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Trends in sociodemographic and lifestyle factors associated with sedentary behavior among Brazilian adults

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Trends in sociodemographic and lifestyle factors associated with sedentary behavior among Brazilian adults

Tendências em fatores sociodemográficos e de estilo de vida associados ao comportamento sedentário em adultos brasileiros

Running title: Sociodemographic and lifestyle factors of sedentary behavior in Brazilian adults

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ABSTRACT

Objective: To analyze sociodemographic and lifestyle factors associated with screen-based sedentary behavior (watching television ≥3 hours/day) among adult individuals in Brazil. *Methods:* Quantitative analysis of ten editions of the cross-sectional health survey VIGITEL, representative at population level. Individuals from states' capitals living in households with land-line telephone were randomly selected and interviewed using structured questionnaire by telephone. A multivariate logistic regression model was estimated for identification of factors associated with screen-based sedentary behavior. *Results:* There was stability in trends referring to prevalence of sedentary behavior from 2008 to 2017. Prevalence of sedentary behavior was higher between individuals with unhealthier lifestyles: consumption of <2 *in natura* food items (vegetables, fruits and beans) per day (26.73% [95%CI 25.2%;28.31%]) in comparison to ≥2 items per day (23.79% [95%CI 21.92%;25.77%]); consumption of soft drinks ≥5 days per week (31.24% [95%CI 29.58%;32.95%]) than <5 days per week (23.82% [95%CI 22.2%;25.52%]); and practice of <150 minutes of physical activity per week (28.2% [95%CI 26.17%;30.33%]) than ≥150 minutes per week (22.54% [21.27%;23.86%]). Regular consumption of *in natura* food items (OR=0.984), practice of physical activity (OR=0.798) and living in richer municipality (OR=0.826) represented protective factors in relation to screen-based sedentary behavior, whilst regular consumption of soft drinks (OR=1.440), smoking (OR=1.375) and alcohol abuse (OR=1.334) represented risk factors. *Conclusion:* The adoption of screen-based sedentary behavior among adult individuals in Brazil presented significant association with modifiable behavioral factors in the period 2008-2017.

Keywords: Sedentary behavior. Screen time. Lifestyle. Cross-sectional studies. Risk factors. Protective factors.

RESUMO

Objetivo: Analisar fatores sociodemográficos e de estilo de vida associados ao comportamento sedentário baseado em tempo de tela (assistir televisão ≥3 horas/dia) entre brasileiros adultos. *Métodos:* Análise quantitativa de dez edições do inquérito de saúde de delineamento transversal VIGITEL, representativo em nível populacional. Indivíduos de capitais estaduais residentes em domicílios com telefone fixo foram selecionados aleatoriamente e entrevistados via questionário estruturado por telefone. Estimou-se modelo de regressão logística multivariada para identificação de fatores associados ao comportamento sedentário. *Resultados:* Observou-se tendência estável na prevalência de comportamento sedentário entre 2008 e 2017. Verificou-se maior prevalência de comportamento sedentário entre indivíduos com padrões de comportamento menos saudáveis: consumo de <2 itens alimentares *in natura* (vegetais, frutas e feijões) por dia (26,73% [95%CI 25,2%;28,31%]) em comparação ao consumo de ≥2 itens por dia (23,79% [95%CI 21,92%;25,77%]); consumo de refrigerantes em ≥5 dias por semana (31,24% [95%CI 29,58%;32,95%]) em comparação a <5 dias por semana (23,82% [95%CI 22,2%;25,52%]); e prática de atividade física <150 minutos por semana (28,2% [95%CI 26,17%;30,33%]) em comparação a ≥150 minutos por semana (22,54% [21,27%;23,86%]). Consumir alimentos *in natura* (OR=0.984); praticar atividade física (OR=0.798) e residir em município de maior renda (OR=0.826) representaram fatores de proteção ao comportamento sedentário baseado em tempo de tela, enquanto consumo de refrigerantes (OR=1.440), fumo (OR=1.375) e abuso de álcool (OR=1.334) representaram fatores de risco. *Conclusão:* A adoção do comportamento sedentário baseado em tela entre indivíduos adultos no Brasil

apresentou associação significativa com fatores comportamentais modificáveis no período 2008-2017.

Palavras-chave: Comportamento sedentário. Tempo de tela. Estilo de vida. Estudos transversais. Fatores de risco. Fatores de proteção.

INTRODUCTION

Sedentary behaviors represent important risk factors for negative health outcomes; however, it differs substantially from absence of engagement in physical activity[1,2]. Evidence on associations between sedentary behavior and chronic non-communicable diseases indicates significant association with cardiometabolic[3] and cardiovascular[4] diseases, cancer[5], overweight and obesity[6], and overall mortality[7].

The recently published guidelines of the World Health Organization on physical activity and sedentary behavior recommend that adult individuals (18-64 years-old) limit sedentarism, especially by replacing sedentary activities with physical activity at least 150 to 300 minutes per week due to substantial benefits to individuals' health, which contributes to well-being and overall quality of life[8,9].

Despite the harmful effects of sedentarism on health status, it presents high prevalence in diverse countries worldwide[8]. A recent study indicated that approximately 65% of adults in the United States devoted two or more hours per day watching television in 2015-2016[10].

It is important to emphasize that sedentary behavior and physical activity may be performed in different domains, e.g., during leisure, transportation or labor, and other occupational or educational activities. In general, sedentary behaviors that occur during leisure are considered discretionary, and time spent watching television is usually adopted as proxy variable for optional sedentary behavior in epidemiological studies, especially considering its sensitivity to influences from cultural and socioeconomic contexts[11-13].

Although there is emerging academic interest in factors associated with sedentary behaviors, most studies focus on high-income countries[12,13], and there is lack of population level evidence for low- and middle-income countries, e.g. Brazil, especially

considering the simultaneity of health behaviors and health conditions during broad periods.

Therefore, the objective of the study was to analyze trends and protective and risk factors associated with adoption of screen-based sedentary behavior (watching television ≥3 hours/day) in adult population (≥18 years-old) living in Brazilian state capitals from 2008 to 2017.

