

The influence of screen time on behaviour and emotional problems among adolescents: A comparison study of the pre-, peak, and post-peak periods of COVID-19

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ABSTRACT

The coronavirus disease 2019 (COVID-19) pandemic has brought drastic changes globally in the past three years, one of which is an increase in the use of digital media or electronic devices. Previous studies have shown that long screen time may stimulate the neurobiological system, resulting in various behavioural and emotional problems; however, there is insufficient population-based evidence. This study aimed to investigate the influence of screen time on behavioural and emotional problems in Indonesian adolescents at three time points: the pre-, peak, and post-peak periods of COVID-19. Data were collected using an online community mental health survey. This survey incorporated the Youth Screen Time Survey to gauge screen time and the adolescent version of the Strengths and Difficulties Questionnaire to assess emotional, conduct, and prosocial behaviour problems. The participants were adolescents in secondary and senior high schools, with 337, 423, and 1,096 participants from the pre-, peak-, and post-pandemic periods, respectively, included in the analysis. Daily average screen time was compared, followed by the calculation of odds ratios for screen time and mental health problems during the different periods. The results demonstrated significant differences in adolescents' total daily average screen time between the different pandemic periods. Decreased screen time was associated with reduced emotional, conduct, and prosocial behaviour problems, especially during the peak period. Thus, psychoeducation on screen time in adolescents should be considered as a point of interest for mental well-being interventions.

1. Introduction

Coronavirus disease 2019 (COVID-19) was designated a worldwide pandemic on March 11, 2020. As of 16 March 2023, there were

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over 760 million confirmed COVID-19 cases globally, with approximately 6.8 million deaths [1]. COVID-19 is transmitted via respiratory droplets and other contact routes [2]. As a result of the rapid outbreak, infections peaked between 2020 and 2022. Significant changes in daily life occurred owing to social distancing and stay-at-home policies, which affected adolescents' routines. Young people were asked to study from home through online learning, avoid public places, social distance, and stay at home. Consequently, they had less contact with their peers [3,4]. However, starting in early 2022, the number of COVID-19 cases showed a decreasing trend. Schools were reopened, social restrictions were relaxed, and children started to resume their pre-pandemic daily routines.

The United Nations defines adolescents as those aged 10–19 years [5]. This age range is considered a vulnerable transition period from childhood to adulthood, in which adolescents must deal with developmental milestones such as the acquisition of functional autonomy, academic challenges, adaptations to new social situations, and decisions related to careers [6]. For most adolescents, schools and other social activities provide structure and routine for daily life. However, adolescence can be a time of interpersonal and relational conflicts, leading to emotional and behavioural problems that persist until adulthood [7–9]. The disruption caused by COVID-19 and its consequences on adolescents' mental well-being, including screen time, have been a major concern for several scholars [4,10–13].

Screen time is defined as the time spent on digital media, including computers, televisions, video games, smartphones, tablets, and handheld devices, excluding acoustic activities such as listening to music or conversing on the phone [14]. A study conducted in the US before the COVID-19 pandemic among adolescents aged 8–18 years found that the participants' mean total screen time was 7.5 h per day and was highest in those aged 11–14 years (9 h) [15]. A study conducted in Indonesia in 2019 showed that 38 % of 200 adolescents spent more time on the Internet (>6 h per day), which is associated with higher screen time usage and sedentary behaviour [16].

During the peak period of the COVID-19 pandemic, with school closures and remote operations in other public places, adolescents were forced to stay at home or in secure indoor places [13,17–19]. These circumstances naturally led to more hours of digital media or gadget use (e.g. personal computers, laptops, televisions, and mobile devices), especially for entertainment purposes, such as interpersonal communications (chatting), watching television, or other leisure activities [20–22]. Thus, the total screen time exceeded the American Academy of Paediatrics' suggestion of 1–2 h of screen time per day [23]. However, the latest policy published in 2016 [24] recommends that families design individualised family digital media use schedules without indicating universal daily screen time thresholds. A previous study investigated the potential adverse mental health consequences of screen time and found that it may be an important element for families to consider when devising digital media use plans [25].

Increasing the total screen time per day is assumed to stimulate the neurobiological system, especially the hypothalamic-pituitary-adrenal axis [26] and dopaminergic, serotonergic, and adrenergic circuits [27], leading to several types of emotional and behavioural problems. Adolescence is a sensitive period of turmoil during which neurobiological systems develop and change, making adolescents particularly vulnerable to emotional and behavioural problems [28–31]. The developmental model of the adolescent brain suggests that the affective-motivational system matures in early adolescence, whereas the control system matures in early adulthood [32]. Thus, the time gap in maturity between the two systems triggers a period of elevated vulnerability, susceptibility to risk-taking, and reward- and adventure-seeking behaviours during middle adolescence [33], especially when social pressure, distancing, isolation, and abandonment are involved [34]. Before the COVID-19 pandemic, several studies revealed that increased screen time was correlated with depression, anxiety, and conduct and prosocial behaviour problems among children and adolescents [35–37].

