Original Article

Developing a Mid-to-Long Term Screen Time Prediction Model Using Metrics from the "Media Control Challenge": An Exploratory Study in School Education

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Background: The Media Control Challenge (MCC) is a ten-day initiative designed to educate and motivate elementary and junior high school students to manage their screen time. However, due to a lack of research on the metrics for interpreting MCC results, it is unclear what points schools should emphasize when providing feedback to students and their parents.

Objective: This study aims to develop a model to predict mid-to-long term screen time using performance metrics from the MCC and to explore how MCC can be effectively utilized in school settings.

Method: A questionnaire survey on current screen time was conducted among families with elementary and junior high school students in a specific region in northern Nagano Prefecture, seven months after the MCC. The survey statistically analyzed the relationship between the average Challenge Level (CL), Achievement Rate (AR), and their product (CL×AR) during the MCC period and the screen time seven months after the MCC.

Results: Among the 92 participants, 40 had screen times exceeding two hours seven months post-MCC. Among the performance metrics, only CL×AR showed a significant negative correlation with screen time after seven months (Spearman's rho = -0.289, $P = 0.005$, 95% Confidence Interval: -0.471 to -0.083). Even after adjusting for covariates using logistic regression analysis, CL×AR was significantly associated with screen time after seven months (Odds ratio = 0.415, $P = 0.003$, 95% Confidence Interval: 0.232 to 0.744). The area under the Receiver Operating Characteristic (ROC) curve (AUC) for the predicted probability including CL×AR and covariates was 0.730. The AUC for CL×AR alone was 0.650. The cutoff value that maximizes the Youden index was estimated to be 1.98. At this cutoff, the sensitivity was 46.2% and specificity was 77.5%.

Conclusion: CL×AR remained significantly associated with mid-to-long term screen time even after adjusting for covariates, indicating its potential usefulness as a predictive model. Additionally, based on the ROC curve for CL×AR alone, cutoff values of 1.98 were considered important as a guideline for maintaining appropriate screen time for students. Future studies should develop Japan-specific intervention strategies based on these results and evaluate their effectiveness through practical research.

Keywords: screen time, media control challenge, school education, media usage

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I. Introduction

The Media Control Challenge (MCC) is an initiative conducted in selected elementary and junior high schools across Japan with the objective of motivating students to self-regulate their media usage time, also known as screen time. This initiative utilizes a specially designed MCC card (**Figure 1**) to help students consciously manage their screen time over a ten-day period. Throughout the MCC, students establish daily individual goals, submit their challenge tiers and achievements to their school, and obtain feedback from their homeroom teachers. Recent practice reports in Japan suggest that the MCC may be effective in motivating children to control their media use[1]. However, because the MCC is conducted at the school or regional level, there is no uniformity in its goal setting, duration, or frequency of implementation. Furthermore, educators have expressed uncertainty about how to provide feedback on the results of the MCC cards.

The necessity to reduce children's excessive media use (such as television, video games, smartphones, and tablet devices) is based on previous research findings that highlight the risks associated with excessive screen time, including obesity[2], sleep disorders[3], emotional and behavioral problems[4], visual impairments[5], and academic underperformance[6]. Considering these risks, the Japan Pediatric Society recommends limiting screen time for children over two years old to no more than two hours per day[7].

Internationally, a combination of educating teachers and children about the health impacts of screen time, frequent distribution of newsletters to parents, and implementing a screen media time reduction challenge for about 10 days has been suggested as effective in reducing screen time[8][9].

As Information and Communication Technology (ICT) becomes increasingly prevalent in Japanese schools, children are likely to encounter more opportunities for screen media engagement. This underscores the importance of uniformly implementing evidence based MCCs in elementary and junior high schools and providing structured feedback to students and parents based on the MCC outcomes. Despite its importance, there is a notable lack of research on establishing appropriate performance metrics for the MCC's implementation. This research gap presents challenges for schools in interpreting MCC results and providing effective feedback.

To address these gaps, this study aims to develop a model to predict excessive screen time seven months after MCC using performance metrics achieved during MCC and to explore the application of MCC in school settings. Based on these findings and insights from previous research, this study further aims to develop Japan-specific strategies for managing children's screen time.