METHODS

Study design

The study presents analysis of datasets from the Surveillance of Risk and Protection Factors for Prevention of Chronic Diseases through Telephone Survey (VIGITEL), conducted by the Brazilian Ministry of Health, including ten years of cross-sectional observational individual-level data from representative sample of the adult population living in Brazilian state capitals and Federal District in the period from 2008 to 2017.

Databases

The VIGITEL is a telephone health survey conducted annually since 2006 by the Brazilian Ministry of Health to monitor risk and protection factors for chronic diseases in the Brazilian population. The databases include individual-level information for each year of the survey, available at the Brazilian Ministry of Health website. Microdata from surveys conducted from 2008 onwards were selected, considering the consolidation process of the survey during the first two years after implementation.

VIGITEL sampling process is based on minimum sample of 1,500 individuals from each of the Brazilian state capitals and Federal District for estimation of frequency of risk and protection factors for chronic diseases in the adult population with 95% confidence and maximum error of three percentage points[14].

The first stage of sampling refers to random selection of at least 5,000 landlines per municipality from landline registrations of main telephone companies in the country. After initial drawing, lines eligible for survey are selected, i.e., active residential lines. The second stage of sampling consists of drawing one adult per household to participate in the survey[14]. Considering the survey sample design, individuals interviewed are assigned weights to allow statistical inferences in relation to the population of 26 state

capitals and Brazilian Federal District, using rake method[14]. Data collection was carried out through structured interview with application of closed questionnaire by telephone[14].

In addition to information from VIGITEL, data referring to Gross Domestic Product (GDP) and population of each municipality, obtained from the Brazilian Institute for Geography and Statistics (IBGE), were included in the dataset to represent certain environmental aspects of the municipality and population economic status and to assess potential effects of economic conjuncture on other variables in the survey period (2008 to 2017).

Variables

Sedentary behavior (outcome) was based on self-reported daily time watching television, considering sedentary individuals with screen time equal or higher than 3 hours per day.

Variables of interest in the present study were: (1) self-reported frequency of consumption of *in natura* food items (vegetables, fruits and beans) per week[15]; (2) self-reported frequency of consumption of soft drinks per week[15]; (3) sociodemographic characteristics: age, biological sex, educational attainment, ethnicity/skin color, marital status and occupation; (4) health characteristics: self-assessment of health status, self-reported diagnosis of diabetes, self-reported diagnosis of hypertension, overweight and obesity; (5) self-reported behavioral characteristics: physical activity, alcohol abuse, and smoking; (6) GDP per capita in the municipality of residence of the individuals, using data obtained from IBGE.

Data processing

Information of VIGITEL databases ranging from 2008 to 2017 were further organized into a single dataset, after selection of variables compatible along the period of analysis, to allow statistical analysis on trends and factors associated with adoption of screen-based sedentary behavior among adult individuals.

A set of variables from VIGITEL was converted into binary variables, coded into 0 (no) and 1 (yes) values, according to specific criteria based on evidence of the literature or cutoff points established by national and/or international organizations: screen-based sedentary behavior, and regular consumption of *in natura* food items and soft drinks.

The adoption of screen-based sedentary behavior was based on self-report of daily duration of television watching, considering the cutoff point of three or more hours per day.

Regular consumption of *in natura* food items and soft drinks was based on self-reported frequency per item: none day, 1 to 2 days, 3 to 4 days, 5 to 6 days or all days of the week[14]. Three variables registering self-reported frequency of *in natura* food items consumption, i.e., beans, fruits and vegetables (considered markers of healthier food consumption patterns), were converted into number of days per week consuming each item, which were added up and divided by seven days per week to comprise total *in natura* food items consumed per day. Then, it was categorized using cutoff point of at least two items per day during the week[14].

Regular consumption of soft drinks (considered marker of unhealthier food consumption patterns) was categorized using cutoff point of consuming five or more days during the week[15].

Regarding sociodemographic characteristics, age and educational attainment were continuous variables maintained in its original format for the analysis. Biological sex, ethnicity/skin color, marital status and occupation were converted into categorical

variables, encompassing the following categories, respectively: female (0) and male (1); white (0) and black, brown and indigenous (1); living with companionship, i.e., married and stable union (0) and living without companionship, i.e., single, divorced and widowed (1); and currently working (1) and not working (0).

Amongst health characteristics, self-assessment of health status in five categories (very good, good, fair, poor or very poor) was converted into binary variable considering individuals who declared having poor or very poor health status. Presence of diabetes or hypertension were registered according to self-report of the individual. Occurrence of overweight (BMI $\geq$ 25 kg/m²)[14] and obesity (BMI $\geq$ 30 kg/m²)[14] in the VIGITEL was based on the estimation of the Body Mass Index (BMI), based on self-reported information about weight and height[14].

Behavioral characteristics were adopted in its original format from VIGITEL: physical activity level ($\geq$ 150 minutes per week), alcohol abuse ($\geq$ 5 doses for men; $\geq$ 4 doses for women at least on one occasion in the last 30 days), and smoking (current use of tobacco products, regardless the amount)[14].

Values of GDP per capita were updated by applying the National Consumer Price Index (IPCA-IBGE), using the accumulated price index of the period of each annual survey to the reference period of January 2019.

Model

Multivariate logistic regression model was estimated to evaluate association of screen-based sedentary behavior with variables of interest selected, resulting in identification of sociodemographic and lifestyle protection and risk factors for adoption of screen-based sedentary behavior (outcome). The model included control variables for municipality, year of survey, and cross-effects of municipality and year of survey, in order to capture

potential influence of local policies. Analyses were performed using statistical software Stata® (Stata Corp., College Station, USA), version 14.2 for Windows, applying *svyset* command for sample design using rake weighting method, considering statistical significance $p \leq 0.05$.

Ethical aspects

The VIGITEL survey project was approved by the National Commission on Research Ethics (CAAE: 65610017.1.0000.0008). Informed consent was obtained verbally at the time of telephone contact[14].

