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Physical activity can attenuate, but not eliminate, the negative relationships of high TV viewing with some chronic diseases: findings from a cohort of 60 202 Brazilian adults

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ABSTRACT

Background This study examined the joint associations of leisure time physical activity and television (TV) viewing time with the prevalence of chronic diseases among Brazilian adults.

Methods Data from the Brazilian Health Survey, a nationally representative survey conducted in 2013 ($n = 60\,202$; ≥18 years), were used. Time spent in TV viewing and leisure physical activity, physician diagnoses of diabetes, hypertension and heart disease and information on co-variables (chronological age, education, ethnicity, candies/sweets consumption, sodium intake and tobacco smoking) were collected via interview. Descriptive statistics (mean and 95% confidence interval) and logistic regression models were used for etiological analyses.

Results Physical activity attenuated but did not eliminate the risk associated with high TV viewing for at least one chronic disease in the general population [odds ratio [OR]: 1.29 (1.11–1.50)] and among women [OR: 1.31 (1.09–1.60)], adults [OR: 1.24 (1.05–1.46)] and older adults [OR: 1.63 (1.05–2.53)]. On the other hand, physical activity eliminated the risk associated with high TV viewing for at least one chronic disease among men [OR: 1.24 (0.98–1.58)].

Conclusions We conclude that physical activity can attenuate but not eliminate the negative effects of high TV viewing on chronic disease among subgroups of Brazilian adults.

Keywords cardiovascular diseases, exercise, sedentary behavior, sitting

Introduction

Physical inactivity is a recognized public health problem and one of the largest challenges that needs to be tackled in the 21st century.[1] Several studies have documented the deleterious effects of physical inactivity on health outcomes and chronic diseases including diabetes, hypertension and heart disease.[2, 3] The greatest mortality and morbidity rates from physical inactivity-related chronic diseases are occurring in low- and middle-income countries,[4] where the least research on physical activity is conducted.[5] Moreover, with the ongoing technological and epidemiological transitions in developing countries and the globalization of inactive lifestyle, physical inactivity is currently recognized as one of the leading causes of death worldwide.[6]

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More recently, at the lower end of the physical activity continuum, a distinct construct of human movement termed sedentary behavior has received attention and emerged as an important public health agenda. Defined as 'any waking behavior characterized by an energy expenditure of ≤ 1.5 metabolic equivalents (METs) while in a sitting or reclining posture',[7] sedentary behavior has been related to cardiovascular risk factors and mortality, independent of and with distinct pathways to physical activity.[8–10] Thus, understanding the combined effects of physical activity and sedentary behavior on chronic diseases is important for the development of public health guidelines targeting both behaviors.

Very few studies have investigated the combined effects of physical activity and sedentary behavior in predicting health risk and mortality. Recently, Ekelund *et al*.[11] addressed this issue through a harmonized meta-analysis of prospective studies and found that high levels of moderate intensity physical activity (60–75 minutes/day) can eliminate the mortality risk derived from sitting time but only attenuate the risk of high amounts of television (TV)-viewing time (≥5 hours/-day). These findings highlight TV viewing (a sub-domain of sedentary behavior) as an independent and stronger predictor of health risks. Stamatakis *et al*.[12] found that physical activity interacted with sitting time for the prediction of all-cause mortality but not cardiovascular mortality. However, the potential differences in the relationships between TV viewing time and physical activity in predicting health outcomes in subgroups, such as gender and age groups, are not clear. Understanding how individual-level factors interact and influence relationships between health outcomes and TV viewing time and physical activity is especially important considering that the conditions of health and prevalence of these behaviors are expected to vary between population subgroups.[2,13] In addition, health determinants tend to vary according to economic conditions and social and cultural norms.[14,15] Thus, our aim was to analyze the joint associations of physical activity and TV viewing time in predicting diabetes, hypertension and heart disease, and how these associations differ by gender and age group (adults and elderly) in a large representative sample of Brazilian adults.