II. Methods

1. Ethical Statement

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Shinshu University Clinical Research Review Board (Approval Number 5926). The study conducted in June 2023 was carried out by *Yogo* teachers (licensed educators supporting children's growth and development through health education and health services) with permission from the principals of the participating schools. Surveys were administered to the students' primary caregivers. Shinshu University collected anonymized data, ensuring the privacy and confidentiality of participants' personal information. Furthermore, anonymized data from the MCC conducted in November 2022 (seven months prior to the survey) were collected from the MCC cards retained by the participating schools. All measures were taken in accordance with ethical guidelines to protect participants' privacy and confidentiality.

2. Study Design and Participants

Figure 2 shows the study flow chart. The screen time survey was conducted from June 17 to June 26, 2023, targeting 438 households in northern part of Nagano Prefecture, focusing on parents and their children in elementary and junior high schools. The targeted schools included three elementary schools and one junior high school, all public schools in the same area. Students from these elementary schools typically progress to the same junior high school unless they transfer to a different school. This means that siblings from the same household are often enrolled in these schools.

The MCC is conducted simultaneously in November each year in both the targeted elementary and junior high schools. This simultaneous implementation aims to efficiently motivate entire families, including siblings, to manage their media use. Data collection for the survey was conducted by local psychiatrists during lectures on screen time aimed at this region. After the lectures, the study received approval from the ethics committee, and

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Media Control Challenge Card

Name

Duration: From November 7th to November 16th, a period of 10 days.

Media refers to all forms of television, games, computers, smartphones, including social networking services (SNS) and video viewing. It does not include the use of tablets for learning or homework.

Level	Challenge
Level 1	Do not use media during meals.
Level 2	Limit total media time to a maximum of 2 hours per day.
Level 3	Limit total media time to a maximum of 1 hour per day.
Level 4	Do not use media for the whole day.

	Level	Achievement ○/×	Alternative activity	Study hour	Time in bed
Day1	( )				:
Day2	( )				:
Day3	( )				:
Day4	( )				:
Day5	( )				:
Day6	( )				:
Day7	( )				:
Day8	( )				:
Day9	( )				:
Day10	( )				:

＊Write down your thoughts on the challenge and submit them to your homeroom teacher by November 18th.

＊Your thoughts	＊Parent's Thoughts

Figure 1 The MCC card used in the northern region of Nagano prefecture.

researchers matched the results of the MCC cards from seven months prior with the survey results for analysis. Researchers obtained anonymized MCC card data from the schools for the MCC conducted from November 7 to November 16, 2022, and matched these data with the survey responses collected in June 2023.

The reason for conducting the survey seven months after the MCC is based on Wu et al.'s review[9] of the effectiveness of screen time reduction strategies. In their review, they used a seven-month period as the cutoff for distinguishing between short-term and long-term effects of interventions. By adopting this period, we aimed to position our study's observation period as a mid-to-long term assessment.

To be eligible for the June 2023 survey, participants had to be parents. Only one member from each household was surveyed. If participants had multiple children, they were instructed to respond regarding their oldest child who was within the 9th grade or below. *Yogo* teachers contacted the primary caregivers and asked them to respond to the survey using Google Forms. A total of 225 households participated in the survey.

Data from 92 participants could be matched with the MCC results from seven months prior. Several factors contributed to the low matching rate: the absence of MCC data for first-grade students, the use of student numbers for anonymization making it difficult to match MCC cards for first-year junior high school students (seventh grade) with their records from the previous sixth grade, and the low recovery rate of MCC cards, with only 152 out of 438 being collected. (Figure 2) Figure2 Study flow chart.

