

**Maternal factors and one-year-olds' screen time: A cross-sectional study  
using birth cohort data from the Japan Environment and Children's Study  
(JECS)**

Mai Fujii,<sup>a\*</sup> Yasuyuki Kawanishi,<sup>a</sup> Fusako Niwa,<sup>b</sup> Kyoko Hirabayashi,<sup>b</sup> Kumiko  
Tsuji Kanatani,<sup>b</sup> Takeo Nakayama,<sup>c</sup> and the Japan Environment and Children's  
Study Group

<sup>a</sup>*Center for Baby Science, Doshisha University, Japan;* <sup>b</sup>*Kyoto University Kyoto Regional  
Centre for Japan Environment and Children's Study, Graduate School of Medicine, Kyoto  
University, Kyoto, Japan;* <sup>c</sup>*Department of Health Informatics, School of Public Health, Kyoto  
University, Kyoto, Japan*

\* Corresponding author: Mai Fujii, PHN, PhD; Center for Baby Science, Doshisha  
University; 4-1-1, Kizugawadai, Kizugawa-shi, Kyoto-fu, 619-0225, Japan; Tel: +81-90-  
9868-0710; E-mail: [ajibui@hotmail.com](mailto:ajibui@hotmail.com)

# **Maternal factors and one-year-olds' screen time: A cross-sectional study using birth cohort data from the Japan Environment and Children's Study (JECS)**

## **Abstract**

Japanese studies have reported that one-year-olds have the longest media exposure among preschoolers. This cross-sectional study assesses associations between the screen time of 12–17-month-old children and their mothers' characteristics. Using data from the Japan Environment and Children's Study (JECS), we analyzed 86,938 singletons whose primary caregivers were their mothers. Screen time was defined as time that mothers allowed their children to watch TV, DVDs, and/or other media, categorized into two groups, "less-than-4-hours" and "4-hours-or-more per day." The independent variables were children's sex, mothers' age, educational attainment, media usage, employment status, frequency of outings, and the existence of caregivers other than the mother. We considered additional factors including scores on the Kessler Psychological Distress Scale (K6) and Mother-to-Infant Bonding Scale, Japanese version (MIBS-J). Ninety percent of one-year-olds viewed media content. A multivariate regression analysis revealed that the mother's media usage was the strongest predictor that a one-year-old would have long screen time (> 4 hours/day). A mother's higher educational attainment and employment status predicted a decreased likelihood of a child's long screen time. MIBS-J (anger and rejection and impaired bonding) showed very a slight association, and the child's sex, mother's age, and K6 had no association with the child's screen-time.

Keywords: infants; Japan Environment and Children's Study (JECS); maternal psychological distress; media use; mother–infant bonding; preschool; screen time; screen view; television; Japan

## **Impact Summary**

### **Prior State of Knowledge:**

International guidelines recommend no screen time for one-year-olds. However, Japanese studies have reported that one-year-olds have the longest screen time among preschoolers. Systematic reviews have indicated that a child's characteristics, family and social context, or ethnicity are factors that influence a child's screen time.

### **Novel Contributions:**

This large-scale, Japanese survey targeting only one-year-olds contributes to knowledge of the possible predictors of children's long screen time. Some findings were similar to previous studies, and some were different. The results differed greatly from international recommendations for the screen time for one-year-olds.

### **Practical Implications:**

The findings indicate the need for policymakers to develop practical guidelines for promoting rather than prohibiting behavioral changes in the screen time of children. They also suggest the possibility for mothers to reduce the screen time of their children by controlling their own media exposure.

The Internet and electronic devices have become a part of children's daily lives. Through electronic devices, children can learn, play games, send messages, and watch videos. The World Health Organization (2019) recommends zero screen time for one-year olds, because sedentary behavior has been identified as a risk factor for children's health and development. Using as a starting point the 0-hour viewing recommended by the guidelines, our research question was what factors are relevant to children with long screen times. Existing studies have reported varying types and lengths of screen time for one-year-olds (Jago et al., 2013; Kahn et al., 2021; Kostyrka-Allchome et al., 2017). In this study, long screen time is defined as any duration that exceeds the average screen time of one-year-olds as reported in existing Japanese studies. Using data on mothers' characteristics, the study aimed to assess the trends in screen time and associated primary caregiver factors. We hypothesized that:

**H1:** Mothers' age and educational attainment and children's sex are not associated with children's screen time.

**H2:** Mothers' excessive media use (**H2a**), limited support for mothers (**H2b**), maternal psychological distress (**H2c**), and low mother–infant bonding (**H2d**) are associated with children's long screen time.

