TINJAUAN PUSTAKA

JIMKI : JURNAL ILMIAH MAHASISWA KEDOKTERAN INDONESIA

EVIDENCE BASED CASE REPORT: PROLONGED SCREEN TIME AS A RISK FACTOR FOR CHILDHOOD OBESITY

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Riwayat Artikel

Diterima: 16 – 07 – 2024
Selesai revisi: 31 – 12 – 2024

DOI :
10.53366/jimki.v11i1.776

Pendahuluan: Pandemi terbukti mempengaruhi aktivitas sehari-hari anak, salah satunya terhadap kegiatan sekolah yang terpaksa dilakukan secara daring. Kondisi tersebut meningkatkan total waktu layar anak - anak. Seiring dengan keadaan ini, terdapat pula peningkatan prevalensi obesitas pada anak-anak karena mereka menjadi kurang aktif. Saat ini belum diketahui bagaimana waktu layar yang berkepanjangan menjadi faktor risiko kelebihan berat badan/obesitas pada anak-anak. Studi ini bertujuan untuk menentukan keterkaitan antara waktu layar yang berkepanjangan dengan *overweight/obesitas* pada anak - anak. **Metode:**Artikel ilmiah dalam studi ini dipilih dari empat database (Pubmed, Embase, Cochrane Library, dan Sciencedirect) dengan limitasi (publikasi dalam bahasa inggris). Artikel kemudian dievaluasi menggunakan *Oxford Critical Appraisal Tools.* **Pembahasan:** Terdapat tiga artikel yang dilakukan telaah lebih lanjut dalam studi ini, dua diantaranya merupakan meta-analisis dan tinjauan sistematis, dan satu artikel merupakan studi kohort. Studi-studi tersebut memiliki kesamaan positif dengan pertanyaan klinis dan menunjukkan hubungan positif antara waktu layar yang berkepanjangan dan *overweight*/obesitas pada anak-anak. Dua studi meta-analisis menunjukkan korelasi positif dengan masing-masing rasio *odds* sebesar 1,67 (95% CI (1.48, 1.88)) dan 1,262 (95% CI (1.155, 1.379)). Artikel lainnya menunjukkan peningkatan besar dalam TSB (*time spent in sedentary behavior*) (β 81,3) di antara siswa yang *overweight* dan peningkatan moderat (β 27,4) di antara siswa yang obesitas dibandingkan dengan siswa dengan berat badan normal. **Simpulan:** Waktu layar yang berkepanjangan (>2 jam/hari) memiliki hubungan yang signifikan dengan peningkatan BMI yang mengarah pada *overweight* dan obesitas.

Kata Kunci: Anak-anak, waktu layar, *overweight*/obesitas

e-ISSN : 2721-1924
ISSN : 2302-6391

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ABSTRACT

Background: *The pandemic has affected children's daily activities, including school activities that are forced to be conducted online and thus increasing their total screen time. Along with this increase, there is likewise an increase in the prevalence of childhood obesity as children become less active. However, it is still unclear how prolonged screen time becomes a risk factor for overweight/obesity in children. This paper aims to determine the association between prolonged screen time and overweight/obesity in children.*

Methods: *The articles in this study were selected from four databases (Pubmed, Embase, Cochrane Library, and ScienceDirect) with language limitations (published in English). Each of the included studies was evaluated using Oxford Critical Appraisal Tools.*

Discussion: *There are three articles that are included in this study, two of which are meta-analysis and systematic review, and the other one is a cohort study. The included studies have positive similarities with clinical questions and showed positive associations between prolonged screen time and overweight/obesity in children. Two meta-analysis studies showed positive correlation with each odds ratio are 1,67 (95% CI(1.48,1.88)) and 1,262 (95% CI(1.155,1,379)). Another article showed large increases in TSB (time spent in sedentary behavior) (β 81.3) among overweight students and a modest increase (β 27.4) among obese students compared to normal weight students.*

Conclusion*: Prolonged screen time (>2 hours/day) has a significant relationship with increased BMI leading to overweight or obesity.*