A systematic review conducted by Trott et al. [38] showed that during the COVID-19 pandemic, adolescents' total screen time and leisure screen time rose on average by 0.9 h/day (95 % CI 0.3–1.5 h/day) and 0.5 h/day (95 % CI 0.3–0.7 h/day), respectively. Moreover, the study reported that 67 % and 59 % of the surveyed children had increased their total screen time and leisure screen time, respectively. However, the study could not stratify the children into specific age groups owing to the paucity of data. The results also revealed a correlation between increased screen time and mental health problems in these age groups. Another study in South Korea reported a significant increase in screen time during the COVID-19 pandemic, which was associated with more mental health problems, such as emotional and conduct behaviours, among adolescents [39]. Furthermore, increased screen time in adolescence has been shown to persist into adulthood, leading to internet addiction at later ages [40]. From a lifestyle perspective, screen time spent on social media or other activities may also safeguard adolescents' mental well-being as it can provide them with access to correct mental health and health information, academic pursuits, social connections with peers, identity formation, and self-expression [41]. However, despite these benefits, several studies have raised concerns about increasing screen time owing to its potentially harmful effects. Specifically, excessive screen time may trigger highly rewarding stimuli and is correlated with decreased sensitivity to general rewards and reduced capacity for enjoyment, thus averting mood and augmenting impulsivity, as emphasised by the involvement of the orbitofrontal cortex (OFC) [40–44]. Screen time, specifically smartphone addiction, has been suggested to contribute to psychopathology in previous studies [45–47]. Therefore, increased screen time during the peak period of the COVID-19 pandemic is assumed to be a potential mental health threat to adolescents, leading to more emotional and behavioural problems [13,38,41,44]. Chen et al. [6] found an association between the use of electronic entertainment, depression, and anxiety among adolescents during the peak period of the COVID-19 pandemic, suggesting that screen time may potentially endanger and critically influence adolescents' mental well-being [13,48,49].

Starting in early 2022, the number of global COVID-19 cases began to gradually decrease. However, there were still significant regional differences, including an increase in some countries [1]. It has been reported that COVID-19 has now entered the post-peak period, which means that with adequate surveillance, the number of COVID-19 cases will drop below the observed peak levels. The post-peak period indicates that pandemic activity is decelerating. However, it remains unclear whether additional waves will occur [1]. This study hypothesised that during the peak of the COVID-19 pandemic, screen time and screen time activities were higher because of the social restriction policy compared to the pre- and post-peak periods. Therefore, this study aimed to elaborate on the differences in screen time and screen time activities during the pre-, peak, and post-peak periods of the COVID-19 pandemic and to

identify their association with emotional, conduct, and prosocial behaviour problems among adolescents. In addition, this study attempted to understand the potential impact of screen time on adolescents' mental well-being more comprehensively and to contribute to planning preventive strategies that may be adopted to address similar issues in the near future.

2. Materials and methods

This cross-sectional study examined the effect of screen time use on emotional, conduct, and prosocial behaviour problems among adolescents during the pre-, peak, and post-peak periods of the COVID-19 pandemic as part of a child and adolescent community mental health survey that have been conducted in Indonesia since 2016. A total 1856 adolescents participated in the study. Data on the pre-, peak, and post-peak periods of the COVID-19 pandemic were collected using crowdsourcing and snowballing methods, which have been widely applied due to Internet proliferation [50]. The target participants were adolescents aged 13–18 years with secondary or senior high school backgrounds. There was a small incentive for participants to join the study during the post-peak period of the COVID-19 pandemic, but not in the pre- and peak periods; therefore, participation in this study depended considerably more on intrinsic motivation rather than external rewards [50]. All data were collected online and disseminated using social media applications such as WhatsApp, Line, Google Form Link, and Facebook.

The pre- and peak pandemic data used were pre-existing data from the child and adolescent community mental health survey in Indonesia. Pre-pandemic data were collected from July to September 2018. (This pertains to a study that elaborated the association between screen time and peer problems among junior and senior high school students; the data has not yet been published. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Universitas Indonesia in July 2018 with Ethical Approval number: KET-0761/UN2.F1/ETIK/2018.) The pre-pandemic data described screen time and adolescents' mental health conditions prior to the COVID-19 pandemic. During this period, 447 individuals participated in the study. However, only 337 individuals who completed the survey met the inclusion criteria and were included in the analysis.

Peak pandemic data were also pre-existing data that collected from 21 August to 10 October 2020. The number of individuals with COVID-19 was estimated to be more than 10,000 per day, and the social restriction policy was fully applied. Schools and public places were completely closed, and students and parents mostly stayed at home. (This concerns a study that elaborated adolescent mental wellbeing during the COVID-19 pandemic in Indonesia. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Universitas Indonesia in April 2020 with Ethical Approval number: KET-375/UN2.F1/ETIK/PPM.00.02/2020.) A total of 743 participants completed the online questionnaire during the study period. However, 320 datasets were incomplete. Consequently, 423 were included in the final analysis.

The post-peak data were collected from October to December 2022, during which the number of COVID-19 cases was less than 1000 per day, social restriction policies were minimal, and schools and public places were reopened. A total of 1,195 adolescents completed the questionnaire during the post-pandemic period, and of those, 1096 fully completed the survey. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Universitas Indonesia in September 2022 (Ethical Approval number: KET-958/UN2.F1/ETIK/PPM.00.02/2022). All participants in the three periods of the study read and signed an informed consent form before the survey.

2.1. Instrument

This study modified questions from the Youth Screen Time Survey to measure screen time. Adolescents were asked to report the number of minutes spent on weekdays and weekends on three typical activities [1]: watching television, with screen time for watching videos or television shows and playing console/offline games [2]; using personal computers such as laptops/tablets/iPads, with screen time for watching television shows, YouTube or social media activities, online/offline games, and chatting; and [3] using smartphones, with screen time for online/offline games, YouTube, social media connections/chatting, online shopping, and so forth. The study also specifically asked about the screen time engaged in online and offline games. Daily total screen time was calculated by dividing the average weekday and weekend screen time for the three typical activities by seven. The total screen time was categorised as < 2 h, 2–4 h, 4–6 h, 6–8 h, 8–10 h, and ≥ 10 h. The average weekday and weekend screen times for each type of activity, divided by seven, were also used in the analysis. The method used to measure screen time followed standard methods employed in several peer-reviewed studies. Demographic data such as age, educational background, number of siblings, and socioeconomic background were also collected.

