Screen-based sedentary behaviors, mental health, and social relationships among adolescents

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Abstract — Aim: To analyze the association between screen-based sedentary behaviors, mental health, and social relationships in Brazilian adolescents. **Methods:** A representative sample of the adolescents from Londrina/PR was selected (n = 1,158; 10 to 17 y). Weekday and weekend screen time (TV-viewing and computer/video-game), mental health indicators (self-rated health, stress, feelings of sadness, and satisfaction with own body), and perceived social relationships (friends, family, and teachers) were collected through questionnaires. Somatic maturation, body mass index, and physical activity were assessed as covariates. **Results:** Adolescents who reported higher TV-viewing presented higher odds (p < 0.05) for poor self-rated health (boys), higher stress (both sexes), and dissatisfaction with own body (boys), friendships (girls), and teachers (girls). In contrast, higher computer/video-game use was associated with lower odds (p < 0.05) for poor self-rated health (girls), higher stress (boys), feelings of sadness (both sexes), and dissatisfaction with friends (both sexes) and family (both sexes). **Conclusion:** While higher TV-viewing is associated with negative outcomes, higher computer/video-game users demonstrate better mental health and lower satisfaction with their social relationships.

Keywords: motor activity, physical inactivity; psychological health; interpersonal relations

Introduction

Beyond well recognized negative effects of physical inactivity, sedentary behavior has been related to several non-communicable diseases [1]. The potential negative effects of sedentary behavior on obesity, hypertension, type 2 diabetes, and even mortality can be independent of physical activity level [2]. However, while biomedical outcomes have been more widely studied, clear evidence on the effects of sedentary behavior on mental health are still lacking [3,4].

As highlighted in the recent terminology consensus [5], sedentary behaviors can present several distinct characteristics with specific impacts on health. One of the main current manifestations of sedentary behavior, especially among young people, is screen use, such as TV-viewing, smartphones, computers, or passive video-games. In a relatively short time, infant screen-based media has become an enormous international industry. Data from different parts of the world show alarming screen time use among children and adolescents, from an early age [6,7]. In Brazil, approximately 60% of the school children in the 9th grade spend more than two hours per day in front of a TV [8]. Additionally, the general screen time level has been increasing among young people and seems to track throughout lifespan [9,10].

Previous studies suggest that high screen time increases the likelihood of depression, anxiety, and low self-esteem among young people [3,11,12]. It is assumed that media use can influence cognitive aspects, impacting the feelings and social environmental perceptions of young people [13]. However, there are also indications that specific types of screen time can have positive effects on social and mental outcomes [14].

Thus, in addition to understanding the impacts of different types of screen time, other knowledge gaps persist regarding the relationship between these exposures and mental health indicators, such as the gradual relation (dose-response), differences between sexes [15], and cultural contexts [16]. In this sense, our aim was to analyze the association between screen time (TV, computer, and video-game), mental health, and social relationships in Brazilian adolescents.

Methods

Sample

This is a cross-sectional epidemiological school-based study of Brazilian adolescents aged between 10 and 17 years old, enrolled in public schools of Londrina/PR. Londrina has 506,701 inhabitants, a average human development index of 0.778, and a gross domestic product per capita of US$ 8,530.77 [17].

Sample recruitment was performed in two stages. First, all public schools in the city were separated into regions (north, south, east, west, and center) and two schools were randomly selected from each location. Subsequently, classes in the schools

were randomly selected and all students in these classes (except those using prescription medicine or undergoing treatment for an illness) were invited to participate in the study. Students that failed to return a consent form signed by parents were ineligible. Recruitment peaked at 1,395 adolescents but 237 failed to provide all required data for the analysis of this study and were excluded, reaching a final sample of 1,158 adolescents. Prior to the main data collection, a pilot study was conducted with 90 adolescents (not included in the main analyses), in which questionnaires were performed with a seven day interval to test the reproducibility of the instruments. The local ethics committee approved all the procedures of this study (process number 10655/2012) according to the Declaration of Helsinki.

