Association between screen time exposure, anxiety, and sleep quality in adolescents

Fátima Larissa Santiago,[1] Alison Oliveira da Silva,[2] Raflésio Ivanildo de Souza Silva,[2]
Wilson Viana de Castro Melo,[3] Edil de Albuquerque Rodrigues Filho,[3] André Luiz Torres Pirauá,[1,4]
Breno Quintella Farah,[1,4] Luciano Machado-Oliveira[1,3]

[1] Programa de Pós-Graduação em Educação Física, Universidade Federal de Pernambuco, Recife, PE, Brasil.

[2] Departamento de Educação Física, Centro Universitário Tabosa de Almeida (Asces-Unita), Caruaru, PE, Brasil.

[3] Departamento de Educação Física e Ciências do Esporte, Universidade Federal de Pernambuco, Centro Acadêmico de Vitória. Vitória de Santo Antão, PE, Brasil.

[4] Departamento de Educação Física, Universidade Federal Rural de Pernambuco. Recife, PE, Brasil.

Correspondence:
Fátima Larissa Santiago
Programa de Pós-Graduação em Educação Física, Universidade Federal de Pernambuco.
Avenida Professor Moraes Rego, Recife, PE, 50670-901, Brasil.
Phone: +55 81 98953-2030
Email: fatimalarissasantiago@gmail.com

ABSTRACT

Introduction. The increase in sedentary screen time can negatively affect the quality of sleep, impacting the performance of daily activities. **Objective.** To analyze the association between sedentary screen time and sleep quality, regardless of the symptoms of anxiety in adolescents of both genders. **Method.** Cross-sectional study integrating school-based epidemiological research with a representative sample (n = 666) of high school students (14 to 19 years old) in public schools in the municipality of Caruaru-PE. The translated versions into Portuguese of the Pittsburgh Sleep Quality Index (PSQI) and the Hospital Anxiety and Depression Scale (HAD) were applied to analyze sleep quality and anxiety, respectively. Binary logistic regression was used to analyze the association, considering sleep quality as an outcome. **Results.** There was a positive, statistically significant ($p < .001$) correlation between sleep quality and symptoms of anxiety (r = .393). A significant association regarding the association between screen time and sleep quality was noted only in those adolescents classified as being possible or probable anxiety cases and only in exposure to the computer (OR = 2.337; 95% CI [1.01, 5.43]) and video games (OR = 8.083; 95% CI [2.0, 32.8]) after adjusting for gender, age, and school shift. **Discussion and conclusion.** Increased interaction with the screen and higher levels of anxiety can be more harmful to sleep in adolescents. Exposure to screen time, specifically those which have a greater interaction such as video games and computers, can have a negative impact on sleep quality, but only in adolescents with a higher risk of anxiety.

Keywords: Sedentary behavior, sleep. anxiety, adolescent, epidemiology.

RESUMEN

Introducción. Un elevado tiempo de exposición de pantalla puede afectar tanto la calidad del sueño como las actividades diarias. **Objetivo.** Analizar la asociación entre el tiempo de pantalla sedentario y la calidad del sueño, independientemente de los síntomas de ansiedad en adolescentes de ambos sexos. **Método.** Estudio transversal que integra la investigación epidemiológica escolar con una muestra representativa (n = 666) de estudiantes (14 a 19 años) de escuelas públicas de Caruaru-PE. Las versiones traducidas al portugués del Índice de Calidad del Sueño de Pittsburgh (PSQI) y la Escala de Ansiedad y Depresión Hospitalaria (HAD) se aplicaron para analizar la calidad del sueño y la ansiedad. Se utilizó regresión logística binaria para analizar la asociación, considerando como resultado la calidad del sueño. **Resultados.** Hubo una correlación positiva y estadísticamente significativa ($p < .001$) entre la calidad del sueño y los síntomas de ansiedad (r = .393). Una asociación significativa en cuanto a la asociación entre el tiempo de pantalla y la calidad del sueño se observó sólo en adolescentes clasificados como casos posibles o probables de ansiedad y sólo en la exposición al ordenador (OR = 2.337; IC 95% [1.01, 5.43]) y videojuegos (OR = 8.083; 95% IC [2.0, 32.8]) después de los ajustes. **Discusión y conclusión.** Una mayor interacción con la pantalla y altos niveles de ansiedad pueden ser perjudiciales para el sueño. La exposición al tiempo de pantalla, específicamente aquellos con mayor interacción, como los videojuegos y las computadoras, puede afectar negativamente la calidad del sueño, pero sólo en adolescentes con mayor riesgo de ansiedad.

Palabras clave: Comportamiento sedentario, sueño, ansiedad, adolescente, epidemiología.

INTRODUCTION

Sedentary behavior comprises low energy demand actions performed in a sitting, reclining, or lying position during the wakefulness (Tremblay et al., 2011). The increase in sedentary behavior and unhealthy lifestyles in adolescence is harmful and can have negative consequences for health in adulthood (Gordon-Larsen, Nelson, & Popkin, 2004), which highlights the importance of fighting some behaviors early on. Among the sedentary behavior indicators is the time of exposure to sedentary screens, which includes the use of various devices such as: television, tablets, computers, video games, and cell phones (Thomas, Bennie, De Cocker, Castro, & Biddle, 2020; Wu et al., 2017). High screen time combined with a low level of physical activity is associated with an increase in psychological problems (Cao et al., 2011).