RESULTS

Participants in VIGITEL survey were usually female individuals, individuals who declared themselves black, brown or indigenous, and individuals who worked. The proportion of young adults (18 to 39 years-old) was higher during the first survey editions; nevertheless, there was an increasing trend in participation of older adults (40 to 59 years-old), and elderly individuals (over 60 years-old) (table 1 and table S1).

The occurrence of individuals who self-reported certain health conditions increased throughout the period: diabetes (from 6.22% [95%CI 5.44% to 7.09%] in 2008 to 7.63% [95%CI 7.10% to 8.19%] in 2017; p<0.001), obesity (from 13.66% [95%CI 13.18% to 14.15%] in 2008 to 18.92% [95%CI 18.08% to 19.79%] in 2017; p<0.001) and overweight (from 44.88% [95%CI 43.64% to 46.14%] in 2008 to 54.00% [95%CI 52.58% to 55.41%] in 2017; p<0.001) in the period (table 1 and table S1).

Adoption of screen-based sedentary behavior showed stability, presenting minor variations during the period (ranging from 22.53% [95%CI 21.11% to 24.02%] in 2015 to 28.58% [95%CI 26.73% to 30.51%] in 2013); however, the differences registered throughout the period were statistically significant (p<0.001) (table 1 and table S1).

Among other behavioral characteristics, physical activity ≥150 minutes/week showed increasing tendency during the period (from 43.07% [95%CI 40.77% to 45.40%] in 2008 to 53.41% [95%CI 49.57% to 57.21%] in 2017; p<0.001), as well as abusive alcohol consumption (from 17.22% [95%CI 14.75% to 20.01%] in 2008 to 19.06% [95%CI 17.7% to 20.49%] in 2017; p=0.003). On the other hand, there was decreasing trend in frequency of consumption of soft drinks (from 26.41% [95%CI 23.10% to 30.01%] in 2008 to 14.62% [95%CI 11.71% to 18.10%] in 2017; p<0.001), and smoking (from 14.77% [12.73% to 17.07%] in 2008 to 10.11% [7.94% to 12.79%] in 2017; p<0.001) (table 1 and table S1).

There were no statistically significant differences among individuals interviewed throughout the period regarding biological sex, occupation, self-assessment of poor health status and self-reported hypertension diagnosis (table 1 and table S1).

Results of the logistic model on adoption of screen-based sedentary habit suggest statistically significant association with age, biological sex, ethnicity/skin color, marital status, educational attainment and occupation: older individuals (OR=0.999) and individuals with higher educational attainment (OR=0.991) had lower probability to adopt screen-based sedentary behavior; whilst women (OR=1.086), individuals who declared themselves to be black, brown or indigenous (OR=1.063), individuals living without companionship (OR=1.148), and individuals who were not working (OR=1.889) had higher probability (table 2).

There were also statistically relevant associations with overweight (OR=1.111), obesity (OR=1.103), self-reported diagnosis of diabetes (OR=1.117), and hypertension (OR=1.097). In relation to behavioral characteristics, results indicated that regular consumption of *in natura* foods (OR=0.984) and practice of physical activity (OR=0.798) were protective factors against adoption of sedentary behavior; whilst consumption of soft drinks (OR=1.440), smoking (OR=1.375), and alcohol abuse (OR=1.334) were considered risk factors. Finally, considering economic context, there was lower adherence to sedentary habit among individuals living in municipalities with higher per capita GDP (OR=0.826) (table 2).

Self-assessment of poor health status (OR=1.047) did not show statistical significance for screen-based sedentary behavior among adult individuals in the period analyzed.

DISCUSSION

The adoption of screen-based sedentary behavior (watching television ≥3 hours/day) among adult individuals in Brazil presented significant association with health behaviors that may be modifiable through public policies strategies designed for primary health care interventions.

Evidence of the study emphasizes the role of sociodemographic, economic and behavioral factors on lifestyle choices that influence health status of the Brazilian population. Mechanisms of reinforcement between screen-based sedentary behavior and other behavior patterns were observed in previous studies. Healthier lifestyle choices, including frequent consumption of *in natura* foods[15] and regular physical activity[8], were protective factors against sedentary behavior of watching television ≥3 hours per day. Conversely, unhealthy behavior patterns were usually risk factors for sedentary behavior, including frequent consumption of soft drinks[15,16,17], smoking[18] and alcohol abuse[19].

In Brazil, evidence referring to the protective role of regular *in natura* food consumption and recommended levels of physical activity in relation to adoption of sedentary behavior was also observed in previous study performed among public school teachers in Presidente Prudente municipality, state of Sao Paulo[20]; in addition, there were also associations between overfeeding and alcohol consumption with time spent watching television[20].

Results obtained in the study, reinforced by evidence in previous studies, draw attention to the concomitance and the repercussion of harmful habits to individual's health, indicating the importance of the discussion on the presence of multiple behavioral risk factors in relation its impacts on health outcomes. Adherence to healthy lifestyles, i.e., combination of healthier behaviors, was significantly associated with reduction in

premature death in the United States, resulting in increase in life expectancy, particularly healthy life years free from chronic non-communicable diseases (NCD)[21,22]. Similar evidence has been observed in studies with Brazilian adolescents[23] and Polish adults[24], particularly regarding eating patterns associated with screen-based sedentary behavior (including watching television). It points out to underlying mechanisms of encouragement for consumption of food items that are considered markers of unhealthier food consumption patterns (e.g., soda, snacks, and sweets) whilst watching television. Furthermore, the habit of watching television has been related to body fat deposits[24], increasing risks of overweight, abdominal obesity, higher BMI and waist circumference[6,25,26], which were partially observed in the results of the study also.

It is important to emphasize that overweight and obesity are important risk factors for NCD[27,28], being responsible for substantial health and economic burden in populations, health systems and households worldwide, considering direct costs with treatments and indirect costs for individuals, e.g., productivity losses, family commitment and emotional health impacts[29-31].

