recreational physical activity	-8.66	-9.47	-7.90	0.745	-1.70	-1.91	-1.71	0.837
Alcohol use (once in the last month)	9.69	0.68	0.06	0.000	4.79	1.71	1.19	0.004
Tobacco use (once in the last month)	-1.68	-2.80	-3.15	0.125	-5.68	-6.32	-8.69	0.290
Drug use (once in the last month)	0.34	0.46	-0.98	0.048	-0.08	4.47	-4.61	0.428
Unsafe sex (in the last sexual intercourse)	-9.67	-6.88	-13.28	0.498	-6.52	-5.44	-6.56	0.914
Domestic violence (once in the last month)	-1.84	-5.24	-6.92	<0.001	-2.72	-7.02	-6.57	0.014
Involvement in gun fights (once in the last month)	-0.76	-1.90	-3.30	0.002	-2.82	-4.42	-8.79	0.029
Bullying victimization (twice or more in the last month)	0.83	-0.20	-6.60	<0.001	0.56	0.59	-4.41	<0.001

In all years, alcohol consumption was the health indicator more equally distributed between wealth quintiles both according to absolute and relative measures. On the other hand, irregular vegetables consumption and unsafe sex had the highest absolute inequality and fights using guns and tobacco use the highest relative inequality. Over time, the absolute (SII) and relative inequalities (CIX) between wealth index quintiles became wider for all three indicators of exposure to violence, and narrower for some indicators of lifestyle behaviour (fruit, beans and soft drinks) and alcohol consumption. There was limited evidence of change in inequalities over time for the other lifestyle behaviours, such as irregular vegetables consumption and recreational physical activity, and indicators of engagement in risky activities, such as tobacco, drug use and unsafe sex (table 3, figure 2).

INSERT FIGURE 2 HERE

DISCUSSION

We showed evidence of persistent socioeconomic inequalities in adolescent health in Brazil. Between 2009 and 2015, lifestyle behaviours (fruit and soft drinks consumption) and alcohol use became more equally distributed between socioeconomic groups, while inequalities in experiencing violence were exacerbated. In this period, there was little evidence of change to inequalities in risky activities (smoking, drugs, unsafe sex).

In general, the direction of health inequalities we observed are similar to that reported in other settings, that is, poorer adolescents are more likely to report harmful health behaviours than richer [5]. For certain harmful behaviours (e.g. alcohol and drug use), however, differences between social groups were not significant or went in the

opposite direction (i.e. wealthier adolescents reported higher prevalences). These findings

are consistent with results observed in other countries [24].

Looking at time-trends in these inequalities, our findings differ to existing

evidence from Western Europe and North America. For some lifestyle (e.g. vegetable

consumption, physical activity) and risky behaviours (drug and tobacco use), inequalities

have not changed significantly between 2009 and 2015 in Brazil. Yet inequality in

lifestyle and risky behaviors have increased over similar period in many other countries

[5, 25]. Similarly to ours, one study found persistent inequality in vegetable consumption

[26]. Despite this, comparable data for many indicators of risk behaviours are lacking.

Rates of violence as well as inequalities in violence increased markedly (gun fights,

domestic violence, bullying), and these trends also differ from other countries [27].

Reasons for differential socioeconomic inequality trends between lifestyle

behaviours, risk behaviours and violence-related indicators in Brazilian adolescents are

unclear. Reductions in lifestyle behaviour inequalities fits with the general trend of

narrowing economic and health inequalities observed for adults in Brazil in that

period[28, 29]. This is often attributed to rising prosperity combined with roll-out of

redistributive health and social programs such as the Bolsa Familia cash transfer program

[30], as well as scaled-up health promotion efforts (especially obesity prevention) [31].

Exacerbation of violence-related inequalities have also been observed in one study of

adult mortality in Salvador [32]. It has been suggested that public health interventions

have focussed on reducing infectious and chronic diseases but neglect, on the other hand,

external causes of ill-health such as interpersonal violence. In fact, violence-related

mortality has declined slower than all other causes in Brazil, and even increased in 19 of

the 27 states [33].

It is worth noting that we found a shift in prevalence of alcohol use and soft drinks consumption between socioeconomic in the period studied. In 2009, these indicators were higher among the wealthiest group, but in 2015 the differences were considerably attenuated. The reduction in the consumption of these products was more pronounced among the wealthiest group than in the poorest group. Conversely, for bean consumption, poorer adolescents reported higher prevalence than wealthiest adolescences. In this regard, the reduction in disparities between wealth groups should be read with caution. In high-income countries, poorer individuals consume more alcohol, relative to wealthier individuals, while in low-middle income countries wealthier individuals are more exposed than the poorer [34]. This trend could be shifting. In fact, industries of unhealthy commodities have moved to, and are growing faster in, low- and middle-income countries comparing to high-income countries [35]. This phenomenon might explain, at least in part, the increase in consumption of ultra-processed products (e.g. sugary drinks) and alcohol, and the reduction of bean consumption in these settings [36]. Brazil seems to be moving towards patterns of health indicators and their inequalities currently observed in high-income countries. In these countries, the reduction in alcohol use and soft drinks consumption among those privileged is not necessarily followed by a reduction among those more socially deprived [5]. Although this trend is measured as a reduction in inequality, it is not desirable.

