

Temporal trend of sedentary behavior in adolescents: A 10-year analysis

Tendência temporal do comportamento sedentário em adolescentes: uma análise de 10 anos

Tendencia temporal del comportamiento sedentario en adolescentes: un análisis de 10 años

Jorge Bezerra (<https://orcid.org/0000-0002-9935-4508>)^{1,2}
Rodrigo Antunes Lima (<https://orcid.org/0000-0002-7778-2616>)^{1,3}
Francys Paula Cantieri (<https://orcid.org/0000-0002-1132-4540>)^{1,2}
Rafael Miranda Tassitano (<https://orcid.org/0000-0002-2713-8670>)⁴
José Cazuza de Farias Júnior (<https://orcid.org/0000-0002-1082-6098>)²
Mauro Virgílio Gomes de Barros (<https://orcid.org/0000-0003-3165-0965>)¹
Fernanda Cunha Soares (<https://orcid.org/0000-0001-6465-3164>)^{1,5,6}

Abstract The aim of the study was to describe the temporal trend of excessive exposure to sedentary behaviors (SB) and analyze its relationship with sociodemographic factors in adolescents. This study was collected in three waves: 2006 (n = 4,207); 2011 (n = 6,264) and 2016 (n = 6,026). Excessive exposure to sedentary behavior (SB) was operationalized from the following indicators: i) watching television (TV); and ii) SB (except TV). Differences in the prevalence of excessive exposure to sedentary behavior indicators between the collection waves were tested through the intersection of confidence intervals (95%CI). Binary logistic regression was used to assess possible changes in the prevalence of excessive exposure to TV and SB and to analyze its association with sociodemographic factors. Over 10 years, the prevalence of excessive exposure to TV decreased by 23.0 percentage points (79.1% vs. 56.1%), being higher in boys (81.3%). Excessive exposure to SB increased by 15.5 percentage points (62.7%; 95%CI: 61.5-64.0 vs. 78.2%; 95%CI: 77.1-79.4), with a similar magnitude between boys and girls. Excessive exposure to TV is on a downward trend, while that of SB has an upward trend. The temporal behavior of excessive exposure to TV and SB were similar in adolescents of different sociodemographic characteristics in both genders.

Keywords Youth, Physical activity, Epidemiology

Resumo O objetivo do estudo foi descrever a tendência temporal da exposição excessiva a comportamento sedentário (CS) e analisar sua relação com fatores sociodemográficos em adolescentes. Este estudo foi composto em três levantamentos: 2006 (n = 4.207); 2011 (n = 6.264) e 2016 (n = 6.026). A exposição excessiva ao comportamento sedentário (CS) foi operacionalizada a partir dos indicadores: a) assistir televisão (TV); e b) CS (exceto TV). As diferenças nas prevalências de exposição excessiva a comportamento sedentário entre os levantamentos foram testadas por intervalos de confiança (IC95%). A regressão logística binária foi utilizada para avaliar possíveis alterações na prevalência de exposição excessiva à TV e ao CS e sua associação com fatores sociodemográficos. Ao longo de 10 anos a prevalência de exposição à TV diminuiu 23,0 pontos percentuais (79,1% vs. 56,1%), sendo maior nos meninos (81,3%). A exposição excessiva ao CS aumentou 15,5 pontos percentuais (62,7%; IC95%: 61,5-64,0 vs. 78,2%; IC95%: 77,1-79,4), com magnitude semelhante entre meninos e meninas. A exposição excessiva à TV apresenta tendência decrescente, enquanto a do CS apresenta tendência crescente. A tendência temporal da exposição excessiva à TV e ao CS foi semelhante em adolescentes de diferentes características sociodemográficas em ambos os sexos.

Palavras-chave Juventude, Atividade física, Epidemiologia

Resumen El estudio tuvo como objetivo describir la tendencia temporal de la exposición excesiva a conductas sedentarias (CS) y analizar su relación con factores sociodemográficos en adolescentes. Este estudio se recopiló en tres encuestas: 2006 (n=4207); 2011 (n=6264) y 2016 (n=6026). La exposición excesiva a conductas sedentarias (CS) se operacionalizó con base en los siguientes indicadores: a) mirar televisión (TV); y b) CS (excepto TV). Las diferencias en la prevalencia de exposición excesiva al comportamiento sedentario entre encuestas se probaron utilizando intervalos de confianza (IC del 95%). Se utilizó regresión logística binaria para evaluar posibles cambios en la prevalencia de exposición excesiva a TV y CS y su asociación con factores sociodemográficos. En 10 años, la prevalencia de exposición a la televisión disminuyó 23,0 puntos porcentuales (79,1% frente a 56,1%), siendo mayor en los niños (81,3%). La exposición excesiva a CS aumentó 15,5 puntos porcentuales (62,7%; IC95%: 61,5-64,0 vs. 78,2%; IC95%: 77,1-79,4), con una magnitud similar entre niños y niñas. La exposición excesiva a la televisión muestra una tendencia decreciente, mientras que la de CS muestra una tendencia creciente. La tendencia temporal de exposición excesiva a la televisión y a la informática fue similar en adolescentes con diferentes características sociodemográficas de ambos sexos.

Palabras clave Juventud, Actividad física, Epidemiología

¹Universidade de Pernambuco, Escola Superior de Educação Física. Av. Arnóbio Marques, 310 Campus Santo Amaro Santo Amaro 50100130 - Recife, PE - Brasil

jorge.bezerra@upe.br

²Universidade Federal da Paraíba. Jardim Universitário, s/n, Castelo Branco, João Pessoa PB Brasil.

³Research, Innovation and Teaching Unit, Parc Sanitari Sant Joan de Déu, Sant Boi de Llobregat, Spain.

⁴Department of Health and Kinesiology, University of Illinois Urbana-Champaign, United States.

⁵Universidade Federal do Rio Grande do Norte. Campo Universitário, Lagoa Nova, Natal RN Brasil.

⁶Department of Dental Medicine, Division of Orthodontics and Pediatric Dentistry, Karolinska Institutet, Stockholm, Sweden.

