



# Associations of sedentary behaviors and physical activity with social isolation in 100,839 school students: The Brazilian Scholar Health Survey

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## ABSTRACT

**Objective:** To examine the relationship between physical activity, sedentary behaviors, and social isolation in a representative sample of Brazilian adolescents.

**Method:** Cross sectional analyses using data from the Brazilian Scholar Health Survey conducted in 2015. The sample included 100,839 adolescents (mean age: 14.3 y, 51.4% Female) from 3040 schools. Information about social isolation (number of close friends and perceived loneliness), physical activity (International Physical Activity Questionnaire) and sedentary behaviors (total sitting time and TV viewing) were self-reported. Chronological age, race and type of city (state capital or other) were co-variables. Logistic regression models were used to analyze the data (results are presented as odds ratios (OR) with 95% confidence intervals).

**Results:** Physical activity was associated with lower odds of both social isolation indicators in boys, and with lower likelihood of having few friends in girls. Greater sitting time was associated with higher likelihood of social isolation, as was low (< 1 h/d) [boys: OR: 1.54 (95% CI: 1.33 to 1.77); girls: OR: 1.31 (95% CI: 1.17 to 1.48)] and high TV viewing ( $\geq$  8 h/d) [boys: OR: 1.75 (95% CI: 1.47 to 2.09)]; girls: OR: 1.58 (95% CI: 1.37 to 1.82)]. More than 300 min/week of physical activity was sufficient to eliminate the association of high TV viewing and high sitting time with markers of social isolation in boys.

**Conclusion:** Physical activity is associated with a lower prevalence of social isolation, especially among boys. Both high and low amounts of TV viewing increase the likelihood of social isolation. Physical activity reduced the association between TV viewing and sitting with social isolation among boys.

## 1. Introduction

Social isolation is defined as the physical, social or psychological separation of individuals or groups and is characterized by low social contact and communication [1]. There is evidence that socially isolated persons are more likely to suffer from suicidal thoughts [2] and depression [3]. Even in childhood, social isolation is associated with adverse mental health [4], and self-perceived loneliness is associated with depression in adolescence [5].

In addition to adverse mental health, socially isolated adolescents are more likely to develop cardiometabolic disorders in adulthood [6]. This is likely because social isolation is associated with multiple unhealthy behaviors. For instance, studies conducted in adolescents have

shown that feeling lonely and having few friends is associated with both physical inactivity [7–9] and higher sedentary behavior [10,11]. Others have reported that more active adolescents demonstrate better social integration skills, which reduces their risk of social isolation [12]. It is a limitation, however, that most studies to date have crudely classified adolescents as either meeting or failing to meet international guidelines for physical activity and sedentary behavior. Consequently, the shape and dose-dependency of relationships of physical activity and sedentary behaviors with social isolation markers has not been examined. Neither have possible interaction effects between physical activity and sedentary behaviors.

Furthermore, there is a gap in the literature regarding associations between different types of sedentary behaviors with social isolation.

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**Table 1**  
Student characteristics stratified by sex.