Screen-based technology is exponentially evolving insofar children and adolescents are often involved with different types of screens and exploring different content (Guerrero, Barnes, Chaput, & Tremblay, 2019). Specifically in adolescents, the increased exposure time to a sedentary screen negatively affects their sleep quality (Guerrero et al., 2019), which can cause insomnia and/or daytime sleepiness and negatively impact daily activities, including school performance (Batista et al., 2018) and some psychological problems such as depression and anxiety (Brand et al., 2016; Maras et al., 2015). Among Brazilian adolescents, it was identified that 28.0% had a moderate level and 23.6% had a severe level of anxiety (Lopes & Rezende, 2013). A longitudinal study found a bidirectional association between increased use of computer/video games and anxiety in adolescentes (Zink, Belcher, Kechter, Stone, & Leventhal, 2019).

Gomes et al. (2017) evaluated 309 adolescents aged 10 to 19 years and found that the symptoms of anxiety and stress in this group were associated with poor sleep quality, corroborating studies which observed a bidirectional relationship between sleep quality and anxiety (Ghrouz et al., 2019; Uhde, Cortese, & Vedeniapin, 2009). The prevalence of poor quality and insufficient sleep duration among Brazilian adolescents is 28.2% (Gomes et al., 2017) and 12.6% (Neto et al., 2021), respectively. The relationship between sedentary screen time and sleep quality can be mediated by the level of anxiety in adolescents. Thus, it is important to assess how different screen types are related to emotional and behavioral health indicators such as sleep.

Moreover, in being aware that anxiety may be in the causal chain of the relationship between sedentary screen time and sleep, we question the existence of the association between time and sedentary screen type and the quality of sleep, regardless of the symptoms of anxiety, since few studies that investigated this relationship considered anxiety in their analyzes.

In view of the above, the objective of this study was to analyze the association between sedentary screen time and sleep quality, considering the level of anxiety as a moderating factor in adolescents of both genders.

METHOD

Design of the study

This is a quantitative, observational, and analytical study integrating the school-based cross-sectional epidemiological survey and municipal coverage. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) standardised reporting guidelines for cross-sectional studies were followed for this study (von Elm et al., 2008).

Description of the sample

The target population consisted of adolescents of both genders aged between 14 and 19 years old and enrolled in high public schools of Caruaru-Pernambuco (PE). A total of 10,033 students were enrolled and distributed in 15 schools in the municipality according to the Pernambuco Education Information System, which provides information about public schools in the state of Pernambuco.

The sample size was calculated using the Sample XS software (http://www.brixtonhealth.com/samplexs.html, Accessed on 28 November 2021), and the following parameters were adopted for the calculation: 95% confidence interval; maximum tolerable error of 5 percentage points; drawing effect (*deff*) = 1.5, and the case study including analysis of multiple risk behaviors and different occurrence frequencies set to an estimated prevalence of 50%. Additionally, it was decided to increase the sample size by 20% in order to mitigate the limitations imposed by eventual losses in the application and/or inadequate filling of the questionnaires.

A two-stage cluster sampling procedure was used to select the required sample, and the school and class respectively represented the sampling units in the first and second stages. All state public schools in Caruaru-PE were considered eligible for inclusion in the study. In the first stage, the density of schools in each micro-region of the city (Center, North and South) according to size (small ≤ 200 enrolled students; medium > 200 – 499; and large ≥ 500) was adopted as a stratification criterion.

Nine schools were selected in proportion to their size, ensuring that at least 50% of the schools of each size were selected (2 large, 4 media, and 3 small). In the second stage, the density of classes in schools selected by period (day and night) and year (1st, 2nd, and 3rd year of high school, containing a greater number of adolescents aged between 14 and 19 years old) was considered as criteria for selecting

those classes in which the questionnaires would be applied. These were applied between the months of September and November 2017.

Measurements

Socioeconomic and sociodemographic variables were assessed by the translated and adapted version of the Global School-based Student Health Survey (GSHS), proposed by the World Health Organization (WHO). Sedentary behavior was assessed using the weighted average of the following questions: "On school days (Monday to Friday), how many hours a day do you watch TV?," and "On weekends (Saturday and Sunday), how many hours a day do you watch TV?" (Question 1 X 5 + question 2 X 2/7).

We similarly determined computer time and the weighted average of the questions: "On school days (Monday to Friday), how many hours per day do you use the computer?," and "On weekend days (Saturday and Sunday), how many hours per day do you use the computer?." Video game time was also evaluated by the weighted average of the questions: "On school days (Monday to Friday), how many hours per day do you play video games?," and "On weekend days (Saturday and Sunday), how many hours per day do you play video games?"

