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Original Article

Influence of screen time and sleep duration on obesity in early adolescents

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Abstract

Background Behavioral and environmental factors increase the risk of obesity. Many Indonesian children have their own smartphones and engage in excessive screen time, which may negatively impact their nutritional status and sleep duration. However, to our knowledge no studies have explained the magnitude of the influence of screen time and sleep duration on obesity in early adolescents.

Objective To analyze the influence of screen time and sleep duration on obesity in children aged 10-13 years.

Methods This case-control study was done from April to June 2019 in Semarang, Central Java. Subjects comprised 70 obese and 70 non-obese children, based on CDC body mass index-for-age percentiles. Subjects were recruited from 7 primary schools. Children's screen time and sleep duration data were collected from the modified 3DPAR questionnaire. Statistical analysis was conducted using Chi-square and logistic regression tests.

Results Obesity had significant associations with short sleep duration (aOR=4.20; 95%CI 1.80 to 9.78) and long computer screen time (OR=4.13; 95%CI 1.28 to 13.25). Total screen time on other media or all media combined were not associated with obesity since both the obese and non-obese groups spent >2 hours/day on screens. Short sleep duration was the dominant risk factor for obesity (OR=4.08; 95%CI 1.78 to 9.35).

Conclusion Short sleep duration (<9 hours/day) is associated with and a dominant risk factor for obesity in children aged 10-13 years. However, screen time is not associated and not influential as a dominant risk factor for obesity, despite the high odds of obesity in children with long computer screen time (>2 hours/day). **[Paediatr Indones. 2020;60:154-9; doi: http://dx.doi.org/10.14238/pi60.3.2020.154-9]**.

Keywords: *screen time; sleep duration; obesity; early adolescents*

Obesity is a global health problem that increases the risk of morbidity and mortality. *The World Health Organization* (WHO) stated that obesity was associated with a greater number of global deaths than underweight.[1] The prevalence of children with overweight and obesity worldwide has increased sharply in recent years.[2] In 2016, the WHO reported that there were 124 million obese children and that number was expected to increase beyond the incidence of underweight in 2022, if the condition was not treated immediately and seriously.[3] Indonesia had the highest prevalence of obesity in children aged 5-12 years (18.8%), with 10.8% overweight and 8% obese.[4]

According to the Republic of Indonesia Ministry of Health, obesity occurs due to an imbalance between diet and physical activity.[5] The rapid development of technology has contributed to the increasing prevalence of obesity by leading to a sedentary or inactive lifestyle.[6] Indonesian children consume a

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variety of media at home, such as television, cell phones, video players, radios, gaming devices, and computers.[7] More than 80% of children aged 10-13 years in Indonesia already own a personal cell phone or smartphone.[8] Excessive screen time is thought to be related to obesity and decreased sleep duration.[9,10] Nonetheless, to the best of our knowledge, no other study has investigated the magnitude of the influence of screen time and sleep duration on obesity among early adolescents. Hence, we aimed to analyze the influence of screen time and sleep duration on obesity in children aged 10-13 years.

Methods

This case-control design was conducted in 70 obese children and 70 non-obese children, aged 10-13 years. Subjects were recruited from 7 primary schools in Semarang, Central Java, from April to June 2019 by consecutive sampling. The inclusion criteria were body mass index (BMI) > 95th percentile for the obese group or 5th to 95th percentile (based on CDC curve according to gender and age)[11,12] for the non-obese group, as well as parental informed consent and willingness to fill the parenting style questionnaire. Sick children were excluded.

The independent variables in this study were screen time and sleep duration, while the dependent variable was obesity. Subjects' gender and physical activity as well as parental income and parenting style were considered to be confounding variables. Physical activity were classified as low (<1 hour/day) or enough (≥ 1 hour/day) physical acitivity showed by how long subjects spent their time in a day for doing some physical aerobic exercise or muscle strengthening exercise, or bone strengthering exercise.

Subjects' weights and heights were measured using body impedance analysis (BIA) and a stadiometer, respectively. Screen time and sleep duration were obtained by the modified 3DPAR questionnaire.13 The 3DPAR is used for self-reporting daily habits by filling in activity codes in 30-minute intervals over 24-hour periods. It has been used by the University of South Carolina13 and tested with Alpha Cronbach reliability test in Semarang after translation to the Indonesian language.[13] The 3DPAR questionnaire was filled by children and parents answer the parenting style questionnaire.

To minimize recall bias, a quick interview session was done after children filled their questionnaires to help them recall their activities in the previous 3 days and to clarify or make sure data was correctly filled. Subjects were sub-classified based on long screen time (>2 hours/day) or short screen time (≤ 2 hours/day), according to the AAP recommendation for screen time in children.[14,15] Subjects were also sub-classified based on long sleep duration (≥ 9 hours/day) or short sleep duration (< 9 hours/day), according to CDC recommendation for sleep duration among school-aged children.[16]

The data were analyzed using *IBM SPSS Statistics 20*. The hypothesis that long screen time and short sleep duration influence obesity (OR≠1) in children aged 10-13 years was tested using Chi-square (for data with expected count >5), Fisher's exact test (for data with expected count <5), Mantel-Haenszel test (to assess potential confounding factors), and multiple logistic regression test (to determine which variable was a dominant risk factor). Results with P values < 0.05 were considered to be significant. The study was approved by the Ethics Committee, Universitas Diponegoro University Medical School/Dr. Kariadi Hospital. The Board of Education permitted the study to be conducted in primary schools in Semarang.