Our results have shown that, besides overweight and obesity, individuals who self-reported diabetes and hypertension diagnosis were also more likely to adopt screen-based sedentary behavior, association also observed in previous studies[3,32]. The evidence on the relationship between NCD and sedentary behavior fosters the discussion on the need for engagement of individuals diagnosed with NCD within initiatives for promotion of physical activity. It is especially important regarding perceived barriers to achieve recommended physical activity practice[33,34], and adoption of healthier eating patterns[35,36], which highlight the social and environmental influences on behavioral change.

In the context of sociodemographic characteristics, results of the study showed higher tendency of screen-based sedentary behavior among individuals who declared being single, divorced, or widower; i.e., individuals living without companionship, in accordance with previous studies with Canadian and Japanese adults[37,38].

However, a systematic review has shown certain inconsistencies regarding the influence of family and household factors, including marital status, on adoption of sedentary behavior during leisure[12]. Therefore, although some evidence point to the adoption of screen-based sedentary behavior among individuals living unaccompanied, additional research is required to identify whether marital status influences sedentary habits like watching television, and its relationship with other sociodemographic factors over time.

In any case, evidence call for attention towards the discussions about influences of peers in adoption of healthier lifestyles, encouraging and/or accompanying practice of physical activity during leisure, instead of sedentary recreational activities like watching television[37,38].

In terms of ethnicity/skin color, it is important to point out that higher trends in screen-based sedentary behaviors among individuals declaring themselves black, brown or indigenous may be linked to environmental characteristics that impose barriers to physical activity practice in ethnic minorities, according to evidence from studies in United Kingdom[39] and United States[40]. Thus, it represents an opportunity to discuss design of health policy interventions with an equitable orientation, focusing on specific characteristics of the Brazilian black, brown, or indigenous individuals.

Sedentary behavior presents socioeconomic and cultural determinants related to the organization of contemporary society, labor and educational activities, i.e., routines that have been designed to occur generally in sitting position with minor energy expenditure, promoting sedentarism in individuals and populations[11]. Whilst adherence to physical

activity is commonly associated with leisure in high-income countries and work in low-income countries, it is possible to observe both situations in middle-income countries like Brazil[41].

Therefore, the adoption of indicators like watching television three or more hours per day for analysis of sedentary behavior may comprise an important marker of discretionary recreational activity, unlike other forms of screen-based sedentary behavior, e.g., duration of activities using computer, which may be linked to occupational activities. Our results showed that individuals who declared that were not working presented higher tendency to maintain screen-based sedentary behavior during leisure by watching television ≥3 hours per day.

However, considering differences observed in time spent in sedentary behaviors in diverse life domains in Brazil, assessed in a study conducted in the city of Pelotas, state of Rio Grande de Sul[42], it is important to further investigate sedentary behavior in different life domains in the Brazilian population.

The main limitations of the study refer to methodological characteristics of VIGITEL databases, especially referring to data collection based on cross-sectional survey design[14], which prevents establishment of causal relationships between screen-based sedentary behavior in relation to sociodemographic and behavioral characteristics of the Brazilian adult population.

In addition, changes in the survey questionnaires throughout the period of analysis limited the possibility of including certain characteristics of interest in the study, like presence of hypercholesterolemia, consumption of other food items (milk, meat, and sweets), among others. Therefore, only variables that remained directly comparable during the period analyzed were selected in the study, allowing consistency for estimation of the model proposed.

VIGITEL includes self-reported characteristics through telephone survey, which may result in underestimation of characteristics that individuals' believe "wrong" or "socially unacceptable" and overestimation of characteristics perceived "right" or "socially acceptable", thus reducing accuracy of analysis referring to certain individual's characteristics and behaviors. Furthermore, the variable for screen-based sedentary habit covers time spent watching television, and it does not include time spent with use of other devices, like computers, tablets and mobile phones, which would potentially increase prevalence of sedentariness in the Brazilian adult population, especially considering the widespread of information and communication technologies throughout the period analyzed.

Sample selection in VIGITEL is based on population representativeness of individuals living in Brazilian state capitals and Federal District that have landline telephone, i.e., areas of high urbanization[43]; thus, there is absence of representativeness of rural population in the study. Previous studies point to need to use alternative weighting strategies in the case of regions with low coverage of household landlines, pointing to potential underestimation biases due to tendency to substitute the use of landlines by mobile phones throughout time[44,45].

However, it is important to point that an assessment on the sampling and stratification processes adopted within VIGITEL indicated validity and representativeness for research and monitoring risk and protection factors related to the health status of the Brazilian population[46]. Furthermore, sample size of the survey and its sampling procedures minimize potential biases in responses that potentially under- or overestimate monitoring of trends and risk or protection factors associated with sedentary behavior in the Brazilian adult population.

Finally, increasing trends towards sedentarism, alcohol abuse, overweight and obesity during period analyzed represent a call for action within the context of the Brazilian health system, especially directed to primary health care strategies for health promotion and disease prevention. Considering the lack of cohort data representative at national level in Brazil, results of the study may subsidize the formulation of strategic interventions in public health policies to promote healthy lifestyles among Brazilian adults.

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Table 1. Sociodemographic and health characteristics and behaviors of participants, according to year of survey. Brazil, 2008-2017.

Characteristics	Estimated prevalence, weighted										*P*
	2008 (n = 54353)	2009 (n = 54367)	2010 (n = 54339)	2011 (n = 54144)	2012 (n = 45448)	2013 (n = 52929)	2014 (n = 40853)	2015 (n = 54174)	2016 (n = 53210)	2017 (n = 53034)	
Sociodemographic characteristics											
Age											**<0,001**
18-39 years	52.85	52.04	51.87	51.29	50.82	50.26	49.76	49.43	49.16	48.73	
40-59 years	32.68	33.19	32.92	33.31	33.58	33.63	33.97	33.69	33.76	33.70	
≥ 60 years	14.47	14.77	15.21	15.40	15.60	16.11	16.27	16.88	17.08	17.57	
Biological sex											0.199
Female	53.88	53.89	53.90	53.91	53.92	53.93	53.94	53.95	53.97	53.98	
Male	46.12	46.11	46.10	46.09	46.08	46.07	46.06	46.05	46.03	46.02	
Ethnicity/skin color											**<0,001**
White	39.03	39.24	39.97	43.50	40.57	41.47	39.75	40.80	43.60	42.04	