Screen time

Adolescents' screen time was accessed through a self-reported questionnaire, which contained four questions asking how many hours a day the adolescent spent watching television and how many hours a day he/she spent using a computer and videogames (PC/VG), on weekdays and weekends. For analyses, screen time was separated into two categories: TV-viewing (0 to 2.0 h/d, 2.1 to 4.0 h/d and > 4h/d) and PC/VG use (0 h/d, 0.1 to 2.0 h/d, 2.1 to 4.0 h/d and > 4h/d). Questions presented an intra-class correlation (ICC) between 0.76 and 0.88.

Perception of social relationships

Self-perceptions about relationships with friends, family, and teachers were assessed through a questionnaire. Specifically, the questions were organized in a Likert scale (from 1 to 4) and asked: "*Regarding your relationship with your classmates and friends, are you*"; "*Regarding your relationship with your family, are you*", and "*Regarding your relationship with your professors, are you*". Options ranged from *very unsatisfied* to *very satisfied,* with four possibilities. The ICCs of the questions were respectively 0.50, 0.53, and 0.69.

Mental health indicators

Sadness was collected through the Likert scale type question: "*How often do you feel sad or depressed*?", options ranged from "*very frequently*" to "*rarely*", with four possibilities and an ICC of 0.62. Stress was evaluated through a Likert scale type question: "*How often do you feel stressed*?", options ranged from "*very frequently*" to "*rarely*", with four possibilities and an ICC of 0.80. Self-rated health was accessed through a self-reported Likert scale type question: "*In general, how do you consider your health?:*", with four possibilities ranging from "*poor*" to "*excellent*" and an ICC of 0.73. Satisfaction with own body was accessed through a dichotomous (yes or no) question: "Are you satisfied with your body?", with an ICC of 0.87.

Covariates

Somatic maturation was estimated through the method of age at peak height velocity [18], which estimates peak height velocity (PHV) through anthropometric values of stature and trunk-encephalic height. After this, PHV is subtracted from chronological age, creating the age at PHV. Habitual physical activity was estimated through the self-reported Baecke questionnaire [19], which contemplates sports, leisure, and occupational domains of physical activity. Socioeconomic status (SES) was assessed by means of the Brazilian Criterion for Economic Classification instrument [20], which considers the education of the household leader and certain possessions, providing a score based on this information.

Statistics procedures

Descriptive statistics (frequencies, mean, and standard deviation) as well as the chi-square, chi-square for trend, and Mann-Whitney tests were used to describe characteristics and compare groups at baseline. Thereafter, logistic regressions, the reporting odds ratio, and a confidence interval of 95% (CI95%), were used to analyze the association between screen time domains and mental health/social relationship variables as well as the association between screen time domains and social/parental environment. All analyses were conducted using SPSS 22.0 software, with a significance level of 5%.

Results

Table 1 presents the characteristics of the sample. In general, boys were older and presented greater time of VG/PC use. On the other hand, girls presented higher rates of being stressed, sad, and dissatisfied with their body.

Table 1. Characteristics of the sample according to gender (Londrina 2011, Brazil; n = 1,158).