Results

Of 174 students, 140 children met the inclusion criteria, 70 per group. The characteristic data collected were gender, sleep duration, and physical activity (**Table 1**).

The mean sleep duration and screen time for all media, smartphone-screen time, TV-screen time, and computer-screen time for obese, non-obese, and all subjects are shown in **Table 2**. The mean time of sleep duration, and screen time varied in each media. Note that mean screen times in the obese group were higher than screen times for all subjects.

The cross-tabulation of screen time, sleep duration, and confounding variables with obesity were analyzed by Chi-square test (**Table 3**). Gender, sleep duration, and computer screen time were significantly different between the obese and non-obese groups.

Table 1. Characteristics of the study subjects

Characteristics	n (%)
Gender	
Male	59 (42.1)
Female	81 (57.9)
Sleep duration	
Short	90 (64.3)
Long	50 (35.7)
Screen time for all media	
Long	121 (86.4)
Short	19 (13.6)
Screen time-TV	
Long	68 (48.6)
Short	72 (51.4)
Screen time-smartphone	
Long	61 (43.6)
Short	79 (56.4)
Screen time-computer	
Long	18 (12.9)
Short	122 (87.1)
Physical activity	
Short	104 (74.3)
Long	36 (25.7)

There was more obese boys compared to girls, more obese adolescents who had shorter sleep duration and longer computer screen time.

Mantel-Haenszel test was done to control for the confounding variable of gender (**Table 4**). After controlling for confounders, short sleep duration retained its significant association with obesity (P=0.001). However, long computer screen time was no longer significantly associated with obesity.

Logistic regression test was done for variables with P values <0.25, in order to assess for a dominant risk factor (**Table 5**). Male gender and short sleep duration were both significant risk factors for obesity. Through multivariate analysis, obtained an equation to count the probabilities (P) for being obese in boys with short sleep duration was 83.1%.

Discussion

In our study, significantly more obese children had short sleep duration (77.1%) than non-obese children (51.4%). The adjusted odds ratio after controlling for confounding variables was >1 (aOR 4.20; 95%CI 1.81 to 9.78; P=0.001).

Screen time was not associated with obesity, since both groups had mean screen time >2 hours/day, which exceeded the American Academic of Pediatrics (AAP) recommended limit. The mean screen times for all subjects were as follows: all media 4.73 hours/day (OR 1.13; 95%CI 0.43 to 2.98; P=0.805), smartphone 2.6 hours/day (OR 1.50; 95%CI 0.77 to 2.95; P=0.233), and TV 2.3 hours/day (OR 1.000; 95%CI=0.52 to 1.94; P=1.000). However, there was a significant relationship between computer screen time and obesity (P=0.012) before controlling for confounding variables (Mantel Haenszel test P>0.05), with a crude odds ratio of >1 (crude OR 4.13; 95%CI 1.28 to 13.25). Short computer screen time was observed in 94.3% of the non-obese group and 80% of the obese group. Mean computer screen time for all subjects was <2 hours/day.

Multivariate analysis revealed that short sleep duration and male gender were significantly associated with obesity, with odds ratios >1 [(OR 4.1; 95%CI 1.78 to 9.35; P=0.001) and (OR 6.4; 95%CI 2.89 to 14.35; P<0.001), respectively]. After adjusting for male gender, short sleep duration (<9 hours/day) remained a significant risk factor for obesity (aOR 4.20). This result was in agreement with a Yogyakarta and Bantul Regency study which showed a significant relationship between shorter sleep duration and obesity.[17]

A number of possible pathways linking sleep deprivation with obesity have been suggested. Chronic sleep deprivation may be related to hormonal distur-

Table 2. Subjects' mean sleep duration and screen times by group

Variables	Obese (n=70)	Non-obese (n=70)	All subjects (N=140)
Mean sleep duration (SD), hours	8.03 (1.56)	8.7 (1.33)	8.37 (1.48)
Mean screen time (SD), hours	5.47 (3.18)	3.98 (1.63)	4.73 (2.63)
Mean TV-screen time (SD), hours	2.34 (1.81)	2.32 (1.56)	2.33 (1.69)
Mean computer-screen time (SD), hours	0.96 (1.79)	0.46 (0.93)	0.72 (1.44)
Mean smartphone-screen time (SD), hours	3.22 (3.03)	1.98 (1.38)	2.6 (2.43)

Table 3. Comparison of sleep duration, screen time, and sociodemographic variables between obese and non-obese adolescents