The adolescent version of the Strengths and Difficulties Questionnaire (SDQ) was designed to assess a range of behavioural and emotional problems, including emotional, conduct, and peer relationship problems; hyperactivity; and prosocial behaviour. However, this study only examined the emotional, conduct, and prosocial behaviour problem domains because schools were closed, and public facilities were partially restricted from use during the study period. Specifically, hyperactivity and peer relationship problems were excluded because all adolescents stayed at home, studied from home, and were supervised by their parents or caregivers during the peak period of the pandemic; thus, it cannot apply to the others period of the pandemic. The Indonesian version of the SDQ was translated by Wiguna and Hestyanti and is available at www.sdqinfo.org. The SDQ consists of 25 items rated on a 2-point Likert scale (0 = not true, 1 = somewhat true, 2 = certainly true), with four domains of difficulty: emotional problems, conduct problems, hyperactivity, peer relationship problems, and prosocial behaviour problems. Higher scores in the difficulty domains indicate a higher risk, based on which respondents can be categorised into normal and at-risk groups [1]: emotional problems (total score = 0–10, total score < 6 = normal group and ≥ 6 = at-risk group) and [2] conduct problems (total score = 10, total score < 4 = normal group and ≥ 4 = at-risk group). The total score for the strength domain (prosocial behaviour) ranged from 0 to 10, with higher scores indicating a lower

risk of prosocial behaviour problems. A total score of prosocial behaviour >5 was categorised as normal and a score ≤ 5 was categorised as at-risk (Youth in mind, 2016).

2.2. Data analysis

Data analyses were performed using SPSS version 25 for Windows. The data comprised numerical and categorical variables. The data were not normally distributed; therefore, the Kruskal-Wallis test was used to compare the amount of screen time per day and SDQ

Table 1

Characteristics of research participants (n = 1,933).

Characteristics	Pre-period of COVID-19 Pandemic (n = 337)	Peak Period of COVID-19 Pandemic (n = 423)	Post-peak Period of COVID-19 Pandemic (n = 1,096)
Age (year)			
Mean (SD)	15.66 (1.167)	14.91 (1.432)	13.89 (0.872)
13–15 (n,%)	121 (35.9)	268 (63.4)	1041 (95)
16–17 (n,%)	216 (64.1)	155 (36.6)	55 [5]
Gender (n,%)			
Male	94 (27.9)	137 (32.4)	448 (40.9)
Female	243 (72.1)	286 (67.6)	648 (59.1)
Education (n,%)			
Junior High School	63 (18.7)	242 (57.2)	999 (91.1)
Senior High School	274 (81.3)	181 (42.8)	97 (8.9)
Family Income (n,%)			
Low Income	22 (6.5)	71 (16.8)	149 (13.6)
Middle Income	34 (10.1)	170 (40.2)	412 (37.6)
High Income	281 (83.4)	182 (43.0)	535 (48.8)
Television Screen Time/Day (n,%)			
<2 h	207 (61.42)	329 (77.78)	946 (86.31)
2–<4 h	92 (27.3)	72 (17.02)	130 (11.86)
4–<6 h	29 (8.61)	14 (3.31)	12 (1.09)
6–<8 h	3 (0.89)	6 (1.42)	3 (0.27)
8–< 10 h	3 (0.89)	1 (0.24)	3 (0.27)
≥10 h	3 (0.89)	1 (0.24)	2 (0.18)
Personal Computer Screen Time/Day (n,%)			
<2 h	164 (48.66)	189 (44.68)	680 (62.04)
2–<4 h	112 (33.23)	96 (22.7)	264 (24.09)
4–<6 h	36 (10.68)	51 (12.06)	86 (7.85)
6–<8 h	13 (3.86)	46 (10.87)	30 (2.74)
8–< 10 h	5 (1.48)	19 (4.49)	15 (1.37)
≥10 h	7 (2.08)	22 (5.2)	21 (1.92)
Smartphone Screen Time/Day (n,%)			
<2 h	15 (4.45)	83 (19.62)	265 (24.18)
2–<4 h	67 (19.88)	58 (13.71)	279 (25.46)
4–<6 h	81 (24.04)	73 (17.26)	218 (19.89)
6–<8 h	58 (17.21)	65 (15.37)	129 (11.77)
8–< 10 h	27 (8.01)	43 (10.17)	82 (7.48)
≥10 h	89 (26.41)	101 (23.88)	123 (11.22)
Online/offline games Screen Time/Day (n,%)			
<2 h	296 (87.83)	304 (71.87)	672 (61.31)
2–<4 h	26 (7.72)	67 (15.84)	218 (19.89)
4–<6 h	12 (3.56)	24 (5.67)	87 (7.94)
6–<8 h	1 (0.3)	13 (3.07)	46 (4.2)
8 - < 10 h	0 (0)	8 (1.89)	25 (2.28)
≥10 h	2 (0.59)	7 (1.65)	48 (4.38)
Total Screen Time/Day (n,%)			
<2 h	4 (1.19)	40 (9.46)	83 (7.57)
2–<4 h	23 (6.82)	31 (7.33)	162 (14.78)
4–<6 h	48 (14.24)	37 (8.75)	171 (15.6)
6–<8 h	51 (15.13)	29 (6.86)	137 (12.5)
8–< 10 h	45 (13.35)	34 (8.04)	154 (14.05)
≥10 h	166 (49.26)	252 (59.57)	389 (35.49)
SDQ-Emotional Problems (n,%)			
At Risk	114 (33.8)	132 (31.2)	286 (26.1)
Normal	223 (66.2)	291 (68.8)	810 (73.9)
SDQ-Conduct Problems (n,%)			
At Risk	59 (17.5)	91 (21.5)	260 (23.7)
Normal	278 (82.5)	332 (78.5)	836 (76.3)
SDQ-Prosocial Behaviour Problems (n,%)			
At Risk	31 (9.2)	58 (13.7)	500 (45.6)
Normal	306 (90.8)	365 (86.3)	596 (54.4)

during the pre-, peak, and post-peak periods of the COVID-19 pandemic. The odds ratios (ORs) between screen time and mental health problems during the pre-, peak-, and post-pandemic periods were calculated using SPSS version 21.