	Boys	Girls	p-value
Age (y)	13.1 ± 1.6	12.8 ± 1.5	0.030
SES (%)			0.290
Lowest	65.0	68.3	
Highest	35.0	31.7	
BMI (kg/m²)	19.7 ± 3.9	19.9 ± 4.1	0.332
TV viewing in week (h/d⁻¹)	3.5 (3.5)	3.9 (3.0)	0.278
TV viewing at weekend (h/d⁻¹)	3.7 (4.0)	3.5 (4.0)	0.223
VG/PC use in week (h/d⁻¹)	3.0 (3.8)	2.0 (3.4)	<0.001
VG/PC use at weekend (h/d⁻¹)	3.1 (5.0)	2.3 (5.0)	<0.001
Health perception (%)			<0.001
Bad	1.6	2.6	
Regular	17.0	21.4	
Good	46.3	54.2	
Excellent	35.0	21.9	
Feeling stressed (%)			<0.001
Rarely	17.7	8.6	
Sometimes	50.7	39.6	
Usually	21.1	33.3	
Always	10.5	18.5	
Sadness (%)			<0.001
Rarely	15.4	4.9	
Sometimes	58.6	52.2	
Usually	20.5	31.9	
Always	5.6	11.0	
Satisfaction with body (%)			<0.001
Yes	66.0	51.9	
No	34.0	48.1	
Satisfaction with family (%)			0.002
Very satisfied	59.5	49.6	
Satisfied	30.2	37.2	
Dissatisfied	7.2	9.3	
Very dissatisfied	3.1	3.9	
Satisfaction with friendship (%)			0.105
Very satisfied	43.1	40.9	
Satisfied	48.7	47.5	
Dissatisfied	6.3	8.9	
Very dissatisfied	2.0	2.7	
Satisfaction with teachers (%)			0.533
Very satisfied	18.1	17.9	
Satisfied	44.0	45.0	
Dissatisfied	23.6	25.3	
Very dissatisfied	14.3	11.8	

Note. SES = socioeconomic status; BMI = body mass index; VG/PC = video game and/or personal computer.

Prevalence of TV-viewing and VG/PC use according to sex are presented in figure 1. In both sexes, the prevalence of watching more than 4 hours of TV was greater than 40%. For VG/PC use, the prevalence of more than 4 hours was around 25% in both sexes.

Figure 1. Distribution of sedentary behavior contexts in Brazilian adolescents.
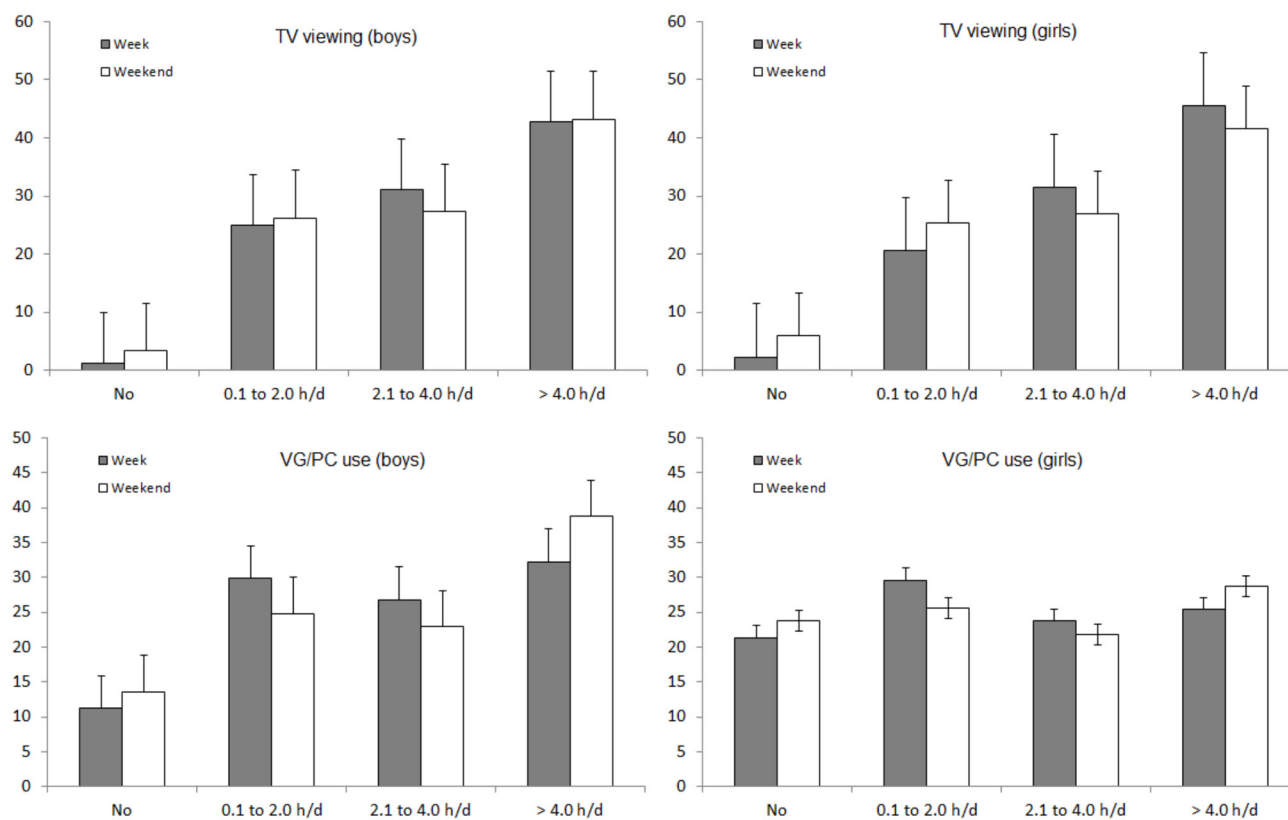
Note. VG/PC = video game and/or personal computer