Keywords: *children, screen time, overweight/obesity*

1. INTRODUCTION

In 2018, Indonesia had a high prevalence of childhood overweight (8-11.2%) and obesity (10-15%).[1] Technological advances are known to cause children to spend more time on screens rather than being physically active, leading to increased food consumption and reduced physical activity, which ultimately contributes to obesity. According to Badan Pusat Statistik (BPS), 67.88% of Indonesians used mobile phones in 2022. Among children aged 0–6, 33.44% were users, with the highest rate in the 5–6 age group (52.76%), and 25.5% of those aged 0–4 also using mobile devices. The increase in children's use of technology was influenced by the pandemic, which led them to rely on digital devices for educational purposes.[2]

In this regard, there are several restrictions on activities outside the home, including school activities, due to the enactment of Large-Scale Social Restriction (or in Indonesian: Pembatasan Sosial Berskala Besar/PSBB) since March 2020.[3] A research by Dhamayanti (2021) shows that 83.3% of children have

screen time for ≥2 hours for online school activities and 63.5% of children have screen time for ≥3 hours for non-school activities.[4] Meanwhile, the guidelines from WHO and the American Academy of Pediatrics and Canadian Pediatric Society recommend screen time with a limited duration, namely <1 hour/day for children aged 1-2 years, eliminating screen time for children aged <1 year, and a maximum of 2 hours/day for children and adolescence.[5][6] Thus, it can be concluded that children experience an increase in screen time, namely the time spent in front of electronic devices, both for school activities and recreational activities.

Based on the case presented in the previous section, it is known that the patient is an obese child with a total screen time that exceeds the recommendation. Therefore, it is hypothesized that prolonged screen time may be a risk factor for childhood obesity. However, it is not clear how the association between the two conditions is established. Hence, this paper aims to determine the association between them according to the accessible evidence that was found.

Theoretically, there are several factors that can cause obesity, i.e., genetic, sociodemographic, and behavioral factors. This study will especially discuss one of the behavioral factors, prolonged screen time.[7] There are several mechanisms through which prolonged screen time causes obesity. These include increased activity of sympathetic neurons, decreasing brain-derived neurotrophic factors (BDNF), decreasing physical activity, increasing incidence of snacking from eating while viewing and/or the effects of advertising, and reducing sleep duration.[8][9][10][11]

A sedentary lifestyle, in this case, prolonged screen time, can increase the activity of sympathetic neurons (SN) and reduce BDNF signaling resulting in a relatively reduced parasympathetic tone. Consequently, heart rate and blood pressure are elevated, and gut motility is reduced, resulting in the diminution of energy expenditure.[9][12] Furthermore, prolonged screen time also leads to decreasing physical activity and sleep deprivation that cause changes in the appetite-regulating hormones ghrelin and leptin to increase hunger and decrease satiety.[13] Therefore, prolonged screen time can be one of the risk factors for overweight or obesity.

2. METHOD

Clinical Question

Does prolonged screen time increase the risk of overweight/obesity in children? **(Table 1)**

Table 1. PICO formulation

Patient/ Problem (P)	Intervention (I)	Comparison (C)	Outcome (O)
Children (2-18 years old)	Prolonged screen time	Screen time <2 hours/day	Overweight/obesity
Clinical Question Types	Etiology		
Study Design	Systematic review of cohort studies, cohort		

Search Strategy

Literature searching was done on March 13th, 2022, using four databases (Pubmed, Embase, Cochrane Library, and ScienceDirect). The terminologies for literature searching are listed in the table **(Table 2)**, with the synonym and Mesh Term.

Table 2 . Searching Strategy

Database	Searching Strategy	Hits	Selected Articles
PubMed (NCBI) (13/03/2022)	(((child* [Title/Abstract]) OR (child*[MeSH Terms])) AND ((screen time[Title/Abstract]) OR (screen time[MeSH Terms]))) AND ((obes*[Title/Abstract]) OR (obes*[MeSH Terms]))	1084	2
Science Direct (13/03/2022)	((child [Title/Abstract]) OR (child[MeSH Terms])) AND ((screen time[Title/Abstract]) OR (screen time(MeSH Terms)))) AND ((obes[Title/Abstract]) OR (obes[MeSH Terms]))	91	0
Cochrane Library (13/03/2022)	((child*[Title/Abstract]) OR (child*)) AND ((screen time[Title/Abstract]) OR (screen time))) AND ((obes*[Title/Abstract]) OR (obes*))	124	0
Embase (13/03/2022)	('child*' AND 'obes*' AND ('screen time'/exp OR 'screen time") AND (2012-2022]/py AND ([cochrane review]/lim OR [systematic review]/lim OR [meta analysis]/lim)) AND ('childhood obesity'/dm OR 'obesity'/dm)	52	1
	Total	1351	3