	n	Boys % (95% CI)	n	Girls % (95% CI)
Age				
< 14 years	7084	16.1 (15.4 to 16.7)	10,019	20.4 (19.8 to 21.1)
14 years	23,428	48.8 (48.0 to 49.6)	27,651	53.3 (52.5 to 54.0)
> 14 years	18,047	35.1 (34.4 to 35.8)	14,610	26.3 (25.7 to 26.9)
Type of city				
Capital	24,511	23.2 (22.7 to 23.7)	26,098	22.8 (22.3 to 23.3)
Other	24,048	76.8 (76.2 to 77.3)	26,182	77.2 (76.7 to 77.7)
Skin color				
White	18,635	41.1 (40.3 to 41.9)	19,340	39.6 (38.9 to 40.0)
Other	29,924	58.9 (58.1 to 59.7)	32,940	60.4 (59.6 to 61.1)
Number of close friends				
Few (< 2)	4968	10.4 (9.9 to 10.9)	5563	10.6 (10.1 to 11.1)
2 or more	43,591	89.6 (89.1 to 90.1)	46,717	89.4 (88.9 to 89.9)
Feeling of loneliness				
No	43,535	89.9 (89.4 to 90.3)	40,362	77.7 (77.0 to 78.3)
Yes	5024	10.1 (9.7 to 10.6)	11,918	22.3 (21.7 to 23.0)
Leisure PA (h/wk)				
0 h	1610	2.8 (2.6 to 3.1)	3879	6.6 (6.2 to 7.0)
< 1 h	4756	9.8 (9.3 to 10.3)	9173	17.3 (16.7 to 17.9)
1–1.9 h	5693	11.7 (11.2 to 12.3)	8498	16.8 (16.2 to 17.4)
2–2.9 h	5857	12.5 (12.0 to 13.1)	7539	14.8 (14.3 to 15.4)
3–3.9 h	5046	10.3 (9.8 to 10.7)	5456	10.8 (10.3 to 11.3)
4–4.9 h	4576	9.6 (9.1 to 10.1)	4571	8.9 (8.5 to 9.4)
5–5.9 h	3928	8.0 (7.5 to 8.4)	3462	6.3 (5.9 to 6.6)
6–6.9 h	3458	7.4 (7.0 to 7.8)	2657	5.3 (4.9 to 5.6)
≥ 7 h	13,635	27.9 (27.2 to 28.6)	7045	13.2 (12.7 to 13.8)
Sitting (h/d)				
< 1 h	9854	20.0 (19.4 to 20.6)	10,335	18.7 (18.2 to 19.3)
1–1.9 h	6249	12.6 (12.1 to 13.2)	6539	12.2 (11.7 to 12.7)
2–2.9 h	6333	12.8 (12.3 to 13.4)	6138	11.4 (10.9 to 11.9)
3–3.9 h	6113	12.1 (11.6 to 12.7)	6096	11.7 (11.2 to 12.2)
4–4.9 h	5211	10.7 (10.2 to 11.2)	5193	9.6 (9.1 to 10.0)
5–5.9 h	4165	9.2 (8.7 to 9.6)	4469	9.0 (8.5 to 9.5)
6–6.9 h	2749	5.8 (5.5 to 6.2)	3176	6.5 (6.1 to 7.0)
7–7.9 h	1926	3.9 (3.6 to 4.3)	2710	5.4 (5.1 to 5.8)
≥ 8 h	5959	12.8 (12.2 to 13.3)	7624	15.4 (14.8 to 16.0)
TV viewing (h/d)				
< 1 h	13,005	25.8 (25.1 to 26.5)	13,629	24.5 (23.8 to 25.1)
1–1.9 h	7806	16.0 (15.4 to 16.6)	7691	14.1 (13.6 to 14.6)
2–2.9 h	7000	13.6 (13.0 to 14.1)	6697	13.0 (12.4 to 13.5)
3–3.9 h	5874	12.8 (12.2 to 13.3)	6066	11.6 (11.1 to 12.1)
4–4.9 h	4174	8.8 (8.4 to 9.3)	4543	8.8 (8.4 to 9.3)
5–5.9 h	3076	6.7 (6.3 to 7.1)	3578	7.4 (7.0 to 7.8)
6–6.9 h	1738	3.6 (3.3 to 3.9)	2130	4.2 (3.9 to 4.5)
7–7.9 h	1404	3.0 (2.7 to 3.3)	2080	4.3 (4.0 to 4.6)
≥ 8 h	4482	9.8 (9.3 to 10.3)	5866	12.3 (11.8 to 12.8)

Note. CI, confidence interval; PA, physical activity; TV, television.

This is important to investigate, as TV viewing and total sitting time appear to be differentially associated with myriad health outcomes in school students [13]. Moreover, it is not clear if physical activity can attenuate associations of sedentary behaviors with elevated risk of social isolation. We examined relationships of physical activity, time spent sitting and TV viewing with markers of social isolation in a representative sample of Brazilian adolescents.

## 2. Methods

### 2.1. Sample

Data from 2015 Brazilian Scholar Health Survey (PeNSE in Portuguese) were used. The PeNSE survey constitutes the main information source on factors related to adolescent health in Brazil [14]. The 2015 edition of PeNSE included a representative sample of students from the final (9th) year of elementary school, selected on the basis of a complex multi-stage, stratified, clustered probability design that is described thoroughly elsewhere [14].