**H3:** Frequent outings (when the child spends time outside of the house, excluding commuting to the nursery) and mothers' unemployed status contribute to children's short screen time.

Previous studies have reported that the children's sex or father's education are not associated with screen time, and mothers' age or education show an unclear association with the same (Dan, 2012; Duch et al., 2013). Gutierrez and Ventura (2021) indicated that mothers' use of media devices, such as TVs and mobile phones, is associated with poor mother-to-infant attachment quality. Furthermore, a systematic review suggested that

distress/depression is positively associated with screen time (Duch et al., 2013). The Benesse Education Research and Development Institute (2017) investigated the reasons why guardians allow children to engage in excessive screen time. The most common reason was that the guardians have to engage in housework and therefore their hands are full. This suggests that when mothers are occupied with some work, they let their children watch the screen. Therefore, we speculated that working mothers' busy status is associated with children's long screen time. Sugawara (2015) indicated that outings and time spent playing outside are possible factors that contribute to reduced screen time in children over two years.

A recent systematic review of children's development and screen time that assessed 38 studies (18,313 participants), showed that studies with smaller sample sizes reported more extreme effects (Madigan et al., 2020), suggesting that a larger data sample would generate more accurate results. A 2017 systematic review of 76 studies of children aged up to 17 years indicated that the effects of television may vary with children's individual characteristics, family, and social context (Kostyrka-Allchorne et al., 2017). Another review of 29 studies, including 18 (62%) cross-sectional studies of children aged below three, found that children's age (older) and race/ethnicity (minority) were most commonly correlated with a longer screen time (Duch et al., 2013). Based on these findings, we speculated in this study that family, especially maternal factors, may be associated with children's screen time.

## **Materials and Methods**

### **Participants**

Data for this cross-sectional study were obtained from a Japanese, nationwide, birth cohort study—the JECS—which recruited pregnant women from January 2011 to March 2014. The study comprises 104,065 fetal records, which is 3% of the total births per year for

three years in Japan. The baseline profiles did not substantially differ from those of the total population; details of the JECS study, which include the baseline profiles of the participants, have been published elsewhere (Michikawa et al., 2018).

Participants in this study were 12–17-months-old children whose main caregivers were their mothers. From the 102,071 fetal records, we excluded 1,994 multiple births, 1,799 cases whose primary caregivers were individuals other than their mothers, and records with insufficient information. We also excluded records of those with a primary caregiver other than their mother and those with missing information concerning the caregiver. Finally, after excluding those who did not meet other criteria, 86,938 singletons remained for the analysis (Figure 1).