Eligibility Criteria

The result articles from 4 enlisted databases were screened for title and abstract using inclusion and exclusion criteria by three independent reviewers. Screening continued by reading the full-text article and hand-searching process, finalized by choosing included papers for the evidence-based case report. The flowchart below shows the searching strategy, exclusion criteria, and inclusion criteria **(figure 1)**. Critical appraisal was done using Oxford Critical Appraisal Tools for Systematic Review on systematic review and meta-analysis studies and Oxford Critical Appraisal Tools for Etiology Study on cohort study.[14]

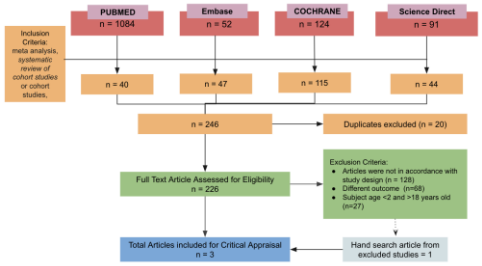

Figure 1. Literature searching process

3. RESULT AND DISCUSSION

The results of the literature search obtained three studies, two of which are meta-analysis and systematic review, and the other one is a cohort study. Two of the three studies used the child's age as the focus in the patient group, and another study used school grade level. The three studies examined the outcome of obesity in the form of body mass index-for-age percentile is at or greater than 85th according to CDC growth chart 2000 and BMI ≥25.[15]

The characteristics of included studies are mentioned on **table 3.** All studies included are relevant with further elaboration described on **table 4.**

Prolonged screen time, as the independent variable, is defined as the excessive duration of activities done in front of a screen, such as watching TV or playing video games, using the recommendation from the American Academy of Pediatrics and Canadian Pediatric Society about screen time limitation for children and adolescents which is >2 hours/day.[6] All of the included articles showed that long screen time was associated with overweight/obesity rates in children. The summary of critical appraisal for systematic review and meta-analysis studies is shown in **table 5**. The critical appraisal summary for the etiology study is displayed in **table 6**.

Table 3. Characteristics of included studies

Author (year)	Patient group	Design study	Outcome	Key results	Comments
Fang K, Mu M, Liu K, He Y (2019)[16]	Children (<18 years)*	Meta-analysis and systematic reviews	Prevalence of childhood overweight/obesity Age- and sex-specific, defined by BMI ≥85th percentile	Childhood overweight/obesity was **positively correlated** with total screen time, television time, and computer time. **screen time ≥2 hr/day was positively associated with childhood (<18 years) overweight/obesity compared with screen time <2 hr/day (OR = 1.67; 95% CI(1, 48,1.88)**	Meta-analysis and systematic review 16 articles included (study design: longitudinal/cohort, cross-sectional) The meta-analysis attributed a variety of races and locations from different studies
Li C, Cheng G, Sha T, Cheng W, Yan Y (2020)[17]	Infants, toddlers, and preschoolers (Children's age as 0-7 years old)*	Meta-analysis and systematic reviews	Physical (overweight/obesity), behavioral, and psychosocial outcomes related to media exposure	Children with excessive screen media use were related to an increased risk of overweight/obesity. This study defined daily screen time according to various recommendations (i.e., ≥1 hr/day, ≥ 2/hrday, >1 hr/day).	Meta-analysis and systematic review 9 studies (study design: cross-sectional, cohort, case-control study)
Leatherdale ST, Harvey A (2015)[18]	Grade 9-12 students	Cohort study	Modifiable risk behaviors for chronic disease (status weight) and key demographic correlates BMI measured classified as underweight, normal-weight, overweight, and obese	Weight status was associated with recreational sedentary behavior (p<0,001). **Compared to normal-weight students, there were large increases in TSB (β 81.3) among overweight students. Compared to normal-weight students, there was a modest increase in TSB (β 27.4) among obese students.**	Individual 1 year Cohort study, conducted in Canada. Year 1 of the COMPASS study

