Rev Bras Cineantropom Hum

original article

DOI: dx.doi.org/10.1590/1980-0037.2019v21e58392

Combined effect of physical activity and reduction of screen time for overweight prevention in adolescents

Efeito combinado da atividade física e redução do tempo de tela para prevenção do excesso de peso em adolescentes

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Abstract – The main objective of this study was to identify the association between combined effect of physical activity, reduction of screen time and overweight in adolescents. The sample of this cross-sectional study consisted of 613 adolescents, aged 15-18 years living in a municipality in northeastern Brazil. Physical activity was measured using the short-version IPAQ (International Physical Activity Questionnaire), and screen time was verified through two questions about the time that, on average, interviewees watched television, played video games, used the cell phone or computer on a normal weekday and one weekend day. The predictive power and cutoff points of screen time and physical activity for the outcome of interest were identified using the Receiver Operating Characteristic (ROC) curves. Different logistic regression models were proposed, with excess weight as dependent variable. In all models, the combination of little physical activity and long screen time was used as reference. A 95% confidence interval (CI) was used. In boys, the combination of physical activity and short screen time on a weekend day was inversely associated with overweight (OR = 0.31; 0.12-0.85). The combined effect of physical activity and reduced time spent watching TV, computer screen and similar devices on a weekend day is inversely associated with overweight in boys.

Key words: Overweight; Physical activity; Sedentary lifestyle.

Resumo – *O principal objetivo deste trabalho foi identificar a associação entre o efeito combinado da atividade física e redução do tempo de tela com excesso de peso em adolescentes. O estudo foi transversal com amostra composta por 613 adolescentes, com idade entre 15 a 18 anos residentes em município do nordeste do Brasil. A atividade física foi medida por meio do IPAQ (International Physical Activity Questionnaire), versão curta e o tempo de tela foi verificado por meio de duas questões sobre o tempo que, em média o entrevistado assistia televisão, jogava videogame, usava o celular ou o computador em um dia de semana normal e em um dia no final de semana. O poder preditivo e os pontos de corte do tempo de tela e da atividade física para o desfecho de interesse foram identificados por meio das curvas Receiver Operating Characteristic (ROC). Foram propostos ainda diferentes modelos de regressão logística tendo o excesso de peso como variável dependente. Em todos os modelos de análise foi fixada como referência a combinação pouca atividade física e muito tempo de tela. Utilizou-se intervalo de confiança (IC) a 95%. Em rapazes, a combinação atividade física e pouco tempo de tela em um dia do final de semana foi inversamente associada ao excesso de peso (OR = 0,31; 0,12-0,85). O efeito combinado da atividade física e redução do tempo sentado frente a TV, tela de computador e assemelhados em um dia no final de semana está inversamente associado ao excesso de peso em rapazes.*

Palavras-chave: *Atividade física; Estilo de vida sedentário; Sobrepeso.*

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Received: July 22, 2018
Accepted: May 06, 2019

How to cite this article
Pitanga FJG, Alves CFA, Pamponet ML, Medina MG, Aquino R. Combined effect of physical activity and reduction of screen time for prevention of overweight in adolescent. Rev Bras Cineantropom Desempenho Hum 2019, 21:e58392. DOI: http://dx.doi.org/10.1590/1980-0037.2019v21e58392

INTRODUCTION

Physical activity has been widely discussed by the scientific community, especially due to its inverse association with non-communicable chronic diseases (NCDs) in both adults and adolescents[1-3].

In the early 1990s, in order to create a model of guidance on physical activity for adults, the US Centers for Disease Control (CDC) and the American College of Sports Medicine (ACSM) published recommendations about physical activity, advising the accumulation of at least 30 minutes of moderate activity on most or every day of the week[4]. For children and adolescents, physical activity is recommended for approximately 60 minutes every day or most days of the week[5-8].

In addition, there is also strong evidence that sedentary behaviors, particularly those related to technology such as watching television, playing mobile or video games, and computer use, i.e., screen time, are important risk factors for metabolic and cardiovascular disorders and need to be investigated as much as levels of physical activity[9-14].