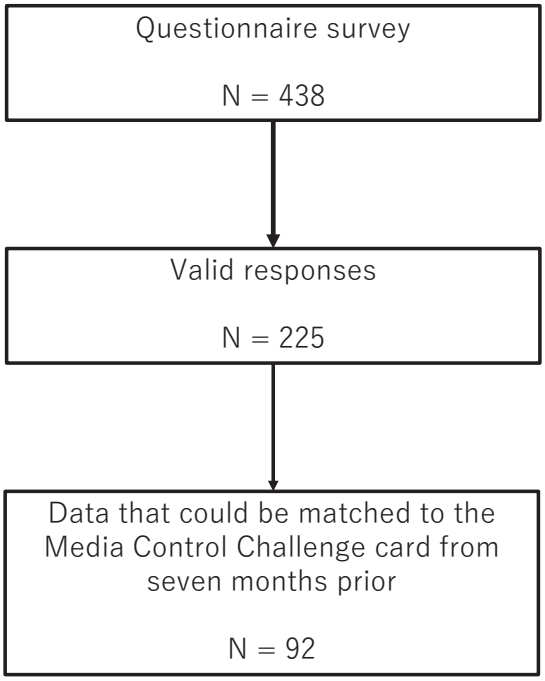

Figure 2 Study flow chart.

3. Procedures and Measures

We collected background information from the survey results (N=92), including students' grade, sex, number of siblings, age, and responses to the Strengths and Difficulties Questionnaire (SDQ)[12]. The SDQ dimensions were defined as follows: low-need (0–13), some-need (14–16), and high-need (17–40). Information on the Challenge Level (CL) and Achievement Rate (AR) of the MCC was gathered from MCC card results. The levels for the MCC were determined as follows: Level 1: Do not use media during meals. Level 2: Limit total media time to a maximum of two hours per day. Level 3: Limit total media time to a maximum of one hour per day. Level 4: Do not use media for the whole day.

MCC metrics were utilized to analyze CL, AR, and the combined variable CL×AR for the following reasons. *Yogo* teachers implementing the MCC in their schools raised questions regarding the optimal balance between setting achievable CL and increasing AR. They wondered whether it is more important to set realistic CL to boost AR, or to set higher CL to challenge students more, or if balancing both is crucial. To address these questions, we examined CL and AR individually and compared a combined variable, CL×AR, to account for both factors simultaneously. Therefore, CL×AR was established as an indicator and examined in an exploratory manner. CL×AR was treated as a continuous parametric variable because it followed a normal distribution (Shapiro-Wilk test: P =0.065).

To assess screen time, participants were asked to report the average daily usage time of their child, excluding study hours, including weekends, over the past week. Screen time was recorded in 30-minute increments, ranging from 0 to 300 minutes.

4. Statistical Analysis

Considering the exploratory nature of this study, no prior sample size calculation was performed. Before conducting descriptive statistics, normality was assessed using the Shapiro-Wilk test and visual inspection with Q-Q plots. Continuous variables following a normal distribution were summarized using means and standard deviations (SD), while ordinal variables and continuous variables not following a normal distribution were

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summarized using medians and interquartile ranges (IQR). Categorical variables were described using frequencies and percentages (%). First, the relationship between MCC performance metrics (CL, AR, and CL×AR) and screen time seven months later was evaluated.

Since screen time was found to be non-normally distributed, correlations were assessed using Spearman's test. To address the issue of multiple comparisons in the correlation analysis, Bonferroni correction was applied.

Second, a logistic regression analysis was conducted to identify the group with screen time exceeding two hours based on the recommendations of the Japan Pediatric Society[7]. This analysis adjusted for covariates was performed on CL×AR, which showed a significant correlation with screen time after seven months in the correlation analysis. The covariates, which have been shown to be associated with screen time in previous research, included sex and SDQ score.

Third, an area under the receiver operating characteristic (ROC) curve (AUC) was created using the predicted probabilities from the logistic regression analysis and using CL×AR alone. For each, a non-parametric test was used to determine whether the AUC was greater than 0.5.

All tests were considered significant at a two-sided *P*-value of <0.05. Statistical analyses were performed using SPSS Statistics Version 29 (IBM Corp.).

III. Results

Table 1 presents the descriptive statistics. Only the Age of the Primary Caregiver and CL×AR were normally distributed. The median grade level of the participants was eighth grade (second year of junior high school). The median SDQ score was 8 points, with over 80% categorized as low need. The median CL of the MCC was 2.00, and the AR was 85.0%. The median daily screen time seven months after the MCC was 120.0 minutes. Forty participants (43.5%) had screen time exceeding 120 minutes, while fifty-two participants (56.5%) had screen time of 120 minutes or less.