* Studies do not include subjects <2 years old

Table 4. Critical relevance of included studies

Author (year)	Criteria relevance			LOE
	Similarity population	Similarity indicators	Similarity outcome	
Fang K, Mu M, Liu K, He Y (2019)[16]	+	+	+	2a
Li C, Cheng G, Sha T, Cheng W, Yan Y (2020)[17]	+	+	+	2a
Leatherdale ST, Harvey A (2015)[18]	+	+	+	2b

Table 5. Critical appraisal of meta-analysis

		Fang K et al.[16]	Li C et al.[17]
Validity	Does the systematic review address a focused question (PICO) and use it to direct the search and select articles for inclusion?	Yes	Yes
	Did the search find all the relevant evidence?	Yes	No
	Have the studies been critically appraised?	Yes	Yes
	Did they only include high-quality studies?	Yes	Yes
	Have the results been totaled up with appropriate summary tables and plots?	Yes	Yes
	And heterogeneity between studies assessed and explained?	Yes	Yes
Importance	What measure was used, and how large was the effect (could it have been due to chance)?	The odds ratio (OR), 95% CI used to measure the outcome, with the intervention examined in overall and subgroup analysis (television screen time and computer screen time). The heterogeneity was measured in I^2 value and P value. There was a significant difference observed in total screen time when screen time ≥2 hr/day compared with <2 hr/day (OR = 1.47; 95% CI [1.27, 1.69]; I2 = 56%, P = .02), the stronger association between screen time and overweight/ obesity was found in TV (OR = 1.77; 95% CI [1.64, 1.92]; I2 = 3%, P = .41) and computer (OR = 2.39; 95% CI [1.98, 2.89]; I2 = 20%, P = .26).	The odds ratio (OR), 95% CI using random effect models are used to measure the outcome, with the intervention examined in the subgroup analysis (≥1 hr/day, ≥ 2/hrday, >1 hr/day). The heterogeneity was measured in I^2 value and P value. The odds ratio for each baseline are 1.872(1.678,2.088), 1,262(1.155,1.379), and 1.988(1.445,2.735)
Applicability	Is your patient so different from those in the study that its results don't apply?	No	No
	What are your patient's preferences, concerns, and expectations from this treatment?	"	"

Table 6. Critical appraisal of cohort studies

		Leatherdale et al.18
Validity	Were there clearly defined groups of patients similar in all important ways other than exposure to the treatment or other cause?	Yes
	Were treatment exposures and clinical outcomes measured the same ways in both groups (e.g., was the assessment of outcomes either objective (e.g., death) or blinded exposure)?	Yes
	Was the follow-up of study patients complete and long enough?	Yes
	Is it clear that the exposure preceded the onset of the outcome?	Yes
	Is there a dose-response gradient?	Yes
	Is there positive evidence from a "dechallenge-rechallenge" study?	Yes
	Is the association consistent from study to study?	Yes
	Does the association make biological sense?	Yes
Importance	Are the valid results from this harm study important?	The study showed linear models to estimate the correlation between overweight/obesity with total sedentary behavior. The value shows β (variables estimates) and SE (standard errors) for the variable estimates. Compared to normal-weight students, there were large increases in TSB (β 81.3) among overweight students. Compared to normal-weight students, there was a modest increase in TSB (β 27.4) among obese students.
Applicability	Can the study results be extrapolated to your patient?	Yes
	What are your patient's risks of the adverse outcome?	-