Recent research conducted in Australia has shown that prolonged sitting time is a risk factor for all-cause mortality regardless of regular physical activity[15]. In the specific case of children and adolescents, studies have shown that having television in the bedroom and / or remaining sitting watching television for more than two hours / day is positively associated with overweight[16,17], and there is evidence that excessive sitting hours have association with several obesity markers and metabolic / cardiovascular risk[18].

The main mechanisms that could explain the association between screen time and metabolic and cardiovascular health point to reductions in muscle lipoprotein lipase activity (LPL) during sedentary activity. Low LPL activity levels seem to be associated with a large decrease in the absorption of plasma triglycerides by skeletal muscles, causing fats to be deposited in vessels or adipose tissue, thus contributing to excess weight[19].

Studies addressing the combined effect of increased physical activity and reduced screen time to prevent overweight should be conducted since the existence of active behavior through physical activity does not guarantee the necessary protection for the occurrence of health problems related to sedentary behavior. These studies can make important contributions to public health, as policies to encourage changes in both behaviors can be implemented for the adolescent population. Thus, the present study aimed to identify the association between the combined effect of physical activity and reduction of screen time and overweight in adolescents.

METHOD

This is a cross-sectional, home survey type study, which is part of the "Assessing the effects of the Family Health Strategy: adopting healthy habits and accessibility to primary health promotion services and risk and health prevention" research, a household survey of young people aged 15-24 years

conducted in the municipality of Camaçari, Bahia, Brazil, whose sample design was detailed in a previous publication[20].

Considering the specific characteristics of the theme and the influence of age, the present study analyzed adolescents aged 15-18 years, representing 45% (n = 769) of the sample. After excluding individuals who did not undergo a complete anthropometric assessment or who did not answer questions related to screen time, a total of 613 individuals, 275 (44.8%) males and 338 (55.2%) females remained in the sample. All study participants or their legal guardians signed an informed consent form and the project was approved by the Research Ethics Committee of the Institute of Collective Health, Protocol No. 019-09 / CEP-ISC.

For the present study, the following independent variables were used:

a) Screen time, defined in hours and verified by two questions about the average time the respondent watched television, played video games, used mobile or computer on a normal weekday and in one weekend day;
b) Physical activity measured by the short-version IPAQ (International Physical Activity Questionnaire), consisting of questions about frequency and duration of physical activities (walking, moderate and vigorous PA)[21]. Physical activity values were reported in minutes / week by multiplying the weekly frequency by the duration of each activity performed.

Overweight was used as dependent variable and analyzed through body mass index (BMI) and identified through percentiles proposed by Cole et al.[22]. To identify overweight, those who were both overweight and obese were included.

The following covariates were analyzed: gender; age, calculated from the informed date of birth, consumption of soft drinks, sweets and fried foods.

Daily consumption of soft drinks, sweets and fried foods was assessed through the following questions from the Food Frequency Questionnaire (FFQ): 1) "How often do you usually consume (food name)?", with alternatives for weekly [("every day", "5 to 6 days", "3 to 4 days", "1 to 2 days") or monthly consumption ("1 to 3 times a month" or "no consumption"]. FFQ has been validated in Brazilian adolescents presenting Pearson correlation coefficients, after being adjusted and corrected for variability, ranging from 0.10 to 0.72 for girls and 0.16 and 0.91 for boys[23].

Data collection was performed between October 2011 and January 2012. It consisted of applying a structured instrument by a team of trained interviewers, accompanied by field supervisors and anthropometric measurements by field supervisors trained by a nutritionist. Supervisors were health professionals and interviewers were undergraduate students. All collection procedures were tested by conducting a pilot study in the same municipality, in an unsorted area, which reproduced the entire field routine.

The comparison between genders for continuous variables was made by the Student's t-test for independent samples and for categorical variables using the chi-square independence test. The cutoff point used for physical

activity was determined based on the analysis of ROC curves proposed in the present study. The cutoff point of 4 hours / day for screen time proposed in a recent publication was used by our research group[20]. Then, different logistic regression models were proposed with overweight as the dependent variable. The main independent variables were introduced in each logistic regression model using different combinations between physical activity and screen time. In all analysis models, the combination of low physical activity and long screen time was adopted as reference. In the different models, covariates age, gender and consumption of soft drinks, sweets and fried foods were tested as modifiers of effect and confounding variables. Logistic regression analysis was performed using the backword method based on the complete model and removing one by one the possible confounding variables, which, when deleted from the model, could cause change equal to or greater than 20%. Finally, odds ratio with 95% confidence interval was calculated.