Black to brown and indigenous	60.97	60.76	60.03	56.50	59.43	58.53	60.25	59.20	56.40	57.96	
Marital status											**<0,001**
Married/stable union	50.19	51.29	51.61	49.31	50.96	48.84	50.31	47.66	47.79	46.33	
Single/divorced/widowed	49.81	48.71	48.39	50.69	49.04	51.16	49.69	52.34	52.21	53.67	
Educational attainment											**<0,001**
0-8 years	43.63	41.97	40.57	38.07	36.77	36.51	35.94	34.58	32.49	30.80	
9-11 years	34.72	35.85	35.88	36.08	38.54	37.58	38.12	38.11	35.87	37.28	
≥ 12 years	21.65	22.18	23.54	24.50	24.69	25.91	25.95	27.30	31.64	31.92	
Occupation											0.014
Working	65.36	64.22	65.29	65.73	65.92	64.50	64.05	62.56	64.59	64.14	
Not working	34.64	35.78	34.71	34.27	34.08	35.50	35.95	37.44	35.41	35.86	
Health characteristics											
Overweight	44.88	45.98	48.19	48.82	51.01	50.77	52.52	53.92	53.82	54.00	**<0,001**
Obesity	13.66	14.34	15.07	16.04	17.39	17.53	17.92	18.95	18.93	18.92	**<0,001**
Diabetes diagnosis	6.22	6.34	6.78	6.29	7.37	6.87	8.04	7.40	8.94	7.63	**<0,001**

Hypertension diagnosis	25.32	25.50	24.26	24.32	24.32	24.09	24.83	24.85	25.71	24.27	0.093
Poor health status	4.58	4.65	4.47	4.54	5.04	4.88	4.44	4.79	4.40	4.10	0.083
Health behaviors											
Screen-based sedentary behavior											**<0.001**
≥ 3 hours a day in the week	24.60	24.04	27.25	25.93	26.41	28.58	25.31	22.53	25.70	24.60	
< 3 hours a day in the week	75.40	75.96	72.75	74.07	73.59	71.42	74.69	77.47	74.30	75.40	
Smoking	14.77	14.30	14.07	13.37	12.11	11.26	10.76	10.37	10.16	10.11	**<0.001**
Alcohol abuse	17.22	18.44	18.08	16.52	18.43	16.38	16.51	17.18	19.09	19.06	**<0.001**
In natura foods consumption											**<0.001**
<2 groups per day	59.67	60.39	60.63	58.05	57.71	55.55	55.80	55.42	58.49	59.67	
≥2 groups per day	40.33	39.61	39.37	41.95	42.29	44.45	44.20	44.58	41.51	40.33	
Soft drinks consumption											**<0.001**
≥5 days a week	26.41	25.95	26.8	27.48	25.96	23.27	20.81	18.96	16.50	14.62	
<5 days a week	73.59	74.05	73.20	72.52	74.04	76.73	79.19	81.04	83.50	85.38	
Physical activity practice											**<0.001**

<150 minutes per week	56.93	56.68	56.59	54.56	52.96	52.83	50.51	48.78	46.38	46.59
≥150 minutes per week	43.07	43.32	43.41	45.44	47.04	47.17	49.49	51.22	53.62	53.41

Data presented in number of individuals, n (%). P-values obtained from Pearson's chi-square test among years of the survey.

Table 2. Multivariate logistic model coefficients for screen-based sedentary behavior. Brazil, 2008-2017.

Watching TV ≥ 3 hours a day	OR	SE	[95%CI]	Sig.
Age (years)	0.999	0.001	[0.998;1.000]	**
Sex	1.086	0.016	[1.055;1.119]	***
Ethnicity/skin color	1.063	0.016	[1.031;1.096]	***
Marital status	1.148	0.017	[1.115;1.181]	***
Educational attainment (years)	0.991	0.002	[0.988;0.995]	***
Occupation	1.889	0.030	[1.832;1.948]	***
Overweight	1.111	0.018	[1.076;1.146]	***
Obesity	1.103	0.022	[1.061;1.147]	***
Diabetes diagnosis	1.117	0.028	[1.064;1.174]	***
Hypertension diagnosis	1.097	0.019	[1.059;1.135]	***
Self-assessment of poor health	1.047	0.034	[0.982;1.116]	ns
In natura foods consumption	0.984	0.003	[0.979;0.990]	***
Soft drinks consumption	1.440	0.026	[1.391;1.492]	***
Physical activity practice	0.798	0.012	[0.775;0.822]	***
Smoking	1.375	0.032	[1.315;1.438]	***
Alcohol abuse	1.334	0.026	[1.283;1.386]	***
Municipal GDP per capita (log)	0.826	0.007	[0.812;0.840]	***

*** $p<0.01$, ** $p<0.05$, ns = not significant. OR = odds ratio; SE = robust standard errors; 95%CI = 95% confidence interval; Sig. = significance. Note: Model estimated using sample weights, including control per municipality, survey year, and cross-effect of municipality and year.

SUPPLEMENTARY MATERIAL

Table S1. Confidence intervals (95%CI) of sociodemographic and health characteristics and behaviors of participants, according to year of survey. Brazil, 2008-2017.