Result Interpretation, Including Strength and Limitations of Each Study

The first article showed evidence that screen time ≥2 hr/day was likely to be associated with a greater risk of childhood (<18 years) overweight/obesity than screen time <2 hr/day (OR = 1.67; 95% CI(1,.48,1.88). This study includes 16 studies that met the criteria, the study design of the studies included are longitudinal/cohort and cross-sectional studies. The obesity/overweight referred to in this study was defined as age- and sex-specific BMI ≥85th percentile, IOTF age- and sex-specific BMI cut-off points, and WHO Child Growth Standards. Screen time was assessed by questionnaire and reported by the type of screen time, including television/computer time, and identified whether >2 hr/day or <2 hr/day. Intervention (≥2hr/day screen time) increases the odds of overweight/obesity to 147% of the odds in the control group (<2 hr/day screen time) (95%CI 1.27-1.69), I2 56%, P<0.00001. Intervention (≥2hr/day television time) increases the odds of overweight/obesity to 177% of the odds in the control group (<2 hr/day television time) (95%CI=1.64-1.92),$I^2$3% P<0.00001. Intervention (≥2hr/day computer time) increase the odds of overweight/obesity to 167% of the odds in the control group (<2 hr/day computer time) (95% CI= 1.48-1.88), I^2 78% P<0.00001.[16]

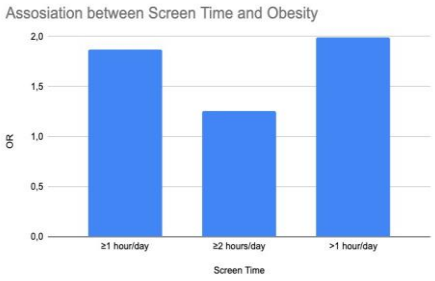

Figure 2. The association between screen time and obesity

The first article has some potential limitations. First, there is high statistical heterogeneity due to study design, race, age, assessment method of weight/height, sample size, and definition of overweight/obesity.

Second, the definition of childhood overweight/obesity is inconsistent that can cause different degrees of completeness and accuracy, which was at risk of definition bias. Third, there is exclusion bias, because of insufficient data from included studies, it is hard to distinguish the relationship between overweight/obesity and screen time, whether it is a result of leisure time or school-related. Fourth, there are confounding bias, because the original study did not include data, such as sex, economic status, degree of education, and screen time on leisure time or if it is school-related, so it was unable to be analyzed by the subgroup analysis and can be potential confounding variables. Fifth, there are exclusion bias because there is not enough data on smartphone use, this study does not examine the connection between smartphone use and overweight/obesity among children.[16]

The second article showed that children with excessive screen media use were related to an increased risk of overweight/obesity. This study defined daily screen time according to various recommendations (i.e., ≥1 hr/day, ≥ 2/hrday, >1 hr/day). The odds ratio for each baseline are 1.872 CI(1.678, 2, 088), 1,262 CI(1.155, 1.379), and 1.988 CI(1.445, 2.735). This study included nine studies that met the criteria, the study design of the studies that are included are cross-sectional, cohort, and case-control studies. The obesity/overweight in this study was defined as increased body mass index (BMI or BMI z-score). Screen time was defined as daily screen time ≥1 hr/day and ≥2 hr/day according to the difference in the recommendations of AAP (<2) and WHO (<2). Screen time Intervention (≥1 hr/day) increase the odds of overweight/obesity to 187.2% compared to the odds in the control group (< 1 hr/day) (95%CI 1.678-2.088) I^2 21% P<0.001. Screen time Intervention (≥2 hr/day) increases the odds of overweight/obesity to 126.2% compared to the odds in the control group (<2 hr/day) (95%CI 1.155-1.379) I^2 71.8% P<0.001. Screen time Intervention (>1 hr/day) increases the odds of overweight/obesity to 198.8% compared to the odds in the control group (≤1 hr/day) (95%CI 1.445-2.735) I^2 0% P<0.001. The study has some advantages. First, the inclusions of health indicators related to screen time were comprehensive and accurate. Second, none of the included studies in this systematic review and meta-analysis were at high risk of bias. However, there were some limitations to this study. First, the duration of children's screen use was mostly reported by parents, which was at risk of recall bias. Third, the inclusion of only articles published in English could result in English language bias. Fourth, the number of articles for each indicator was different, which may weaken the credibility of the evidence of health indicators and make an unequal contribution to health indicators related to children's health. Lastly, the results of this study combined infants, toddlers, and preschoolers, which could not give suggestions on children's screen use at different ages.[17]

The third article showed a large (β 83.1) and moderate (β 27.4) increase in total sedentary behavior, respectively among overweight and obese students, compared to normal-weight students. The study included