The time spent sitting variable (except the screen exposure time) was evaluated by the weighted average of the questions: "On school days (Monday to Friday), how much time do you spend sitting, chatting with friends, playing cards or dominoes, talking on the phone, driving or as a passenger, reading or studying (not considering time watching TV and using a computer)" and "On weekend days (Saturday and Sunday), how much time do you spend sitting, talking with friends, playing cards or dominoes, talking on the phone, driving or as a passenger, reading or studying? (Do not consider time watching TV and using computer)."

Symptoms of anxiety were obtained through the Hospital Anxiety and Depression Scale (HADS) where signs of anxiety were assessed using a previously validated questionnaire for the adolescent population (Cronbach's Alpha coefficients: .84; Bjelland, Dahl, Haug, & Neckelmann, 2002; Faro, Araújo, Maciel, Lima, & Souza, 2021). The HADS classifies the anxiety and depression level and is composed of 14 multiple choice questions where the even questions assess the level of depression and the odd questions assess anxiety. The cut-off point was ≥ 9 (White, Leach, Sims, Atkinson, & Cottrell, 1999), categorizing the group into risk-free and at risk of presenting symptoms of anxiety (Teychenne & Hinkley, 2016).

Sleep quality was obtained using the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), standardized and previously validated for the Brazilian Portuguese language (Bertolazi et al., 2011) and for the adolescent population (Cronbach's alpha coef-

ficients: .71; intraclass correlation coefficient: .65; Passos et al., 2017). A cut-off score of 0-4 points for good quality sleep was used, 5-10 points for poor sleep quality, and sleep disturbances were classified for scores above 10 points (Chellappa & Araujo, 2007; Schlarb, Friedrich, & Claßen, 2017). The use of these cut-off points was based on a recent systematic review that highlights that the cut-off point 5, used for PSQI, has a low sensitivity in the identification of sleep disorders than higher cut-off points (Fabbri et al., 2021).

Procedure

All students in the selected classes were invited to participate in the study, regardless of their age. Informed consent was obtained for all participants. The parents or guardians of the adolescents were invited to sign a consent form, with the consent signed by the guardian, the adolescent interested in participating, also signed a term declaring their agreement to participate in the research.

Questionnaires answered by students under 14 and over 19 years old were excluded after application. The questionnaires were applied in the classroom in the form of a collective interview without the presence of teachers. Students were continuously assisted by five researchers (two professors and three undergraduate students) to clarify doubts when filling out the form questionnaires.

Statistical analyses

The final tabulation of the data was performed using the EPIDATA program version 3.1 (http://www.epidata.dk/download.php/downloads/php/php/downloadc.php?file=-setup_epidata.exe#ee; accessed on 28 November 2021). Data entry was repeated and typing errors were detected and corrected using the duplicate file comparison function.

Distribution frequency was observed in the descriptive analysis. The Pearson's chi-squared test was used (χ^2) in the inferential analysis in order to analyze the association between sedentary behavior, sleep quality, and anxiety in adolescents; explore possible confounding factors; and identify the need for statistical adjustment of the analyzes. We used logistic binary regression in the multivariate analysis estimated by the odds ratio (odds ratio = OR) and 95% confidence intervals to express the degree of association between the dependent variable (sleep quality) and the independent variables (sedentary behaviors), controlling possible confounding variables such as sex, age, skin color, and school shift. In addition, the interaction test with the anxiety level was performed, which was considered as a moderating variable (effect modifiers; Bauman, Sallis, Dzewaltowski, & Owen, 2002). Thus, each statistical model was carried out in a stratified manner (without risk of anxiety and at risk for anxiety).

Table 1

Sociodemographic characteristics and associations with sleep quality of adolescent high school students from the public state network of Caruaru-PE

Variables	Without sleep disorder		With sleep disorder		Total (666)		p-value
	n	(%)	n	(%)	n	(%)	
	586	(89.6)	68	(10.4)	654	(100)	
Gender							
Male	281	48.0	26	38.2	307	46.9	.129
Female	305	52.0	42	61.8	347	53.1	
Age (years)							
14 – 15	74	13.2	12	19.0	86	13.8	.438
16 – 17	359	64.0	38	60.3	397	63.6	
18 – 19	128	22.8	13	20.6	141	22.6	
School shift							
Daytime	468	79.9	57	83.8	525	80.3	.437
Night	118	20.1	11	16.2	129	19.7	
Occupation							
Work	210	36.6	28	41.8	238	37.1	.404
No work	364	63.4	39	58.2	403	62.9	
Skin color							
White	171	29.4	12	17.6	183	28.2	.057
Non-white	410	70.6	56	82.4	466	71.8	
Maternal education							
> 8 years of study	48	9.4	7	11.5	55	9.6	.595
≤ 8 years of study	465	90.6	54	88.5	519	90.4	

The Student's *t*-test and Pearson's linear correlation between the sleep quality and symptoms of anxiety variables were also applied. The significance level adopted for all tests was $p < .05$, and all analyzes were performed using the SPSS statistical software (version 21.0).

Ethical considerations

This study followed the agreements of the National Health Council, approved by the Human Research Ethics Committee of the Centro Universitário Tabosa de Almeida (Asces-Unita) number: (CAAE-22210913.8.0000.5203/ CEP-ASCES: 072403/2013).