Methods

Sample

This was a cross-sectional epidemiological investigation conducted in a nationally representative sample of adults (≥18 years old) during 2013 in Brazil. The sampling process was conducted in clusters. First, census tracts were randomly selected; next, households were randomly selected; and finally, in the households, one adult was randomly selected. The target study sample size was based on prevalence of different health indicators and outcomes in the population, including diabetes, hypertension, depression, hospitalization in the last 12 months, coverage of health insurance, tobacco smoking, obesity, physical inactivity, alcohol use, physical limitations and vaccination coverage.[16] Recruitment was performed across different levels, including state level, region level, state capital level and state interior level, and it was estimated that inclusion of at least 900 households for each level was needed. The initial estimated sample size was 79 875, including the theoretical 20% nonresponse rate and the final sample approximated 63 900 households. After the selection of households, one adult inhabitant of each household was randomly selected to take part in the study. Therefore, the minimum sample size per federal unit ($n = 27$) was 1800 households, with a total of 64 348 households, where interviews were conducted. For this investigation, the sample was composed of 60 202 for all correlates. Estimates were weighted considering the weight of the household, adjusted for non-response by sex and total population by sex and age, and counting the number per household. More details of the sample process and weighting have been previously published.[16,17] All variables were collected through household interviews. The national council of ethics in research approved all procedures according to the Helsinki declaration.

Outcomes

The outcomes were assessed through questions related to chronic disease status. For hypertension, the following question was asked: 'Has a physician already given you a diagnosis of hypertension?'. Possible answers were as follows: 'Yes', 'No' and 'During gestation'. We considered as a diagnosis of hypertension those who responded 'Yes'. Similarly, we assessed diabetes data with the question: 'Has a physician already given you a diagnosis of diabetes?'. Answers were as follows: 'Yes', 'No' and 'During gestation'. We considered as a diagnosis of diabetes those who responded 'Yes'. Heart disease was evaluated through the question: 'Has a physician already given you a diagnosis of heart disease, such as heart attack, angina, heart failure or another?'. The answers were as follows: 'Yes' or 'No'. We considered individuals who answered 'Yes' as having a heart disease. Moreover, we created a general indicator of any disease, called 'at least one chronic disease' (diabetes and/or hypertension and/or heart disease), which was dichotomous (0 = no disease; 1 = at least one disease).

Table 1 Characteristics of the study sample according to exposures (physical activity and TV watching patterns) ($n = 60\,202$)

Factors	*Physical activity*			*TV viewing time*		
	0 minutes	*1–149 minutes*	*≥ 150 minutes*	*<2 hours*	*2–4 hours*	*≥ 4 hours*
Sex						
Male	63.1 (62.1–64.2)	18.1 (17.2–19.0)	18.8 (17.9–19.6)	51.8 (50.7–52.9)	35.5 (34.4–36.6)	12.7 (12.0–13.4)
Female	73.2 (72.3–74.0)	11.7 (11.1–12.3)	15.1 (14.4–15.9)	45.6 (44.6–46.5)	36.9 (36.0–37.8)	17.5 (16.8–18.3)
Age group						
18–64.9	66.9 (66.2–67.6)	15.1 (14.6–15.7)	18.0 (17.4–18.6)	48.8 (48.0–49.6)	36.4 (35.7–37.2)	14.8 (14.2–15.3)
>65	79.6 (78.0–81.2)	11.7 (10.4–13.0)	8.7 (7.7–10.0)	46.4 (44.4–48.4)	35.0 (33.2–36.9)	18.6 (17.2–20.1)
Education years						
0	67.0 (65.2–68.7)	14.5 (13.3–15.9)	18.5 (17.0–20.1)	57.5 (55.8–59.2)	29.9 (28.3–31.5)	12.6 (11.6–13.7)
1–11	72.5 (71.7–73.2)	13.5 (12.9–14.1)	14.0 (13.4–14.6)	45.4 (44.6–46.3)	37.7 (37.0–38.5)	16.9 (16.3–17.5)
12+	50.1 (48.2–52.0)	20.8 (19.3–22.4)	29.1 (27.4–30.8)	53.9 (52.0–55.8)	36.1 (34.3–37.9)	10.0 (9.0–11.1)
Ethnicity						
White	66.1 (65.2–67.2)	15.9 (15.1–16.7)	18.0 (17.1–18.7)	49.5 (48.5–50.6)	36.7 (35.6–37.7)	13.8 (13.1–14.5)
No white	70.5 (69.6–71.4)	13.6 (12.9–14.3)	15.9 (15.2–16.6)	47.5 (46.6–48.5)	35.9 (35.0–36.8)	16.6 (15.9–17.3)
Tobacco smoking						
No	66.9 (66.1–67.6)	15.4 (14.9–16.0)	17.7 (17.1–18.3)	49.3 (48.5–50.0)	36.2 (35.5–37.0)	14.5 (14.0–15.0)
Yes	77.6 (76.0–79.1)	10.5 (9.4–11.7)	11.9 (10.7–13.2)	44.1 (42.3–46.0)	36.4 (34.6–38.2)	19.5 (18.1–21.0)
Sodium intake						
Normal	68.9 (68.1–69.6)	14.6 (14.0–15.1)	16.6 (16.0–17.2)	48.8 (48.0–49.5)	36.4 (35.7–37.2)	14.8 (14.3–15.4)
Elevated	65.9 (64.1–67.7)	15.5 (14.2–17.0)	18.6 (17.1–20.1)	46.9 (45.1–48.8)	35.3 (33.5–37.0)	17.8 (16.5–19.2)
Candies/sweets intake						
<7 days/week	69.1 (68.4–69.8)	14.3 (13.8–14.9)	16.6 (16.0–17.1)	48.8 (48.0–49.5)	36.5 (35.8–37.3)	14.7 (14.2–15.2)
7 days/week	64.9 (63.1–66.7)	16.6 (15.3–18.0)	18.5 (17.0–20.0)	47.0 (45.1–49.0)	34.7 (32.9–36.5)	18.3 (16.9–19.8)
Diabetes						
No	67.9 (67.2–68.6)	14.9 (14.4–15.5)	17.2 (16.6–17.7)	48.8 (48.0–49.5)	36.3 (35.6–37.0)	14.9 (14.4–15.4)
Yes	76.0 (73.5–78.0)	11.6 (9.9–13.5)	12.4 (10.6–14.5)	44.8 (42.0–47.7)	35.3 (32.7–37.9)	19.9 (17.9–22.1)
Hypertension						
No	66.5 (65.7–67.3)	15.3 (14.7–15.9)	18.2 (17.6–18.9)	49.3 (48.5–50.1)	36.1 (35.3–36.8)	14.6 (14.0–15.1)
Yes	75.1 (73.8–76.4)	12.7 (11.7–13.7)	12.2 (11.2–13.2)	45.6 (44.2–47.1)	36.8 (35.4–38.3)	17.5 (16.4–18.6)
Heart disease						
No	68.2 (65.5–68.9)	14.8 (14.3–15.3)	17.0 (16.5–17.6)	48.7 (48.0–49.5)	36.3 (35.6–37.0)	15.0 (14.5–15.5)
Yes	74.1 (70.5–77.3)	12.9 (10.6–15.7)	13.0 (10.5–16.0)	43.1 (39.5–46.8)	36.0 (32.5–39.7)	20.9 (18.1–24.0)