Table 2 presents the association of screen time patterns with social relationships and mental health indicators among boys. In general, TV viewing was positively associated with poor self-rated health (weekend), higher stress (weekdays), and dissatisfaction with body (both weekdays and weekend). On the other hand, VG/PC use was inversely related to higher perception of stress (weekend), higher sadness (weekdays), dissatisfaction with relationships with family and friends (both weekdays and weekend). However, for half of these associations, reduced odds were observed only from 2 to 4 h/d of exposure.

Table 2. Association between sedentary behavior contexts and indicators of mental health and social relationships in boys (Londrina 2011, Brazil; n = 605).

| | Poor health | Stressed | Sadness | Dissatisfied | | | |
| | | | | with body | with family | with friendship | with teachers |
	OR (CI 95%)	OR (CI 95%)	OR (CI 95%)	OR (CI 95%)	OR (CI 95%)	OR (CI 95%)	OR (CI 95%)
TV viewing in week							
0 to 2.0 h/d	1	1	1	1	1	1	1
2.1 to 4.0 h/d	1.05 (0.57 to 1.92)	1.17 (0.71 to 1.96)	1.65 (0.98 to 2.78)	1.07 (0.64 to 1.82)	0.74 (0.35 to 1.62)	1.50 (0.64 to 3.54)	0.81 (0.51 to 1.29)
> 4.0 h/d	1.46 (0.84 to 2.53)	**2.25 (1.41 to 3.58)**	1.43 (0.87 to 2.36)	**2.40 (1.48 to 3.88)**	1.04 (0.52 to 2.08)	1.37 (0.60 to 3.15)	1.38 (0.90 to 2.13)
TV viewing at weekend							
0 to 2.0 h/d	1	1	1	1	1	1	1
2.1 to 4.0 h/d	**2.07 (1.12 to 3.84)**	1.11 (0.68 to 1.82)	0.74 (0.45 to 1.24)	**1.91 (1.14 to 3.22)**	0.53 (0.24 to 1.18)	0.74 (0.34 to 1.62)	0.86 (0.55 to 1.37)
> 4.0 h/d	**1.86 (1.05 to 3.31)**	1.49 (0.97 to 2.32)	0.85 (0.54 to 1.34)	**2.27 (1.42 to 3.65)**	0.82 (0.43 to 1.57)	0.58 (0.28 to 1.22)	0.90 (0.60 to 1.36)