3. Results

A total of 1,856 adolescents participated in the study. The mean age of the adolescents studied was 15.66 (SD: 1.17) in the pre-period of the COVID-19 pandemic, 14.91 (SD: 1.43) in the peak period, and 13.89 (SD: 0.87) in the post-peak period. Overall, a higher proportion of girls than boys participated in this study (63.4 % vs. 36.6 %). Most of the participants had completed junior high school and had a middle-high economic background. Nearly 60 % of participants in the peak period of COVID-19 had a total screen time of more than 10 h per day, which decreased during the post-peak period. During the pre-COVID-19 pandemic period, 38.58 % of participants watched television for more than 2 h, but this decreased during the peak (22.12 %) and post-peak (13.69 %) periods. In contrast, 32.62 % of the participants used personal computers for more than 4 h during the peak period, which was higher than the pre-peak (18.28 %) and post-peak (8.88 %) periods. Moreover, 34.05 % of participants in the peak period of the COVID-19 pandemic had more than 6 h of smartphone screen time, which was higher than the pre-peak (34.42 %) and post-peak (18.70 %) periods of the pandemic. More participants reported engaging in online/offline game screen time for more than 2 h in the post-peak period of the pandemic (38.69 %) than in the pre-peak (12.17 %) and peak (28.13 %) periods. In general, 67.61 % of the participants had a total screen time of more than 8 h, which was higher than that of participants in the pre-peak (62.61 %) and post-peak (49.54 %) periods of the pandemic. During the peak period of pandemic, the proportion of conduct and prosocial behaviour problems was higher compared to the pre-peak period (21.5 % vs. 17.5 % and 13.7 % vs. 9.2 %). Moreover, the study found that the post-peak period of pandemic the number of adolescents with conduct (23.7 %) and prosocial behaviour problems (45.6 %) was the highest proportion that the other two periods of pandemic (Table 1).

The mean rank of total screen time per day among participants in the peak period of the COVID-19 pandemic was higher than that in the pre- and post-peak periods. Moreover, the analysis showed that the mean rank of television and smartphone screen time was higher in the pre-period of the pandemic, but not for personal computer screen time, which was higher during the peak period compared to the other two periods. Meanwhile, online games screen time was found higher in the post-peak pandemic period respectively (Table 2, Fig. 1).

During the post-peak period of the pandemic, the mean rank of emotional and prosocial behaviour problems was significantly lower than during the other two periods. However, there were no significant differences in emotional, conduct, or prosocial behaviour problems between the pre- and peak periods of the pandemic (Table 3, Fig. 2).

Before the pandemic, <2 h per day of screen time spent on television, laptop, and smartphone yielded lower odds of emotional problems, despite lack of significance. Similarly, spending <2 h of screen time on any device was generally protective against conduct and prosocial behaviour problems (see Tables 4A, 4B, and 4C). However, interestingly, spending less (<2 h) of screen time on video games was significantly associated with greater odds of emotional problems across all periods before, during, and after COVID-19 peak. In contrast, in terms of conduct and prosocial behaviour problems, spending <2 h per day on video games was protective across all periods. Meanwhile, spending <2 h per day on television on the post-peak period of COVID-19 yielded significantly lower odds of prosocial behaviour problems.

4. Discussion

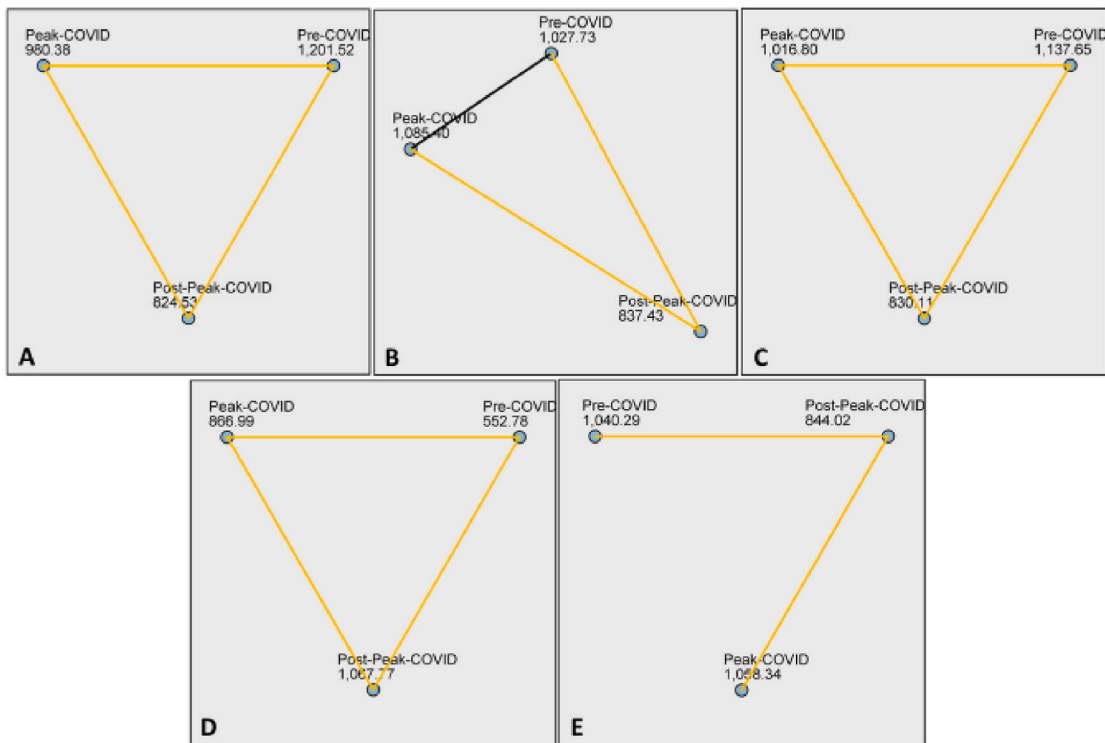
The findings revealed a higher total screen time during the peak COVID-19 period than during the pre- and post-peak periods. The results of this comparative study are interesting because they strengthen the results of prior research that showed an increase in the total average screen time per day during the pandemic, exceeding the recommendations of the American Academy of Child and Adolescent Psychiatry (AACAP) and American Academy of Paediatrics (AAP) [17]. The pre-, peak-, and post-peak COVID-19 results showed that the total average screen time per day was approximately 10 h. A study conducted in 2010 on a US sample showed that the total screen time was approximately 7.5 h per day, among which the highest exposure occurred in 11-to-14-year-old adolescents (9 h) [15]. Schmidt et al. [51] revealed that the total average screen time for recreational use among adolescents in Germany increased significantly during the peak of the COVID-19 pandemic. Similar results were reported in China and Spain. A study from China