Note. Data are presented by relative frequency and 95% CI.

Exposures

Leisure time physical activity was assessed through three self-reported questions. First, the subject was asked if they had performed any sport or physical activity in the previous 3 months with the question: 'Have you practiced any sport and/or activity in the last three months?'. The possible answers were as follows: 'Yes' and 'No'. Next, the frequency of participation was established with the question: 'How many days a week do you practice sports or physical exercise?' Finally, the participants were asked a question concerning the length of participation: 'In general, on the day that you practice sports and/or physical exercise, how many hours/minutes does it take?'. We classified physical activity into three categories, 1 = inactive (0 minutes/week), 2 = suboptimally active (1–149 minutes/week) and 3 = active (≥ 150 minutes/week). Leisure time physical activity is the most reliable domain of physical activity on the International Physical Activity Questionnaire in Brazil. [18]

TV viewing was estimated through the question: 'How many hours a day do you usually spend watching TV?'. Responses were as follows: (i) <1, (ii) 1–2, (iii) 2–3, (iv) 3–4, (v) 4–5, (vi) 5–6, (vii) >6 hours and (viii) I do not watch

Table 2 Prevalence of outcomes overall and by subgroups according to exposures (physical activity and TV watching patterns) ($n = 60\,202$)

Outcomes	*Physical activity*			*TV viewing time*		
	0 minutes	*1–149 minutes*	*≥150 minutes*	*<2 hours*	*2–4 hours*	*≥4 hours*
Diabetes	7.2 (6.8–7.7)	5.1 (4.4–6.0)	4.7 (4.1–5.6)	6.0 (5.5–6.6)	6.3 (5.8–6.9)	8.5 (7.6–9.5)
Male	6.4 (5.7–7.1)	3.4 (2.6–4.4)	3.8 (2.9–4.9)	5.0 (4.2–5.8)	5.2 (4.5–6.0)	7.4 (6.1–9.1)
Female	7.9 (7.3–8.4)	7.5 (6.2–9.1)	5.8 (4.7–7.2)	7.1 (6.4–7.8)	7.3 (6.5–8.1)	9.2 (8.0–10.4)
Adults	5.0 (4.6–5.4)	3.8 (3.2–4.7)	3.9 (3.3–4.7)	4.4 (3.9–4.9)	4.4 (3.9–4.9)	6.0 (5.2–7.0)
Elderly	20.6 (18.8–22.6)	16.6 (12.8–21.3)	17.3 (12.7–23.3)	18.1 (15.8–20.7)	20.8 (18.2–23.8)	22.3 (19.0–26.1)
Hypertension	24.8 (24.1–25.6)	19.5 (18.1–21.0)	16.4 (15.1–17.7)	21.3 (20.5–22.1)	23.0 (22.0–24.0)	26.0 (24.5–27.6)
Male	21.5 (20.3–22.6)	13.2 (11.7–15.0)	12.5 (10.9–14.2)	17.8 (16.6–19.0)	18.0 (16.7–19.4)	21.2 (18.9–23.6)
Female	27.4 (26.5–28.4)	28.2 (25.7–30.7)	20.7 (18.7–22.8)	24.9 (23.7–26.1)	27.3 (25.9–29.7)	29.1 (27.1–31.2)
Adults	20.1 (19.4–20.9)	15.2 (13.9–16.6)	13.9 (12.7–15.2)	17.2 (16.4–18.1)	18.6 (17.7–19.6)	20.8 (19.3–22.4)
Elderly	53.0 (50.8–55.2)	59.2 (53.1–65.0)	52.5 (46.1–58.9)	51.6 (48.6–54.6)	55.5 (52.3–58.6)	55.5 (51.2–59.8)
Heart disease	4.5 (4.2–4.9)	3.7 (3.0–4.5)	3.2 (2.6–4.0)	3.7 (3.3–4.1)	4.2 (3.7–4.7)	5.7 (4.9–6.7)
Male	4.5 (3.9–5.1)	2.7 (1.9–3.6)	3.3 (2.3–4.6)	3.4 (2.8–4.1)	3.9 (3.2–4.7)	6.2 (4.9–7.9)
Female	4.5 (4.1–5.0)	5.1 (3.9–6.7)	3.2 (2.4–4.3)	4.0 (3.5–4.6)	4.4 (3.7–5.2)	5.3 (4.4–6.5)
Adults	3.2 (2.8–3.5)	2.8 (2.1–3.6)	2.6 (2.0–3.4)	2.8 (2.4–3.2)	2.9 (2.5–3.4)	4.0 (3.3–5.0)
Elderly	12.6 (11.3–14.2)	12.2 (8.7–16.8)	12.4 (8.3–18.3)	10.8 (9.1–12.7)	13.5 (11.3–16.1)	15.2 (12.4–18.6)
At least one disease	28.9 (28.2–29.7)	22.9 (21.3–24.4)	19.9 (18.5–21.3)	24.9 (24.0–25.8)	26.9 (25.9–28.0)	30.6 (29.0–32.2)
Male	25.5 (24.3–26.7)	15.8 (14.1–17.7)	15.7 (14.0–17.7)	21.0 (19.7–22.3)	21.8 (20.3–23.3)	26.3 (23.8–28.9)
Female	31.6 (30.6–32.6)	32.5 (30.0–35.2)	24.5 (22.3–26.7)	28.9 (27.7–30.2)	31.4 (30.0–32.8)	33.4 (31.3–35.5)
Adults	23.4 (22.7–24.2)	18.1 (16.6–19.6)	17.2 (15.7–18.5)	20.3 (19.4–21.2)	21.8 (20.8–22.9)	24.5 (22.9–26.2)
Elderly	61.9 (59.8–64.0)	67.2 (61.3–72.6)	61.3 (54.9–67.4)	59.4 (56.5–62.4)	65.0 (62.0–67.9)	65.2 (61.0–69.3)

Note. Data are presented by relative frequency and 95% CI.

TV. Based on a previous investigation[9], we classified TV-viewing time into three categories (1 = <2, 2 = 2−4 and 3 = ≥4 hours).

Covariates

Chronological age was collected in a continuous manner, and was separated into adults (18–64.9 years) and elderly (≥ 65 years) for the analyses. Educational status was collected through the question: 'What is your highest academic qualification?', after which we created three categories (0 years, corresponding to no academic degree; 1–11 years, corresponding to 1 year up to high school; and 12 or more, which correspond to college or more). Ethnicity was self-reported and dichotomized based on the skin color as white and not white (others). Candies/sweets intake was collected through the report of how many days per week they consumed snacks and sweet foodstuffs (e.g. cake, sweets, chocolate, candies, or biscuits; 7 days/week equated to high intake) and on a five-point Likert scale whether they perceived their diet was characterized by 'a little' to 'a lot' of salt (diets containing 'quite a lot' and 'a lot' were considered indicative of high sodium intake). Tobacco smoking was evaluated through the question 'Do you use any tobacco product?'; answers were 'yes, daily', 'yes, but not daily' and 'no'. We considered those who answered 'yes, daily' and 'yes, but not daily' as having exposure.