	Poor health OR (CI 95%)	Stressed OR (CI 95%)	Sadness OR (CI 95%)	with body OR (CI 95%)	Dissatisfied with family OR (CI 95%)	with friendship OR (CI 95%)	with teachers OR (CI 95%)
VG/PC use in week							
No	1	1	1	1	1	1	1
0.1 to 2.0 h/d	0.98 (0.44 to 2.20)	0.60 (0.33 to 1.11)	**0.30 (0.16 to 0.56)**	1.04 (0.53 to 2.05)	**0.16 (0.06 to 0.40)**	**0.27 (0.10 to 0.69)**	1.05 (0.57 to 1.94)
2.1 to 4.0 h/d	0.87 (0.38 to 1.97)	0.63 (0.34 to 1.18)	**0.39 (0.21 to 0.72)**	1.08 (0.55 to 2.14)	**0.34 (0.15 to 0.75)**	**0.15 (0.05 to 0.45)**	1.04 (0.56 to 1.93)
> 4.0 h/d	1.62 (0.75 to 3.48)	0.87 (0.48 to 1.59)	**0.47 (0.26 to 0.86)**	1.32 (0.68 to 2.57)	**0.30 (0.14 to 0.64)**	0.55 (0.25 to 1.25)	1.45 (0.79 to 2.65)
VG/PC use at weekend							
No	1	1	1	1	1	1	1
0.1 to 2.0 h/d	0.99 (0.49 to 2.03)	**0.54 (0.30 to 0.98)**	0.36 (0.19 to 0.69)	1.04 (0.55 to 1.96)	**0.26 (0.11 to 0.63)**	0.60 (0.24 to 1.48)	1.05 (0.59 to 1.88)
2.1 to 4.0 h/d	1.07 (0.52 to 2.21)	**0.54 (0.30 to 0.99)**	0.39 (0.20 to 0.74)	0.99 (0.52 to 1.89)	**0.34 (0.15 to 0.80)**	**0.33 (0.11 to 0.94)**	0.64 (0.35 to 1.17)
> 4.0 h/d	0.77 (0.39 to 1.52)	0.74 (0.43 to 1.26)	0.78 (0.45 to 1.35)	1.19 (0.66 to 2.16)	**0.31 (0.15 to 0.66)**	0.51 (0.22 to 1.20)	1.21 (0.71 to 2.08)

Note. VG/PC = video game and/or personal computer. All models are adjusted for chronological age, somatic maturity, BMI, and physical activity.

The associations between screen time patterns, social relationships, and mental health among girls are presented in table 3. Similarly to the boys, TV-viewing was positively associated with higher stress (weekdays) and dissatisfaction with relationships with friends (weekend) and teachers (weekdays), while VG/PC use was negatively related to poor self-rated health (both weekdays and weekend), higher sadness (weekdays), and dissatisfaction with relationships with family and friends (both weekdays and weekend). Except for self-rated health and relationships with friends, reduced odds were observed at lower or moderate levels of VG/PC, only.

Table 3. Association between sedentary behavior contexts and indicators of mental health and social relationships in girls (Londrina 2011, Brazil; n = 737).