Firstly, were formed 53 strata, with 26 state capitals and the federal district plus 26 other cities inside each state, excluding capital cities.

The cluster sampling was performed in two stages in capital cities (with schools as primary units and classes as secondary units) and three stages in other municipalities within each stratum (with municipalities as primary units, schools as secondary units and classes as tertiary units). Schools were selected based on the 2013 school census. The selected schools were visited, and classes were selected within each school. All students within each class were invited to participate in this study. From 3160 public and private schools, a sample of 3040 schools and 124,227 students were eligible. Of all the students that were at school on the day of data collection, 102,301 (82%) accepted to participate. Due to missing data, the current analyses are based on 100,839 students.

Data collection involved a self-administered questionnaire consisting of two sections. The first section was about school characteristics (e.g. number of students enrolled; if after school sports are offered; the structure of school sport and study facilities; items for sale in the school canteen) and was answered by the school director/coordinator. The second section was completed by students themselves and covered individual characteristics as well as information about social isolation, physical activity and sedentary behaviors. All study procedures were approved by the Research Ethics National Council and were conducted

**Table 2**  
Association between leisure physical activity, sitting time, and TV viewing with social isolation outcomes.

	Low number of friends		Loneliness	
	Boys OR (CI 95%)	Girls OR (CI 95%)	Boys OR (CI 95%)	Girls OR (CI 95%)
Leisure PA (h/wk)				
0 h	1	1	1	1
< 1 h	<b>0.73 (0.54 to 0.98)</b>	<b>0.81 (0.67 to 0.98)</b>	0.79 (0.57 to 1.09)	0.89 (0.76 to 1.04)
1–1.9 h	0.79 (0.59 to 1.06)	<b>0.68 (0.56 to 0.82)</b>	0.76 (0.55 to 1.05)	<b>0.82 (0.70 to 0.97)</b>
2–2.9 h	<b>0.62 (0.46 to 0.84)</b>	<b>0.76 (0.62 to 0.93)</b>	<b>0.62 (0.46 to 0.86)</b>	0.91 (0.77 to 1.08)
3–3.9 h	<b>0.53 (0.39 to 0.72)</b>	<b>0.65 (0.52 to 0.81)</b>	<b>0.57 (0.41 to 0.78)</b>	0.87 (0.73 to 1.04)
4–4.9 h	<b>0.55 (0.40 to 0.75)</b>	<b>0.67 (0.52 to 0.84)</b>	<b>0.63 (0.45 to 0.88)</b>	0.98 (0.81 to 1.18)
5–5.9 h	<b>0.57 (0.41 to 0.78)</b>	<b>0.69 (0.53 to 0.89)</b>	<b>0.64 (0.45 to 0.90)</b>	1.00 (0.82 to 1.21)
6–6.9 h	<b>0.50 (0.36 to 0.69)</b>	<b>0.65 (0.49 to 0.87)</b>	<b>0.57 (0.39 to 0.81)</b>	0.83 (0.67 to 1.02)
≥ 7 h	<b>0.49 (0.37 to 0.64)</b>	<b>0.62 (0.50 to 0.76)</b>	<b>0.64 (0.48 to 0.87)</b>	1.16 (0.98 to 1.37)
Sitting (h/d)				
< 1 h	1.08 (0.88 to 1.32)	<b>1.35 (1.12 to 1.62)</b>	0.88 (0.71 to 1.09)	0.97 (0.84 to 1.12)
1–1.9 h	0.99 (0.79 to 1.23)	1.10 (0.89 to 1.36)	0.91 (0.72 to 1.16)	1.03 (0.87 to 1.22)
2–2.9 h	1	1	1	1
3–3.9 h	0.89 (0.70 to 1.12)	0.94 (0.75 to 1.17)	0.90 (0.72 to 1.14)	<b>1.21 (1.03 to 1.43)</b>
4–4.9 h	0.84 (0.66 to 1.07)	0.85 (0.68 to 1.07)	1.08 (0.84 to 1.37)	<b>1.20 (1.02 to 1.42)</b>
5–5.9 h	0.86 (0.67 to 1.10)	0.99 (0.77 to 1.27)	<b>1.46 (1.15 to 1.87)</b>	<b>1.55 (1.30 to 1.85)</b>
6–6.9 h	1.05 (0.79 to 1.41)	1.26 (0.96 to 1.66)	<b>1.51 (1.14 to 1.99)</b>	<b>1.65 (1.37 to 1.99)</b>
7–7.9 h	0.97 (0.70 to 1.34)	1.06 (0.78 to 1.43)	<b>1.78 (1.32 to 2.41)</b>	<b>1.78 (1.48 to 2.16)</b>
≥ 8 h	1.02 (0.81 to 1.27)	1.16 (0.95 to 1.41)	<b>2.26 (1.84 to 2.79)</b>	<b>2.17 (1.87 to 2.51)</b>
TV viewing (h/d)				
< 1 h	<b>1.44 (1.20 to 1.73)</b>	<b>1.49 (1.25 to 1.78)</b>	<b>1.60 (1.33 to 1.92)</b>	<b>1.23 (1.07 to 1.41)</b>
1–1.9 h	1.10 (0.89 to 1.35)	1.06 (0.86 to 1.31)	1.10 (0.89 to 1.37)	0.92 (0.79 to 1.07)
2–2.9 h	1	1	1	1
3–3.9 h	1.13 (0.90 to 1.42)	1.06 (0.85 to 1.32)	1.18 (0.94 to 1.50)	1.17 (1.00 to 1.38)
4–4.9 h	1.24 (0.96 to 1.60)	1.08 (0.85 to 1.37)	<b>1.40 (1.10 to 1.79)</b>	1.06 (0.89 to 1.26)
5–5.9 h	1.20 (0.92 to 1.56)	1.05 (0.81 to 1.36)	<b>1.55 (1.17 to 2.06)</b>	1.17 (0.98 to 1.39)
6–6.9 h	0.90 (0.65 to 1.25)	1.20 (0.89 to 1.62)	<b>1.70 (1.25 to 2.30)</b>	<b>1.25 (1.01 to 1.54)</b>
7–7.9 h	<b>1.46 (1.00 to 2.14)</b>	0.85 (0.61 to 1.17)	<b>1.68 (1.18 to 2.39)</b>	<b>1.27 (1.02 to 1.59)</b>
≥ 8 h	<b>1.44 (1.14 to 1.82)</b>	1.11 (0.90 to 1.36)	<b>2.07 (1.67 to 2.57)</b>	<b>1.71 (1.37 to 1.99)</b>