RESULTS

A total of 687 students from nine schools in the municipality of Caruaru-PE, were interviewed. The final sample was 666 adolescents after 14 refusals by parents and students, and the exclusion of seven questionnaires from students under the age of 14 and over 19, where most were female (53.1%), aged between 16 and 17 years (63.6%), who studied during the day (80.3%), did not work (62.9%), and had maternal education of less than or equal to eight years of study (90.4%). The prevalence of sleep disturbances among adolescents was 10.4%, of which 76.5% were at risk of having anxiety symptoms. The other socio-demographic and sedentary behaviors characteristics of the adolescents are shown in Tables 1 and 2. It must be emphasized that some variables have a lower quantity than the final sample, since, in order to respect their ethical rights, some students chose not to answer some questions, classified as missing.

Figure 1 shows the positive correlation ($p < .001$) of sleep quality and symptoms of anxiety (Pearson's correlation, $r = .393$) of adolescents.

After the interaction test and verification of the anxiety level as a moderating variable, the results of the crude and adjusted odds ratio for the explicative variables (gender, age, skin color, and school shift) were stratified by the anxiety level of adolescents (without risk of anxiety and at risk of anxiety). After adjustment, sleep disorder was sig-

Table 2
Sedentary behaviors and associations with sleep quality of adolescent high school students from the public state network of Caruaru-PE

| | Sleep quality | | | | | | |
| | Without sleep disorder | | With sleep disorder | | Total (666) | | |
Variables	n	(%)	n	(%)	n	(%)	p-value
	586	(89.6)	68	(10.4)	654	(100)	
TV time							
Exposed for less than 4 hours	496	84.6	57	83.8	553	84.6	.860
Exposed for 4 hours or more	90	15.4	11	16.2	101	15.4	
Computer time							
Exposed for less than 4 hours	521	88.9	54	79.4	575	87.9	.023
Exposed for 4 hours or more	65	11.1	14	20.6	79	12.1	
Video game time							
Exposed for less than 4 hours	561	95.7	61	89.7	622	95.1	.029
Exposed for 4 hours or more	25	4.3	7	10.3	32	4.9	
Sitting time excluding screen time							
Exposed for less than 4 hours	346	59.7	42	63.6	580	89.7	.492
Exposed for 4 hours or more	234	40.3	24	36.4	66	10.2	
Anxiety symptoms							
Not risk	384	65.5	16	23.5	400	85.5	< .001
At risk	16	34.5	52	76.5	68	14.5	

nificantly associated with computer exposure time (OR = 2.337; CI 95% [1.01, 5.43]) and video game (OR = 8.083; CI 95% [2.0, 32.8]) only in adolescents at risk of anxiety symptoms, as shown in Table 3.

DISCUSSION AND CONCLUSION

The aim of this study was to analyze the association between sedentary screen time and sleep quality, regardless of the symptoms of anxiety in adolescents of both genders. Among the main results, we can highlight: a) a low prev-
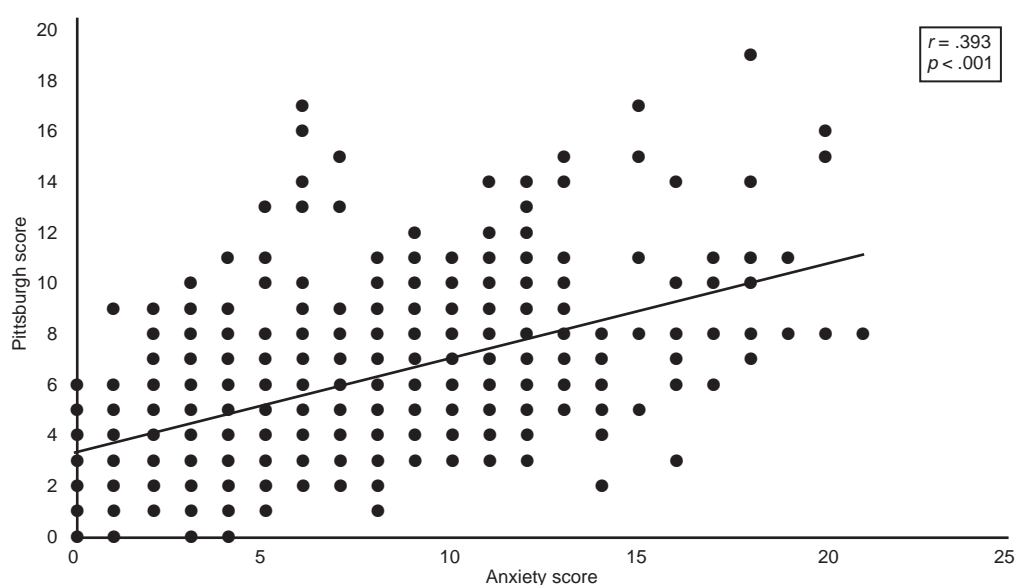

r = .393
p < .001

Figure 1. Positive correlation of sleep quality and the symptoms of anxiety.