Table 2
Screen time characteristics.

Activity	The Pre-period of COVID-19 Pandemic (Minutes, n = 337)		The Peak Period of COVID-19 Pandemic (Minutes, n = 423)		The Post-peak Period of COVID-19 Pandemic (Minutes, n = 1,096)		Sig. (p)
	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median	
TV	97.54 (104.94)	60.00	62 (81.04)	30.00	42.29 (63.88)	20.00	0.000 ^a
PC	135.37 (142.99)	120.00	181.81 (192.94)	120.00	109.07 (168.00)	60.00	0.000 ^a
SP	421.13 (286.83)	360.00	374.31 (295.29)	330.00	286.32 (275.23)	240.00	0.000 ^a
OG	28.83 (77.78)	0.00	85.06 (153.06)	20.00	135.50 (210.81)	60.00	0.000 ^a
Total	682.88 (423.99)	580.00	703.19 (456.25)	660.00	568.13 (509.11)	460.00	0.000 ^a

Note: TV=Television, PC=Personal Computer, SP=Smartphone, OG=Offline/Online games.

^a Kruskal-Wallis Test.



Note: (A=Television Screen Time, B=Personal Computer Screen Time, C=Smartphone Screen Time, D=Online/Offline Games Screen Time, E=Total Screen Time)

Fig. 1. (A–E), pairwise comparison analysis of screen time during the pre-, peak-, and post-peak periods of the COVID-19 pandemic.

Table 3
SDQ characteristics.

SDQ Domain	The Pre-period of COVID-19 Pandemic		The Peak Period of COVID-19 Pandemic		The Post-Peak Period of COVID-19 Pandemic		Sig. (p)
	(Score, n = 337)		(Score, n = 423)		(Score, n = 1096)		
	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	
Emotional Problems	4.45 (2.40)	4 (0–10)	4.12 (2.84)	4 (0–10)	3.72 (2.85)	3 (0–10)	0.000^a
Conduct Problems	2.24 (1.34)	2 (0–8)	2.51 (1.60)	2 (0–8)	2.56 (1.55)	2 (0–10)	0.026^a
Prosocial Behaviour Problems	7.91 (1.72)	8 (0–10)	7.61 (1.85)	8 [1–10]	5.86 (2.10)	6 (0–10)	0.000^a

^a Kruskal Wallis Test.

reported that during the peak of COVID-19, the daily total average screen time rose from 87.1 to 334.3 min among those aged 6–17 years [52]. Similarly, a Spanish study found that adolescents engaged in more screen time (an increase of 198 min per day) during the peak period of the pandemic than before the pandemic [53]. Although the average increase in total screen time during the pandemic in Indonesia was less than that in China and Spain, it has important clinical implications, as more extensive screen time may influence adolescents’ mental well-being [52,53]. Several studies explain that screen-based technologies, such as personal computers, smartphones, and television, are brain-stimulating, especially for adolescents, who are highly novelty-seeking due to their identity development. When used extensively, such technologies may displace important protective behaviours such as family connectedness, role models, and empathetic validation from family, peers, and the environment [54,55]. Thus, screen time may have been harmful to psychological well-being, especially during the peak period of COVID-19, which may have created additional stressors, such as compulsively seeking online social connectedness from peers due to feelings of loneliness, worry stemming from anxiety due to the spread of COVID-19, or screen time fatigue [51,56,57].

Interestingly, this study demonstrated that while the average smartphone screen time was higher during the pre-COVID-19 period, significant differences were observed during the peak and post-peak periods. It may be assumed that, starting in March 2020, all adolescents studied from home most of the time owing to the Indonesian government’s stay-at-home policy, schools’ initiation of