Note. Adjusted for chronological age, race, type of city (state capital or other) and physical activity or sitting time (depending on the model). OR, odds ratio. CI, confidence interval. PA, physical activity. TV, television. Bold values represent  $p < 0.05$ .

in accordance with the principles of the Declaration of Helsinki.

which schools were located (state capital or other) was recorded.

## 2.2. Social isolation

Two indicators of social isolation were investigated. Students first reported how many close friends they had (response options: zero/one/two/three or more). The data were dichotomized to identify children with few ( $< 2$ ) close friends. Children further reported how frequently in the previous 12 months they had felt lonely (never/rarely/sometimes/frequently/very frequently). The data were dichotomized by combining the last two categories, thereby identifying children who perceived themselves to be lonely with greatest frequency. The same methods have been used previously [15].

## 2.3. Physical activity and sedentary behaviors

Physical activity and sitting time were self-reported by students using a validated adaptation of the long form International Physical Activity Questionnaire (IPAQ) [16]. To achieve greater relevance to school students, the occupational domain section was replaced with questions about physical education classes. Questions about transportation to school, and physical activity participation after school, were also included. All domains of physical activity were summed to provide an estimate of the total minutes of physical activity per week (min/week). Children also reported the average number of hours per day they watched television (TV).

## 2.4. Covariates

Chronological age and race were self-reported by students. Race was subsequently reclassified as white or non-white. The type of city in

## 2.5. Statistical procedures

Logistic regression models were used to investigate associations of physical activity, sitting time and TV viewing with social isolation, given low values of ICC (ranging between 0.01 and 0.02). Models were adjusted for student age, race, type of city where schools were located, physical activity (when TV viewing and sitting time were modelled as exposures of interest) and sitting time (when physical activity was modelled as the exposure of interest). The results are presented as odds ratios with 95% confidence intervals. Interaction terms were used to investigate effect modification by sex. Estimation of sampling weights accounted for the type of school (public or private), number of classes inside each school, valid questionnaires inside each class, number of classes selected in the school and representativeness of all country regions. All analyses were conducted using sampling weights in STATA 15.0, adopting  $p < 0.05$ .