Table 3

Crude and adjusted odds ratio of sleep disturbances related to sedentary behaviors in adolescents without risk of anxiety, high school students from the state public network of Caruaru-PE

Variables	Sleep disturbances					
	Odds ratio (Crude)	95% CI	p-value	Odds ratio (adjusted#)	95% CI	p-value
Without risk of anxiety						
TV time						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	.871	.19-3.98	.859	1.157	.24-5.62	.856
Computer time						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	2.234	.60-8.33	.231	3.847	.86-17.27	.079
Videogame time						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	1.337	.17-10.71	.784	2.788	.28-27.31	.378
Sitting time excluding screen time						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	.855	.28-2.60	.783	.768	.22-2.66	.677
At risk for anxiety						
TV time						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	1.301	.57-2.96	.531	.994	.41-2.41	.989
Computer time						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	2.088	.94-4.62	.069	2.690	1.10-6.56	.030
Videogame time						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	6.457	1.75-23.81	.005	7.659	1.84-31.85	.005
Sitting time excluding screen time or physical activity						
Exposed for less than 4 hours	1			1		
Exposed for 4 hours or more	.878	.47-1.65	.686	.938	.48-1.82	.851

Notes: OR: Odds ratio; 95% CI: Confidence interval 95%; # Adjusted for sex, age, skin color and school shift.

alence of exposure to sedentary screen time; b) a strong correlation between the sleep quality and the symptoms of anxiety; c) after adjusting for different confounders, a significant association was found only between exposure time to screens of interactive devices (computer and video game) and sleep quality, only in adolescents with risk of having symptoms of anxiety.

The prevalence of adolescents exposed to more than four hours of television and computers was 12% and 15.4%, respectively. This prevalence is low when compared to the prevalence presented in systematic reviews studies (Guerra, Farias Júnior, & Florindo, 2016; Silva, Soares, Silva, & Tassitano, 2016) and recent meta-analyses (Schaan et al., 2019). This difference can be partly explained by the cut-off point adopted in the present study, highlighting the lack of a standardized cut-off point in the

national literature which aims at an adaptation to determine the exposure to sedentary screen time (Guerra et al., 2016).

The American Academy of Pediatrics recommends that children and adolescents limit their total screen-based entertainment time to a maximum of two hours a day (Council on Communications and Media, 2013). However, nowadays adolescents spend more time on sedentary activities based on screen studying or for entertainment (Schaan et al., 2019) due to the high availability of technological devices, so it is important that this cut-off point be reviewed and monitor the access to technological devices by children and adolescents.

As seen in the present study, the association between screen exposure and sleep in adolescents is commonly observed (Silva, Oliveira, Santos, & Tassitano, 2017), and this relationship maybe explained by the fact that an excessive exposure to the blue light of the screen can suppress mel-

atonin production, altering aspects of the circadian cycle and increasing mental and physiological arousal (Cajochen et al., 2011; Wahl, Engelhardt, Schaupp, Lappe, & Ivanov, 2019). The wavelength of the blue light emitted and the viewing distance from the screen can influence the impact that this blue light may have on sleep (Komada, Aoki, Gohshi, Ichioka, & Shibata, 2015; Yoshimura et al., 2017). However, the present study did find a significant association between sleep quality and exposure to sedentary screen time only in devices with more interaction (computer and video games). The higher use of these devices is associated with a higher level of anxiety (Moge & Romano, 2020; Zink et al., 2019), which can impair the quality of sleep. In addition, excessive use can develop dependence and also influence sleep. It should also be noted that some adolescents emphasize that TV may to help fall asleep (Eggermont & Bulck, 2006), thus partly explaining the non-association between this electronic device and poor sleep quality. This non-association can also be related to the viewing distance from the TV, which is usually greater than other devices.

The interaction pattern of allied devices including the use of social networking seems to impact the sleep quality and anxiety in adolescents (Aros, Germano-Soares, Silva, Silva, & Tassitano, 2017; Silva et al., 2014). For example, in a study conducted by Espinoza and Juvone (2011) with 268 young adolescents, it was found that 37% reported having lost sleep due to the use of social networking sites. In this sense, greater interactivity and a multitude of access possibilities, including computer games, may influence usage patterns and stimulated physiological responses in relation to the central nervous system, increasing the state of excitation, and impairing sleep patterns (Dworak, Schierl, Bruns, & Struder, 2007; Instituto Brasileiro de Geografia e Estatística, 2013).

Corroborating the findings of this study regarding video games, a recent systematic review (Peracchia & Curcio, 2018) found that playing video games at night may delay the onset of sleep and interfere with the duration and sleep efficiency by changing its architecture and temporal structure, directly affecting the quality of adolescents' sleep. It is noteworthy that the intensity (Altintas, Karaca, Hullaert, & Tassi, 2019) and the type of game (violent, exciting, competitive) can also interfere with the sleep pattern (Koepp et al., 1998).

As previously detected (Ghrouz et al., 2019), the present study also observed a negative relationship between anxiety and sleep quality. However, an intriguing fact was that the relationship between screen exposure, specifically in those interacting behaviors, and sleep quality was only found in those with high symptoms of anxiety. In this sense, the higher interaction with the screen plus the higher level of anxiety can be more damaging to sleep.