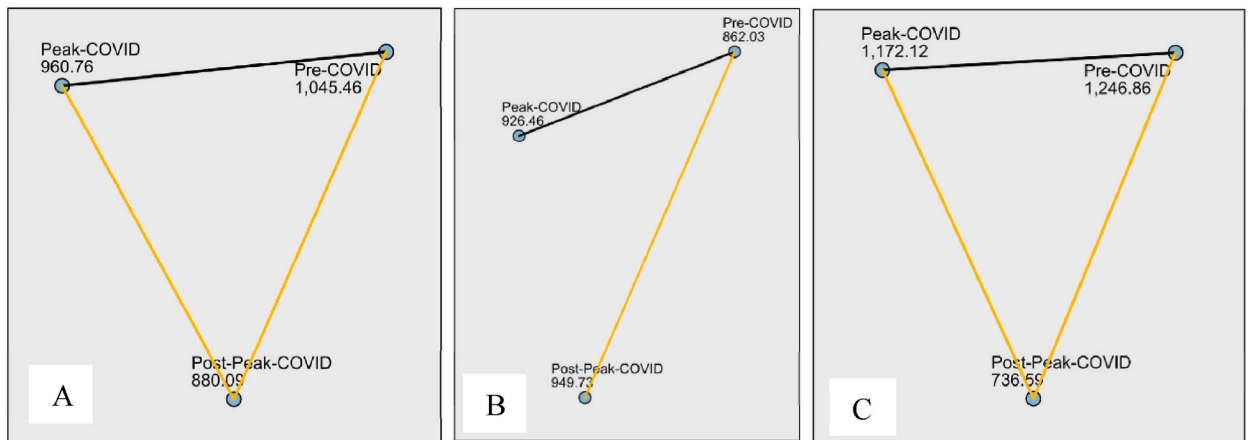


Fig. 2. (A–C), The pairwise comparison of SDQ during pre-, peak and post-peak period of COVID-19 pandemic (A. Emotional Problems; B. Conduct Problems; C. Prosocial Behavior).

distance/online learning programs, and physical distancing restrictions [13]. Therefore, it was supposed that students had more access to personal computers not only for online learning but also for other purposes at home, such as social media, playing games, watching movies, and chatting, especially during the peak period of COVID-19. Smartphones may be left behind because all applications can be accessed through a personal computer. It can be seen that personal computer screen time was higher during the peak period of the pandemic. During the post-peak period, screen time on personal computers seemed to decrease because they were returning to school, and adolescents mostly enjoyed spending their time re-socialising with their peers at school after approximately two years of studying from home. Thus, the screen time on personal computers or smartphones during this period was the lowest compared to the others. This may reflect the fact that adolescents returned to their daily routine and had better activity choices with less screen time.

Moreover, the lower amount of smartphone screen time per day among adolescents during the peak and post-peak periods of the COVID-19 outbreak can be explained by the fact that most participants in these two pandemic periods were junior high school students (>50 %) and may still have been under parental guidance and supervision. Several studies have also suggested that late adolescents begin to gain higher levels of independence from their parents and caregivers; therefore, it is assumed that they use smartphones more frequently as they age [58–60]. However, in this study, smartphone screen time per day was still the highest compared to television, personal computer, or video game screen time. This may reflect the fact that smartphones are the preferred gadgets among adolescents. Pratama and Scarlatos [61] found that Indonesian students favoured smartphones the most among various electronic devices, regardless of their socioeconomic background. Additionally, previous studies have shown that excessive daily smartphone screen time can cause mental health problems [25,62]. The current study's analysis indicated that a smartphone screen time of less than 2 h per day significantly lowered the risk of emotional problems during all periods of the COVID-19 pandemic, except for the peak period. This could be due to the positive effects of smartphones compared to other gadgets, which are said to be a newer class of cell phones that can provide information when someone needs it by merely touching a button [63]. Therefore, in the context of the pre- and post-peak periods of the COVID-19 pandemic, adolescents may use smartphones because of their entertainment utility, which is thought to reduce stress in schools and other environments. However, during the peak period of the pandemic, smartphones may pose a risk because of the large amount of information related to the pandemic [13,64]. Two studies have found that adolescents with higher levels of smartphone screen time during the peak period of the pandemic had lower psychological well-being, including poorer emotional regulation and impulse control [25,65]. Increased smartphone screen time has also been correlated with impaired sleep in adolescents [66]. The relationship between sleep disturbance and psychological problems can be bidirectional, as it can act either as a risk factor or symptom of a problem [67,68]. On the other hand, using smartphones in certain time period (<2 h per day) may have become another coping strategy during the pre- and peak periods of the pandemic among adolescents seeking to overcome the feeling of boredom and stress at school or at home, or even to feel accepted by their peers, who can create social relationships with them through collaboration and competition in games, which reinforces wider and stronger social relationships that may strengthen prosocial behaviour [25,69].

In our study, the odds of conduct and prosocial behaviour problems may generally decrease in trend when the participants spent less than 2 h on any device. Similarly, lower odds of emotional problems were found when spending <2 h on television, laptop, and smartphone. This is straightforward and supported by previous studies that demonstrated the adverse psychosocial effects of spending too much time on digital media. These findings indicate that proper utilisation can result in positive outcomes (e.g. alleviating anxiety, depression, and loneliness) during the pandemic [6,70,71]. In general, watching television is a recreational activity that may replace physical activities usually conducted by adolescents [51]. While excessive use may result in psychological drawbacks, such as the exacerbation of anxiety and depression [19,72], this was not supported by the results from our study, and the potential difference in mechanism around COVID-19 warrants further exploration.

Our results also showed that video gaming for less than 2 h was interestingly associated with higher odds of emotional problems across all periods studied, but the reverse was true for conduct and prosocial behaviour problems. This is understandable since

Table 4A

The association between screen time and emotional problems during the pre-, peak-, and post-peak periods of the COVID-19 pandemic.