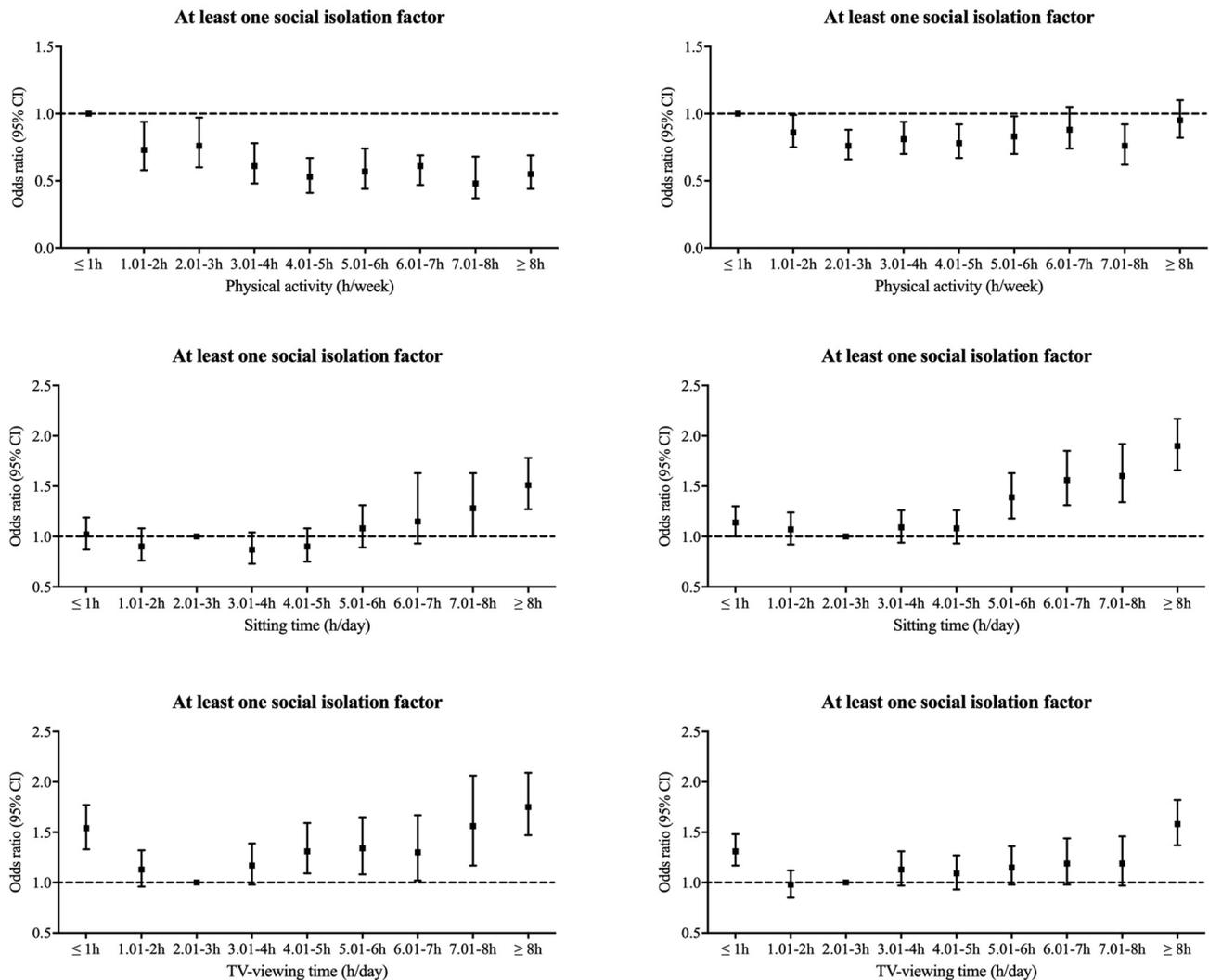
## 3. Results

The characteristics of students are described in Table 1. The mean age of the study sample was 14.2 y. A higher proportion of girls than boys reported feeling lonely and more girls than boys reported both sitting and watching TV for  $\geq 7$  h/day, respectively. A higher proportion of boys performed  $\geq 300$  min/week of physical activity.