	Poor health OR (CI 95%)	Stressed OR (CI 95%)	Sadness OR (CI 95%)	with body OR (CI 95%)	Dissatisfied with family OR (CI 95%)	with friendship OR (CI 95%)	with teachers OR (CI 95%)
TV viewing in week							
0 to 2.0 h/d	1	1	1	1	1	1	1
2.1 to 4.0 h/d	0.84 (0.52 to 1.38)	1.20 (0.79 to 1.83)	0.96 (0.63 to 1.47)	1.18 (0.77 to 1.82)	0.60 (0.32 to 1.11)	0.67 (0.36 to 1,26)	1.54 (0.99 to 2.41)
> 4.0 h/d	1.08 (0.70 to 1.69)	**1.52 (1.03 to 2.24)**	1.09 (0.74 to 1.61)	1.07 (0.72 to 1.59)	0.74 (0.43 to 1.28)	0.71 (0.40 to 1.25)	**1.58 (1.04 to 3.28)**
TV viewing at weekend							
0 to 2.0 h/d	1	1	1	1	1	1	1
2.1 to 4.0 h/d	1.12 (0.69 to 1.81)	0.86 (0.58 to 1.28)	0.86 (0.58 to 1.30)	0.97 (0.64 to 1.48)	1.02 (0.57 to 1.80)	**1.96 (1.04 to 3.69)**	0.77 (0.51 to 1.17)
> 4.0 h/d	1.44 (0.94 to 2.20)	0.96 (0.67 to 1.38)	1.16 (0.81 to 1.66)	1.19 (0.82 to 1.73)	0.67 (0.39 to 1.16)	1.38 (0.75 to 2.53)	0.95 (0.66 to 1.37)
VG/PC use in week							
No	1	1	1	1	1	1	1
0.1 to 2.0 h/d	**0.48 (0.30 to 0.79)**	0.69 (0.45 to 1.06)	**0.64 (0.41 to 0.99)**	1.13 (0.72 to 1.76)	**0.43 (0.22 to 0.83)**	**0.39 (0.21 to 0.74)**	0.50 (0.32 to 0.80)
2.1 to 4.0 h/d	**0.57 (0.35 to 0.95)**	1.12 (0.72 to 1.76)	0.90 (0.57 to 1.42)	1.02 (0.63 to 1.63)	**0.47 (0.24 to 0.93)**	**0.42 (0.22 to 0.80)**	1.04 (0.66 to 1.64)
> 4.0 h/d	0.61 (0.37 to 0.99)	1.13 (0.72 to 1.76)	1.20 (0.77 to 1.87)	1.11 (0.69 to 1.76)	0.77 (0.42 to 1.42)	**0.30 (0.15 to 0.61)**	0.90 (0.57 to 1.41)

	Poor health	Stressed	Sadness	with body	Dissatisfied with family	with friendship	with teachers
	OR **(CI 95%)**	**OR** **(CI 95%)**	**OR** **(CI 95%)**	**OR** **(CI 95%)**	**OR** **(CI 95%)**	**OR** **(CI 95%)**	**OR** **(CI 95%)**
VG/PC use at weekend							
No	1	1	1	1	1	1	1
0.1 to 2.0 h/d	**0.50** **(0.30 to 0.82)**	0.70 (0.45 to 1.07)	1.17 (0.75 to 1.81)	1.01 (0.64 to 1.57)	0.55 (0.29 to 1.03)	**0.47** **(0.25 to 0.87)**	0.85 (0.54 to 1.32)
2.1 to 4.0 h/d	0.72 (0.44 to 1.19)	0.80 (0.51 to 1.25)	1.16 (0.74 to 1.83)	1.03 (0.64 to 1.64)	**0.39** **(0.19 to 0.81)**	**0.43** **(0.22 to 0.84)**	0.65 (0.40 to 1.05)
> 4.0 h/d	0.76 (0.48 to 1.22)	0.95 (0.63 to 1.45)	1.21 (0.79 to 1.85)	1.16 (0.75 to 1.80)	0.67 (0.37 to 1.21)	**0.31** **(0.16 to 0.61)**	1.15 (0.75 to 1.77)

Note. VG/PC = video game and/or personal computer. All models are adjusted for chronological age, somatic maturity, BMI, and physical activity.

Discussion

The purpose of this study was to evaluate the association between screen-based sedentary behaviors, mental health, and perceived social relationships among adolescents. We found that, in both sexes, adolescents with higher TV-viewing demonstrated poorer self-rated health (boys), higher stress (habit on weekdays), and greater dissatisfaction with own body (boys) and social relationships (girls). On the other hand, those who reported higher VG/PC use presented better self-rated health (girls), lower feelings of sadness (habit on weekdays; only moderate use in girls), and higher satisfaction with family and friends relationships.

Physical inactivity is well recognized as a risk factor for cardiovascular health as well as mental health among adolescents [21,22]. However, sedentary behavior emerged in the area of human kinetics as distinct risk factor for cardiovascular health [23–25]. Studies conducted with adolescents have already demonstrated positive relationships of screen time, especially TV-viewing, with dyslipidemia and other risk factors such as hypertension and fasting glucose [26,27]. More recently, mental health has been receiving attention from early ages, given its influence on the prevalence of mental disorders among adults [28], which represents a current global challenge [29].