Characteristics	Confidence intervals [95%CI], weighted										*P*
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Sociodemographic characteristics											
Age											**<0,001**
18-39 years	[50.36; 55.32]	[49.42; 54.64]	[49.14; 54.59]	[48.58; 54.00]	[48.34; 53.28]	[47.86; 52.67]	[47.51; 52.00]	[46.87; 52.00]	[46.76; 51.56]	[46.39; 51.07]	
40-59 years	[31.93; 33.43]	[32.14; 34.26]	[31.99; 33.87]	[32.25; 34.39]	[32.76; 34.42]	[32.80; 34.46]	[33.31; 34.64]	[32.89; 34.50]	[32.95; 34.58]	[32.81; 34.60]	
≥ 60 years	[12.78; 16.36]	[13.18; 16.51]	[13.45; 17.14]	[13.71; 17.25]	[13.98; 17.38]	[14.47; 17.90]	[14.68; 17.99]	[15.08; 18.84]	[15.45; 18.85]	[15.86; 19.43]	
Biological sex											0.199
Female	[53.53;	[53.54;	[53.57;	[53.58;	[53.59;	[53.61;	[53.62;	[53.63;	[53.65;	[53.66;	

	54.23]	54.23]	54.24]	54.24]	54.25]	54.25]	54.26]	54.27]	54.29]	54.30]	
Male	[45.77;	[45.77;	[45.76;	[45.76;	[45.75;	[45.75;	[45.74;	[45.73;	[45.71;	[45.7;	
	46.47]	46.46]	46.43]	46.42]	46.41]	46.39]	46.38]	46.37]	46.35]	46.34]	
Ethnicity/skin color											**<0,001**
White	[32.82;	[32.9;	[33.54;	[35.57;	[33.72;	[34.45;	[33.23;	[33.72;	[35.97;	[34.83;	
	45.61]	45.95]	46.76]	51.77]	47.82]	48.85]	46.66]	48.29]	51.55]	49.60]	
Black to brown and indigenous	[54.39;	[54.05;	[53.24;	[48.23;	[52.18;	[51.15;	[53.34;	[51.71;	[48.45;	[50.40;	
	67.18]	67.10]	66.46]	64.43]	66.28]	65.55]	66.77]	66.28]	64.03]	65.17]	
Marital status											**<0,001**
Married/stable union	[47.58;	[49.05;	[48.91;	[46.91;	[48.72;	[46.90;	[47.04;	[44.10;	[43.98;	[42.75;	
	52.81]	53.52]	54.30]	51.71]	53.19]	50.79]	53.57]	51.24]	51.62]	49.94]	
Single/divorced/widowed	[47.19;	[46.48;	[45.70;	[48.29;	[46.81;	[49.21;	[46.43;	[48.76;	[48.38;	[50.06;	
	52.42]	50.95]	51.09]	53.09]	51.28]	53.10]	52.96]	55.90]	56.02]	57.25]	
Educational attainment											**<0,001**
0-8 years	[41.26;	[39.66;	[38.23;	[36.12;	[34.53;	[34.01;	[33.84;	[32.26;	[30.21;	[28.84;	

	46.03]	44.32]	42.96]	41.34]	39.06]	39.09]	38.09]	36.98]	34.86]	32.83]	
9-11 years	[32.39;	[33.10;	[33.22;	[33.95;	[35.60;	[34.92;	[36.12;	[35.63;	[33.49;	[35.07;	
	37.14]	38.69]	38.64]	39.75]	41.58]	40.31]	40.15]	40.66]	38.32]	39.54]	
≥ 12 years	[20.06;	[20.44;	[21.49;	[22.86;	[23.06;	[24.31;	[24.54;	[25.40;	[29.84;	[29.79;	
	23.33]	24.03]	25.72]	26.22]	26.40]	27.58]	27.41]	29.28]	33.49]	34.13]	
Occupation											0.014
Working	[64.01;	[62.42;	[63.03;	[63.08;	[63.29;	[62.79;	[62.24;	[59.92;	[61.25;	[62.35;	
	66.69]	65.97]	67.48]	68.29]	68.45]	66.18]	65.81]	65.13]	67.8]	65.89]	
Not working	[33.31;	[34.03;	[32.52;	[31.71;	[31.55;	[33.82;	[34.19;	[34.87;	[32.20;	[34.11;	
	35.99]	37.58]	36.97]	36.92]	36.71]	37.21]	37.76]	40.08]	38.75]	37.65]	
Health characteristics											
Overweight	[43.64;	[44.49;	[46.64;	[47.62;	[49.85;	[49.65;	[51.46;	[52.39;	[52.66;	[52.58;	**<0,001**
	46.14]	47.48]	49.76]	50.02]	52.16]	51.89]	53.58]	55.45]	54.97]	55.41]	
Obesity	[13.18;	[13.32;	[14.10;	[15.27;	[16.38;	[16.41;	[16.97;	[17.42;	[18.03;	[18.08;	**<0,001**
	14.15]	15.42]	16.09]	16.84]	18.45]	18.71]	18.92]	20.58]	19.86]	19.79]	

Diabetes diagnosis	[5.44; 7.09]	[5.59; 7.18]	[6.02; 7.63]	[5.88; 6.74]	[6.37; 8.51]	[6.10; 7.73]	[7.17; 8.99]	[6.90; 7.92]	[8.14; 9.80]	[7.10; 8.19]	**<0,001**
Hypertension diagnosis	[23.07; 27.71]	[23.94; 27.12]	[22.52; 26.09]	[22.22; 26.56]	[22.51; 26.24]	[22.50; 25.75]	[23.52; 26.18]	[22.93; 26.89]	[23.68; 27.84]	[22.12; 26.55]	0.093
Poor health status	[4.28; 4.89]	[4.24; 5.11]	[4.04; 4.95]	[4.00; 5.14]	[4.58; 5.54]	[4.58; 5.20]	[3.92; 5.02]	[4.38; 5.23]	[4.16; 4.64]	[3.85; 4.36]	0.083
Health behaviors											
Screen-based sedentary behavior											**<0.001**
≥ 3 hours a day in the week	[22.74; 26.57]	[22.40; 25.76]	[25.37; 29.22]	[23.99; 27.97]	[24.40; 28.52]	[26.73; 30.51]	[23.56; 27.15]	[21.11; 24.02]	[24.14; 27.33]	[22.80; 26.49]	
< 3 hours a day in the week	[73.43; 77.26]	[74.24; 77.60]	[70.78; 74.63]	[72.03; 76.01]	[71.48; 75.60]	[69.49; 73.27]	[72.85; 76.44]	[75.98; 78.89]	[72.67; 75.86]	[73.51; 77.20]	
Smoking	[12.73; 17.07]	[12.54; 16.25]	[11.63; 16.93]	[10.84; 16.37]	[10.15; 14.39]	[9.22; 13.67]	[8.94; 12.9]	[8.42; 12.72]	[8.41; 12.24]	[7.94; 12.79]	**<0.001**
Alcohol abuse	[14.75;	[16.13;	[16.13;	[14.85;	[16.96;	[14.96;	[14.82;	[15.22;	[17.18;	[17.7;	**<0.001**