Table 2 shows the adjusted associations of physical activity, sitting time and TV viewing with the odds of having a low number of friends and feeling lonely. Compared to the reference group of no leisure-time physical activity, higher physical activity was consistently associated with lower odds of both social isolation indicators. That is with the

## Boys

## Girls



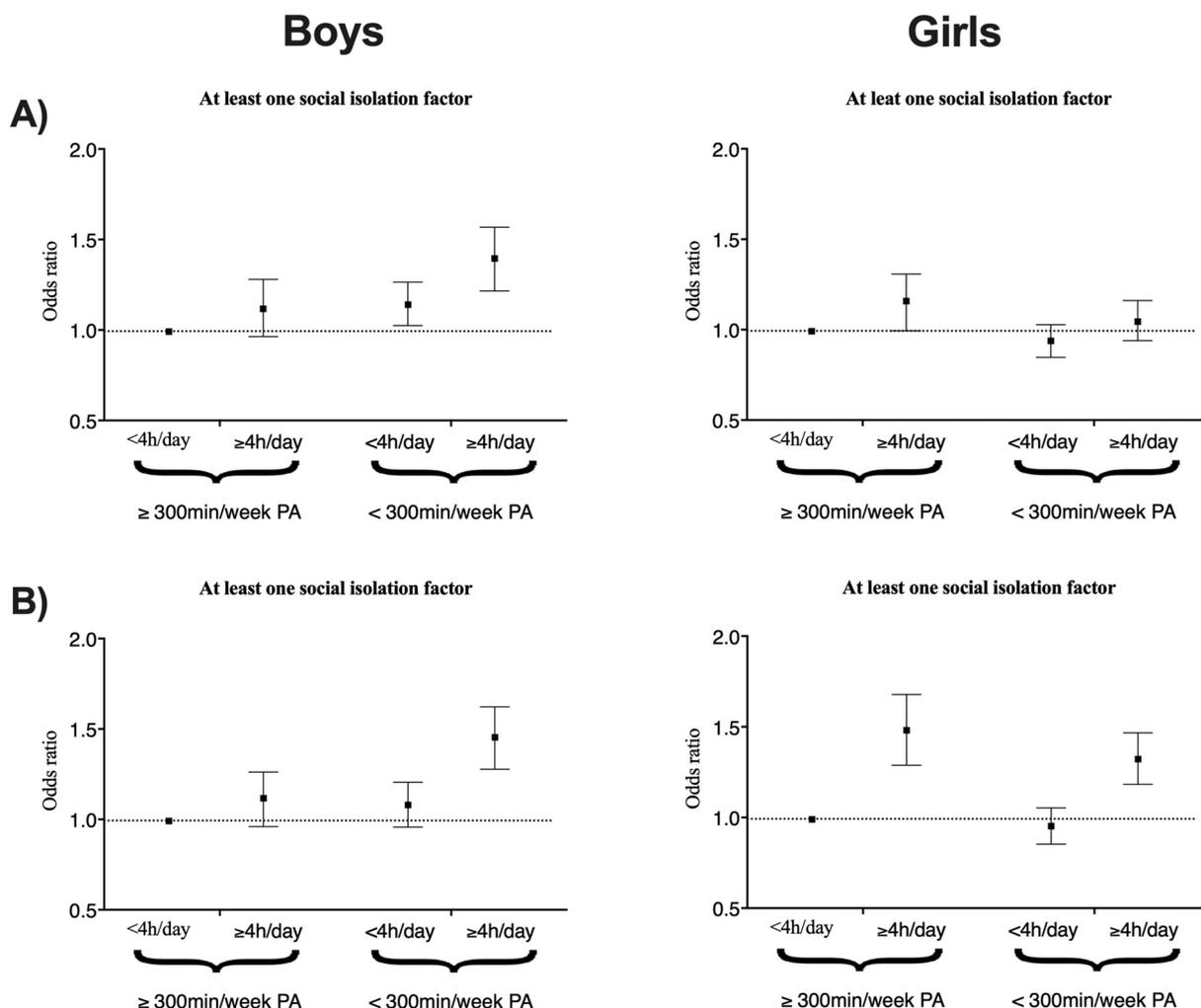
**Fig. 1.** Associations between leisure-time physical activity, sitting time, and TV viewing with social isolation outcomes. Note. Adjusted for chronological age, race, type of city (state capital or other) and physical activity or sitting time (depending on the model).