Statistical analysis

For the statistical analyses, we used proportions and 95% confidence intervals (CIs) to describe the sample and prevalence of outcomes (chronic diseases—type 2 diabetes, hypertension and heart diseases) between the physical activity and TV viewing groups. The Chi-square test for trend was adopted to test the crude associations of both physical activity and TV viewing time with chronic diseases (diabetes, hypertension, heart disease and at least one chronic disease). To verify the joint association of physical activity and TV viewing time with at least one chronic disease, we created logistic regression models with odds ratios (ORs), adjusted by age, ethnicity, educational status, sodium consumption, sugar consumption and tobacco smoking. To explore subgroup specific joint association of physical activity and TV viewing time with chronic disease, separate gender-based (male and female) and age group (adults and elderly) logistic regression analyses were conducted. All statistical procedures were conducted using

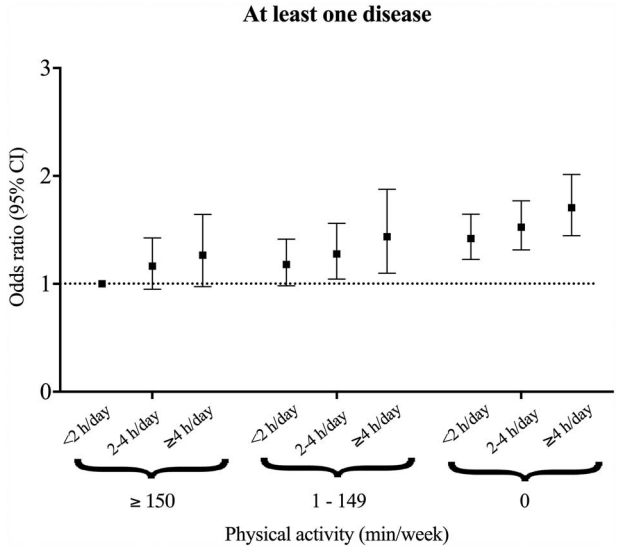

Fig. 1 OR values of the association between at least one disease and physical activity and TV viewing patterns for the overall sample. Adjusted for age, education, ethnicity, candies/sweets intake, sodium intake and tobacco smoking. Full interaction terms: Physical activity 0 minutes/week = TV viewing 2–4 hours: OR: 0.92 (95% CI: 0.74–1.15); TV viewing > 4 hours: OR: 0.95 (95% CI: 0.71–1.26). Physical activity 1–149 minutes/week = TV viewing 2–4 hours OR: 0.93 (95% CI: 0.70–1.23); TV viewing > 4 hours: OR: 0.96 (95% CI 0.66–1.39).

sampling weights (svy command) in Stata 15.1 (Stata Statistical Software: College Station, TX, USA: Stata Corp LP).

Results

Table 1 presents characteristics of the sample according to physical activity and TV viewing patterns. A higher prevalence of chronic diseases was observed among inactive individuals and those who reported more hours in front of the TV. Table 2 presents the prevalence of outcomes according to physical activity and TV viewing time by sex and age group.

The prevalence of chronic diseases according to TV viewing patterns within physical activity categories are shown in Supplementary table A. Achieving the guidelines for physical activity (> 150 minutes/week) and less TV time (0–2 hours/d) were associated with a lower prevalence of chronic diseases. It was observed that physical activity attenuated the effects of high TV viewing time on the prevalence of chronic diseases in the suboptimal middle physical activity category (1–149 minutes/week) and eliminated it in the active category (more than 150 minutes/week), with the exception of diabetes for women and heart disease for the elderly. Moreover, regardless of outcomes and subgroup (sex and age), physically active individuals with high TV viewing time were not consistently different from the inactive individuals with low TV viewing time.

Figure 1 presents the joint associations of physical activity and TV viewing patterns with at least one chronic disease (diabetes, hypertension or heart disease) for the whole sample, adjusted for age, education, ethnicity, candies/sweets consumption, sodium intake and tobacco smoking. Compared with the reference group (<2 hours/day and active for ≥ 150 minutes/week), the prevalence of chronic diseases was ∼ 71% higher in those who watched TV for ≥ 4 hours/day and also reported no leisure-time physical activity (OR: 1.71; 95% CI: 1.45–2.01). However, the interaction was not significant.