The main strength of this study is to explore a wide spectrum of health indicators, which provides information on prevalence and trends in key risk factors for adolescent health. Another positive aspect is the large representative urban samples from Brazilian adolescents attending public and private schools. In Brazil, the school coverage in this age is very high (88-97%) [37], which reduces significantly the risk of selection bias. Despite this, is plausible to assume that students at higher risk of harmful health behaviors

have higher truancy and dropout rates. Therefore, this could have masked the true extent of the inequalities. We also report a range of simple and complex measures of inequalities to allow clear interpretation of trends as well as presenting rigorous hypothesis tests which make use of all data. Concordance between the absolute and relative measures of inequality adds strength to our conclusions.

Some limitations should be acknowledged. The engagement in health-related behaviours was self-reported by adolescents, and therefore, misclassification may have occurred towards social desirable behaviors. Misclassification likely affected the prevalence of health indicators similarly over three surveys. Although, use of self-reported outcomes is a limitation, it is widely recognised as an acceptable and often the only feasible approach for monitoring adolescent health behaviours [38]. Moreover, there is evidence of validity of the dietary indicators used in the PeNSE survey [17], and a US survey on which the PeNSE survey was based demonstrated good test-retest reliability and consistency across different modes of questioning [39].

The surveys were available only for a period of 6 years, which may be too short to expect significant changes in inequalities. To continue monitoring trends in adolescent health inequality for longer periods is desirable. Also, the data analysed are representative of Brazilian state capitals, not the whole country. State Capitals are highly urbanized cities and more developed than other cities, therefore, these results may not be generalizable to small cities and rural areas. However state capitals are the most populous and unequal areas of Brazil [40], making them important settings for studying inequality trends, and meaning they can act as sentinels to the country as a whole.

Brazil is facing a huge economic recession since 2015, which deepened in 2016. Unemployment and inflation have increased and people's purchasing power has been reduced, with the poor especially affected. Therefore it will be vital to continue

monitoring the trends observed in this study and take action to prevent exacerbation of existing inequalities.

Policy makers and researchers should be alert to the fact that possible reductions in health risky behaviours may be unbalanced between social groups and even be increasing in disadvantaged social groups while decreasing on average [22]. In this study, we found that the gap between poor adolescents and wealthy adolescents is reducing for lifestyle behaviours such as fruit consumption; while it is increasing for violent behaviours. For alcohol, irregular bean consumption and regular soft drink consumption we found that the gap between social groups is narrowing, although represented by a reduction in these risk behaviours among rich and an increase among poor adolescents.

Conflict of interest: None.

Data Sharing Statement: The dataset of 2009, 2012 and 2015 PeNSE are publicly available at: https://www.ibge.gov.br/estatisticas-novoportal/sociais/educacao/9134-pesquisa-nacional-de-saude-do-escolar.html?=&t=microdados

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Figure 1 - Time trends in health-related behaviours by wealthy quintile among adolescent

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Figure 2- Prevalence of health-related behaviours among adolescent in 2015 and Slope

Index of Inequality (SII, absolute inequality).

Figure 1 - Time trends in health-related behaviours by wealthy quintile among adolescent.

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Figure 2- Prevalence of health-related behaviours among adolescent in 2015 and Slope Index of Inequality (SII, absolute inequality).