- **Model 1**
  Dependent variable: Overweight
  Main independent variable: Active and short screen time
  Covariates: All cited above
- **Model 2**
  Dependent variable: Overweight
  Main independent variable: Active and long screen time
  Covariates: All cited above
- **Model 3**
  Dependent variable: Overweight
  Main independent variable: Little active and short screen time
  Covariates: All cited above

Predictive power and cutoff point, with their respective sensitivity and specificity of physical activity for overweight, were identified using Receiver Operating Characteristic (ROC) curves, which are frequently used to determine cutoff points in diagnostic or screening tests[24]. Nonparametric estimation, with clustered bootstrap, stratified by gender and age, was used to obtain a quantitative measure of physical activity accuracy to discriminate overweight. Bootstrapping corrects the uncertainty of estimates associated with ROC curves by incorporating the cluster sampling process into the estimation methodology[25]. Data were analyzed using the "STATA" statistical software, version 12.0.

RESULTS

For the purpose of the present study, all adolescents aged 15-18 years who underwent all anthropometric assessment and who answered questions regarding physical activity and screen time totaling 275 boys and 338 girls were analyzed.

The proportion of overweight was 17.8% among boys and 20.4% among

girls. The sample characteristics are as shown in Table 1. It was observed that boys have higher absolute weight and height values, are more physically active and spend more time watching TV, computer screen and similar on the weekend compared to girls. Regarding the absolute waist circumference and screen time during the week values, there are no differences between girls and boys. There are also no differences in the proportions of overweight and consumption of fried foods and soft drinks between genders. It is observed that the daily consumption of sweets among girls is higher than that of boys.

Table 1. Mean, standard deviation, minimum, maximum or percentage values of variables analyzed in the study. Camaçari, Bahia, Brazil, 2012

	Boys (n=275) $\overline{X}$±SD	Girls (n=338) $\overline{X}$±SD	p
WEIGHT (kg)	62.6 ± 12.9 (37.1-124.2)	57.2 ± 12.3 (35.6-117.0)	0.00*
HEIGHT (m)	1.71 ± 0.07 (1.49-1.90)	1.61 ± 0.06 (1.45-1.88)	0.00*
WAIST (cm)	72.6 ± 8.6 (40.0-114.5)	71.5 ± 9.8 (54.9-119.0)	0.14
SCREEN TIME (hours / day)			
Weekday	5.8 ± 3.8 (0.0-20.0)	5.5 ± 4.0 (0.0-20.0)	0.34
Weekend	6.0 ± 4.6 (0.0-20.0)	4.9 ± 4.4 (0.0-20.0)	0.00*
PHYSICAL ACTIVITY (minutes / week)	204.3 ± 251.3 (0.0-2241.0)	158.6 ± 157.5 (0.0-1377.0)	0.00*
CONSUMPTION OF SWEETS			
Every day	101 (35.7%)	161 (46.4%)	
5 to 6 days p / week	52 (18.4%)	45 (12.9%)	
3 to 4 days p / week	41 (14.5%)	61 (17.6%)	
1-2 days p / week	54 (19.1%)	43 (12.4%)	
1 to 3 times per month	19 (6.8%)	16 (4.6%)	0.04*
No consumption	16 (5.6%)	21 (6.1%)	
CONSUMPTION OF FRIED FOODS			
Every day	45 (15.9%)	74 (21.3%)	
5 to 6 days p / week	28 (9.9%)	32 (9.2%)	
3 to 4 days p / week	55 (19.5%)	57 (16.4%)	
1-2 days p / week	77 (27.3%)	108 (31.1%)	0.59
1 to 3 times per month	34 (12.1%)	34 (9.8%)	
No consumption	43 (15.2%)	42 (12.1%)	
CONSUMPTION OF SOFT DRINKS			
Every day	111 (39.1%)	136 (39.2%)	
5 to 6 days p / week	40 (14.1%)	42 (12.1%)	
3 to 4 days p / week	56 (19.8%)	68 (19.6%)	
1-2 days p / week	56 (19.8%)	65 (18.7%)	0.97
1 to 3 times per month	11 (3.9%)	17 (4.9%)	
No consumption	9 (3.2%)	19 (5.5%)	

Note. Kg, kilogram; m, meter; cm, centimeters; * Different values between boys and girls

Table 2 shows the areas under the ROC curve for physical activity as discriminator of the absence of overweight in adolescents of both genders. It is observed that physical activity discriminates the absence of overweight in boys.