Tables 2 presents the correlations between MCC performance metrics and screen time seven months later. Statistically significant negative correlations were found between screen time and CL (Spearman's Rho = -0.222,

Table 1 Demographic and clinical characteristics

Category	Variable	Value:Median(Q1–Q3) or Mean(SD) or N(%)
Demographics	School Year	8.0 (5.0 - 9.0)
	Sex (Male)	45 (48.9%)
	Number of Siblings	2.0 (2.0 - 3.0)
	Age of Primary Caregiver (years)	44.5 (6.2)
Strengths and Difficulties Questionnaire (SDQ)	SDQ Total Score (points)	8.00 (6.0 - 12.0)
	Low Need (0 - 13 points)	77 (83.7%)
	Some Need (14 - 16 points)	7 (7.6%)
	High Need (17 - 40 points)	8 (8.7%)
Media Control Challenge	Challenge Level	2.0 (1.5 - 2.7)
	Achievement Rate	0.85 (0.7 - 1.0)
	Challenge Level×Achievement Rate	1.7 (0.9)
Screen Time (7 months later)	Screen Time per Day (minutes)	120.0 (90.0 - 180.0)
	> 120 minutes per day	40 (43.5%)
	≤ 120 minutes per day	52 (56.5%)

Notes: Abbreviations: SDQ = Strengths and Difficulties Questionnaire, SD = Standard Deviation, N = Number, Q1 = First Quartile, Q3 = Third Quartile

Table 2 Spearman's correlation analysis to examine the relationships between screen time and variables of Media control challenge.

Variables	Spearman's Rho	*P*	95% CI Lower	95% CI Upper
Screen Time – Challenge Level	−0.222	0.033*	−0.413	−0.012
Screen Time – Achievement Rate	−0.186	0.076	−0.382	0.026
Screen Time – Challenge Level×Achievement Rate	−0.289	0.005*	−0.471	−0.083

Notes: Abbreviations: CI = confidence interval.

Table 3 A logistic regression analysis of screen time after 7 months.

Variables	B	SE	*P*	Exp(B)	95%CI for Exp(B) Lower	95%CI for Exp(B) Upper
CL×AR	−0.878	0.297	0.003*	0.415	0.232	0.744
Sex	1.198	0.47	0.011*	3.312	1.319	8.317
SDQ score	−0.05	0.05	0.324	0.952	0.862	1.050

Notes: Abbreviations: B = Regression coefficient SE: Standard error, Exp(B): Odds ratio, CI: Confidence Interval, CL: Challenge Level, AR: Achievement Rate, SDQ: Strengths and Difficulties Questionnaire

P = 0.033, 95% Confidence interval: -0.413 to -0.012) and between screen time and CL×AR (Spearman's Rho = -0.289, *P* = 0.005, 95% Confidence interval: -0.471 to -0.083). However, after Bonferroni correction for multiple comparisons, only CL×AR remained significant of *P* = 0.017.

Table 3 shows the results of the logistic regression analysis adjusted for covariates of the CL×AR score during the MCC period. Even after adjusting for sex and SDQ score, it was found that the CL×AR score during the MCC period was significantly associated with screen time seven months later (Odds ratio = 0.415, *P* = 0.003, 95% Confidence interval = 0.232 – 0.744). Among the covariates, being male was significantly associated with screen time (Odds ratio = 3.312, *P* = 0.011, 95% Confidence interval = 1.319 – 8.317).

Figure 3 shows the ROC curve for identifying whether screen time exceeds two hours seven months after the MCC, using predicted probabilities adjusted for covariates including CL×AR. The AUC for this predictive model was 0.730 (Standard error = 0.52, *P* < 0.001, 95% Confidence interval = 0.628 – 0.832).

Figure 4 shows the ROC curve for identifying whether screen time is less than or equal to two hours seven months after the MCC, using CL×AR alone. Note that CL×AR has a negative correlation with screen time, so the outcome in Figure 4 is the inverse of the predictive probabilities shown in Figure 3. The AUC for this predictive model was 0.650 (Standard error= 0.57, *P* = 0.014, 95% Confidence interval = 0.537-0.762). The cutoff value for CL×AR that maximizes the Youden index [sensitivity – (1 - specificity)] was estimated to be 1.98. At this cutoff, the sensitivity was 46.2% and specificity was 77.5%.