exception of feeling lonely in girls, for whom only 1–1.9 h/week of physical activity was associated with lower odds of the outcome [OR: 0.82 (95% CI: 0.70 to 0.97)]. With regard to TV viewing, compared to the reference group of 2–2.9 h/day, watching < 1 h/day of TV was associated with higher odds of having few friends [Boys: 1.44 (1.20 to 1.73); Girls: 1.49 (1.25 to 1.78)] and feeling lonely [Boys: 1.60 (1.33 to 1.92); Girls: 1.23 (1.07 to 1.41)]. Similarly, compared to sitting for 2–2.9 h/day, < 1 h/day of sitting was associated with higher odds of girls having few friends [1.35 (1.12 to 1.62)]. Exceeding 2–2.9 h/day of daily sitting time or TV viewing was consistently associated with higher odds of feeling lonely, and the associations appeared to be dose-dependent. The longest duration ( $\geq 8$  h/day) of sitting time was associated with 2.26 (1.84 to 2.79) and 2.17 (1.87 to 2.51) higher odds of feeling lonely in boys and girls, respectively. Equivalent values for TV viewing  $\geq 8$  h/day were 2.07 (1.67 to 2.57) and 1.71 (1.37 to 1.99) higher odds of loneliness. In boys, TV viewing was also associated with higher odds of having few friends. Results for tests of interaction by sex are presented in Supplementary Table A. We found that the protection of physical activity for social isolation outcomes was larger for boys.

Fig. 1 shows associations of physical activity, sitting time and TV viewing with the odds of reporting at least one social isolation marker

(a low number of friends and/or feeling lonely). Higher physical activity in boys, and moderate levels in girls, were associated with lower odds of reporting at least one social isolation factor. Longer sitting time was associated with higher likelihood of social isolation. For instance,  $\geq 8$  h/day of sitting was associated with 1.51 (1.27 to 1.78) higher odds in boys, and 1.90 (1.66 to 2.17) higher odds in girls, of reporting at least one social isolation factor. There was a shallow J-shaped association for TV viewing. For instance, compared to TV viewing for 2–2.9 h/day, watching  $\leq 1$  h/day [(Boys: 1.54 (1.33 to 1.77); Girls: 1.31 (1.17 to 1.48)] and  $\geq 8$  h/day of TV [Boys: 1.75 (1.47 to 2.09); Girls: 1.58 (1.37 to 1.82)] were both associated with higher odds of reporting at least one social isolation marker.

The joint associations of sedentary behaviors and physical activity with reporting at least social isolation marker are presented in Fig. 2. Compared to the reference group of high activity ( $\geq 300$  min/week) and low sitting (< 4 h/d), boys who were physically inactive for < 300 min/week had higher odds for social isolation even if sitting time was < 4 h/day [OR:1.14 (95% CI: 1.02 to 1.26)]. However, boys that performed < 300 min/week of physical activity and simultaneously reported sitting for  $\geq 4$  h/day had the highest likelihood for social isolation [OR: 1.38 (95% CI: 1.22 to 1.57)]. However, the interaction



**Fig. 2.** Joint associations between (a) physical activity and sitting time and (b) physical activity and TV viewing with social isolation. Note. < 4 h/day and ≥ 4 h/day represents sitting or TV viewing. Adjusted for chronological age, race and type of city (state capital or other). OR, odds ratio. CI, confidence interval.

term of sitting time and physical activity for boys, adopting low sitting time and elevated physical activity as reference was not significant [OR: 1.01 (95% CI: 0.92 to 1.12)]. No associations were observed in girls, including interaction term adopting low sitting time and elevated physical activity as reference [OR: 0.95 (95% CI: 0.86 to 1.03)]. Boys that watched TV for ≥ 4 h/day exhibited higher odds for social isolation but only if they jointly performed < 300 min/week of physical activity [OR: 1.44 (95% CI: 1.28 to 1.62)]. Moreover, the interaction term adopting low TV viewing and elevated physical activity as reference for boys was significant [OR: 1.12 (95% CI: 1.02 to 1.23)]. TV viewing was associated with higher likelihood of social isolation in girls, regardless of their physical activity level, with a non-significant interaction (adopting low TV-viewing and elevated physical activity as reference) [OR: 0.99 (95% CI, 0.91 to 1.08)].