Table 2. Areas under the ROC curve and 95% CI of physical activity as discriminator of the absence of overweight in adolescents of both genders, Camaçari, Bahia, Brazil, 2012

	BOYS	GIRLS
PHYSICAL ACTIVITY minutes / week	0.62 (0.53-0.71) *	0.41 (0.32-0.50)

Note. ROC = receiver operating characteristic; 95% CI = 95% confidence interval; *Area under the ROC curve showing discriminatory power for the presence of overweight, obesity and abdominal obesity (Li-IC ≥ 0.50).

Figure 1 shows the cutoff point for physical activity, with its respective sensitivities and specificities, as discriminator of the absence of overweight in boys. It was observed that accumulating more than 137 minutes per week of physical activity discriminates absence of overweight.

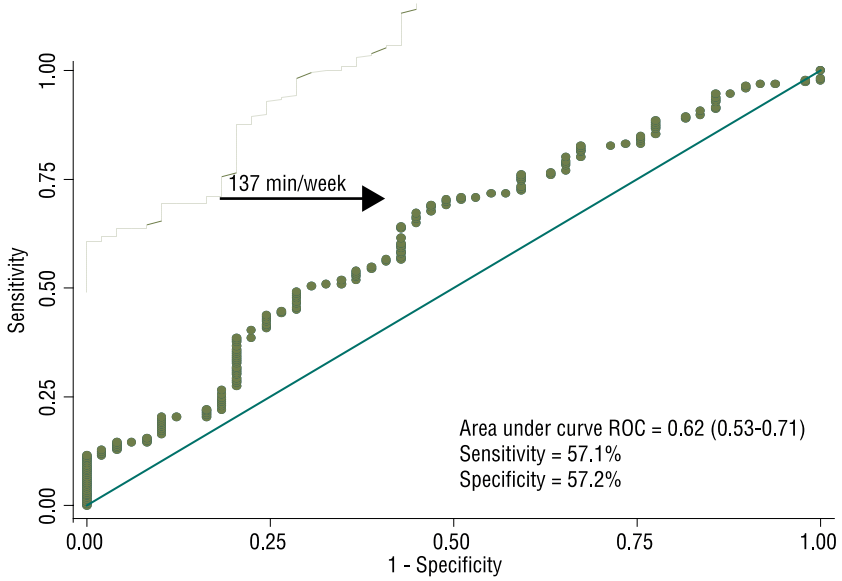

Figure 1. Area under the ROC curve with its respective cutoff point, sensitivity and specificity of physical activity as discriminator of the absence of overweight in boys (15-18 years), Camaçari, Bahia, Brazil, 2012.

Table 3 presents the odds ratios (OR) of the association between physical activity and overweight with screen time in adolescents of both genders. It was observed that in boys, the combination of physical activity and short screen time on a weekend day was inversely associated with overweight with the combination of low physical activity and long screen time as reference.

DISCUSSION

This research sought to identify the association between the combined effect of physical activity and screen time with overweight in adolescents of both genders.

Table 3. Association of combinations between physical activity and screen time on one day on the week and one day on the weekend and overweight in adolescents of both sexes, Camaçari, Bahia, Brazil, 2012

Physical activity and screen time	Boys	Girls
DAY OF THE WEEK		
Little Physical Activity-Long Screen Time	1.00	1.00
Active - Short Screen Time	0.69 (0.27-1.76)	1.30 (0.60-2.84)
Little Physical Activity – Short Screen Time	1.15 (0.47-2.81)	0.93 (0.46-1.88)
Active - Long Screen Time	0.55 (0.24-1.25)	1.19 (0.57-2.46)
WEEKEND DAY		
Little Physical Activity - Long Screen Time	1.00	1.00
Active - Short Screen Time	0.31 (0.12-0.85)	0.87 (0.38-1.98)
Little Physical Activity – Short Screen Time	0.68 (0.29-1.63)	1.02 (0.50-2.05)
Active - Long Screen Time	0.55 (0.24-1.23)	1.81 (0.83-3.95)