Introduction

Excessive exposure to sedentary behaviors (SB) has been considered a risk factor for health in different cycles of life, including in adolescents¹, being associated with obesity², cardiometabolic risk factors³, cardiovascular diseases, diabetes³, depressive symptoms, anxiety symptoms, low self-esteem, suicidal ideation, loneliness, stress and psychological suffering⁴. Children and adolescents who spend more than two hours a day in SB are more likely to be overweight, have higher levels of cholesterol, smoke and have poor physical condition as adults^{5,6}.

Global recommendations and proposals in several countries suggest that children and adolescents should limit the time they spend per day in SB, particularly in recreational activities in front of the screens⁷, in addition to practicing at least 60 minutes of physical activity per day on average; however, the evidence is insufficient to quantify a SB⁷ threshold.

The effects of changes in social organization and unplanned urbanization of cities have contributed to the increase in time spent in SB, increasing the time spent sitting at work and while commuting. In addition to these factors, the spread and mass use of electronic devices, digital resources and applications and social networks have contributed to a wide digital/virtual transition. Television (TV), which previously was the only screen activity for most teenagers, now competes with computers, smartphones, tablets, and video games, which all contribute to the increase in time spent in sedentary behavior, especially in free time⁸. Even though access to digital technology in low-income and lower-middle-income countries is not massive compared to that observed in high-income countries, it is still occurring. For example, data from the 2018 National Survey by Household Samples⁹ in Brazil showed that less than half (41%) of the population had a computer and 12% had a tablet. However, 79.4% reported using the internet and 99.2% of these reported that a cell phone was used for this purpose⁹.

The time people spend awake has been increasingly occupied with sedentary behaviors: computer use, social networks, communication apps, games, teaching apps, sitting in the classroom, commuting from one place to another, and watching TV¹⁰. Studies show that teenagers occupy on average about 9 hours of their day in SB¹¹ and 7 hours in recreational media (screen time), of which 2.5 hours are

spent watching TV^{12,13}. Data from the National Adolescent Health Survey (*PeNSE*) showed that 78% of adolescents spent more than 2 hours watching TV on normal weekdays, and 56.1% spent more than 3 hours watching TV, using a computer, playing video games or other seated activities¹⁴.

Despite the solid body of evidence indicating that the proportion of adolescents exposed to SB is high¹⁵, and that there is an increase in other types of SB¹⁶, there are few studies evaluating the temporal trend of excessive TV exposure separately from other SB, especially in Brazil. Brazil has been going through an economic and social evolution since the last decade, with a better distribution of income in the population and in turn an increase in the purchasing power (acquisition of refrigerator, TV, computer, cell phone, among others) in the general population¹⁷. Over the last 10 years there have been changes which have had an impact on the time adolescents spend in SB: although there are indications that some SBs are in the process of declining in the population, the time spent sitting throughout the day has been increasing due to the insertion of new habits into daily life such as the use of cell phones, video games, computers, social networks and communication applications¹⁴. Despite these changes, studies with representative samples that assess the temporal trend of excessive time watching TV and other SB over time in adolescents aged 14 to 19 years, especially in low- and middle-income countries, are scarce.

Thus, the objective of the study was to describe the temporal trend of excessive exposure to TV and SB and to analyze the relationship of high exposure to sedentary behavior in different sociodemographic groups in a representative sample of adolescents aged 14 to 19 years of the Pernambuco state public education network from 2006 to 2016.

Method

This is a temporal trend study based on a data analysis of the “*Atitude*” research project – “Practice of Physical Activities and Health Risk Behaviors in High School Students in the State of Pernambuco: A Temporal Trend Study (2006-2011-2016)”. This project was approved by the Ethics Committee for Research with Human Beings at the University of Pernambuco (Opinion No. 1630.937).

The target population was limited to stu-

dents enrolled in public high schools in Pernambuco. The number of students enrolled in these schools ranged from 367,813 in 2011 to 288,770 in 2016, respectively representing 88.9% and 88.1% of students enrolled in secondary education throughout the state of Pernambuco. Next, the following parameters were adopted in calculating the sample size: confidence interval of 95%, prevalence of 50% (this prevalence value was chosen because it is a study with multiple risk behaviors, and because it produces the highest expected prevalence for the same maximum acceptable error), maximum acceptable error in 2006 was 3 percentage points, and 2 percentage points in 2011 and 2016. A design effect was adopted (deff) equal to 4 in 2006, and equal to 2 in 2011 and 2016. The minimum sample size was increased by 20% every year to compensate for possible losses and/or refusals. The number of schools selected for the study was 76, 86 and 77 in 2006, 2011 and 2016, respectively.

A total of 6,031 adolescents were interviewed in 2006, while 6,845 and 6,338 were included in the 2011 and 2016 surveys, respectively. Adolescents outside the age group 14-19 years old and those who did not report valid data for sedentary behavior were excluded. Thus, data from 4,191, 6,254 and 5,930 adolescents were analyzed in the three surveys, respectively (Figure 1). Adolescents with mental disabilities who were unable to complete the questionnaire or adolescents who missed the data collection day were excluded from the study.

A double-stage cluster sampling process was used, with the first cluster being the school and the second the class. The sampling took into account the sizes of schools, as follows: size I (small) – less than 200 students; size II (medium) – 200 to 499 students; and size III (large) – more than 500 students. Students in the 2006 and 2011 surveys were grouped according to the study period: day and night. Students enrolled in the morning, afternoon and full-time shifts were grouped into the “day shift student” category.

Data were collected through the “Global School-based Student Health Survey” (GSHS) questionnaire proposed by the World Health Organization (WHO, 2005). This questionnaire was translated and adapted for this study, with reproducibility of the questions with a Kappa agreement index ranging from 0.62 to 0.80. The questionnaire was applied in the classroom without the presence of teachers through the collective interview technique, in which the

researcher read the question and waited for the adolescents to respond.

Training was carried out with the collection team members before beginning the data collection in the three surveys to standardize the questionnaire application and carry out anthropometric and hemodynamic measurements. The same protocol was used to collect data from the three surveys.