Figure 2 shows the analysis by sex and age group (adults and elderly). Confirming the whole analysis, physical activity attenuated the negative effects of high TV viewing time on chronic diseases for females, adults and the elderly. Although increasing according to increases in TV viewing time, inactive females and adults (except for the intermediate category of both behaviors) presented a higher prevalence of chronic diseases compared with the reference group, regardless of TV viewing. Inactive elderly people who reported less than 4 hours/day of TV viewing time did not present higher odds compared with the reference group and presented lower odds of at least one chronic disease compared with the active but sedentary (≥4 hours/day) elderly people. No interaction was significant, indicating a potential indirect effect.

Discussion

Main finding of this study

This investigation examined the joint associations of leisure time physical activity and TV viewing time with prevalence of chronic diseases in Brazilian adults and explored subgroup specific differences in these associations. The main finding was that meeting recommended physical activity levels attenuated the risk derived from elevated TV viewing on chronic diseases, suggesting a potential indirect effect. Also, the prevalence of chronic diseases was lower among participants who were not only most active (≥ 150 minutes) but who also reported the least TV viewing time (<2 hours).

What is already known on this topic

Confirming previous studies,[8,19,20] we found that the inactive and more sedentary population groups presented with a higher prevalence of diabetes, hypertension, heart disease and at least one of these chronic diseases. Interestingly, the intermediate group of physical activity (0–149 minutes/week) presented a lower prevalence of negative outcomes in men, but not in women. Differences between males and females in the relationship between physical