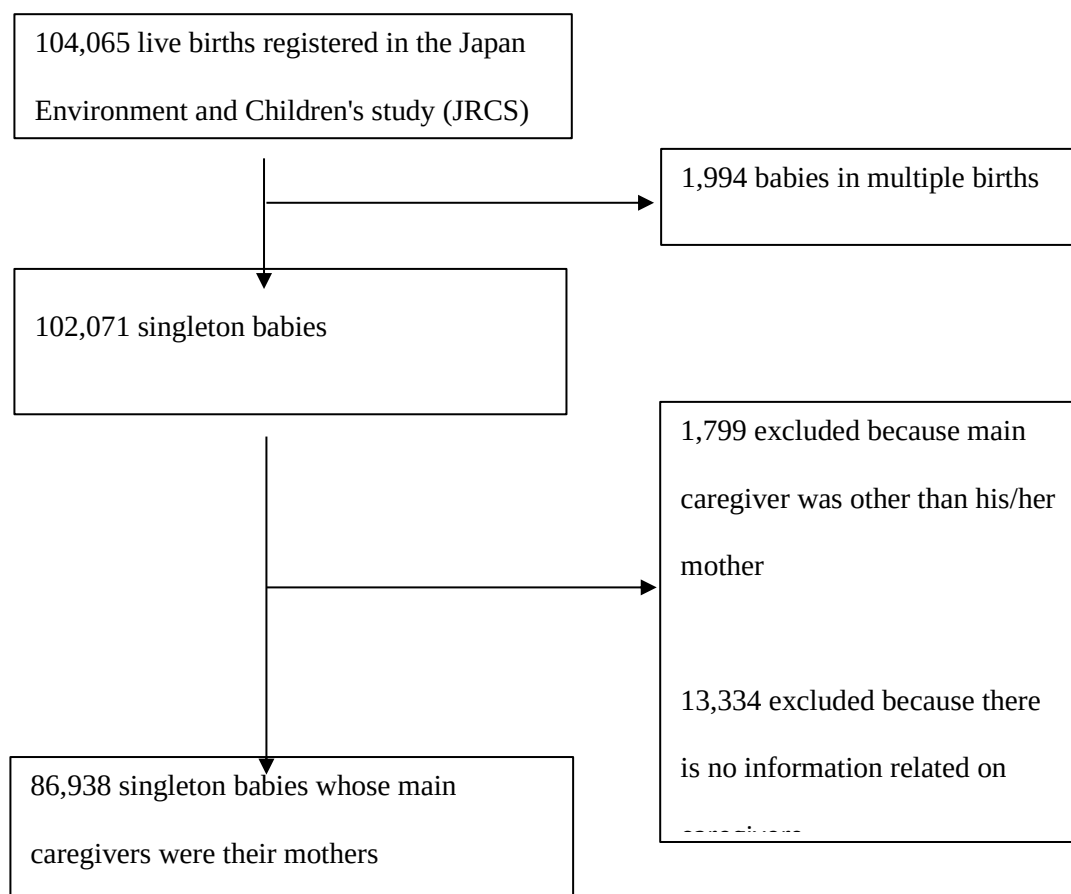


Figure 1: Flowchart of data selection

Data were extracted from the dataset distributed in March 2018 (jecs-an-20180131) to assess the association between children's screen time and related factors. Of the 42 questions JECS included, items about children's food intake (Nutrition Survey), food allergies (Allergy Survey), health screening and medical history, and developmental measurement by ASQ (Development Survey) were not the focus for our analysis. We used the remaining 11 items for our study. Written informed consent was obtained from all participants.

The percentage of mothers in Japan who had electronic media at home was already high at the time of the survey: 99.6 % had TVs, 97.4% had video/DVD devices, 94.7% had computers, 60.5% had smartphones, and 43.3% had portable phones or devices on which TV programs could be watched (Benesse Education Research and Development Institute, 2017). These data suggested that most children's homes had some form of electronic media.

## **Variables and definitions**

### *Dependent variable*

The dependent variable for this study was screen time, defined as the amount of time per day that mothers allowed their children to watch TV, DVDs, and/or other media. The specific question was "How long do you let your child watch TV, DVDs, and/or other media on a typical day?" The five possible answers were: none (not at all), less than 1 hour, 1–2 hours, 2–4 hours, or more than 4 hours. Media other than TV and DVDs were also included in

the question as “other media.” Whereas studies in other countries indicated an average screen time of 1–2 hours (Barr et al., 2010, Tooth et al., 2019), some studies in Japan reported an average screen time of 3 or more hours (NHK Broadcasting Culture Research Institute, 2010b; Sugawara, 2015). Therefore, we considered screen time of 4 or more hours to be an appropriate indication of long screen time in this Japanese study. This 4-hour cut-off has already been used by the Japanese Society of Pediatrics (Tanimura et al., 2004). In their study of children aged 17–19 months, the Japanese Pediatric Association reported that delays in word use were 1.3 times greater in those with long screen time (Tanimura et al., 2004). Therefore, based on the classification in the survey conducted by Japan’s Pediatrics Association (Tanimura et al., 2004), we divided the participants into two groups: less-than-4-hours group ( $< 4$  hours screen time) and 4 hours-or-more group ( $\geq 4$  hours screen time).

### *Independent variables*

Independent variables for this study were variables that had been indicated as significant in univariable analyses and children’s sex. Therefore, those variables were the following: children’s sex; mothers’ age, educational attainment, and employment status; children’s frequency of outings with their mothers; existence of caregivers other than the mother; maternal support system (presence of person/s with whom the mother could consult about her child); mothers’ media-use duration when the child was awake; mothers’ psychological distress level and mother–infant bonding as measured by two subscales. All information except children’s sex and mothers’ educational attainment was obtained when the children were one year old.