Two indicators of overexposure to SB (>2 hours/day)^{18,19} were analyzed: i) overexposure to TV (time watching TV on school days (Monday to Friday) and on weekends (Saturday and Sunday)). The combination of these variables was categorized into ≤ 2 hours and > 2 hours a day; and ii) excessive exposure to SB (except TV) (time spent sitting, talking with friends, playing cards or dominoes, talking on the phone, driving or as a passenger, reading or studying and time spent using a computer and/or playing video games?). The variable was also categorized into ≤ 2 hours and > 2 hours a day.

Excessive exposure to TV in the 2006 and 2011 surveys was categorically measured for both the week and the weekend. A combination of weekday and weekend results was performed for results purposes, considering ≤ 2 hours and > 2 hours a day when analyzing weekdays and weekends together. Behavior was continuously assessed in the 2016 survey, and subsequently categorized in the same way.

Excessive exposure to SB (except TV) was not assessed in the 2006 survey, while excessive time spent in SB (except TV) was categorically measured in 2011. Such behavior was continuously assessed in the 2016 survey, and later categorized into ≤ 2 hours and > 2 hours.

The sociodemographic factors evaluated were age group (14-15 years; 16-17 years; 18-19 years), maternal education (≤ 7 years, 8-10 years, 11 years, > 12 years or more), area of residence (urban, rural), worked (yes, no), has a computer connected to the internet (yes, no), high school grade (1st, 2nd or 3rd), shift (day (morning and afternoon), full-time, night).

The sampling plan (sampling by clusters, multiple stages) was considered in all statistical analyses incorporating the prefix “svyset” into the syntax, a resource available in Stata. Descriptive analysis included absolute and relative frequency distribution. Differences in the prevalence of excessive exposure to TV and SB between the data collection waves were tested through the intersection of 95% confidence intervals (95%CI).

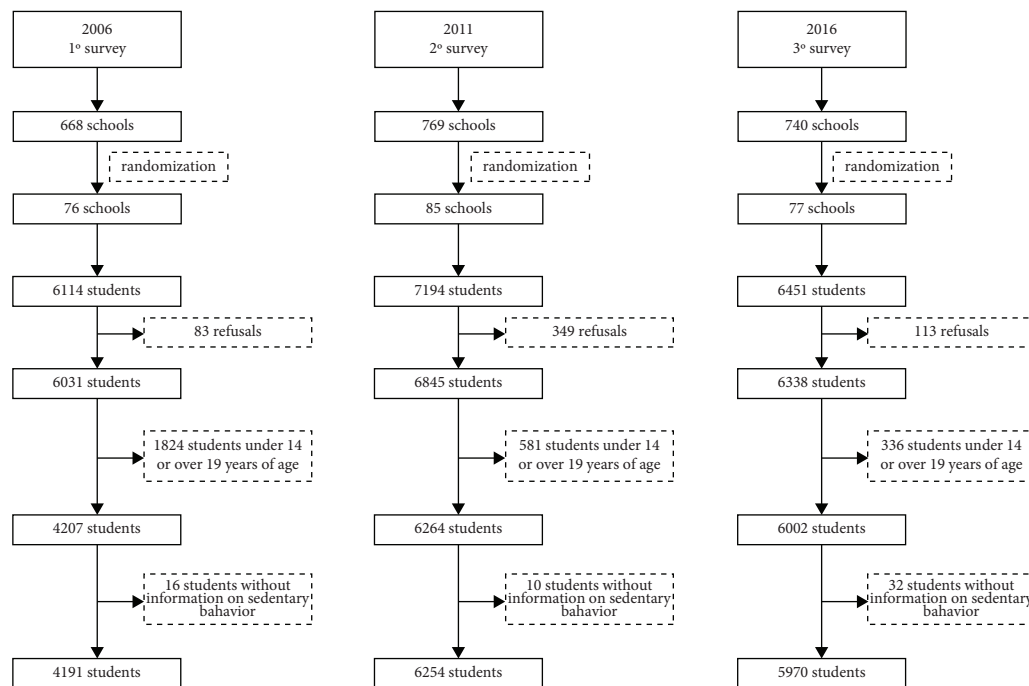


Figure 1. Flowchart of the study sample of the three Project “Attitude” surveys carried out in 2006, 2011 and 2016.

Binary logistic regression was used to assess the odds ratio of overexposure (no = 0 and yes = 1) to TV comparing the year 2016 to 2006 and the odds of overexposure to SB (except TV) comparing the year from 2016 to 2011. Binary logistic regression was also used to analyze whether demographic factors were associated with excessive exposure to these behaviors during this period. An odds ratio equal to 1.0 reflects stability in excessive exposure to sedentary behavior over the 10-year period; values between 0 and 0.99 indicate a decrease in the chance of having excessive exposure to sedentary behavior over time; results above 1.0 show an increased chance of having excessive exposure to sedentary behavior over time. All analyzes were stratified by gender. The variance related to clusters (region and school) was considered in the regression models, and the intraclass correlation coefficient (ICC) of each model was calculated. The ICCs of both clusters were all less than 3%.

Results

Differences in the sample profile were observed between the three surveys: an increase in the proportion of adolescents aged 16 to 17 years old (48.5% in 2006 to 58.7% in 2016), of mothers with higher education (6.4% in 2006 to 16.6% in 2016), and computer availability at home (10.7% in 2006 and 58.9% in 2016). Most adolescents in all surveys were female (ranging from 59.8% to 55.2%) and lived in urban areas (approximately 80%). The proportion of students with a computer at home increased in both genders compared to 2006 and 2016 (Table 1): 13.1% to 64.0% in boys; and from 9.1% to 54.6% in girls.

Excessive exposure to television

The prevalence of overexposure to TV decreased by 23.0 percentage points in 10 years (2006-2016): 79.1%; 95%CI: 77.8-80.4 vs. 56.1%; 95%CI: 54.7-57.5. The decrease in boys was 28.2 percentage points (81.3%; 95%CI: 79.3-83.2 vs. 53.1%; 95%CI: 51.0-55.2) and in girls it was 19.2 percentage points (77.7%; 95%CI: 76.0-79.4 vs.

58.5; 95%CI: 56.6-60.4) (Figure 2). Over the 10 years of the analyzed period, the chance of an adolescent having excessive exposure to TV in 2016 compared to 2006 was 0.49 (95%CI: 0.45-0.53) in males and 0.62 (95%CI: 0.58-0.66) in females.