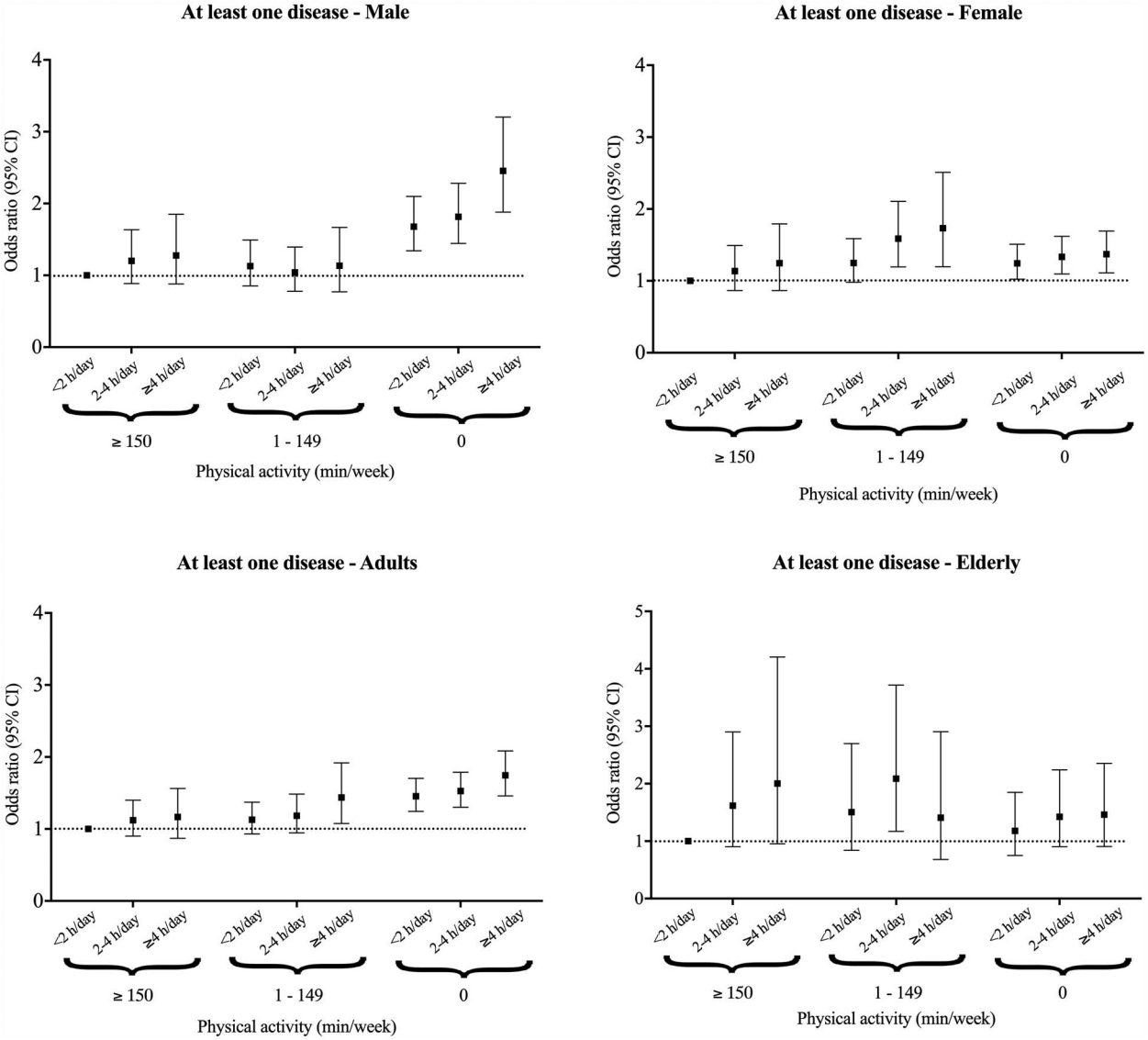

Fig. 2 OR values of logistic regression models of the association between at least one disease and physical activity and TV viewing time patterns, according to sex and age group. Adjusted for age, education, ethnicity, candies/sweets intake, sodium intake and tobacco smoking. Full interaction terms: **Men:** Physical activity 0 minutes/week = TV viewing 2–4 hours: OR: 0.90 (95% CI: 0.64–1.26); TV viewing > 4 hours: OR: 1.15 (95% CI: 0.75–1.75). Physical activity 1–149 minutes/week = TV viewing 2–4 hours: 0.77 (95% CI: 0.50–1.17); TV viewing > 4 hours: OR: 0.79 (95% CI: 0.46–1.34). **Women:** Physical activity 0 minutes/week = TV viewing 2–4 hours: OR: 0.94 (95% CI: 0.70–1.26); TV viewing > 4 hours: OR: 0.88 (95% CI: 0.60–1.30). Physical activity 1–149 minutes/week = TV viewing 2–4 hours: 1.12 (95% CI: 0.76–1.64); TV viewing > 4 hours: OR: 1.11 (95% CI: 0.67–1.86). **Adults:** Physical activity 0 minutes/week = TV viewing 2–4 hours: OR: 0.93 (95% CI: 0.73–1.19); TV viewing > 4 hours: OR: 1.03 (95% CI: 0.75–1.41). Physical activity 1–149 minutes/week = TV-viewing 2–4 hours: 0.93 (95% CI: 0.68–1.27); TV viewing > 4 hours: OR: 1.09 (95% CI: 0.72–1.64). **Older adults:** Physical activity 0 minutes/week = TV viewing 2–4 hours: OR: 0.75 (95% CI: 0.40–1.38); TV viewing > 4 hours: OR: 0.62 (95% CI: 0.28–1.35). Physical activity 1–149 minutes/week = TV viewing 2–4 hours: 0.86 (95% CI: 0.38–1.91); TV viewing > 4 hours: OR: 0.47 (95% CI: 0.17–1.30).

activity and mortality in a population-based investigations are not well established.[2,21] However, some physiological mechanisms could exist related to the higher muscle mass and basal metabolic rate in men, which may provide inherent protection against cardiovascular risk factors.[22,23] Moreover, performed on average men performed more leisure time physical activity within both suboptimal (men: 60 minutes/week versus women: 39 minutes/week) and active categories (men: 402 minutes/week versus women: 338 minutes/week). Therefore, it is possible that even being in the same category, men can present larger benefits for health than women, given a dose–response association.[24] Also, considering that none of the questions adopted for physical activity estimation requested information about intensity of