Information on children’s sex was provided at birth, and that of the mothers’ educational attainment was provided during pregnancy. Mothers were asked the following question regarding their use of media: “For how many hours do you operate a computer or a

mobile phone (including emails, games, etc.) alongside your child, while he/she is awake on a typical day?” To measure mothers’ psychological distress levels, we used the Kessler Psychological Distress Scale (K6; Kessler et al., 2003). The Japanese version of K6 was developed and validated earlier (Furukawa et al., 2008; Sakurai et al., 2011). The K6 comprises six items, each having five possible responses corresponding to scores 0–4. A higher total score (total score range: 0–24) indicates a greater level of psychological distress. The cut-off point of 4 or 5 may be used to screen for mood or anxiety disorders, and a score of 13 or more indicates severe mental illness in the general population (Sakurai et al., 2011). In their survey targeting the general public, Kawakami et al. (2005) reported that the average ( $\pm$  standard deviation [SD]) K6 score among women was  $2.6 \pm 3.6$ .

Mother–infant bonding was measured using the Mother-to-Infant Bonding Scale (MIBS), Japanese version (MIBS-J) (Taylor et al., 2005, Yoshida et al., 2012), with two subscales: “impaired bonding” and “anger and rejection.” The MIBS-J comprises 10 items that are to be answered on a 4-point Likert scale (0 = not at all, 1 = slightly, some of the time, 2 = very much so, some of the time, 3 = very much so, most of the time). Some items are reverse-scored to reduce response bias; the higher the MIBS-J score, the worse the mother–infant bonding (Kasamatsu et al., 2020). The mean  $\pm$  SD of subscales for the mothers four months afterbirth was  $0.53 \pm 1.15$  for impaired bonding and  $0.65 \pm 1.08$  for anger and rejection (Yoshida et al., 2012).

### **Statistical analysis**

Descriptive statistics were used to describe the sample. A logistic regression analysis was performed using the groups of screen time as the dependent variable, with the less-than-4-hours group defined as “0” and the 4-hours-or-more group as “1.” After assessing the variance inflation factor of the independent variables, children’s status of attending a nursery

was excluded from this study because of its high collinearity with mothers' employment status. The multiple imputation technique was employed to compensate for missing values. A p-value less than 0.05 indicated statistical significance. All analyses were performed using SPSS software (version 26.0).

## Results

### Sociodemographic characteristics

Table 1 presents the sociodemographic characteristics of the participating children and their mothers and the children's screen time. The children were aged 12–17 months and included 44,613 (51.3%) boys and 42,323 (48.7%) girls. The mean  $\pm$  SD age of mothers was  $32.3 \pm 5.0$ . Of the mothers, 22.5% were university-level graduates or higher; 42.7% had attained a high school- or university-level education; 30.6% were high school graduates; 4.2% were junior high school graduates; 34.8% were high school graduates or those with less than a high school education, and they accounted for nearly one-third of the sample. The mothers included 52.8% who were not employed, whereas 47.2% were employed. The average score  $\pm$  SD of the K6 was  $2.8 \pm 3.6$ , and, for the MIBS-J, the average score  $\pm$  SD was  $0.6 \pm 0.9$  for impaired bonding and  $0.9 \pm 1.1$  for anger and rejection.

Table 1: Sociodemographic characteristics of the participants and their mothers

| Variables   | Available records | N (%), Mean $\pm$ SD |
|-------------|-------------------|----------------------|
| Child's sex | 86,936            |                      |
| Male        |                   | 44,613 (51.3)        |
| Female      |                   | 42,323 (48.7)        |

|                                                       |        |               |
|-------------------------------------------------------|--------|---------------|
| Age of mothers                                        | 86,927 | 32.3 ± 5.0    |
| Mother-infant bonding score<br>(MIBS-J) (total)       | 77,269 | 1.5 ± 1.8     |
| Impaired bonding                                      | 86,531 | 0.6 ± 0.9     |
| Anger and rejection                                   | 77,957 | 0.9 ± 1.1     |
| Kessler Psychological<br>Distress Scale (K6)          | 86,773 | 2.8 ± 3.6     |
| Mother's highest level of<br>education                | 85,868 |               |
| Junior high school                                    |        | 3,603 (4.2)   |
| High school                                           |        | 26,266 (30.6) |
| Technical junior<br>college,                          |        |               |
| Technical/vocational<br>college, associate<br>degree, |        | 36,652 (42.7) |
| Bachelor's degree or higher                           |        | 19,347 (22.5) |