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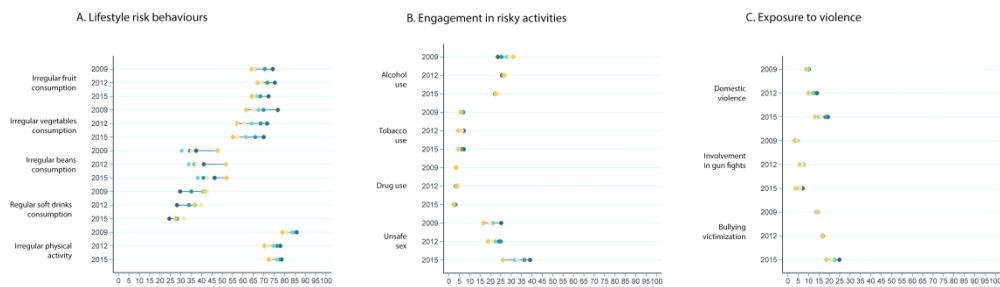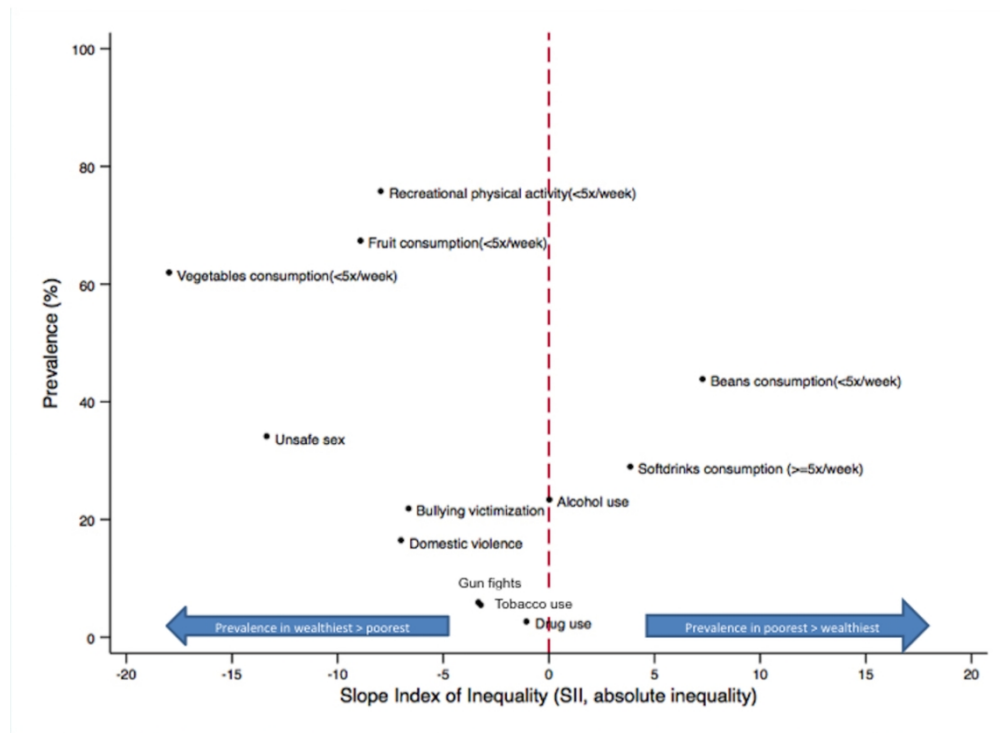
Appendix 1

Simple measures of inequality in health-related behaviours among Brazilian adolescents from PeNSE surveys 2009, 2012 and 2015.

Indicator	PeNSE survey year	National	Q1 (poorest) %	Q5 (richest) %	Difference (quintile 5 - quintile 1) %	Difference (quintile 5 - quintile 1) 95% CI	Ratio (quintile 5/ quintile 1) %	Ratio (quintile 5/ quintile 1) 95% CI	Population Attributable risk (PAR)	Population Attributable risk percentage (PAR%)
	2009	68.49	74.34	64.00	10.34	8.06; 12.62	1.16	1.12; 1.20	-4.49	-6.56
Irregular fruit consumption	2012	70.24	75.35	66.96	8.39	6.03; 10.74	1.13	1.08; 1.16	-3.28	-4.67
	2015	67.17	72.29	64.15	8.14	5.28; 11.00	1.13	1.08; 1.18	-3.02	-4.50
	2009	68.77	76.81	61.47	15.34	13.28; 17.41	1.25	1.21; 1.29	-7.30	-10.62
Irregular vegetables consumption	2012	64.12	71.64	56.99	14.65	12.46; 16.83	1.26	1.21;1.30	-7.13	-11.12
	2015	61.73	69.97	55.14	14.83	11.66;18.01	1.27	1.20; 1.34	-6.59	-10.68
	2009	37.45	37.38	47.74	-10.36	-12.96; -7.77	0.78	0.74; 0.83	10.29	27.48
Irregular beans consumption	2012	40.00	41.09	51.74	-10.65	-13.88; -7.42	0.79	0.74; 0.85	11.74	29.35
	2015	43.74	46.27	52.07	-5.80	-9.17; -2.43	0.89	0.83; 0.95	8.33	19.04
	2009	37.21	29.67	41.59	-11.92	-14.32; -9.50	0.71	0.67; 0.76	4.38	11.77
Regular softdrinks consumption	2012	35.44	28.17	36.62	-8.45	-10.69; -6.20	0.77	0.72; 0.83	1.18	3.33
	2015	28.84	24.51	27.42	-2.91	-5.45; -0.33	0.89	0.81; 0.98	-1.42	-4.92
	2009	82.96	85.88	78.96	6.92	5.30; 8.55	1.09	1.07; 1.11	-4.00	-4.66
Irregular recreational physical activity	2012	74.15	77.97	70.27	7.70	5.82; 9.58	1.11	1.08; 1.14	-3.88	-4.98
	2015	75.58	78.58	72.36	6.22	3.93; 8.51	1.09	1.05; 1.12	-3.22	-4.10
	2009	27.13	23.57	31.02	-7.45	-9.22; -5.67	0.76	0.71; 0.81	3.89	14.33
Alcohol use (once in the last month)	2012	26.78	25.55	26.33	-0.78	-2.94; 1.37	0.97	0.89; 1.05	-0.45	-1.67
	2015	23.2	22.24	22.50	-0.26	-2.99; 2.47	0.99	0.87; 1.12	-0.70	-3.03
	2009	6.25	6.70	5.63	1.07	0.09; 2.06	1.19	1.01; 1.40	-0.62	-9.92
Tobacco use (once in the last month)	2012	6.08	7.20	4.44	2.76	1.70; 3.82	1.62	1.35; 1.95	-1.64	-26.99
	2015	5.34	7.18	4.41	2.77	1.48; 4.06	1.63	1.28; 2.08	-0.93	-17.35

