Epidemiology

Active commuting and healthy eating habits are inversely associated with screen time in Brazilian adolescents

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Abstract - Aim This study aimed to evaluate the association between screen time and health behaviors (physical activity and healthy eating habits) in adolescents. **Methods:** A cross-sectional school-based study was conducted on 1233 adolescents (13 - 19 years) from private and public schools of Pelotas, RS, Brazil. Participants reported socio-demographic and behavioral (i.e., physical activity, food intake, and screen time) characteristics via questionnaire. Screen time was assessed as the sum of the time spent in the following activities: watching TV, using a computer, and playing video games. **Results:** A negative effect in screen time was observed in adolescents who engaged in 16 min or more of active commuting per day (β = -1.02 95%CI -1.79 to -0.24). A similar effect was observed in adolescents who reported a daily intake of breakfast (β = -0.81 95%CI -1.40 to -0.22), fruits (β = -0.60 95%CI -1.18 to -0.01), and vegetables (β = -0.99 95%CI -1.70 to -0.28). **Conclusion:** A healthy lifestyle, such as engaging in active commuting and having healthy eating habits, was associated with a reduced time spent in sedentary screen-based activities.

Keywords: adolescents, screen time, physical activity.

Introduction

Screen time is defined as the period that a person spends in front of an electronic screen, such as watching TV, using a computer, or playing video games. These activities are well known to be of low energy expenditure[1,2]. Children and adolescents are recommended not to engage in screen-based activities for more than 2 h per day during leisure time, for health benefits[3].

Adolescents are recommended to engage in at least 60 min of moderate to vigorous physical activity (MVPA) daily, to accumulate 300 min per week [4]. Evidence is still inconsistent on the relationship between physical activity and screen time, in adolescents. The way that physical activity is considered (e.g., sports activity)[5] or assessed (e.g., objectively)[6] might influence this relationship. Also, even though evidence shows that active commuting is inversely associated with screen time in adults, this type of physical activity is not considered in studies with the adolescent population[5,7,8].

Also, children and adolescents may present unhealthy eating behaviors due to psychological, socioeconomic, and cultural aspects that determine their food choice, therefore directly interfering in the formation of eating habits[9,10]. Studies have shown that unhealthy eating behaviors such as skipping breakfast and decreased intake of healthy foods (e.g., fruits and vegetables) are related to the increased time spent in screen-based sedentary activities[11,12]. However, other associations are not clear in the literature, such as screen time and dairy product intake, which might be influenced by cultural factors. In Brazil, for example, adolescents usually drink chocolate milk, which can contribute to a high caloric food intake[13,14].

Nowadays, children and adolescents are more likely to engage in sedentary activities than a decade ago, as there is increased availability of screen-based electronic devices, such as smartphones and laptops, which might have impaired effects on their health[15,16]. This rise in screen time might be associated with unhealthy habits[17]. Thus, this study aimed to evaluate the relationship between physical activity (e.g., sports and commuting activities), eating habits, and screen time in adolescents from southern Brazil.

Methods

Study design and participants

A cross-sectional school-based study was conducted in the city of Pelotas, southern Brazil. Participants were students from public and private high schools located in the urban area of the city. All participants received a con-

sent form that was signed by them (if they were of legal age) or by their parents or legal guardians. Socioeconomic, demographic, behavioral, nutritional and health characteristics were assessed using a questionnaire.

Procedure

All high schools in the urban area of Pelotas were randomly selected taking into account the proportional representation of private and public institutions (i.e., municipal, state, and federal). Schools were randomly selected using a strategy that considered the proportionality between municipal, state, federal, and private institutions. Overall, 25 schools were assessed from private (n = 7) and public (state n = 15, federal n = 2, and municipal n = 1) network. From these data, the number of students required per education network was calculated, as follows: (a) public network: state schools (n = 15) with 5,680 students, representing 62% of the total population; federal schools (n = 2) with 1,570 students, representing 17% of the total population; municipal school (n = 1) with 860 students, representing 9%; (b) private schools (n = 6) with 1,123 students, representing 12% of the total population. More details can be found elsewhere[18].

Data collection

We assessed screen time as the total time spent in front of an electronic screen, such as watching TV, using a computer, or playing video games. First, participants were asked if they engaged in these activities. If the answer was "yes", a second question regarding the daily time spent on each activity was asked (e.g., *How many hours per day do you watch TV?*). Total daily screen time was considered as the sum of the time spent on these three activities (watching TV, using a computer, and playing video games).

We measured the total physical activity score using a validated instrument considering commuting and recreational physical activity domains[19,20]. We used the cut-off point proposed by international physical activity guidelines to classify participants as active if the participant engaged in 300 min or more of MVPA per week[21].