Table 2 shows the prevalence of excessive exposure to TV time in each survey based on sociodemographic characteristics and stratified by gender. The prevalence of excessive TV time in both genders decreased in all sociodemographic subgroups analyzed (dwelling area, age, occupation, owning a computer, maternal education, school shift and adolescent grade level). Teenagers of both genders who had a computer

and studied full-time had a greater magnitude of reduced excessive TV time than those who did not have a computer and studied during the daytime, respectively. In addition, adolescents of both genders who were 14 to 15 years of age and those who lived in urban areas also had a greater magnitude of reduced excessive exposure to TV time when compared to 18 to 19 years of age and those who lived in the countryside. There was a greater magnitude of reduced excessive exposure to TV time among girls for those who worked compared to those who did not work (Table 2).

Excessive exposure to sedentary behavior (except TV)

Table 1. Characteristics of high school students from the Pernambuco state public school network in the surveys of 2006, 2011 and 2016, stratified by gender.

Variables	2006				2011				2016			
	Boys		Girls		Boys		Girls		Boys		Girls	
	(n= 1,686)		(n= 2,505)		(n= 2,517)		(n= 3,737)		(n= 2,659)		(n= 3,271)	
	n	%	n	%	n	%	n	%	n	%	n	%
Residence												
Urban	1,311	78.2	1,977	79.5	1,871	74.5	2,766	74.5	2,124	80.5	2,594	79.6
Rural	366	21.8	510	20.5	639	25.5	945	25.5	514	19.5	665	20.4
Age range (years)												
14-15	254	15.1	577	23.0	460	18.3	886	23.8	517	19.5	804	24.7
16-17	841	49.9	1,195	47.7	1,345	53.5	1,988	53.3	1,569	59.2	1,906	58.5
18-19	591	35.0	733	29.3	710	28.2	856	22.9	565	21.3	548	16.8
Work												
Yes	1,254	75.1	2,171	87.0	1,706	68.0	3,137	84.2	2,170	82.3	2,968	91.0
No	416	24.9	323	13.0	803	32.0	588	15.8	467	17.7	294	9.0
Have a computer at home												
Yes	220	13.1	226	9.1	1,174	46.7	1,390	37.3	1,694	64.0	1,781	54.6
No	1,457	86.9	2,267	90.9	1,338	53.3	2,340	62.7	954	36.0	1,478	45.4
Mother's education												
Elementary	1,085	69.3	1,765	74.4	1,319	60.4	2,167	67.7	944	42.7	1,348	48.6
Incomplete high school	81	5.2	105	4.5	119	5.5	167	5.2	140	6.3	143	5.2
Complete high school	271	17.3	375	15.8	502	23.1	603	18.8	721	32.6	863	31.1
Post-secondary	127	8.2	126	5.3	240	11.0	265	8.3	408	18.4	418	15.1
School shift												
Night	908	53.9	1,502	60.0	1,390	55.1	2,122	56.8	1,042	39.2	1,281	39.2
Day	777	46.1	1,000	40.0	774	30.7	979	26.2	409	15.4	453	13.8
Full-time	-	-	-	-	358	14.2	636	17.0	1,208	45.4	1,537	47.0
High School year												
1st year	769	45.9	1,092	43.8	976	38.8	1,353	36.2	1,027	38.6	1,254	38.3
2nd year	524	31.2	808	32.4	804	32.0	1,215	32.5	947	35.6	1,137	34.8
3rd year	384	22.9	595	23.8	734	29.2	1,167	31.2	685	25.8	880	26.9

* 40 adolescents did not answer about their sex

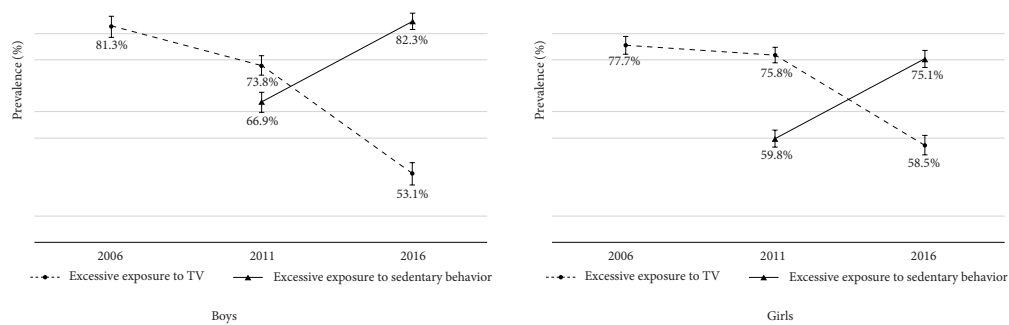


Figure 2. Temporal trend in the prevalence of excessive exposure to TV (> 2 hours) and sedentary behavior - except TV (> 2 hours) in high school adolescents in the Pernambuco state education network from 2006 to 2016, stratified by gender: boys, girls.

The prevalence of excessive exposure to SB (except TV) increased by 15.5 percentage points in 5 years (62.7%; 95%CI: 61.5-64.0 vs. 78.2%; 95%CI: 77.1- 79.4). The increase in boys was 15.4 percentage points (66.9%; 95%CI: 64.9-68.8 vs. 82.3%; 80.7-83.9), while the increase in girls was 15.3 percentage points (59.8%; 95%CI: 58.2-61.5 vs. 75.1%; 95%CI: 73.5-76.7) (Figure 2). The chance of an adolescent having excessive exposure to SB (except TV) in 2016 compared to 2011 was 2.36 (95%CI: 2.04-2.73) in males, and 2.07 (95%CI: 1.84-2.32) in females.

Table 3 shows the prevalence of overexposure in SB (except TV) in the 2 surveys (2011 and 2016) for the different sociodemographic characteristics stratified by gender. The prevalence of excessive time spent in SB (except TV) increased in both genders, regardless of sociodemographic characteristics (zone of residence, age, occupation, owning a computer, maternal education, shift and school grade). The magnitude of the increase in both genders was greater in rural residents and in those who studied full-time. The magnitude of the increase in excessive time in SB (except TV) in girls was greater in those who had a computer compared to those who did not (Table 3).