	Year								
Drug use (once in the last month)	2009	3.32	3.01	3.52	-0.51	-1.29; 0.27	0.85 0.67; 1.08	0.20	6.02
	2012	3.81	3.94	3.63	0.31	-0.70; 1.32	1.09 0.83; 1.42	-0.18	-4.72
	2015	2.45	2.55	2.20	0.35	-0.52; 1.22	1.16 0.80; 1.69	-0.25	-10.20
Unsafe sex (in the last sexual intercourse)	2009	21.46	25.19	16.65	8.54	5.27; 11.82	1.51 1.27; 1.80	-4.81	-22.41
	2012	22.5	24.29	18.83	5.46	2.10; 8.81	1.29 1.10; 1.51	-3.67	-16.31
	2015	33.86	39.11	26.00	13.11	8.21; 18.01	1.50 1.28; 1.77	-7.86	-23.21
Domestic violence (once in the last month)	2009	9.54	10.13	8.79	1.34	0.06; 2.62	1.15 1.00; 1.33	-0.75	-7.86
	2012	11.6	14.08	9.87	4.21	2.82; 5.61	1.43 1.27; 1.61	-1.73	-14.91
	2015	16.17	19.33	13.11	6.22	4.48; 7.96	1.47 1.32; 1.65	-3.06	-18.92
Involvement in gun fights (in the last month)	2009	4.01	3.93	3.15	0.78	0.02; 1.53	1.25 1.00; 1.55	-0.86	-21.45
	2012	6.94	7.50	5.65	1.85	0.82; 2.88	1.33 1.13; 1.55	-1.29	-18.59
	2015	5.61	7.19	3.70	3.49	2.41; 4.58	1.94 1.56; 2.42	-1.91	-34.05
Bullying victimization (twice or more in the last month)	2009	14.16	13.71	14.54	-0.83	-2.16; 0.50	0.94 0.86; 1.04	0.38	2.68
	2012	16.5	16.90	16.73	0.17	-1.68; 2.04	1.01 0.90; 1.13	0.23	1.39
	2015	21.74	24.88	18.51	6.37	4.28; 8.45	1.34 1.22; 1.48	-3.23	-14.86

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract 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 Page3
Objectives	3	State specific objectives, including any prespecified hypotheses Page 4
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 and 5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up NA *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls NA *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants –Page4 and first para page 5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed NA *Case-control study*—For matched studies, give matching criteria and the number of controls per case NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Page 5 and 6
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 Table 1 – page 6
Bias	9	Describe any efforts to address potential sources of bias Last para Page 4 and first para page 5 (response rate – selection bias); page 5 (validation of measures – information bias)
Study size	10	Explain how the study size was arrived at . Page 4 and Reference: Oliveira et al. 2017
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Pages 8 and 9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Pages 8 and 9
		(*b*) Describe any methods used to examine subgroups and interactions NA

1	
2	(*c*) Explain how missing data were addressed Page 9
3	(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed NA
4	
5	*Case-control study*—If applicable, explain how matching of cases and controls was
6	addressed NA
7	*Cross-sectional study*—If applicable, describe analytical methods taking account of
8	sampling strategy Page 9 last para
9	
10	(*e*) Describe any sensitivity analyses NA

11   Continued on next page

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 Table 2
		(b) Give reasons for non-participation at each stage Response rate 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 2
		(b) Indicate number of participants with missing data for each variable of interest Page 9 (we used multiple imputation)
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure NA
		Cross-sectional study—Report numbers of outcome events or summary measures Table 2
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 Table 3, figures 1 and 2.
		(*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 NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses NA

Discussion

Key results	18	Summarise key results with reference to study objectives Page 15
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 18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Pages 15-18
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 17 last para

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 19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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.