In addition to total physical activity, active commuting to or from school (walking or cycling) and time in sports activity were also assessed. For analysis purposes we stratified active commuting into three categories: ≤ 5 min per day, between 6 and 15 min per day, and, ≥ 16 min per day. Sports activity was also stratified into three categories, as follows: ≤ 2 h per week, between 3 and 7 h per week, and, ≥ 8 h per week[6].

We asked participants about their eating habits (i.e., frequency of fruits, vegetables, and dairy products intake) and behavior (i.e., breakfast). For fruits, vegetables, and dairy products intake, "daily", "weekly", "monthly" and "never" were the response options. For analysis purposes these variables were dichotomized. We assessed daily breakfast intake by a yes/no question.

We used sex (male and female), age (years), socioeconomic level (based on years of maternal schooling), and body mass index (BMI) as covariates. BMI was calculated using the following formula: Body mass (kg)/ Height^2 (m). Body weight was measured using a digital scale with 0.1 kg precision. Height was measured using a stadiometer with 0.1 cm precision. Participants were barefoot and wore only shorts and a t-shirt at the time of the measurement. Overweight and obesity were defined as having a BMI equal to or greater than the 85th and 95th percentiles for age and gender[22].

Data analyzes

We presented descriptive data as means and standard deviations for continuous variables and as total and relative frequencies for categorical variables. We used linear regression models to evaluate the relationship between screen time and main exposures (physical activity and eating habits and behavior). The regression model was adjusted for the following potential confounders: sex, maternal schooling, age, and BMI. All variables were inserted in the model and those with $p < 0.2$ were included in the final model. A 5% level was set to indicate statistical significance. Stata statistical software (StataCorp. 2018, Stata Statistical Software: Release 15, Version 15.1, StataCorp LP, College Station, TX, USA) was used.

Results

Overall, 1,233 participants completed self-reported data for physical activity (active commuting, sports activity, and total physical activity) and vegetables daily intake, 1,231 for daily breakfast, and 1,228 for dairy products and fruit daily intake. The refusal rate was 8.7%.

Characteristics of participants are presented in Table 1. Most participants were girls, aged between 15 and 17 and had normal BMI. Regarding physical activity, most participants reported less than 16 min of active commuting per day and 2 h of sports activity per week. In addition, most participants (63.9%) did not meet physical activity recommendations (300 min/week). Two-thirds reported breakfast and dairy products daily intake. On the other hand, 37.9% consumed fruits and only 19.5% consumed vegetables daily. The mean screen time was 7.2 ± 4.9 h per day.

Table 2 shows crude and adjusted analyzes of screen time and active commuting, physical activity recommendations and sports activity. Meeting physical activity recommendations, as well as engaging in sports activity 3 or more hours per week, were not associated with a decreased screen time.

In crude analysis engaging in 6-15 min and 16 min or more minutes of active commuting per day showed a negative association with screen time. However, in the adjusted analysis, the significant effect remained only for

Table 1 - Participants sociodemographic and behavioral characteristics. Pelotas, Brazil (n = 1,233).

Sex	n (%)
Boys	567 (46.0)
Girls	666 (54.0)
Age (years)	
13-14	156 (12,6)
15	149 (22.5)
16	277 (32.5)
17	401 (23.6)
18-19	108 (8,8)
Maternal schooling (years) (n = 1,197)	
0-4	131 (10.9)
5-8	317 (26.5)
≥ 9	749 (62.6)
BMI* (n = 1,191)	
Normal	889 (74.6)
Overweight	235 (19.7)
Obesity	67 (5.7)
Active transport (min/d)	
≤ 5	231 (18.7)
6-15	416 (33.7)
≥ 16	586 (47.6)
Sports activity (h/week)	
≤ 2 h/week	701 (56.8)
3-7 h/week	258 (20.9)
≥ 8 h/week	274 (22.2)
Total physical activity (min/week)	
< 300	788 (63.9)
≥ 300	445 (36.1)
Breakfast daily (n = 1,231)	
No	437 (35.5)
Yes	794 (64.5)
Fruit daily intake (n = 1,228)	
No	762 (62.1)
Yes	466 (37.9)
Vegetables daily intake	
No	993 (80.5)
Yes	240 (19.5)
Milk products daily intake (n = 1,228)	
No	494 (40.2)
Yes	734 (59.8)
Fruit weekly intake	
No	671 (54.6)
Yes	557 (45.4)
Fruit monthly intake	
No	1,109 (90.3)
Yes	119 (9.7)
Vegetables weekly intake	
No	839 (68.1)
Yes	394 (31.9)
Vegetables monthly intake	
No	1,177 (95.5)
Yes	56 (4.5)

*Body mass index.
min/d = minutes/day; min/week = minutes/week; h/week = hours/week.

Table 2 - Crude and adjusted analyzes between screen time and physical activity (n = 1,159).