Discussion

The results of the present study revealed that the prevalence of excessive exposure to TV showed a significant decline for adolescents of both genders in 10 years, but slightly higher in males; in contrast, excessive exposure to SB (except TV) increased in both boys and girls in 5 years. Hav-

ing a computer and studying full-time showed a greater magnitude of reduced excessive time spent watching TV in both sexes. Being younger and living in the urban area also showed a greater magnitude of reduced excessive exposure to TV time in boys when compared to being older and living in rural areas. This result was also verified in girls who worked. The increase in overexposure in SB (except TV) magnitude was greater in rural residents and those who studied full-time in both genders.

Over the course of 10 years, it was found that the prevalence of excessive TV exposure decreased, reinforcing the phenomenon that has been observed in other studies such as a survey conducted in the United States by the National Health and Nutrition Examination Survey (NHANES), in which there was a significant decrease in the average TV exposure per day over time. Boys showed the greatest reduction in the average time exposed to TV, from 2.2 hours of TV exposure per day to 1.6 hours²⁰. The decrease in the average number of hours per day of TV exposure between 2002 and 2010 in other western countries was 18.6 minutes for girls and 24.0 minutes for boys^{19,20}. The prevalence of young people in Brazil who watched TV for two hours or more a day between 2001 and 2011 decreased from 76.8% to 61.5%²³.

In contrast, the prevalence of excessive exposure to SB (except TV) increased in adolescents in Pernambuco. Recent findings on total screen time using data from 2000 to 2010 among teenagers in the Czech Republic found a decrease in TV time which was replaced by an increase in computer use²⁴. There was an increase in the prevalence of adolescents who

Table 2. Temporal trend in the prevalence of excessive TV exposure (2006 – 2011 – 2016) and the odds ratio of excessive TV exposure between 2016 and 2006 in high school students according to demographic variables, stratified by gender.

Variables	Excessive exposure to TV (> 2 hours)					
	Boys			Girls		
	2006	2011	2016	OR between 2016 and 2006 ‡ (95%CI)	2006	2011
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
Residence						
Urban	82.1 (79.9-84.3)	73.9 (71.7-76.0)	50.7 (48.3-53.0)	0.45 (0.41-0.49)	78.9 (77.0-80.7)	75.4 (73.6-77.1)
Rural	78.3 (73.9-82.7)	73.9 (70.1-77.6)	62.8 (58.2-67.5)	0.67 (0.57-0.80)	72.8 (68.8-76.8)	77.3 (74.4-80.3)
Age range (years)						
14-15	87.9 (83.7-92.1)	83.2 (79.4-86.9)	57.2 (52.4-62.0)	0.37 (0.30-0.47)	82.8 (79.6-86.0)	80.2 (77.4-83.0)
16-17	81.2 (78.5-84.0)	72.6 (70.1-75.2)	51.2 (49.4-54.9)	0.48 (0.44-0.54)	77.3 (74.8-79.7)	76.3 (74.3-78.3)
18-19	78.3 (74.8-81.8)	70.5 (67.0-74.1)	52.4 (47.8-57.0)	0.55 (0.48-0.63)	74.3 (71.1-77.5)	70.0 (66.7-73.3)
Work						
Yes	82.9 (80.7-85.1)	76.8 (74.7-79.0)	54.3 (51.9-56.6)	0.47 (0.43-0.51)	79.7 (77.9-81.4)	77.0 (75.4-78.6)
No	75.8 (71.6-80.0)	67.8 (64.4-71.2)	48.3 (43.4-53.2)	0.54 (0.46-0.62)	64.6 (59.2-69.9)	69.3 (65.4-73.2)
Have a computer at home						
Yes	84.5 (79.5-89.4)	71.8 (69.1-74.6)	50.3 (47.7-52.9)	0.41 (0.36-0.47)	84.0 (79.1-88.8)	76.1 (73.7-78.4)
No	80.8 (78.7-82.9)	75.9 (73.4-78.4)	58.0 (54.4-61.6)	0.58 (0.52-0.64)	76.9 (75.2-78.7)	75.7 (73.9-77.6)
School shift						
Day	84.9 (82.5-87.3)	75.9 (73.5-78.4)	52.8 (49.4-56.2)	0.43 (0.38-0.48)	80.3 (78.2-82.4)	76.5 (74.5-78.5)
Night	77.2 (74.2-80.3)	68.8 (65.3-72.3)	53.4 (48.0-58.7)	0.59 (0.51-0.67)	73.8 (71.0-76.6)	71.4 (68.4-74.5)
Full-time	-	77.0 (72.5-81.6)	52.9 (49.9-55.9)	0.33 (0.25-0.44)	-	79.9 (76.5-83.2)
High School year						
1st year	79.6 (76.6-82.7)	74.5 (71.5-77.6)	56.2 (52.7-59.7)	0.56 (0.49-0.63)	78.1 (75.5-80.6)	77.2 (74.8-79.7)
2nd year	83.9 (80.6-87.1)	75.0 (71.8-78.2)	50.9 (47.4-54.4)	0.42 (0.37-0.49)	79.7 (76.8-82.5)	76.6 (74.1-79.2)
3rd year	80.4 (76.3-84.5)	71.7 (68.3-75.1)	52.0 (47.9-56.0)	0.49 (0.42-0.57)	74.2 (70.6-77.8)	73.5 (70.8-76.2)

‡ Adjusted for mother's education in 2006

Table 3. Temporal trend of the prevalence of excessive exposure to sedentary behavior - except TV (2011 - 2016) and the odds ratio of excessive exposure to sedentary behavior in leisure between the years 2016 and 2006, among high school students according to demographic variables, stratified by gender.