Frequency of going out with

86,656

babies

|                         |               |
|-------------------------|---------------|
| Almost never            | 395 (0.5)     |
| 1-3 times/month         | 2,676 (3.1)   |
| 1-2 times/week          | 22,382 (27.5) |
| 3-4 times/week          | 24,397 (28.2) |
| 5 times or<br>more/week | 35,368 (40.8) |

---

Existence of caregivers for

82,767

other than mothers

|     |               |
|-----|---------------|
| Yes | 79,268 (95.8) |
| No  | 3,499 (4.2)   |

---

Existence of person(s) with

whom mother can consult

82,303

regarding her child

|     |               |
|-----|---------------|
| Yes | 81,411 (98.9) |
| No  | 892 (1.1)     |

---

|                                                                                           |        |               |
|-------------------------------------------------------------------------------------------|--------|---------------|
| Duration of mother's media use, such as computer or mobile phone while her child is awake | 86,477 |               |
| None                                                                                      |        | 10,485 (12.2) |
| Less than 1 hour                                                                          |        | 51,267 (59.3) |
| 1-2 hour(s)                                                                               |        | 16,406 (19.0) |
| 2-4 hours                                                                                 |        | 6,746 (7.8)   |
| 4 hours or more                                                                           |        | 1,573 (1.8)   |
| Mother's employment status                                                                | 85,704 |               |
| Not employed                                                                              |        | 45,290 (52.8) |
| Employed                                                                                  |        | 40,414 (47.2) |
| Area of habitation                                                                        | 86,938 |               |
| Region 1 (Hokkaido)                                                                       |        | 6883 (7.9)    |
| Region 2 (Tohoku)                                                                         |        | 18,490 (21.3) |
| Region 3 (Kanto)                                                                          |        | 10,826 (12.5) |
| Region 4 (Chubu)                                                                          |        | 15,977 (18.4) |
| Region 5 (Kinki)                                                                          |        | 14,730 (16.9) |

|                             |                            |                      |
|-----------------------------|----------------------------|----------------------|
|                             | Region 6 (Chugoku-Shikoku) | 8,645 (9.9)          |
|                             | Region 7 (Kyushu)          | 11,387 (13.1)        |
| <hr/>                       |                            |                      |
| Screen time of participants |                            |                      |
|                             | None                       | 86,0135 8,899 (10.3) |
|                             | Less than 1 hour           | 28,846 (33.5)        |
|                             | 1 and up to 2 hours        | 25,813 (33.0)        |
|                             | 2 and up to 4 hours        | 17,060 (19.8)        |
|                             | 4 hours or more            | 5,517 (6.4)          |
| <hr/>                       |                            |                      |

### *Children's screen time*

With regard to children's screen time, 8,899 (10.3%) indicated no screen time, whereas 28,846 (33.5) reported screen time of less than 1 hour, 25,813 (33.0) for 1 and up to 2 hours, 17,060 (19.8) for 2 and up to 4 hours, and 5,517 (6.4%) reported screen time of more than 4 hours per day, as shown in Table 1.

### **Multivariate analysis results**

The results of the multivariate analysis are shown in Table 2 (less-than-4-hours group = 0, 4-hours-or-more group = 1). Anger and rejection (MIBS-J), impaired bonding (MIBS-J), mothers' low educational attainment, frequency of mothers' outings with children, mothers' own media use, and maternal unemployment predicted long screen time (Table 2). Children's sex, maternal age, maternal support system, and the K6 factors were not significantly associated with children's screen time.

Table 2: Results of the multiple logistic regression analysis of the association between children's screen time and maternal factors

| Variables                 | Coefficient         |        | Odds ratio  | 95% CI      | P Value |
|---------------------------|---------------------|--------|-------------|-------------|---------|
|                           | $(\beta)$           |        |             |             |         |
|                           |                     |        |             |             |         |
| Child's sex               |                     |        |             |             |         |
|                           | Male                |        | (reference) |             |         |
|                           | Female              | -0.008 | 0.99        | (0.94-1.05) | 0.784   |
| Age of mothers            |                     | -0.005 | 1.00        | (0.99-1.00) | 0.112   |
| Mother-infant bonding     |                     |        |             |             |         |
| score (MIBS-J) (total)    |                     |        |             |             |         |
|                           | Anger and rejection | 0.047  | 1.049       | (1.01-1.08) | 0.011   |
|                           | Impaired bonding    | 0.073  | 1.075       | (1.04-1.11) | < 0.001 |
| Kessler Psychological     |                     | 0.01   | 1.01        | (1.00-1.02) | 0.009   |
| Distress Scale (K6)       |                     |        |             |             |         |
| Mother's highest level of |                     |        |             |             |         |
| education                 |                     |        |             |             |         |
|                           | Bachelor's degree   |        | (reference) |             |         |
|                           | or higher           |        |             |             |         |
|                           | Junior high school  | 0.393  | 1.482       | (1.27-1.73) | < 0.001 |