**4. Discussion**

We analyzed associations of physical activity and sedentary behaviors with markers of social isolation in a nationally representative sample of Brazilian adolescents. Higher levels of physical activity were associated with lower likelihood of social isolation in boys, as was moderate levels of physical activity performed by girls. We further observed that both low (especially applicable to TV viewing) and high volumes of sedentary behaviors were associated with higher likelihood of social isolation. An examination of joint associations revealed that

≥ 300 min/week of physical activity reduced the association of TV viewing and sitting time with higher social isolation in boys.

Our findings extend the current literature. Previous studies conducted in high and middle-income countries have likewise reported that high sedentary time and physical inactivity are associated with perceptions of loneliness [9,17]. However, these studies did not mutually adjust their analyses for sedentary time and physical activity. Studies have also reported associations of greater peer-acceptance with higher physical activity and lower sedentary time [8,9], which somewhat agrees with our results regarding close friends. The most comparable study that has been performed to date, conducted in 4207 adolescents from one region of northeast Brazil, concluded that participation in physical education classes, but not overall physical activity level, protected against feelings of loneliness and having few friends [15]. The difference in results could be explained by our much larger nationally representative sample.

More time spent sitting was associated with higher odds of social isolation, but a novel finding was that both low (< 1 h/day) and high TV viewing was associated with higher likelihood of social isolation markers. These differences may be explained by the specific characteristics of activities. TV viewing is one of many sedentary behaviors, and watching TV can be a social event when performed with family or friends [10,18]. This may partly explain why compared to watching TV for 2–2.9 h/day, < 1 h/day of TV viewing was associated with higher odds of social isolation. Total sitting time likely includes different

activities such as computer use and studying which are often performed alone. The stronger associations between sitting time with social isolation markers among girls could be explained by boys more frequently playing online games with their peers, whereas girls tend to spend more time on social media which can increase perceptions of loneliness [19].

We examined joint associations of physical activity with TV viewing and sitting time in predicting social isolation markers. To our knowledge this is the first nationally representative study from a middle-income country to do so. We observed that  $\geq 300$  min/week of physical activity reduced the association between high TV viewing ( $> 4$  h/day) with social isolation in boys, but not girls. A possible explanation for these results is that Brazilian girls often exercise alone [20], whereas boys tend to participate in team sports that involve social interaction [12]. Based on our findings, interventions might investigate the potential benefits of replacing TV viewing and other seated and screen-based behaviors (for example using laptops, tablets, games consoles, smartphones) with more physically and socially active pastimes performed with peers [12,21,22].

It is important to consider that this is a cross sectional study and hence direction of associations cannot be inferred. Evidence is available to suggest that physical activity is associated with greater social integration and vice versa, indicating a possible bidirectional relationship [7,12]. The same applies to associations between TV viewing and sitting with markers of social isolation [9,17,22]. Longitudinal studies are therefore needed to better understand these complex and potentially reciprocal relationships. Future studies should also try to incorporate objective measures of physical activity and sedentary behavior, as self-reported data are prone to error and bias. Although the markers of social isolation used in this study have been used previously [15] we were unable to corroborate their validity against an objective measure.

In conclusion, physical activity seems to be associated with lower odds of social isolation, particularly in boys. Conversely, both low and high volumes of sedentary behaviors (especially TV viewing) were associated with higher likelihood of social isolation. Reassuringly, a physical activity level exceeding 300 min/week was sufficient to reduce the association of TV-viewing with social isolation in boys, but this was not the case in girls. Interventions targeting increased physical activity and social integration may be warranted to reduce the burden of social isolation in adolescence.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.genhosppsych.2019.04.010>.

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## Conflict of interest statement

On behalf of all authors, the corresponding author states that there is 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 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 as well as participants' parents included in the study.

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