Variables	Excessive exposure to sedentary behavior - except TV (> 2 hours)					
	Boys			Girls		
	2011	2016	OR between	2011	2016	OR between
	%(95%CI)	%(95%CI)	2016 and 2011 ¥	%(95%CI)	%(95%CI)	2016 and 2011 ¥
Residence						
Urban	72.3 (70.7-74.9)	84.5 (82.8-86.2)	2.07 (1.74-2.46)	65.7 (63.8-67.6)	77.6 (75.8-79.3)	1.83 (1.60-2.09)
Rural	46.7 (42.5-51.0)	74.2 (70.0-78.4)	3.34 (2.52-4.43)	40.7 (37.3-44.2)	66.2 (62.1-70.3)	2.89 (2.29-3.66)
Age range (years)						
14-15	70.9 (66.4-75.3)	83.6 (80.0-87.2)	2.14 (1.51-3.04)	59.9 (56.1-63.7)	80.3 (76.7-84.0)	2.76 (2.08-3.66)
16-17	69.0 (66.4-71.6)	82.8 (80.8-84.9)	2.22 (1.83-2.69)	69.4 (66.1-72.6)	76.5 (73.3-79.8)	2.17 (1.86-2.53)
18-19	59.9 (56.1-63.7)	80.3 (76.7-84.0)	2.75 (2.08-3.66)	49.6 (46.0-53.2)	71.3 (67.1-75.5)	2.57 (1.99-3.32)
Work						
Yes	73.3 (71.1-75.5)	83.7 (82.0-85.5)	1.91 (1.60-2.27)	61.8 (60.0-63.6)	76.3 (74.6-77.9)	2.02 (1.79-2.29)
No	53.0 (49.4-56.6)	76.6 (72.5-80.8)	2.97 (2.25-3.92)	48.8 (44.6-53.0)	65.0 (59.0-70.8)	1.97 (1.44-2.70)
Have a computer at home						
Yes	83.5 (81.2-85.7)	89.5 (87.9-91.0)	1.69 (1.33-2.13)	83.4 (81.3-85.4)	82.4 (80.5-84.3)	0.93 (0.76-1.14)
No	49.3 (46.4-52.2)	70.4 (67.1-73.8)	2.46 (2.02-3.01)	42.9 (40.7-45.1)	67.5 (64.8-70.2)	2.78 (2.39-3.25)
School shift						
Day	63.2 (60.5-65.9)	83.4 (80.8-85.9)	2.99 (2.40-3.73)	52.4 (50.2-54.7)	78.1 (75.5-80.6)	3.39 (2.83-4.05)
Night	43.3 (39.5-47.0)	76.8 (72.2-81.3)	4.41 (3.27-5.94)	38.3 (35.1-41.6)	65.1 (60.1-70.1)	3.05 (2.35-3.96)
Full-time	74.9 (70.3-79.5)	84.5 (82.3-86.7)	1.86 (1.38-2.52)	65.5 (61.6-69.4)	76.9 (74.6-79.1)	1.76 (1.42-2.19)
High school year						
1st year	63.8 (60.5-67.0)	82.1 (79.4-84.8)	2.68 (2.11-3.40)	59.1 (56.3-62.0)	76.1 (73.4-78.7)	2.23 (1.84-2.70)
2nd year	67.7 (64.4-71.1)	83.4 (80.8-86.0)	2.45 (1.91-3.15)	59.5 (56.6-62.4)	74.7 (71.9-77.5)	2.05 (1.69-2.50)
3rd year	69.7 (66.2-73.1)	81.2 (78.0-84.3)	1.91 (1.46-2.49)	60.9 (58.0-63.8)	74.5 (71.4-77.5)	1.92 (1.56-2.36)

¥ Adjusted for mother's education in 2006.

used the computer and/or video game for two hours or more a day in the southern region of Brazil, going from 37.9 to 60.6%²³.

This scenario indicates that the occupation of free time of adolescents watching TV has been decreasing and that this behavior does not represent the exposure of adolescents to SB, especially in isolation¹⁶. Despite this finding, it is noteworthy that the time watching TV is a sedentary behavior with particular implications for health and other behaviors, such as the consumption of unhealthy foods in front of the TV, violent behavior or certain behavior patterns disseminated in programs, advertisements which seek to increase unrestrained consumption, in addition to being associated with less PA practice time and affecting social relations between people. Although its measurement does not reflect sedentary behavior in general or screen time, studies which intend to assess the implications of watching TV should consider the measurement of this behavior.

The use of digital media, including interactive and social media, has grown substantially over the last decade. Traditional media, such as TV and radio, have been replaced by new technologies which promote interactive and social engagement and allow teenagers instant access to entertainment, information, knowledge and especially social contact²⁵. Digital technologies that promoted greater exposure to sedentary behavior in high-income countries^{26,27} were introduced in developing countries in recent years²⁸. The proportion of households with internet access in Brazil increased from 15% to 54% in 10 years (2006-2016). In addition, 13% of internet users over 10 years of age accessed the internet daily in 2006, while this proportion rose to 86% in 2016²⁹. This transformation in developing countries, including Brazil, called structural transformation, is defined as the transition from an economy of low productivity and labor-intensive economic activities to greater productivity and skill-intensive activities³⁰. The speed of this transformation is driven by technology, whose main representative is the smartphone and with it the connections to social networks. For example, a total of 19.2% of teenagers between 10 and 14 years old and 35.0% of teenagers between 15 and 17 years old had their own cell phone in Brazil in 2005, while this number increased to 54.1% and 80.8% in 2014, respectively³¹.

Thus, the massification of digital media, the use of social networks, chat applications,

exchanging messages on the network, the evolution of mobile phones with the availability of electronic games on the network, the possibility of browsing the Internet, low-cost film, tv series and documentary platforms and online commerce are all perceived, in such a way that these devices are being or are becoming increasingly popularized, covering all social levels. Adolescents started to value these means of fun, connection and interaction in their free time, leading to an increase in SB (except TV). The internet and the use of digital media have become one of the main means used by teenagers for social inclusion, allowing for quick, easy and comprehensive socialization. Adolescents virtually gather around common interests, inserting themselves in groups, communities and strengthening the feeling of belonging to their peers³².

In addition to other important factors such as less leisure spaces, insecurity and long periods of commuting, contributing to the increase in time spent in sedentary behavior, there is also the modification of social organization, stimulation of consumption and the digitization of the world. It is clear from the present study that changes based on the incorporation of media and social networks in adolescents' lifestyles over the years present a relevant contribution to the increase in the total time spent in sedentary behavior. More modern facilities, presence of electricity and internet contribute to replacing physically active tasks for a longer time browsing social networks and playing video games³³. Furthermore, the chance that a teenager who had a computer at home of being exposed to excessive sedentary behavior was greater due to the ease of access to social networks, online games, and general use of digital media was expected in a period of 5 years.