|                                                                         |                                |        |             |             |         |
|-------------------------------------------------------------------------|--------------------------------|--------|-------------|-------------|---------|
|                                                                         | High school                    | 0.577  | 1.782       | (1.62-1.96) | < 0.001 |
|                                                                         | Technical junior college,      |        |             |             |         |
|                                                                         | technical/vocation-al college, | 0.391  | 1.479       | (1.35-1.62) | < 0.001 |
|                                                                         | associate degree               |        |             |             |         |
| <hr/>                                                                   |                                |        |             |             |         |
| Frequency of going out with babies                                      |                                |        |             |             |         |
|                                                                         | 5 times or more/week           |        | (reference) |             |         |
|                                                                         | Almost never                   | 0.187  | 1.206       | (0.81-1.81) | 0.364   |
|                                                                         | 1-3 times/month                | -0.075 | 0.928       | (0.76-1.13) | 0.462   |
|                                                                         | 1-2 times/week                 | 0.068  | 1.07        | (0.99-1.16) | 0.088   |
|                                                                         | 3-4 times/week                 | 0.262  | 1.299       | (1.22-1.39) | < 0.001 |
| <hr/>                                                                   |                                |        |             |             |         |
| Existence of caregivers other than mothers                              |                                |        |             |             |         |
|                                                                         | Yes                            |        | (reference) |             |         |
|                                                                         | No                             | 0.028  | 1.029       | (0.89-1.19) | 0.705   |
| <hr/>                                                                   |                                |        |             |             |         |
| Existence of person(s) with whom mother can consult regarding her child |                                |        |             |             |         |
|                                                                         | Yes                            |        | (reference) |             |         |
|                                                                         | No                             | 0.032  | 1.033       | (0.81-1.33) | 0.799   |
|                                                                         |                                |        |             |             |         |

|                            |                  |        |             |               |          |
|----------------------------|------------------|--------|-------------|---------------|----------|
| Duration of mother's media |                  |        |             |               |          |
| use, such as computer or   |                  |        |             |               |          |
| mobile phone while her     |                  |        |             |               |          |
| child is awake             |                  |        |             |               |          |
|                            | None             |        | (reference) |               |          |
|                            | Less than 1 hour | 0.324  | 1.383       | (1.22-1.57)   | < 0.001  |
|                            | 1-2 hour(s)      | 0.932  | 2.539       | (2.23-2.89)   | < 0.001  |
|                            | 2-4 hours        | 1.649  | 5.201       | (4.54-5.96)   | < 0.001  |
|                            | 4 hours or more  | 2.585  | 13.262      | (11.28-15.60) | < 0.001  |
| Mother's employment        |                  |        |             |               |          |
| status                     |                  |        |             |               |          |
|                            | Not working      |        | (reference) |               |          |
|                            | Working          | -0.551 | 0.576       | (0.53-0.63)   | < 0.0001 |

### *Mother–Infant bonding and children's screen time*

The association of screen time with mother–infant bonding was very weak for both **subscales** of anger and rejection (OR: 1.05, 95% CI: 1.01–1.08) and impaired bonding (OR: 1.08, 95% CI: 1.04–1.11).

### *Educational attainment and children's screen time*

Mothers' educational attainment showed significant association with children's screen time. Education levels below a university degree showed a higher odds ratio with children's screen time: junior high school (OR: 1.49, 95% CI: 1.27–1.73), high school (OR: 1.78, 95% CI: 1.62–1.96), technical junior college, technical/vocational college, and associate degree

(OR: 1.48, 95% CI: 1.35–1.62) than mothers with bachelor's degrees.

#### *Frequency of children's outings with mothers and children's screen time*

Compared to those who went out with children most frequently, only the second-most frequent outing group (3–4 times/week) showed a higher odds ratio (OR: 1.30, 95% CI: 1.22–1.39).