	Crude analysis β (95%CI)	**P-value**	**Adjusted analysis* β (95%CI)**	**P-value**
Active commuting (min/d)				
≤ 5	Ref.		Ref.	
6-15	-0.82 (-1.61; -0.02)	0.044	-0.75 (-1.57; 0.06)	0.070
≥ 16	-1.08 (-1.83; -0.33)	0.005	-1.02 (-1.79; -0.24)	0.010
Sports activity (h/week)				
≤ 2	Ref.		Ref.	
3-7	0.47 (-0.24; 1.18)	0.190	0.12 (-0.61; 0.84)	0.746
≥ 8	0.58 (-0.11; 1.28)	0.097	0.12 (-0.62; 0.85)	0.756
Total physical activity (min/week)				
< 300	Ref.		Ref.	
≥ 300	0.29 (-0.29; 0.87)	0.323	-0.09 (-0.70; 0.52)	0.779

*Adjusted for gender, maternal schooling, age and BMI. min/d = minutes/day; min/week = minutes/week.

16 min or more per day of active commuting (β = -1.02 95%CI -1.79 to -0.24) (Table 2).

Crude and adjusted analyzes of eating habits (fruits, vegetables, and dairy products intake), behavior (breakfast), and screen time are presented in Table 3. Having breakfast daily was associated with a reduced screen time (β = -0.81 95%CI -1.40 to -0.22). In addition, a daily intake of fruits and vegetables was negatively associated with screen time (β = -0.60 95%CI -1.18 to -0.01; β = -0.99 95%CI -1.70 to -0.28, respectively). On the other hand, eating dairy products daily, as well as fruits and vegetables on a weekly and monthly basis, did not show an association with screen time, in both crude and adjusted analyzes.

Discussion

Main findings

We revealed that adolescents spend a mean time of 7.2 h per day in activities such as TV watching, computer, and video gaming. Engaging in active commuting, and keeping healthy eating habits (eating vegetables and fruits) and behavior daily (having breakfast) were associated with reduced screen time. On the other hand, engaging in sports activity, meting the physical activity recommendation, and drinking and eating dairy products daily were not.

Physical activity

The relationship between physical activity and screen time in adolescents is not well established in the literature. Factors such as, how physical activity is assessed (i.e., objectively or subjectively) and considered (i.e., sports activity or meeting physical activity recommendation), as well as how screen time is considered (i.e., as a continuous or categorical variable) might influence[6-8,23]. We considered screen time as a continuous variable and assessed physical activity by questionnaire.

When physical activity was assessed objectively (i.e., by accelerometer) and screen time considered as a continuous variable, an association between screen time and physical activity was found in cross-sectional, but not in prospective analyzes[6]. Furthermore, studies that assessed physical activity by questionnaire presents inconsistent results, probably due to different cut-off points used for excessive screen time (e.g., ≥ 2 h/day; ≥ 4 h/day)[5,7,8,23]. When using a cut-off point of up to 2 h per day of screen time, it was observed that adolescents who spent up to 2 h per day in screen-based sedentary activities were more likely to engage in adequate levels of physical activity[7,8,23]. On the other hand, a study that used a 4-h/day cut-off point did not find an association between screen time and physical activity[5].

Physical activity assessed as hours per week[7] and MVPA[23] was associated with less screen time in adolescents. However, when analyzed by physical activity recommendation (300 min/week) no association was observed[5]. Furthermore, we did not find an association between screen time and physical activity, when evaluating by sports activity (hours/week) and physical activity recommendation. The different ways in which physical activity is analyzed (e.g., hours per week) might explain the differences between studies.

Active commuting was associated with a lower amount of time spent in sedentary activities, such as screen time, in adults[24]. However, studies that investigated the relationship between screen time and physical activity in adolescents, did not consider active commuting as a physical activity variable[5,7,8]. Our data indicates that adolescents who engage in 16 min or more of active commuting to or from school are less likely to spend time in screen-based sedentary activities. In other words, increasing time walking/bicycling to or from school reduces time spent on screen-based activities such as computers and video-games. Strategies to encourage active commuting in this population are necessary, to increase physical activity and reduce sedentary behaviors.

Table 3 - Crude and adjusted analyzes between screen time and dietary habits and behavior.