The way in which sedentary behavior was measured and operationalized in this study needs to be highlighted as a limitation. The questions used in the three surveys to measure sedentary behavior, despite approaching the topic in a similar way, were not the same; however the answers from the 3 surveys were operationalized in the same way. Using SB (except TV) as the measure did not cover all activities in SB, however our measure reflects the time in SB relatively well, since the most frequent activities were addressed.

This study has strengths which should be taken into account: it is one of the only studies with 3 surveys carried out on representative

samples of public-school students in a North-eastern state, and it can be carefully extrapolated to the national level and to other developing countries. In addition, these results may serve as support for future public health strategies aimed at Brazilian adolescents, as they describe a growing trend in the prevalence of excessive exposure to SB in adolescents. Highlighting the important role of the school setting in the reduction of sedentary behavior among adolescents since schools represent an unique social context for health promotion among youth. Particularly for adolescents from low-income families, who are often overlooked in health care promotion programs. In fact, schools are considered the ideal setting for health promotion programs among youth considering that the vast majority of children and adolescents, even in low-income countries, are enrolled in the educational system, and that schools already have installed infrastructure³⁴. Furthermore, it has been shown that interventions in the school setting, such as implementing low-complexity strategies (e.g., additional physical educational classes, workshops for physical education teachers), can decrease time dedicated to sedentary behaviors and enhance time spent in physical activities^{35,36}.

The present study showed that there was a change in the time trend in excessive exposure to TV over 10 years, with a decrease of approximately 23 percentage points being observed; in contrast, there was an increase of 15 percentage points in excessive exposure to SB (except TV) in 5 years. These results suggest that watching TV, although clearly an important sedentary behavior and still having a high prevalence, does not reflect the total time or does not explain the variation in time spent in SB in adolescents very well.

Contributions

J Bezerra and RA Lima contributed to data acquisition, analysis, and interpretation; they also drafted and critically revised the manuscript. Francys Paula Cantieri, Rafael Miranda Tassitano, José Cazuza de Farias Júnior and Mauro Virgílio Gomes de Barros contributed to design, data analysis, and interpretation; they also drafted and critically revised the manuscript. Fernanda Cunha Soares, contributed to conception, design, data acquisition, analysis, and interpretation; she also drafted and critically revised the manuscript. All authors gave their final approval of the text and agree to be accountable for all aspects of the work.

Acknowledgments

Acknowledgments for their support National Council for Scientific, Technological Development (CNPq) National Council for the Improvement of Higher Education (CAPES) and Foundation for the Support of Science and Technology of the State of Pernambuco (FACEPE).

Funding Source

This study was supported financially by National Council for Scientific, Technological Development (CNPq; grant 432144/2016-1).

References

- Patterson R, McNamara E, Tainio M, de Sá TH, Smith AD, Sharp SJ, Edwards P, Woodcock J, Brage S, Wijndaele K. Sedentary behaviour and risk of all-cause, cardiovascular and cancer mortality, and incident type 2 diabetes: a systematic review and dose response meta-analysis. *Eur J Epidemiol* 2018; 33(9):811-829. PMID: 29589226
- Shields M, Tremblay MS. Sedentary behaviour and obesity. *Health Rep*; 2008; 19(2):19-30. PMID: 18642516
- Rohm YD, Marie-France H, Sofiya A, Neville O, Juned S, M. Sedentary Behavior and Cardiovascular Morbidity and Mortality: A Science Advisory From the American Heart Association *Circulation* [serial on the Internet]. American Heart Association; 2016. Sep 27;134(13):e262-e279. Available from: <https://doi.org/10.1161/CIR.0000000000000440> [cited 2023 out 19]; 134(13)
- Hoare E, Milton K, Foster C, Allender S. The associations between sedentary behaviour and mental health among adolescents: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity* 2016; 13(1):108. PMID: 27717387
- Crichton GE, Alkerwi A. Association of sedentary behavior time with ideal cardiovascular health: the ORISCAV-LUX study. *PLoS One* [Internet]. 2014 Jun 12;9(6):e99829-e99829. Available from: <https://pubmed.ncbi.nlm.nih.gov/24925084>
- Faith MS, Berman N, Heo M, Pietrobello A, Gallagher D, Epstein LH, Eiden MT, Allison DB. Effects of contingent television on physical activity and television viewing in obese children. *Pediatrics* United States; 2001; 107(5):1043-1048. PMID: 11331684
- Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MB, Cardon G, Carty C, Chaput JP, Chastin S, Chou R, Dempsey PC, DiPietro L, Ekelund U, Firth J, Friedenreich CM, Garcia L, Gichu M, Jago R, Katzmarzyk PT, Lambert E, Leitzmann M, Milton K, Ortega FB, Ranasinghe C, Stamatakis E, Tiedemann A, Troiano RP, van der Ploeg HP, Wari V, Willumsen JF. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med* 2020; 54(24):1451-1462. PMID: 33239350
- Biddle SJH, García BE, Pedisic Z, Bennie J, Vergeer I, Wiesner G. Screen Time, Other Sedentary Behaviours, and Obesity Risk in Adults: A Review of Reviews. *Curr Obes Rep*. 2017; 6(2):134-147. PMID: 28421472
- Instituto Brasileiro de Geografia e Estatística (IBGE). *Pesquisa Nacional por Amostra de Domicílios Contínua*: Acesso à Internet e à televisão e posse de telefone móvel celular para uso pessoal 2018. Rio de Janeiro: IBGE; 2019.
- Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: the population health science of sedentary behavior. *Exerc Sport Sci Rev* 2010; 38(3):105-113. PMID: 20577058
- LeBlanc AG, Katzmarzyk PT, Barreira TV, Broyles ST, Chaput JP, Church TS, Fogelholm M, Harrington DM, Hu G, Kuriyan R, Kurpad A, Lambert E V, Maher C, Maia J, Matsudo V, Olds T, Onywera V, Sarmiento OL, Standage M, Tudor-Locke C, Zhao P, Tremblay MS. Correlates of Total Sedentary Time and Screen Time in 9-11 Year-Old Children around the World: The International Study of Childhood Obesity, Lifestyle and the Environment. *PLoS One* 2015; 10(6):e0129622. PMID: 26068231
- Rideout V, Peebles A, Mann S, Robb MB. *The common sense census: media use by tweens and teens*. San Francisco: Common Sense, 2015. Pai Seeta editor. 2015.
- Barnett TA, Kelly AS, Young DR, Perry CK, Pratt CA, Edwards NM, Rao G. Sedentary Behaviors in Today's Youth: Approaches to the Prevention and Management of Childhood Obesity: A Scientific Statement From the American Heart Association. *Circulation*. 2018; 138(11):e142-e159.
- Instituto Brasileiro de Geografia e Estatística (IBGE). *Pesquisa nacional de saúde do escolar: 2015*. Rio de Janeiro: Coordenação de População e Indicadores Sociais; 2016.
- Arundell L, Fletcher E, Salmon J, Veitch J, Hinkley T. A systematic review of the prevalence of sedentary behavior during the after-school period among children aged 5-18 years. *Int J Behav Nutr Phys Act* 2016; 13(1):93.
- Felez-Nobrega M, Raine LB, Haro JM, Wijndaele K, Koyanagi A. Temporal trends in leisure-time sedentary behavior among adolescents aged 12-15 years from 26 countries in Asia, Africa, and the Americas. *International Journal of Behavioral Nutrition and Physical Activity* 2020; 17(1):102.
- Victora CG, Aquino EML, do Carmo Leal M, Monteiro CA, Barros FC, Szwarcwald CL. Maternal and child health in Brazil: progress and challenges. *Lancet* 2011; 377(9780):1863-1876.
- Liu M, Wu L, Yao S. Dose-response association of screen time-based sedentary behaviour in children and adolescents and depression: a meta-analysis of observational studies. *Br J Sports Med* 2016 1;50(20):1252-1258.
- Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, Goldfield G, Gorber SC. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity* 2011.
- Loprinzi PD, Davis RE. Secular trends in parent-reported television viewing among children in the United States, 2001-2012. *Child Care Health Dev* 2016; 42(2):288-291.
- Bucksch J, Sigmundova D, Hamrik Z, Troped PJ, Melkevik O, Ahluwalia N, Borraccino A, Tynjälä J, Kalman M, Inchley J. International Trends in Adolescent Screen-Time Behaviors From 2002 to 2010. *J Adolesc Health* 2016; 58(4):417-425.