#### *Mothers' media-use duration when the child is awake and children's screen time*

The screen time for infants increased with mothers' media usage. Compared to the reference group of mothers who reported zero media usage when their child was awake, the odds of the child having long screen time increased with mothers' media-use duration, from less than one hour (OR: 1.38, 95% CI: 1.22–1.57) to 1–2 hours (OR: 2.54, 95% CI: 2.23–2.89) to 2–4 hours (OR: 2.54, 95% CI: 2.23–2.89) to 4-hours-or-more group (OR: 13.26, 95% CI: 11.28–15.60).

#### *Mothers' employment status*

Mothers' unemployment status was also significantly correlated with the probability of children engaging in long screen time. The odds of long infant screen time were lower for mothers who were not working than those for working mothers (OR: 0.58, 95% CI: 0.53–0.63).

## **Discussion**

This cross-sectional study of children aged 12–17 months used the largest Japanese birth cohort data from JECS. Given that one-year-olds have been found to have the longest screen time compared to other young children in Japan (NHK Broadcasting Culture Research Institute, 2010a; Sugawara, 2015), we examined whether long screen time at this age is associated with different maternal factors.

### **Duration of screen time**

Both national and international guidelines recommend little to no screen time for children under two years of age (Tanimura et al., 2004; World Health Organization, 2019), although the current study found that nearly 90% of one-year-olds engaged in screen time on a typical day. To ensure that major guidelines' recommendations are more effectively followed, it is necessary to scrutinize the possible factors leading to excessive screen time and to identify infants most at risk from (or those who benefit from) it. Based on the results, we recommend that the guidelines not be a simple prohibition but rather include detailed advice on how to choose good quality media content. The median duration of children's screen time in this study in Japan was 1–2 hours, which is consistent with the results of prior studies of children in the United States or Australia (Barr et al., 2010, Tooth et al., 2019).

### **Mothers' media use and children's screen time**

Among all the analyzed factors, the duration of mothers' media use had the highest correlation with the long screen time of infants (**H2a**<sub>[vk1]</sub><sub>[FF2]</sub>). This result aligns with previous findings that parental screen time is associated with children's media use (Bernard et al., 2017; Dan, 2012; Duch et al., 2013). The Benesse Education Research and Development Institute (2017) reported that mothers' engagement in other tasks was the most important reason for them to allow their children to watch media content. Similarly, in this study, when mothers needed to use computers or handphones themselves, they may have allowed their children some screen time. Furthermore, there may be other reasons that were not considered in this study. However, the strong association between mothers' and children's screen times suggests that if mothers reduce their own screen time, it may in turn reduce children's screen time.

### **Mother–infant bonding and children's screen time**

A weak association was found between children's screen time and mother–infant bonding was very for both **subscales**. This association between “impaired bonding” or “anger

and rejection” and children’s long screen time may suggest that children spent more time viewing media content than with their mothers (**H2d**). Factors associated with poor mother–infant bonding; these include children’s low frequency of toothbrushing, violence experienced by mothers from their husbands, and mothers’ autistic tendencies (Hirokawa et al., 2019; Tsuchiya et al., 2022; Yamada et al., 2021). Those might lead to a low bonding level. It is not clear whether this relationship is causal. It is possible that low mother-infant bonding causes more screen time, that high screen time causes low mother-infant bonding, or that some third factor (such as household conflict or domestic violence) leads to both low mother-infant bonding and high screen time. Further research is needed to examine this relationship and determine whether reduced screen time might strengthen the mother-infant bond (or vice-versa).

### **Maternal psychological distress and children’s screen time**

The results of this study did not support (**H2c**) that mothers with greater psychological distress allow their children longer screen time. In a previous study of children under three years of age, five (63%) out of eight studies employing various measurements reported positive associations between mothers’ psychological distress and children’s screen time (Duch et al., 2013). However, of those eight studies, only three included one-year-olds as participants as a part of a wider age group range, and two of the three studies reported an unclear association between mothers’ psychological distress and children’s screen time. It is difficult to make comparisons because of variations in measurement scales, characteristics of the study group, and the inclusion of children from multiple age groups. However, the psychological distress severity of mothers included in this study appears not to be particularly correlated with one-year-olds’ screen time.