Variables	Group		OR (95% CI)	P value
	Obese n (%)	Non-obese n (%)		
Gender				
Male	43 (61.4)	16 (22.9)	5.38 (2.57 to 11.23)	<0.001+
Female	27 (38.6)	54 (77.1)		
Sleep duration				
Short	54 (77.1)	36 (51.4)	3.18 (1.54 to 6.61)	0.001+
Long	16 (22.9)	34 (48.6)		
Screen time				
Long	61 (87.1)	60 (85.7)	1.13 (0.43 to 2.98)	0.805+
Short	9 (12.9)	10 (14.3)		
Screen time-TV				
Long	34 (48.6)	34 (48.6)	1.00 (0.52 to 1.94)	1.000+
Short	36 (51.4)	36 (51.4)		
Screen time-smartphone				
Long	34 (48.6)	27 (38.6)	1.50 (0.77 to 2.95)	0.233+
Short	36 (51.4)	43 (61.4)		
Screen time-computer				
Long	14 (20)	4 (5.7)	4.13 (1.28 to 13.25)	0.012+
Short	56 (80)	66 (94.3)		
Physical activity duration				
Short	52 (74.3)	52 (74.3)	1.00 (0.469 to 2.134)	1.000+
Long	18 (25.7)	18 (25.7)		

+Chi-square test

bances, such as decreased leptin release by adipocytes or low leptin level, and increased ghrelin level.[18] Ghrelin acts as a potent stimulator of appetite, while leptin acts as a suppressor.[19] Low leptin has a much stronger effect than high leptin levels, which have been associated with leptin resistance usually observed in obesity.[20,21] Sleep deprivation also plays a role in reduced inhibition of orexigenic activity in the hypothalamus (orexin as a strong appetite stimulant that rises in response to low leptin level).[22,23] These neurohormonal changes lead to increased hunger or appetite and desire for calorie-dense food that may result in more weight gain in the short term and obesity in the long term.[24-26] Another possible pathway is that reduced sleep duration may cause fatigue, leading to reduced physical activity.[27] Chronic low physical activity and uncontrolled appetite or food intake causes an imbalance between energy consumption and energy expenditure that may lead to obesity.[5]

Table 4. Association between obesity and sleep duration and computer-screen time, adjusted for gender

	aOR (95% CI)[a]	P value
Sleep duration (short)	4.20 (1.81 to 9.78)	0.001[α]
Computer-screen time (long)	3.64 (0.95 to13.91)	0.059

[α]Mantel-Haenszel test

Table 5. Multivariate analysis of sleep duration, gender, as well as computer and smartphone screen times

Variables	B	P	OR	95%CI
Sleep duration (short)	1.40	0.001*	4.08	1.78 to 9.35
Gender (male)	1.86	<0.001*	6.44	2.89 to 14.35
Computer screen time (long)	0.89	0.174	2.44	0.67 to 8.84
Smartphone screen time (long)	-0.18	0.653	0.83	0.37 to 1.87
Constant	-1.681	<0.001	0.19	

*significance <0.05

We found that screen time (all media, smartphone-media only, or TV-media only) was not influential as a risk factor for obesity in children, but screen time for all media categories were longer in the obese group than in the non-obese group. Similarly, a Denpasar, Indonesia study reported that obese children had longer screen time (and greater than average screen time among all groups) than non-obese children.[9]

The odds of obesity in children with long computer screen time (>2 hours/day) were 4.1 times higher than in children with short computer screen time (≤2 hours/day), but gender was a confounder in this relationship. Furthermore, the mean computer screen time in all subjects was less than 2 hours/day. These findings differed from smartphone and TV screen time, perhaps because children use TV more than computers.[28] A number of possible mechanisms linking long screen time to obesity have been suggested, including sleep deprivation. Short sleep duration has been associated with obesity.[29] Another possible mechanism is that screen time displaces the time spent doing physical activity. However, physical activity duration was not associated with obesity in our study. Moreover, a study showed that a reduction in screen time only gave a slight increase in physical activity, and screen time is not the only factor for developing obesity.[30]

We found that short sleep duration was influential as a dominant risk factor for obesity by 4.1 times. Male gender, a confounding variable, was also influential as a dominant risk factor for obesity. The odds of obesity in 10 to 13-year-old boys were 6.4 times higher than in girls of similar age range. If a boy also had a short sleep duration, his probability of obesity was 83.1%. Boys tend to have higher risk of obesity because they have higher average energy and high carbohydrate-dense intake.[31] Leptin is also thought to play a role at this age, and its level varies by gender.[32]

The limitations of this study were that data were taken from self-reported questionnaires and not measured by an objective instrument to measure sleep duration and screen time. Recall bias and overestimates may have influenced our findings.

Our study provides evidence that significantly more obese children have short sleep duration than non-obese children. In addition, short sleep duration is a dominant risk factor for obesity in children aged 10-13 years. Mean screen times for smartphone, TV, and all media in both groups are each longer than 2 hours/day, and these three types of screen time are not associated with obesity. In addition, computer screen time is not influential as a dominant risk factor for obesity, although the odds of obesity in children with long computer screen time is quite high.

Conflict of Interest

None declared.

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