22. Bucksch J, Currie D, Elgar F, Hamrik Z, Inchley J, Keane E, Kelly C, Rasmussen M. Adolescent obesity and related behaviours: trends and inequalities in the WHO region 2002-2014, Observations from the Health Behaviour in School-aged Children (HBSC) WHO collaborative cross-national study. *World Health Organization*. 2017; 130(4):207-217.
23. Silva KS, Silva Lopes A, Dumith SC, Garcia LMT, Bezerra J, Nahas MV. Changes in television viewing and computers/videogames use among high school students in Southern Brazil between 2001 and 2011. *Int J Public Health* 2014; 59(1):77-86. PMID: 23552993
24. Sigmundová D, El Ansari W, Sigmund E, Frömel K. Secular trends: a ten-year comparison of the amount and type of physical activity and inactivity of random samples of adolescents in the Czech Republic. *BMC Public Health* 2011; 11:731.
25. Chassiakos Y (Linda) R, Radesky J, Christakis D, Moreno MA, Cross C, Media CC. Children and Adolescents and Digital Media. *Pediatrics* 2016; 138(5): e20162593.
26. Griffiths. Trends in technological advance: implications for sedentary behaviour and obesity in screenagers. *Education and Health* 2010; 28(2):35-38.
27. Mielke GI, Brown WJ, Nunes BP, Silva ICM, Hallal PC. Socioeconomic Correlates of Sedentary Behavior in Adolescents: Systematic Review and Meta-Analysis. *Sports Med* 2017; 47(1):61-75.
28. United Nations. *Digital economy report 2019 value creation and capture: implications for developing countries*. USA: United Nations Publications; 2019.
29. Belli L, Cavalli O. *Governança e regulações da internet na América Latina* Rio de Janeiro: FGV; 2019.
30. Oyeleran-Oyeyinka O, Lal K. *Structural Transformation in Developing Countries: Cross Regional Analysis* Nairobi: Unah; 2016.
31. Instituto Brasileiro de Geografia e Estatística (IBGE). *Acesso à internet e posse de telefone móvel celular para uso pessoal, 2014*. Rio de Janeiro: IBGE; 2014.
32. Lima NL, Souza EP, Rezende AO, Mesquita ACR. Os adolescentes na rede: uma reflexão sobre as comunidades virtuais. *Arq Bras Psicol* 2012; 64(3):2-18.
33. Ojiambo RM, Easton C, Casajús JA, Konstabel K, Reilly JJ, Pitsiladis Y. Effect of urbanization on objectively measured physical activity levels, sedentary time, and indices of adiposity in Kenyan adolescents. *J Phys Act Health* 2012; 9(1):115-123.
34. Centers for Disease Control and Prevention (CDC). *Improving the health of adolescents & young adults: a guide for states and communities*. USA: Centers for Disease Control and Prevention 2004.
35. Lima RA, de Barros MVG, Bezerra J, dos Santos SJ, Monducci E, Rodriguez-Ayllon M, Soares FC. Universal school-based intervention targeting depressive symptoms in adolescents: A cluster randomized trial. *Scand J Med Sci Sports* 2022 1; 32(3):622-631.
36. Xu T, Tomokawa, Gregorio R, Mannava P, Nagai M, Sobel H. School-based interventions to promote adolescent health: A systematic review in low- And middle-income countries of WHO Western Pacific Region. *PLoS One* 2020; 15(3): e10230046.

Article submitted 27/10/2023

Approved 04/04/2024

Final version submitted 06/04/2024

Chief Editors: Maria Cecília de Souza Minayo, Romeu Gomes, Antônio Augusto Moura da Silva