Constant message alerts put considerable pressure on being available 24/7 days a week and contribute to the fear of missing the content of these messages (Thomée, Dellve, Härenstam, & Hagberg, 2010), which may in turn bring about symptoms of anxiety and altered sleep patterns. Thus, teenagers who already have a high level of anxiety, in addition to behaviors with a high degree of stimulation, may have their sleep quality even more impaired. In a study by Woods and Scott (2016), the increase in the general use of social media, specifically night use of social media and the emotional investment in these media were associated with worse sleep quality and higher anxiety and depression levels, constituting a fact which may somehow explain the results found.

This study has limitations which deserve to be mentioned such as there was no controlled screen exposure time, the form of computer use (study, work, or entertainment), bedtime and chronotype-related adolescent sleep (morning, intermediate and evening). Among the strengths of this study, we can highlight the representative sample of high school students in the municipality and the originality of the analysis, considering the symptoms of anxiety and the different types of exposure to the screen, in addition to controlling intervening variables such as gender, age, and school shift.

It is concluded that exposure to screen time, specifically those have greater interaction, such as video games and computers, can have a negative impact on sleep quality, and this relationship was only found in those with a higher risk of anxiety, regardless of gender, age, and school shift. Thus, it is highlighted that interactivity plus anxiety can potentiate the negative effects related to sleep in adolescents.

Funding

Conflict of interest

The authors declare they have no conflicts of interest.

REFERENCES

Altintas, E., Karaca, Y., Hullaert, T., & Tassi, P. (2019). Sleep quality and video game playing: Effect of intensity of video game playing and mental health. *Psychiatry Research*, *273*, 487-492. doi: 10.1016/j.psychres.2019.01.030

Aros, L. J. L., Germano-Soares, A. H., Silva, C. R. de M., Silva, A. O. da, & Tassitano, R. M. (2017). Trends in television and computer/videogame use and total screen time in high school students from Caruaru city, Pernambuco, Brazil: A repeated panel study between 2007 and 2012. *Motriz: Revista de Educação Física*, *23*(spe2), 1-8. doi: 10.1590/s1980-6574201700si0093

Batista, G. de A., Silva, T. N. da, Oliveira, M. R. de, Diniz, P. R. B., Lopes, S. S., & Oliveira, L. M. F. T. de. (2018). Associação entre a percepção da qualidade do sono e a assimilação do conteúdo abordado em sala de aula. *Rev Paul Pediatr*, *36*(3), 315 321. doi: 10.1590/1984 0462/;2018;36;3;00008

Bauman, A. E., Sallis, J. F., Dzewaltowski, D. A., & Owen, N. (2002). Toward a better understanding of the influences on physical activity. *American Journal of Preventive Medicine*, *23*(2), 5-14. doi: 10.1016/S0749-3797(02)00469-5

Bertolazi, A. N., Fagondes, S. C., Hoff, L. S., Dartora, E. G., da Silva Miozzo, I. C., de Barba, M. E. F., & Menna Barreto, S. S. (2011). Validation of the Brazilian Portuguese version of the Pittsburgh Sleep Quality Index. *Sleep Medicine*, *12*(1), 70-75. doi: 10.1016/j.sleep.2010.04.020

Bjelland, I., Dahl, A. A., Haug, T., & Neckelmann, D. (2002). The validity of the hospital anxiety and depression scale: an updated literature review. *J Psychosom Res*, *52*(2), 69-77. doi: 10.1016/S0022-3999(01)00296-3

Brand, S., Kirov, R., Kalak, N., Gerber, M., Schmidt, N. B., Lemola, S., … Holsboer-Trachsler, E. (2016). Poor Sleep Is Related to Lower Emotional Competence Among Adolescents. *Behavioral Sleep Medicine*, *14*(6), 602-614. doi: 10.1080/15402002.2015.1048450

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213. doi: 10.1016/0165-1781(89)90047-4

Cajochen, C., Frey, S., Anders, D., Späti, J., Bues, M., Pross, A., … Stefani, O. (2011). Evening exposure to a light-emitting diodes (LED)-backlit computer screen affects circadian physiology and cognitive performance. *Journal of Applied Physiology*, *110*(5), 1432-1438. doi: 10.1152/japplphysiol.00165.2011

Cao, H., Qian, Q., Weng, T., Yuan, C., Sun, Y., Wang, H., & Tao, F. (2011). Screen time, physical activity and mental health among urban adolescents in China. *Preventive Medicine*, *53*(4-5), 316-320. doi: 10.1016/j.ypmed.2011.09.002

Chellappa, S. L., & Araujo, J. F. (2007). Qualidade subjetiva do sono em pacientes com transtorno depressivo. *Estudos de Psicologia (Natal)*, *12*(3), 269-274. doi: 10.1590/S1413-294X2007000300009

Council on Communications and Media. (2013). Children, Adolescents, and the Media. *Pediatrics*, *132*(5), 958-961. doi: 10.1542/peds.2013-2656

Dworak, M., Schierl, T., Bruns, T., & Struder, H. K. (2007). Impact of Singular Excessive Computer Game and Television Exposure on Sleep Patterns and Memory Performance of School-aged Children. *Pediatrics*, *120*(5), 978-985. doi: 10.1542/peds.2007-0476