	Crude analysis β (95%CI)	P-value	Adjusted analysis* β (95%CI)	P-value
Breakfast daily (n = 1,158)	-0.73 (-1.31; -0.15)	0.014	-0.81 (-1.40; -0.22)	0.008
Fruit daily intake (n = 1,156)	-0.54 (-1.12; 0.03)	0.062	-0.60 (-1.18; -0.01)	0.046
Vegetable daily intake (n = 1,159)	-0.86 (-1.55; -0.16)	0.016	-0.99 (-1.70; -0.28)	0.006
Milk products daily intake (n = 1,155)	0.35 (-0.22; 0.92)	0.224	0.16 (-0.42; 0.75)	0.584
Fruit weekly intake (n = 1,156)	-0.06 (-0.61; 0.50)	0.842	0.22 (-0.35; 0.79)	0.440
Vegetable weekly intake (n = 1,159)	-0.36 (-0.95; 0.23)	0.235	-0.24 (-0.84; 0.36)	0.438
Fruit monthly intake (n = 1,156)	0.91 (-0.31; 1.84)	0.058	0.47 (-0.49; 1.43)	0.335
Vegetable monthly intake (n = 1,159)	1.27 (-0.06; 2.59)	0.061	1.06 (-0.29; 2.41)	0.125

*Adjusted for gender, maternal schooling, age and BMI.

However, one should note that Brazil south region presents a high rate of active commuting among adolescents, ranging from 62.5% to 71.5%[25]. Active commuting is associated with economic characteristics, such as low family income[26] and lack of non-active means of transportation (e.g., car or motorcycle)[27]. Furthermore, adolescents of low-income families in addition to engaging in active commuting might not have access to video games and computers, for example, which might explain our findings.

Eating habits and behavior

Studies have shown that healthy eating habits are inversely associated with screen time in children and adolescents[11,28]. A systematic review pointed to positive effects of breakfast consumption on health outcomes such as improved quality of life and reduced risk factors for morbidity[29]. Skipping breakfast one or more days in a week has been associated with more time in sedentary screen-based activities in adolescents[12]. Our results suggest that daily breakfast is associated with reduced screen time.

Regarding dairy product intake, our data did not indicate a significant association with screen time. Data from other studies pointed to an unclear relationship[30,31]. Although an association was reported for 4 or more hours per day of screen time in Iranian adolescents[30], no association was found in European adolescents for up to, or more than 4 h per day[31]. A possible explanation for the inconsistencies of these results is that children and adolescents in Brazil usually drink chocolate milk, a more caloric food, thus contributing to a higher daily sugar intake[13,14]. Therefore, further studies should focus on this variable refinement, clarifying whether dairy products were consumed with or without other unhealthy foods (e.g., chocolate). This approach would help to understand the relationship between screen time and dairy product intake.

Screen time exposure seems to influence children and adolescents eating habits. A lower intake of healthy food (e.g., fruits and vegetables) and an increase in the consumption of foods with higher caloric density (e.g., French fries, sweets, cookies, and sugar drinks) have been reported[17]. Our findings are consistent with previous studies that showed an inverse relationship between fruits and vegetable intake and screen time[11,17].

Some of the explanations behind this suggest that one or two exposures to an advertisement may be sufficient to influence youth's food preferences[32]. In addition, an experimental study has shown that a single video game session is associated with an increase in caloric consumption, regardless of feelings of appetite[33]. This reinforces the need for interventions through health promotion strategies and policies that address the reduction of unhealthy behaviors and encourage the adoption of healthy habits including an adequate and balanced diet along with regular physical activity.

Strength and limitations

The limitations of our study should be listed. First, the cross-sectional study design does not allow us to determine causal relationships between outcome and exposures, thus reversal causality cannot be discarded. Second, physical activity was assessed through a questionnaire which can over-(or under-) estimate their levels[34]. Third, screen time and food intake were self-reported and could be subject to recall bias. However, it should be highlighted that our study was conducted with a representative sample of high school students from the city of Pelotas (1,233 adolescents aged 13 to 19). Additionally, a low refusal rate was observed (8.7%).

Practical implications

High screen time might be associated with obesity and other health issues in children and teenagers. Encouraging active commuting, like walking or biking to school, could help reduce the time adolescents spend in front of screens. Additionally, promoting healthy eating habits is essential in this age group, as it can support efforts to limit screen time and foster better overall health. Schools, parents, and communities should work together to encourage more active transportation and healthier diets, which could be effective strategies for reducing screen time and improving health outcomes in young people.

Conclusion

Less time spent in screen-based sedentary activities in adolescents is associated with engagement in 16 min or more of active commuting and daily eating habits (eating vegetables and fruits) and behavior (having breakfast daily). Further studies, with different designs (i.e., longitudinal), are necessary to better understand this relationship, especially with different assessments of physical activity.

Reducing the time that children and adolescents spend in sedentary activities is an important goal to achieve health benefits in this population. As adolescents spend most of their time sitting in school or front of a screen, increasing their time in active commuting might be an alternative to increase physical activity, and therefore decrease the burden of sedentary activities for health. Also, programs that aim to improve adolescents' nutrition are necessary to decrease the consumption of high-energy food. Programs that have students enrolled in public and private schools should focus on food safety, the promotion of adequate and healthy food, as well as physical activity.

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