	20.01]	21.00]	20.22]	18.34]	20.00]	17.92]	18.34]	19.33]	21.16]	20.49]	
In natura foods consumption											**<0.001**
<2 groups per day	[55.93;	[56.47;	[56.69;	[54.40;	[53.98;	[51.84;	[52.34;	[51.77;	[54.79;	[56.04;	
	63.30]	64.18]	64.44]	61.61]	61.35]	59.19]	59.21]	59.01]	62.11]	63.19]	
≥2 groups per day	[36.70;	[35.82;	[35.56;	[38.39;	[38.65;	[40.81;	[40.79;	[40.99;	[37.89;	[36.81;	
	44.07]	43.53]	43.31]	45.60]	46.02]	48.16]	47.66]	48.23]	45.21]	43.96]	
Soft drinks consumption											**<0.001**
≥5 days a week	[23.10;	[23.19;	[23.86;	[24.11;	[22.72;	[20.70;	[18.03;	[15.66;	[13.48;	[11.71;	
	30.01]	28.93]	29.96]	31.14]	29.49]	26.06]	23.89]	22.77]	20.04]	18.10]	
<5 days a week	[69.99;	[71.07;	[70.04;	[68.86;	[70.51;	[73.94;	[76.11;	[77.23;	[79.96;	[81.90;	
	76.90]	76.81]	76.14]	75.89]	77.28]	79.30]	81.97]	84.34]	86.52]	88.29]	
Physical activity practice											**<0.001**
<150 minutes per week	[54.60;	[53.56;	[53.34;	[51.76;	[49.91;	[50.17;	[48.13;	[44.55;	[42.91;	[42.79;	
	59.23]	59.75]	59.79]	57.33]	55.98]	55.48]	52.89]	53.02]	49.88]	50.43]	
≥150 minutes per week	[40.77;	[40.25;	[40.21;	[42.67;	[44.02;	[44.52;	[47.11;	[46.98;	[50.12;	[49.57;	

45.40]	46.44]	46.66]	48.24]	50.09]	49.83]	51.87]	55.45]	57.09]	57.21]

P-values obtained from Pearson's chi-square test among years of the survey. 95%CI = 95% confidence interval.

Table S1. Confidence intervals (95%CI) of sociodemographic and health characteristics and behaviors of participants, according to year of survey. Brazil, 2008-2017.

Characteristics	Confidence intervals [95%CI], weighted										*P*
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Sociodemographic characteristics											
Age											**<0,001**
18-39 years	[50.36; 55.32]	[49.42; 54.64]	[49.14; 54.59]	[48.58; 54.00]	[48.34; 53.28]	[47.86; 52.67]	[47.51; 52.00]	[46.87; 52.00]	[46.76; 51.56]	[46.39; 51.07]	
40-59 years	[31.93; 33.43]	[32.14; 34.26]	[31.99; 33.87]	[32.25; 34.39]	[32.76; 34.42]	[32.80; 34.46]	[33.31; 34.64]	[32.89; 34.50]	[32.95; 34.58]	[32.81; 34.60]	
≥ 60 years	[12.78; 16.36]	[13.18; 16.51]	[13.45; 17.14]	[13.71; 17.25]	[13.98; 17.38]	[14.47; 17.90]	[14.68; 17.99]	[15.08; 18.84]	[15.45; 18.85]	[15.86; 19.43]	
Biological sex											0.199
Female	[53.53; 54.23]	[53.54; 54.23]	[53.57; 54.24]	[53.58; 54.24]	[53.59; 54.25]	[53.61; 54.25]	[53.62; 54.26]	[53.63; 54.27]	[53.65; 54.29]	[53.66; 54.30]	

Male	[45.77; 46.47]	[45.77; 46.46]	[45.76; 46.43]	[45.76; 46.42]	[45.75; 46.41]	[45.75; 46.39]	[45.74; 46.38]	[45.73; 46.37]	[45.71; 46.35]	[45.7; 46.34]	
Ethnicity/skin color											**<0,001**
White	[32.82; 45.61]	[32.9; 45.95]	[33.54; 46.76]	[35.57; 51.77]	[33.72; 47.82]	[34.45; 48.85]	[33.23; 46.66]	[33.72; 48.29]	[35.97; 51.55]	[34.83; 49.60]	
Black to brown and indigenous	[54.39; 67.18]	[54.05; 67.10]	[53.24; 66.46]	[48.23; 64.43]	[52.18; 66.28]	[51.15; 65.55]	[53.34; 66.77]	[51.71; 66.28]	[48.45; 64.03]	[50.40; 65.17]	
Marital status											**<0,001**
Married/stable union	[47.58; 52.81]	[49.05; 53.52]	[48.91; 54.30]	[46.91; 51.71]	[48.72; 53.19]	[46.90; 50.79]	[47.04; 53.57]	[44.10; 51.24]	[43.98; 51.62]	[42.75; 49.94]	
Single/divorced/widowed	[47.19; 52.42]	[46.48; 50.95]	[45.70; 51.09]	[48.29; 53.09]	[46.81; 51.28]	[49.21; 53.10]	[46.43; 52.96]	[48.76; 55.90]	[48.38; 56.02]	[50.06; 57.25]	
Educational attainment											**<0,001**
0-8 years	[41.26; 46.03]	[39.66; 44.32]	[38.23; 42.96]	[36.12; 41.34]	[34.53; 39.06]	[34.01; 39.09]	[33.84; 38.09]	[32.26; 36.98]	[30.21; 34.86]	[28.84; 32.83]	