Eggermont, S., & Bulck, J. (2006). Nodding off or switching off? The use of popular media as a sleep aid in secondary-school children. *Journal of Paediatrics and Child Health*, *42*(7-8), 428-433. doi: 10.1111/j.1440-1754.2006.00892.x

Espinoza, G., & Juvonen., J. (2011). The pervasiveness, connectedness, and intrusiveness of social network site use among young adolescents. *Cyberpsychology, Behavior, and Social Networking*, *14*(12), 705-709. doi: 10.1089/cyber.2010.0492

Fabbri, M., Beracci, A., Martoni, M., Meneo, D., Tonetti, L., & Natale, V. (2021). Measuring Subjective Sleep Quality: A Review. *International Journal of Environmental Research and Public Health*, *18*(3), 1082. doi: 10.3390/ijerph18031082

Faro, A., Araújo, L. F. de, Maciel, S. C., Lima, T. J. S. de, & Souza, L. E. C. de. (2021). Structure and invariance of the Hospital Anxiety Depression Scale (HADS) in adolescents. *Ciencias Psicológicas*, *15*(2), 1-14. doi: 10.22235/cp.v15i2.2069

Ghrouz, A. K., Noohu, M. M., Dilshad Manzar, M., Warren Spence, D., BaHammam, A. S., & Pandi-Perumal, S. R. (2019). Physical activity and sleep quality in relation to mental health among college students. *Sleep and Breathing*, *23*(2), 627-634. doi: 10.1007/s11325-019-01780-z

Gomes, G. C., Passos, M. H. P. dos, Silva, H. A., Oliveira, V. M. A. de, Novaes, W. A., Pitangui, A. C. R., & Araújo, R. C. de. (2017). Qualidade de sono e sua associação com sintomas psicológicos em atletas adolescentes. *Revista Paulista de Pediatria*, *35*(3), 316-321. doi: 10.1590/1984-0462/;2017;35;3;00009

Gordon-Larsen, P., Nelson, M. C., & Popkin, B. M. (2004). Longitudinal physical activity and sedentary behavior trends: Adolescence to adulthood. *American Journal of Preventive Medicine*, *27*(4), 277-283. doi: 10.1016/j.amepre.2004.07.006

Guerra, P. H., Farias Júnior, J. C. de, & Florindo, A. A. (2016). Comportamento sedentárioemcrianças e adolescentes brasileiros: revisão sistemática. *Revista de Saúde Pública*, *50*(9), 1-15. doi: 10.1590/S1518-8787.2016050006307

Guerrero, M. D., Barnes, J. D., Chaput, J.-P., & Tremblay, M. S. (2019). Screen time and problem behaviors in children : exploring the mediating role of sleep duration. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(105), 1-10. doi: 10.1186/s12966-019-0862-x

Instituto Brasileiro de Geografia e Estatística. (2013). *Pesquisa Nacional por Amostra de Domicílios: Síntese de Indicadores*. Retrieved from IBGE website: https://ww2.ibge.gov.br/home/estatistica/populacao/trabalhoerendimento/pnad2013/ on March 6, 2020.

Koepp, M. J., Gunn, R. N., Lawrence, A. D., Cunningham, V. J., Dagher, A., Jones, T., … Grasby, P. M. (1998). Evidence for striatal dopamine release during a video game. *Nature*, *393*(6682), 266-268. doi: 10.1038/30498

Komada, Y., Aoki, K., Gohshi, S., Ichioka, H., & Shibata, S. (2015). Effects of television luminance and wavelength at habitual bedtime on melatonin and cortisol secretion in humans. *Sleep and Biological Rhythms*, *13*(4), 316-322. doi: 10.1111/sbr.12121

Lopes, A. P., & Rezende, M. M. (2013). Anxiety and the use of psychoactive substances among adolescents. *Estudos de Psicologia (Campinas)*, *30*(1), 49-56. doi: 10.1590/S0103-166X2013000100006

Maras, D., Flament, M. F., Murray, M., Buchholz, A., Henderson, K. A., Obeid, N., & Goldfield, G. S. (2015). Screen time is associated with depression and anxiety in Canadian youth. *Preventive Medicine*, *73*, 133-138. doi: 10.1016/j.ypmed.2015.01.029

Moge, C. E., & Romano, D. M. (2020). Contextualising video game engagement and addiction in mental health: the mediating roles of coping and social support. *Heliyon*, *6*(11), e05340. doi: 10.1016/j.heliyon.2020.e05340

Neto, J. M. de S., Costa, F. F. da, Barbosa, A. O., Filho, A. P., Santos, E. V. O. dos, & Júnior, J. C. de F. (2021). Physical activity, screen time, nutritional status and sleep in adolescents in Northeast Brazil. *Revista Paulista de Pediatria*, *39*, e2019138. doi: 10.1590/1984-0462/2021/39/2019138

Passos, M. H. P., Silva, H. A., Pitangui, A. C. R., Oliveira, V. M. A., Lima, A. S., & Araújo, R. C. (2017). Reliability and validity of the Brazilian version of the Pittsburgh Sleep Quality Index in adolescents. *Jornal de Pediatria*, *93*(2), 200-206. doi: 10.1016/j.jped.2016.06.006