IV. Discussion

To the best of our knowledge, this study is the first to evaluate the relationship between MCC metrics and mid-to-long term screen time among elementary and junior high school students in Japan. The findings of this study have the potential to contribute not only to providing effective feedback to parents and students but also to the development of the MCC approach in Japan. The main findings of this study are that it revealed that nearly half of the participants, 40 out of 92 (43.5%), had screen time exceeding two hours seven months after the MCC. Additionally, it demonstrated a significant negative correlation between CL×AR and screen time seven months after the MCC. This significance remained even after adjusting for covariates. Furthermore, the ROC curve using predicted probabilities based on CL×AR, sex, and SDQ scores showed an AUC of 0.730, indicating fair accuracy. These findings suggest that particular attention

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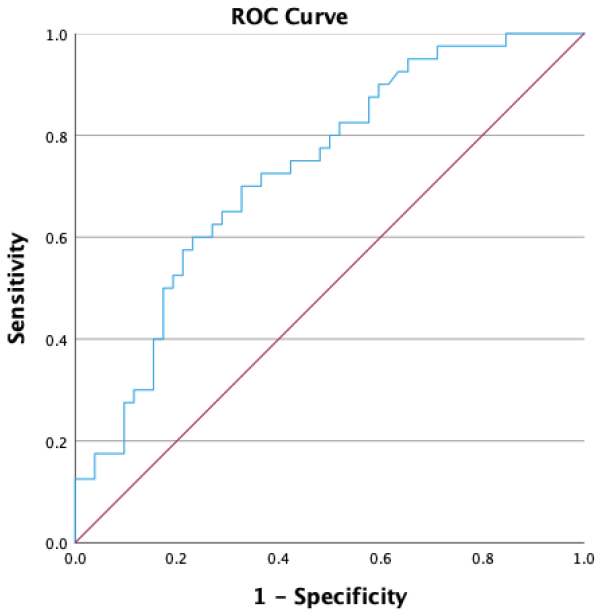

Figure 3 The ROC curve used to detect groups with screen time exceeding two hours seven months after the MCC. The explanatory variable used is the predicted probability of Challenge Level × Achievement Rate, adjusted for covariates of sex and SDQ scores.

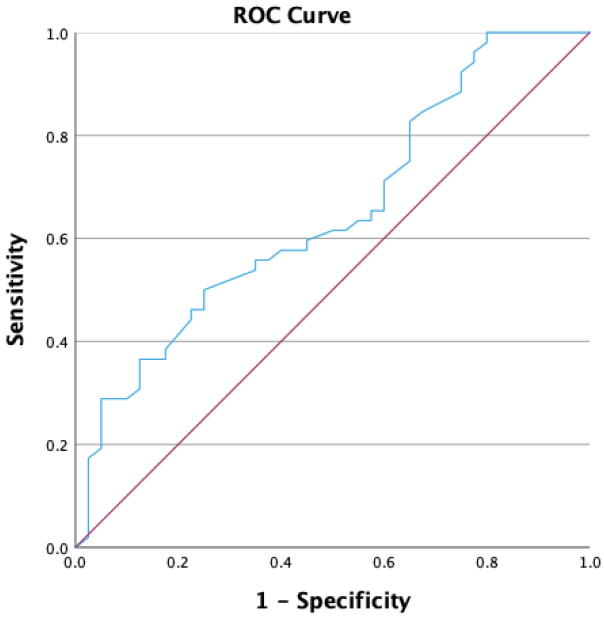

Figure 4 The ROC curve used to detect groups with screen time of two hours or less seven months after the MCC. The explanatory variable used is Challenge Level × Achievement Rate.

should be paid to participants with low CL×AR scores in the MCC.

Leveraging the finding of this study, schools can calculate students' CL×AR scores after the MCC to identify those at risk of excessive screen time seven months later. Logistic regression analysis and the ROC curve indicate that particular attention should be given to male students and those with low CL×AR scores. Setting an appropriate cutoff value for CL×AR is crucial for applying these findings in educational settings.

The ROC curve for predicting screen time of 120 minutes or less seven months later had an AUC of 0.650, indicating poor accuracy. Although the AUC is poor, rejecting the null hypothesis of true area=0.5 suggests the distribution is not random. Therefore, using the existing curve to determine the cutoff value remains important. The cutoff value for CL×AR that optimizes the Youden index was 1.98, resulting in a sensitivity of 46.2% and specificity of 77.5%.