activities, we can speculate that men generally are involved in more intense sports and physical exercises than women, which could have a greater impact on health and thus protect against the negative consequence of high TV viewing.[25,26]

What this study adds

By studying the joint associations of physical activity and TV viewing, we found that the active and low TV viewing group had a lower prevalence of hypertension, diabetes and heart disease in both sexes and age groups. In the intermediate group of physical activity (1–149 minutes/week), the risk of high TV viewing was eliminated for hypertension and attenuated for diabetes and heart disease. These findings indicate that even relatively low amounts of physical activity could protect against the negative effects of TV viewing, but the effects are specific for outcomes and subgroups. Overall, achievement of the physical activity guidelines eliminated the risk of high TV viewing for most outcomes, except for heart disease among the elderly and diabetes among women, which although not eliminated, were attenuated. These findings partially support those in recent harmonized meta-analysis of data from more than 1 million men and women mostly from high-income countries.[11] With the present cross-sectional data, we extended the evidence to specific morbidities (hypertension, diabetes and heart disease) and population sub-groups beyond high-income countries. One difference in results compared to the recent harmonized meta-analysis is the amount of physical activity needed to eliminate the negative effects of high sedentary time. While Ekelund *et al*.[27] found that only high amounts of moderate intensity physical activity (60–75 minutes/day) could eliminate the negative effects of more than 5 hours overall sitting time and attenuate the effects of high TV viewing, we observed that the current guidelines of at least 150 minutes/week of moderate-to-vigorous physical activity[28] were enough to eliminate the harmful effects of more than 4 hours of TV viewing.