Characteristics	Pre-period of COVID-19 Pandemic				Peak Period of COVID-19 Pandemic				Post-peak Period of COVID-19 Pandemic				
	Emotional Problems												
Screen time	At Risk (n, %)	Normal (n, %)	Odds Ratio [#] (CI 95 %)	Sig. (p)	At Risk (n, %)	Normal (n, %)	Odds Ratio (CI 95 %)	Sig. (p)	At Risk (n, %)	Normal (n, %)	Odds Ratio (CI 95 %)	Sig. (p)	
TV	<2 h	70 (32.3)	147 (67.7)	0.931 (0.587–1.477)	0.996	109 (33.1)	220 (66.9)	1.529 (0.906–2.581)	0.110	251 (26.5)	695 (73.4)	1.187 (0.792–1.779)	0.407
	≥2 h	44 (33.8)	86 (66.2)			23 (24.5)	71 (75.5)			35 (23.3)	115 (76.7)		
Laptop	<2 h	49 (29.9)	115 (70.1)	0.708 (0.449–1.115)	0.136	58 (30.7)	131 (69.3)	0.957 (0.633–1.448)	0.836	179 (26.3)	501 (73.7)	1.032 (0.781–1.363)	0.826
	≥2 h	65 (37.6)	108 (62.4)			74 (31.6)	160 (68.4)			107 (25.7)	309 (74.3)		
Smartphone	<2 h	1 (6.7)	14 (93.3)	0.132 (0.017–1.018)	0.052	31 (37.3)	52 (62.7)	1.411 (0.854–2.330)	0.178	55 (20.8)	210 (79.2)	0.680 (0.487–0.950)	0.023*
	≥2 h	113 (35.1)	209 (64.9)			101 (29.7)	239 (70.3)			231 (27.8)	600 (72.2)		
Online/Offline Video Games	<2 h	106 (35.8)	190 (64.2)	2.301 (1.026–5.163)	0.039*	108 (35.5)	196 (64.5)	2.181 (1.316–3.616)	0.002*	199 (29.6)	473 (70.4)	1.630 (1.222–2.174)	0.001*
	≥2 h	8 (19.5)	33 (80.5)			24 (20.2)	95 (79.8)			87 (20.5)	337 (79.5)		

Note: *Chi Square $p < 0.05$; [#]<2h was used as a reference.

Table 4B

The association between screen time and conduct problems during the pre-, peak-, and post-peak periods of the COVID-19 pandemic.

Characteristics		Pre-period of COVID-19 Pandemic				Peak Period of COVID-19 Pandemic				Post-peak Period of COVID-19 Pandemic			
		Conduct Problems											
Screen time		At Risk (n, %)	Normal (n, %)	Odds Ratio [#] (CI 95 %)	Sig. (p)	At Risk (n, %)	Normal (n, %)	Odds Ratio (CI 95 %)	Sig. (p)	At Risk (n, %)	Normal (n, %)	Odds Ratio (CI 95 %)	Sig. (p)
TV	<2 h	32 (15.5)	175 (84.5)	0.698 (0.396–1.230)	0.212	72 (21.9)	257 (78.1)	1.106 (0.627–1.950)	0.728	226 (23.9)	720 (76.1)	1.071 (0.710–1.614)	0.743
	≥2 h	27 (20.8)	103 (79.2)			19 (20.2)	75 (79.8)			34 (22.7)	116 (77.3)		
Laptop	<2 h	24 (14.6)	140 (85.4)	0.676 (0.382–1.195)	0.177	42 (22.2)	147 (77.8)	1.079 (0.677–1.718)	0.750	153 (22.5)	527 (77.5)	0.838 (0.631–1.114)	0.224
	≥2 h	35 (20.2)	138 (79.8)			49 (20.9)	185 (79.1)			107 (25.7)	309 (74.3)		
Smartphone	<2 h	3 (20.0)	12 (80.0)	1.188 (0.324–4.347)	0.795	19 (22.9)	64 (77.1)	1.105 (0.622–1.963)	0.733	58 (21.9)	207 (78.1)	0.873 (0.626–1.216)	0.420
	≥2 h	56 (17.4)	266 (82.6)			72 (21.2)	268 (78.8)			202 (24.3)	629 (75.7)		
Online/offline Video Games	<2 h	47 (15.9)	249 (84.1)	0.456 (0.217–0.958)	0.034*	64 (21.1)	240 (78.9)	0.909 (0.546–1.513)	0.713	131 (19.5)	541 (80.5)	0.554 (0.418–0.734)	0.000*
	≥2 h	12 (29.3)	29 (70.7)			27 (22.7)	92 (77.3)			129 (30.4)	295 (69.6)		

Note: Chi Square $p < 0.05$; [#]<2h was used as a reference.

Table 4C

The association between screen time and prosocial behaviour problems during the pre-, peak-, and post-peak periods of the COVID-19 pandemic.

Characteristics	Pre-period of COVID-19 Pandemic				Peak Period of COVID-19 Pandemic				Post-peak Period of COVID-19 Pandemic				
	Prosocial Behaviour Problems												
Screen time	At Risk (n, %)	Normal (n, %)	Odds Ratio [#] (CI 95 %)	Sig. (p)	At Risk (n, %)	Normal (n, %)	Odds Ratio (CI 95 %)	Sig. (p)	At Risk (n, %)	Normal (n, %)	Odds Ratio (CI 95 %)	Sig. (p)	
TV	<2 h	16 (7.7)	191 (92.3)	0.642 (0.306–1.348)	0.239	48 (14.6)	281 (85.4)	1.435 (0.696–2.958)	0.326	420 (44.4)	526 (55.6)	0.699 (0.495–0.987)	0.041*
	≥2 h	15 (11.5)	115 (88.5)			10 (10.6)	84 (89.4)			80 (53.3)	70 (46.7)		
Laptop	<2 h	12 (7.3)	152 (92.7)	0.640 (0.300–1.364)	0.245	24 (12.7)	165 (87.3)	0.856 (0.488–1.501)	0.586	304 (44.7)	376 (55.3)	0.908 (0.710–1.159)	0.437
	≥2 h	19 (11.0)	154 (89.0)			34 (14.5)	200 (85.5)			196 (47.1)	220 (52.9)		
Smartphone	<2 h	1 (6.7)	14 (93.3)	0.695 (0.088–5.473)	0.728	10 (12.0)	73 (88.0)	0.833 (0.402–1.726)	0.623	134 (50.6)	131 (49.4)	1.300 (0.985–1.714)	0.063
	≥2 h	30 (9.3)	292 (90.7)			48 (14.1)	292 (85.9)			366 (44.0)	465 (56.0)		
Online/Offline Video Games	<2 h	25 (8.4)	271 (91.6)	0.538 (0.207–1.403)	0.199	35 (11.5)	269 (88.5)	0.543 (0.306–0.966)	0.036*	283 (42.1)	389 (57.9)	0.694 (0.544–0.886)	0.003*
	≥2 h	6 (14.6)	35 (85.4)			23 (19.3)	96 (80.7)			217 (51.2)	207 (48.8)		