23,031 students with an average duration of sedentary behavior of 492 minutes/day. It was also found that 96.7% of the students exceeded the ≤2 hours/day recommendation. Total sedentary behavior was defined as the average time spent watching/streaming TV shows or movies, playing video/computer games, talking on the phone, surfing the internet, and texting, messaging, and emailing and was measured by the COMPASS questionnaire that had previously been validated. The weight status of the subjects was determined by BMI calculations with self-reported height and weight and was classified by the WHO system published in 2007 with the adjusted age and sex cut-points. The analyses were done descriptively and with linear models. Although this study involved a large number of subjects and detailed analyses of other risk factors, including smoking, drinking, marijuana-using, physical activity, fruit and vegetable consumption, ethnicity, and weekly spending money, it did not clearly show whether the time spent playing video or computer games, texting, messaging, or emailing were inactive. Moreover, the data were longitudinal and based on self-reported measures, which could be a potential source of bias.[18]

There is a risk of selection bias, as schools were purposively selected rather than randomized. This reduces generalizability and may lead to overrepresentation or underrepresentation of certain populations. Measurement bias is also a concern, as the data were self-reported, which can introduce recall bias and social desirability bias, particularly among adolescents. Confounding bias should be considered as well, since residual confounding is likely—especially regarding socioeconomic status and unmeasured parental or environmental factors—despite adjustments for multiple demographic and behavioral variables. Information bias is present, as sedentary behavior was conservatively estimated, potentially leading to underestimation, and certain types of sedentary activity (e.g., active video gaming) may have been misclassified. Finally, bias due to missing data should be noted. A total of 1,142 participants were excluded due to missing gender or sedentary behavior data, and the authors acknowledged that missing BMI data may be associated with overweight status.[18]

Consistency-Discrepancy Results

All the studies indicated a significant relation between prolonged screen time (>2 hours/day) and increased BMI leading to overweight and obesity. The mechanisms explained in the studies were quite similar, that screen time is often accompanied by lower physical activity and increased sedentary behavior, which would lead to lower energy expenditure. The studies reported that taking a meal while watching TV or using a computer would increase body weight by decreasing attentiveness to food intake and delaying internal signals of satiety. No discrepancy was found among the studies.

Study Relevance and Validity

All the studies included, are using a similar population (children 2-18 years old), indicators (screen time >2 hr/day), and outcomes (overweight/obesity). The three

critically reviewed studies in this evidence-based case report have fairly good validity, importance, and applicability points and consist of two meta-analyses and systematic review with 2a level of evidence and a cohort study with 2b level of evidence in the etiology area.

Strength and Limitations

This study uses four international databases to search for evidence. After a thorough screening and selection process, three articles were included and discussed in this paper. Two of which are systematic reviews and meta-analyses, which are considered studies with a high level of evidence and have passed critical appraisals using well-standardized tools. The other included article is a primary cohort study that still correlates with the preferred study design for an etiology area.

There are several limitations of this study. Our search for evidence only includes articles that were published in the aforementioned databases and doesn't include any unpublished reports. The included studies use self-reporting as a method to measure screen time, which is considered a non-objective measure that could be a source of bias. Lastly, there is high heterogeneity detected among the studies. Therefore, any confounding factors that could influence the association should be investigated.

4. CONCLUSION

Based on the results of a critical review of the included research studies, prolonged screen time (>2 hours/day) has a significant relation with increased BMI leading to overweight or obesity. Thus, reducing screen time could be an important protective factor to prevent childhood obesity.

Recommendation for children aged 2-18 years old is to reduce screen time to less than 2 hours/day and do more physical activity (for school-age children: moderate-to-vigorous physical activity, 60 minutes/day three times per week or 150 minutes/week).[19]

It is recommended that the patient reduce his screen time which may influence his obesity status. Screen time should be limited for educational purposes since the patient's school time is 3-4 hours/day. For recreational purposes, the screen time should be limited to less than 2 hours/day.

Additionally, it is also recommended that the patient do more physical activity. A 12-year-old child should do moderate-to-vigorous physical activity 60 minutes/day three times per week or 150 minutes/week, including aerobic activity such as walking and running, muscle-strengthening exercises such as climbing, and bone-strengthening exercises such as jumping or running.[19]

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