9-11 years	[32.39; 37.14]	[33.10; 38.69]	[33.22; 38.64]	[33.95; 39.75]	[35.60; 41.58]	[34.92; 40.31]	[36.12; 40.15]	[35.63; 40.66]	[33.49; 38.32]	[35.07; 39.54]	
≥ 12 years	[20.06; 23.33]	[20.44; 24.03]	[21.49; 25.72]	[22.86; 26.22]	[23.06; 26.40]	[24.31; 27.58]	[24.54; 27.41]	[25.40; 29.28]	[29.84; 33.49]	[29.79; 34.13]	
Occupation											0.014
Working	[64.01; 66.69]	[62.42; 65.97]	[63.03; 67.48]	[63.08; 68.29]	[63.29; 68.45]	[62.79; 66.18]	[62.24; 65.81]	[59.92; 65.13]	[61.25; 67.8]	[62.35; 65.89]	
Not working	[33.31; 35.99]	[34.03; 37.58]	[32.52; 36.97]	[31.71; 36.92]	[31.55; 36.71]	[33.82; 37.21]	[34.19; 37.76]	[34.87; 40.08]	[32.20; 38.75]	[34.11; 37.65]	
Health characteristics											
Overweight	[43.64; 46.14]	[44.49; 47.48]	[46.64; 49.76]	[47.62; 50.02]	[49.85; 52.16]	[49.65; 51.89]	[51.46; 53.58]	[52.39; 55.45]	[52.66; 54.97]	[52.58; 55.41]	**<0,001**
Obesity	[13.18; 14.15]	[13.32; 15.42]	[14.10; 16.09]	[15.27; 16.84]	[16.38; 18.45]	[16.41; 18.71]	[16.97; 18.92]	[17.42; 20.58]	[18.03; 19.86]	[18.08; 19.79]	**<0,001**
Diabetes diagnosis	[5.44;	[5.59;	[6.02;	[5.88;	[6.37;	[6.10;	[7.17;	[6.90;	[8.14;	[7.10;	**<0,001**

	7.09]	7.18]	7.63]	6.74]	8.51]	7.73]	8.99]	7.92]	9.80]	8.19]	
Hypertension diagnosis	[23.07; 27.71]	[23.94; 27.12]	[22.52; 26.09]	[22.22; 26.56]	[22.51; 26.24]	[22.50; 25.75]	[23.52; 26.18]	[22.93; 26.89]	[23.68; 27.84]	[22.12; 26.55]	0.093
Poor health status	[4.28; 4.89]	[4.24; 5.11]	[4.04; 4.95]	[4.00; 5.14]	[4.58; 5.54]	[4.58; 5.20]	[3.92; 5.02]	[4.38; 5.23]	[4.16; 4.64]	[3.85; 4.36]	0.083
Health behaviors											
Screen-based sedentary behavior											**<0.001**
≥ 3 hours a day in the week	[22.74; 26.57]	[22.40; 25.76]	[25.37; 29.22]	[23.99; 27.97]	[24.40; 28.52]	[26.73; 30.51]	[23.56; 27.15]	[21.11; 24.02]	[24.14; 27.33]	[22.80; 26.49]	
< 3 hours a day in the week	[73.43; 77.26]	[74.24; 77.60]	[70.78; 74.63]	[72.03; 76.01]	[71.48; 75.60]	[69.49; 73.27]	[72.85; 76.44]	[75.98; 78.89]	[72.67; 75.86]	[73.51; 77.20]	
Smoking	[12.73; 17.07]	[12.54; 16.25]	[11.63; 16.93]	[10.84; 16.37]	[10.15; 14.39]	[9.22; 13.67]	[8.94; 12.9]	[8.42; 12.72]	[8.41; 12.24]	[7.94; 12.79]	**<0.001**
Alcohol abuse	[14.75; 20.01]	[16.13; 21.00]	[16.13; 20.22]	[14.85; 18.34]	[16.96; 20.00]	[14.96; 17.92]	[14.82; 18.34]	[15.22; 19.33]	[17.18; 21.16]	[17.7; 20.49]	**<0.001**

In natura foods consumption											**<0.001**
<2 groups per day	[55.93; 63.30]	[56.47; 64.18]	[56.69; 64.44]	[54.40; 61.61]	[53.98; 61.35]	[51.84; 59.19]	[52.34; 59.21]	[51.77; 59.01]	[54.79; 62.11]	[56.04; 63.19]	
≥2 groups per day	[36.70; 44.07]	[35.82; 43.53]	[35.56; 43.31]	[38.39; 45.60]	[38.65; 46.02]	[40.81; 48.16]	[40.79; 47.66]	[40.99; 48.23]	[37.89; 45.21]	[36.81; 43.96]	
Soft drinks consumption											**<0.001**
≥5 days a week	[23.10; 30.01]	[23.19; 28.93]	[23.86; 29.96]	[24.11; 31.14]	[22.72; 29.49]	[20.70; 26.06]	[18.03; 23.89]	[15.66; 22.77]	[13.48; 20.04]	[11.71; 18.10]	
<5 days a week	[69.99; 76.90]	[71.07; 76.81]	[70.04; 76.14]	[68.86; 75.89]	[70.51; 77.28]	[73.94; 79.30]	[76.11; 81.97]	[77.23; 84.34]	[79.96; 86.52]	[81.90; 88.29]	
Physical activity practice											**<0.001**
<150 minutes per week	[54.60; 59.23]	[53.56; 59.75]	[53.34; 59.79]	[51.76; 57.33]	[49.91; 55.98]	[50.17; 55.48]	[48.13; 52.89]	[44.55; 53.02]	[42.91; 49.88]	[42.79; 50.43]	
≥150 minutes per week	[40.77; 45.40]	[40.25; 46.44]	[40.21; 46.66]	[42.67; 48.24]	[44.02; 50.09]	[44.52; 49.83]	[47.11; 51.87]	[46.98; 55.45]	[50.12; 57.09]	[49.57; 57.21]	

P-values obtained from Pearson’s chi-square test among years of the survey. 95%CI = 95% confidence interval.