Note: Chi Square $p < 0.05$; [#]<2h was used as a reference.

adolescents are naturally prone to emotional problems due to the lack of capacity to resolve problems in a mature manner [36,73], and inside video games problems are typically more complex than those real-life. In contrast, conduct and prosocial problems are more related with empathy and willingness to help; these problems might be usually found in adolescents who face difficulties joining their peer groups [74,75]. Thus, associating with peers in other platforms and consequently less alone time in games might actually reduce the odds of conduct and prosocial problems. These results can also be interpreted in reverse - spending more time (>2 h per day) in video gaming increased the odds of conduct and prosocial problems, especially in the peak and post-peak periods of the pandemic. Indeed, the post-peak COVID-19 pandemic condition had additional impacts on adolescents: 1) they returned to resocialisation after a few years of social distancing and learning from home, and 2) they needed to re-adapt to alterations in routine learning, which may have led to frustration and anxiety [3,4,13]. Uncertainty about academic events due to online schooling might also increase psychosocial problems during peak period of the COVID-19 pandemic [4,76]. Adolescents might be more inclined to search for the latest information concerning COVID-19, inducing robust information influx that could worsen their psychosocial states [77,78]. This unfavourable situation could drive adolescents to use maladaptive coping mechanisms that result in increased screen time including in video games [72,79]. Thus, maladaptive behavioural and prosocial problems might arise as a result, and the effect of screen time spent via games was more pronounced in peak and post-peak periods. However future studies need to be done to elaborate more on this manner.

This study had several limitations. First, we were unable to reach those without an internet connection because the study was conducted using an online survey. This study was not a longitudinal study because the three groups of participants were different and were taken from three different time periods. Therefore, the results should be cautiously interpreted because participants may not be representative of the total population. Nevertheless, the results can still provide a sketch of adolescent mental well-being related to screen time in Indonesia and can serve as a reference for future research. Second, the study did not report the respondents screen time usage in depth. However, an example of each screen usage such as TV, smartphones, online/offline games, and laptop was stated in the questionnaire. Nonetheless, this is the first study to compare the relationship between screen time and associated mental health problems in adolescents during the pre-, peak, and post-peak periods of COVID-19. The data from this study can provide substantial information for the development of health policies regarding screen time regulation to prevent further mental health problems beyond the pandemic. Our study has several strengths, including the nature of the analysis, which may provide insights into the three different periods of time that included the pre-, peak, and post-peak period of the pandemic; hence it would be useful for understanding the trajectory of the pre – and the pandemic period that related to screen time, behaviour, and emotional problems among adolescents. Moreover, as a highly critical topic in this VUCA (Volatile, Uncertain, Complex and Ambiguous) environment nowadays, considering the increasing use of digital media in adolescents, our study revealed important information about its impact of screen time on behaviour and emotional problems that may be referred for future studies.

5. Conclusions

This study found significant differences in adolescents' total average screen time per day during the pre-, peak, and post-peak periods of the COVID-19 pandemic. In general, spending less (<2 h) of screen time on led to a trend of reduced odds of emotional, conduct, and prosocial behaviour problems. Specifically, less (<2 h) time spent on video games led to significant decrease in the odds of conduct and prosocial behaviour problems. Therefore, regular psychoeducation on screen time for families in general, and adolescents in particular, is necessary, especially regarding its impact on adolescents' mental well-being. Moreover, screen time is a sedentary behaviour that can negatively affect cardiometabolic health [79]; therefore, adolescents need to gain a more thorough understanding of its effects on their physical and mental well-being. Indeed, greater parental support was an important factor for intervention, especially during the peak period of COVID-19, regardless of the setting (home, primary care, school, or community). During the peak period, all screen-based activities could be reduced to mitigate risks (e.g., not using gadgets in the bedroom or at mealtimes, and having more family interaction by playing board games). Parents should be encouraged to plan and enforce proper screen time oversight and remodel healthy non-screen-based behaviours via novel approaches that encourage face-to-face and outdoor activities in healthy environments, while maintaining social distancing rules, wearing face masks, and staying away from crowds.

Ethics statement

This study was approved by the Ethics Committee of the Faculty of Medicine, Universitas Indonesia in September 2022 (Ethical Approval number: KET-958/UN2.F1/ETIK/PPM.00.02/2022).

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Data availability

No. Data will be made available on request.

CRediT authorship contribution statement

Tjhin Wiguna: Writing - review & editing, Writing - original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Kusuma Minayati:** Writing - review & editing, Writing - original draft, Visualization, Validation, Supervision, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization. **Fransiska Kaligis:** Writing - review & editing, Methodology, Conceptualization. **Sylvia Dominic Teh:** Writing - original draft, Visualization, Investigation, Formal analysis, Data curation. **Andre Sourander:** Writing - review & editing, Resources, Methodology. **Valerie Josephine Dirjayanto:** Writing - review & editing, Formal analysis. **Maria Krishnandita:** Investigation, Data curation. **Nabella Meriem:** Investigation, Data curation. **Sonja Gilbert:** Resources, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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