Our findings showed that, regardless of age, maturation, physical activity, and BMI, higher TV viewing during the week was positively associated with stress in both sexes, and poor self-rated health and dissatisfaction with body among boys. A possible mechanism could be through commercials exhibiting extremely artificial and ideal body images, which can induce adolescents to think that their body is not attractive [30,31]. A similar hypothesis can also cause stress [31]. In addition, having a TV in the bedroom has been pointed out as a risk factor for sleep deprivation, which can mediate the relationship between screen time and health outcomes [32].

Moderate and high TV viewing were, respectively, associated with dissatisfaction with relationships with friends (habit on weekend) and teachers (habit on weekdays) among girls. The time spent watching TV can compromise time with friends [33] and doing school homework [34]. High TV time has been related to poor academic achievement through different pathways [35], a fact that could affect students' perception of teachers. The isolation caused by screen-based sedentary behaviors could also be a mediator in the relation between TV viewing and stress in both sexes [36], which is related to depressive symptoms [4], higher risk of poor social behavior, and disengagement in school [37].

Interestingly, PC/VG use was a "protection factor" for stress (habit on weekend for boys), feelings of sadness (habit on weekdays only), and dissatisfaction with family and friends for both sexes; and for poor self-rated health among girls. The relation between PC/VG time and health is unclear. There are indications of negative effects [38], however this relationship seems to vary according to the characteristics of the use and type of game [39]. Thus, it is possible to reduce stress and improve other mental health outcomes playing videogames [40], given that through PC/VG use, adolescents can socialize with their peers [39]. Future research should investigate the contexts in which these behaviors occur. Co-viewing TV, and using the computer or playing video games with friends and parents can influence their psychological effects [13].

Our findings build upon information about the potential overall effects of screen-based sedentary behaviors on health. However, several questions remain to be answered. In the present study, although some insights into gradual association were gained, we had low sensibility to this end, and objective measures of sedentary behaviors in different contexts should elucidate the specific dose-response between screen time and outcomes. In addition, the co-occurrence of these behaviors, specific phase of manifestation (e.g., critical window of neurological development) [41], and their interaction with other correlates of mental health, such as family history/structure and physical/social environment, should be investigated.

Considering alarming levels of sedentary behaviors worldwide, we corroborate that not all sedentary behaviors are equal. Among the screen-based behaviors, TV viewing has been more related to negative cardiovascular health compared to PC/VG [27], which we extend to mental health. Interestingly, while prevalence of TV viewing declined, PC/VG use increased among Brazilian young people between 2001 and 2011 [42]. Although more studies are warranted, the above information could help in the formulation of specific interventions to reduce sedentary behaviors, beginning with the most harmful. Interventions based on physical environment have been showing promising results [43,44].

Our study presents limitations that have to be mentioned. Firstly, our indicator of sedentary behavior only contemplates screen-based sedentary behavior and is subjective, despite our aim to analyze separate domains. Furthermore, due to our study design (cross-sectional), we cannot pinpoint causality. For example, a bidirectional relationship was proposed between screen time and mental health [45]. On the other hand, we adjusted analyses by body mass index, somatic maturation, and physical activity, which are important correlates of mental health [46,47]. As a first threshold of "risk", we adopted the internationally recommended cutoff for young people (2h/d) [48], followed by another cutoff widely used in the literature (4h/d) [4], which also allowed the understanding of gradual relationships. Moreover, within a growing research field, we presented data of screen-based sedentary behaviors, mental health, and social relationship perceptions of more than a thousand adolescents of a middle income country.

Thus, we conclude that TV-viewing is associated with poor mental health (e.g. stress, sadness, and dissatisfaction with own body) and perception of poor social relationships. On the other hand, PC/VG use is associated with good mental health indicators and better social relationships.

Informed consent

Informed consent was obtained from all individual participants and the parents of the adolescents included in the study.

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