Note. Adjusted for consumption of sweets, fried foods and soft drinks

Areas under the ROC curve were statistically significant for physical activity as discriminator of overweight in male adolescents. Although the main studies use the reference of 150 minutes per week as a recommendation for physical activity for health benefits in adults[26] and approximately 60 minutes every day or most days of the week for children and adolescents[5-8], in our study, we found 137 minutes per week as cutoff point to discriminate overweight in male adolescents, a fact that may reflect the lower level of physical activity found among adolescents involved in the study.

With respect to screen time, a recent publication by our research group has observed areas under the ROC curve with statistical significance for overweight in adolescents. The identification of the cutoff point of 4 hours / day to discriminate the event under analysis was highlighted. These results indicate that screen time discriminates overweight in adolescents and point to the need for actions to reduce this sedentary behavior[20].

Independent associations between physical activity[7] and screen time for overweight[27,28] are well documented in literature, but little is known about the combined effect of these behaviors and their association with weight alterations in adolescents. A recent publication showed that the probability of being obese was significantly higher for subgroups classified as low physical activity and long screen time compared to high physical activity and low screen time, especially in boys[29].

This study showed similar results for boys when we found an inverse association in the combination of physical activity and short screen time on the weekend with overweight. The fact that no associations were found among girls may be explained by the lower influence of physical activity on overweight in female adolescents, since in our study, the combined effect of physical activity and reduction in screen time was evaluated. In addition, boys have more screen time on weekends than girls, which may have influenced associations only on weekend days.

In a recent systematic review, it was observed that adiposity markers and cardiometabolic risk are positively associated with sedentary behavior in general, especially with sitting time related to computer and television

use, and these relationships appear to be mediated by the influence of sedentary food intake behaviors, and also due to a direct metabolic impact of prolonged sitting time[18].

Some authors suggest that sedentary screen-based behaviors, especially watching television, may lead to higher calorie consumption through a variety of mechanisms that increase food intake[30], which could contribute to overweight and obesity. In our analysis, associations were adjusted for consumption of sweets, fried foods and soft drinks, which allows inferring that the combination of increased physical activity and reduced screen time can have a protective effect on overweight regardless of food consumption.

The mechanisms by which increased screen time influences overweight are related to reduced lipoprotein lipase (LPL) activity that decreases the absorption of plasma triglycerides, mainly by skeletal muscles[19]. Thus, fats are deposited in vessels or adipose tissue, contributing to weight gain.

As the main limitation of this work, we can highlight the construction of the screen time variable from self-reported information, which may have underestimated sedentary behavior, as well as information about physical activity, as it was also obtained through questionnaires, which, however, is an instrument widely used in national and international studies. In addition, the use of the 137 min / week cutoff point of physical activity to discriminate overweight, which despite being found in our own sample, does not correspond to values shown in international literature[5-8]. As strength, we can emphasize the analysis of the joint association of physical activity and screen time for overweight, since there are few studies conducted with these characteristics in Brazilian adolescents.

CONCLUSION

Based on the results found in the present study, it could be evidenced that the combined effect of physical activity and reduced time spent watching TV, using computer and similar devices day on a weekend is inversely associated with being overweight, mainly in boys aged 15-18 years.

These results point to the need to expand health promotion actions among young people by incorporating actions to encourage the practice of physical activities and to reduce time spent watching TV, using computer and similar devices, especially in weekend days.

COMPLIANCE WITH ETHICAL STANDARDS

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-profit sectors. This study was funded by the authors.

Ethical approval

Ethical approval was obtained from the local Human Research Eth-

ics Committee – Ethics Research Committee of the Collective Health Institute, CEP-ISC/UFBA and the protocol (no. 019-09) was written in accordance with standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: RA, CFAA, MLP, MGM. Performed the experiments: RA, CFAA, MLP, MGM, FJGP. Contributed with reagents/materials/analysis tools: RA, CFAA, MLP, MGM. Wrote the paper: FJGP.

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