When we utilized in the analysis a more prevalent outcome (at least one chronic disease), the results changed. While physical activity eliminated the risk of high TV viewing on chronic disease among men, TV viewing ≥4 hours/day remained a risk factor regardless of achievement of physical activity guidelines in females and among adults and the elderly. It is probable that the intensity of sports and physical activity is higher among men, and this could explain the difference.[25,29] Indeed, more intense physical activity, controlling for the total amount of energy expenditure, was found to be more protective against metabolic disease than moderate physical activity.[29] This implies that for an equivalent energy expenditure, more intense physical activity has a greater preventative influence, and future research should focus on the role of total overload (volume and intensity) of physical activity to overcome the effects of high TV viewing on chronic diseases. The difference between results from isolated and combined outcomes could be due to the compositions and definitions of these variables. If in isolated and less prevalent outcomes physical activity can eliminate the harmful effects of TV viewing, in a more prevalent and general outcome (at least one chronic disease) physical activity only attenuates this effect. This result could partly explain recent findings[27] which analyzed mortality as an outcome and observed that even high amounts of physical activity can only attenuate the effects of TV viewing.

Our data reinforce that both behaviors are related to health, probably through different pathways. Even attenuating or eliminating the risk of high TV viewing, there is a trend between TV viewing patterns with physical activity groups, since a higher prevalence of negative outcomes was found among the high TV viewing group (≥4 hours/day). Yet, the fact that the active/high TV viewing group was also frequently equal to the inactive/low TV viewing group indicates that both TV viewing and physical inactivity are independently related to health risk.[10]

In addition to explaining some differences between our data and previous studies, population characteristics should be considered when intervention actions are taken. Brazil is a country with continental dimensions and inequalities. While determinants of both physical activity and sedentary behavior are specific and involve multiple levels, we consider that initial actions targeting the reduction and interruption of TV viewing time at an individual level could be a starting point, especially for women, the elderly and low educational status groups. These actions have to be followed by higher level determinants of sedentary behavior and specific actions to provide opportunities for an active leisure time, such as safety and environmental improvements.

Limitations

The main strength of this investigation was the large representative sample which allowed for detailed subgroup analyses and generalization to the target population. However, this investigation also has some limitations that should be mentioned. First, only physical activity in leisure time was assessed (specifically sports and physical exercises). Even though this domain presents a greater relationship with negative health outcomes,[24] individuals inactive during leisure could be active in other domains of life (i.e., occupation, transportation, household). Similarly, even though it is mostly associated with negative health risk factors,[30] TV viewing is only a

sub-domain of sedentary behavior. The way in which we obtained exposure information could also be a limitation due to possible errors in estimation (over/under reporting) of self-reported behaviors, and this may have biased the observed relationships between physical activity/TV viewing patterns with chronic diseases. Reassuringly, with regards to outcomes, self-reports of chronic morbidities and medical diagnoses seem to be reliable.[31,32] Finally, this was a cross-sectional investigation, and so we cannot decipher temporality between variables. For example, some irregular results among the elderly could be explained by reverse causality, such as once diseases are diagnosed people may be encouraged to be more active, alternatively health conditions and ill health could lead to more sedentary and less active behaviors.[33] To the best of our knowledge, this is the first investigation to test sub-group interaction between leisure physical activity and TV viewing through a representative sample from a developing country. In addition, data collection by household interviews should be considered a positive aspect of the investigation.

Conclusion

In conclusion, we found in a comprehensive sample of 60 202 individuals that physical activity and TV viewing are independent risk behaviors for hypertension, diabetes and heart disease. Their association with these chronic diseases varies according to sex and age groups likely due to different prevalence of these behaviors and different health status. Overall, physical activity can attenuate, but not eliminate, the negative associations of high TV viewing time on prevalence of chronic diseases.

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethics approval

All procedures performed in the original studies involving human participants were approved by National Council of Ethics in Research (CONEP: 10853812.7.0000.0008) in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Data sharing statement

All data are open published as microdata at http://www.ibge.gov.br/home/.

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