The appropriateness of this cutoff value should be considered from the perspective of its significance and practical use in educational settings. For accurately identifying those who will exceed 120 minutes of screen time seven months later, higher specificity than sensitivity is desirable. The specificity of 77.5% is reasonably high for practical purposes. While the sensitivity of 46.2% is low, meaning some students who have less than 120 minutes of screen time might be incorrectly identified as exceeding it, over-triaging these students is not necessarily harmful considering the potential health impacts of excessive screen time. Thus, this cutoff value is practically useful.

Additionally, the feasibility of achieving this cutoff value during the MCC is important. This CL×AR cutoff value of 1.98 lies between the second and third quartiles of the study population, suggesting it is a feasible target. This cutoff value also allows teachers to provide students with clear, specific goals. For example, teachers could say, "During the MCC period, achieve Level 2 (limit total media use to a maximum of 2 hours per day) for 10 consecutive days, or achieve Level 3 (limit total media use to a maximum of 1 hour per day) for 7 out of 10 days."

In summary, the cutoff value of 1.98 is appropriate for its intended role, functioning well as a target within the MCC and providing a clear guideline for educational settings. Based on these results, we consider the cutoff value of 1.98 to be a suitable metric.

It is crucial for schools to provide feedback to students and parents based on MCC results and propose measures to reduce future screen time. In particular, students with low CL×AR scores require individualized support and

advice. Previous studies have shown that education about screen time in schools, regular newsletters to parents, education for teachers, and implementing a screen media time reduction challenge for about ten days effectively reduced children's excessive screen time[8)9)]. Incorporating the findings of this study into these initiatives might further enhance their effectiveness. For example, creating personalized newsletters for parents based on the results of the MCC to inform them if their child is at high risk of long-term excessive screen time could be effective. Additionally, increasing the frequency of the MCC for high-risk individuals might also be beneficial. Therefore, it is important to innovate the MCC within school education.

Furthermore, previous research has identified factors associated with children's prolonged screen time, including short sleep duration[10)], limited parent-child interaction[11)], high SDQ scores[10)], and the presence or absence of parental control over screen time[10)]. In Japan, where ICT is widespread, school education that considers these factors will become increasingly important.

Conversely, this study found no significant association between SDQ scores and screen time in the logistic regression analysis. This contrasts with a previous study[10)]. However, caution is needed when interpreting these results. The present study was not primarily designed to investigate the relationship between SDQ scores and screen time, and thus the sample size was not determined for this purpose. Moreover, previous study that found significant differences had much larger sample sizes compared to this study.

The limitations of this study are as follows. First, the exploratory nature of the research resulted in a small sample size. Since the MCC is widely implemented in Japanese schools, future research with larger sample sizes is desirable. Second, the study did not consider pre-MCC screen time as a covariate for screen time seven months later. Therefore, the effectiveness of the MCC could not be validated by this study. Third, the study did not consider screen time by the time of day. From a sleep medicine perspective, nighttime screen time is suggested to negatively affect the quantity and quality of sleep, whereas the health impacts of screen time from the morning to early evening remain unclear. Future research should include detailed investigations divided by time of day and content of screen time.

V. Conclusion

This study revealed that CL×AR remained significantly associated with mid-to-long term screen time even after adjusting for covariates, indicating its potential usefulness as a predictive model. Additionally, from the ROC curve of CL×AR alone, a cutoff value of 1.98 was identified as a threshold for managing appropriate screen time, suggesting that students with scores below 1.98 may need support and advice. Due to the exploratory nature and small sample size of the study, future research should involve larger sample sizes and more detailed investigations. Moving forward, practical research is needed to develop Japan-specific interventions based on these results and to evaluate their effectiveness.

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Declaration of competing interest

SW has received scholarship donations from Eisai Co., Ltd. over the past three years, and there are no other conflicts of interest to disclose.

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- Yusuke Arai, Daimei Sasayama, Kazuhiro Suzuki et al.: Association between children's difficulties, parent-child sleep, parental control, and children's screen time: A cross-sectional study in Japan. Pediatric Reports, 15: 668-678, 2023
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