Peracchia, S., & Curcio, G. (2018). Exposure to video games: effects on sleep and on post-sleep cognitive abilities. A sistematic review of experimental evidences. *Sleep Sci*, *11*(4), 302-314. doi: 10.5935/1984-0063.20180046

Schaan, C. W., Cureau, F. V, Sbaraini, M., Sparrenberger, K., Kohl, H. W., & Schaan, B. D. (2019). Prevalence of excessive screen time and TV viewing among Brazilian adolescents: a systematic review and meta-analysis. *Jornal de Pediatria*, *95*(2), 155-165. doi: 10.1016/j.jpedp.2018.06.016

Schlarb, A., Friedrich, A., & Claßen, M. (2017). Sleep problems in university students – an intervention. *Neuropsychiatric Disease and Treatment*, *13*, 1989-2001. doi: 10.2147/NDT.S142067

Silva, A. O. da, Oliveira, L. M. F. T. de, Santos, M. A. M. dos, & Tassitano, R. M. (2017). Tempodetela, percepdaqualidadedesonoeepisdeparassoniaemadolescentes. *Revista Brasileira de Medicina Do Esporte*, *23*(5), 375-379. doi: 10.1590/1517-869220172305163582

Silva, A. O. da, Soares, A. H. G., Silva, B. R. V. S., & Tassitano, R. M. (2016). Prevalência do tempo de tela como indicador do comportamento sedentário em adolescentes brasileiros: uma revisão sistemática. *Motricidade*, *12*(2), 155-164.

Silva, K. S., da Silva Lopes, A., Dumith, S. C., Garcia, L. M. T., Bezerra, J., & Nahas, M. V. (2014). Changes in television viewing and computers/videogames use among high school students in Southern Brazil between 2001 and 2011. *International Journal of Public Health*, *59*(1), 77-86. doi: 10.1007/s00038-013-0464-3

Teychenne, M., & Hinkley, T. (2016). Associations between Screen-Based Sedentary Behaviour and Anxiety Symptoms in Mothers with Young Children. *PLoS One*, *11*(5), e0155696. doi: 10.1371/journal.pone.0155696

Thomas, G., Bennie, J. A., De Cocker, K., Castro, O., & Biddle, S. J. H. (2020). A Descriptive Epidemiology of Screen-Based Devices by Children and Adolescents: a Scoping Review of 130 Surveillance Studies Since 2000. *Child Indicators Research*, *13*(3), 935-950. doi: 10.1007/s12187-019-09663-1

Thomée, S., Dellve, L., Härenstam, A., & Hagberg, M. (2010). Perceived connections between information and communication technology use and mental symptoms among young adults-a qualitative study. *BMC Public Health*, *10*(1), 66. doi: 10.1186/1471-2458-10-66

Tremblay, M. S., LeBlanc, A. G., Kho, M. E., Saunders, T. J., Larouche, R., Colley, R. C., … Gorber, S. C. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 98. doi: 10.1186/1479-5868-8-98

Uhde, T. W., Cortese, B. M., & Vedeniapin, A. (2009). Anxiety and sleep problems: Emerging concepts and theoretical treatment implications. *Current Psychiatry Reports*, *11*(4), 269-276. doi: 10.1007/s11920-009-0039-4

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2008). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting

observational studies. *Journal of Clinical Epidemiology*, *61*(4), 344-349. doi: 10.1016/j.jclinepi.2007.11.008

Wahl, S., Engelhardt, M., Schaupp, P., Lappe, C., & Ivanov, I. V. (2019). The inner clock—Blue light sets the human rhythm. *Journal of Biophotonics*, *12*(12), 1-14. doi: 10.1002/jbio.201900102

White, D., Leach, C., Sims, R., Atkinson, M., & Cottrell, D. (1999). Validation of the Hospital Anxiety and Depression Scale for use with adolescents. *British Journal of Psychiatry*, *175*(5), 452-454. doi: 10.1192/bjp.175.5.452

Woods, H. C., & Scott, H. (2016). #Sleepyteens : Social media use in adolescence is associated with poor sleep quality, anxiety, depression and low. *Journal of Adolescence*, *51*, 41-49. doi: 10.1016/j.adolescence.2016.05.008

Wu, X. Y., Han, L. H., Zhang, J. H., Luo, S., Hu, J. W., & Sun, K. (2017). The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review. *PloS One*, *12*(11), e0187668. doi: 10.1371/journal.pone.0187668

Yoshimura, M., Kitazawa, M., Maeda, Y., Mimura, M., Tsubota, K., & Kishimoto, T. (2017). Smartphone viewing distance and sleep: an experimental study utilizing motion capture technology. *Nature and Science of Sleep*, *9*, 59-65. doi: 10.2147/NSS.S123319

Zink, J., Belcher, B. R., Kechter, A., Stone, M. D., & Leventhal, A. M. (2019). Reciprocal associations between screen time and emotional disorder symptoms during adolescence. *Preventive Medicine Reports*, *13*, 281-288. doi: 10.1016/j.pmedr.2019.01.014