### **Support system for caregivers and children’s screen time**

No association was found between children's screen time and the existence/non-existence of support caregivers were receiving (H2b). In total, 99% mothers reported having a person to whom they can turn for advice, and 95% reported having someone who takes care of the children in their place. This indicates that some form of support was available for most primary caregivers. Low variability in caregiver support because of near-universal access to a support system likely explains why caregiver support failed to predict children's screen time in this study.

### **Outing frequency and children's screen time**

Compared to mothers who went out with their children most frequently, our results showed that only the second-most frequent group showed higher odds for allowing their children longer screen time (**H3**). The reason for this finding is unclear. Sugawara (2015) reported a significant correlation between the duration of TV viewing (including passively playing TV in the background) and playing outside, indicating that a possible reason for the reduction in screen time after two years of age may be an increase in time spent playing outside. However, this tendency has not been reported in non-Japanese studies, and some studies have shown that one-year-olds' screen time is shorter than that of older children (Jago et al., 2013; Kostyrka-Allchorne et al., 2017). Lifestyle differences may explain these findings. For example, until a child in Japan is one-year-old, the parents usually let the child play in the house, and after the child is able to walk (approximately 1.5 years old), the mother takes the child to a nearby park every day to play outside.

### **Mothers' employment status and children's screen time**

Contrary to our hypothesis that only employed mothers' children would engage in longer screen time, mothers' unemployment status was also associated with their children's screen time. A possible reason for home-based mothers' children being exposed to relatively longer screen times is that most employed mothers in Japan send their children to nurseries

that allow almost no screen time for one-year-olds. Given these circumstances, advice to improve the quality of the content viewed by such children may be helpful for unemployed mothers of one-year-olds. The same pattern was also found in Dan's (2012) study, although a more recent study showed no differences in children's screen times allowed by homemakers and employed mothers (Hashimoto et al., 2018). Further studies to assess the status of children who attend nurseries and mothers' employment status are needed to elucidate this finding.

### **Children's sex, primary caregiver's age and educational attainment, and children's screen time**

Children's sex and mothers' age were not associated with children's screen time, which is consistent with previous findings (Dan, 2012; Duch et al., 2013). Meanwhile, mothers' education and children's screen time were found to be significantly correlated, when holders of a bachelor's degree are used as the reference group (**H1**). The odds of infants having long screen time was lower for mothers with a bachelor's degree than for mothers without one. Yatagawa (2010) stated in her study of the influence of childhood experiences on later life that the more educated parents are, the more "cultural experiences (capital) at an early age" and "out-of-school educational investment" their children have. This indicates that mothers with bachelor's degrees may have given their children a variety of cultural experiences, similar to what they have experienced. However, this study did not capture other characteristics, such as the mother's experience of being disciplined for screen viewing when young or having a greater recognition of the risk of screen time. These aspects should be further clarified with a more in-depth study. Although recent studies have confirmed this tendency (Bernard et al., 2017; Hashimoto et al., 2018), a systematic review showed that the association between screen time and maternal education is unclear (Duch et al., 2013).

## **Study limitations**

All information was obtained using self-reporting questionnaires, which may entail a rater or common methods bias. The cross-sectional nature of this study precluded longitudinal inferences. The information regarding children's screen time was obtained as categorical data, and meticulous analysis using continuous values could not be conducted. Furthermore, the data were obtained between 2011 and 2014, which may not have captured the most recent trends, particularly those during the nationwide, stay-home restrictions due to the COVID-19 pandemic. This study was originally intended to focus on children's environment and to include all caregivers other than mothers as primary caregivers (i.e., fathers and grandparents). However, unlike the data on mothers, those on other family members were scarce; therefore, the analysis was limited to mothers who were the primary caregivers.

## **Conclusions**

This study aimed to assess the relationship between children's screen time and maternal factors. Ninety percent of the children watched media content, with a median screen time of 1–2 hours. Hence, in addition to the recommendation by the guideline of zero screen time, this 90% of the sample must be encouraged to make behavioral changes. Mothers' media usage had the strongest correlation with one-year-olds' long screen time (> 4 hours/day). Therefore, mothers limiting their own screen time may help reduce children's screen time too. Higher educational attainment and employment status of mothers also tended to decrease the likelihood of long screen time.

## **Funding**

This study was funded by the Ministry of the Environment, Japan. The findings and conclusions of this article are solely the responsibility of the authors and do not represent the official views of the government.

### **Ethics approval and consent to participate**

The study protocol was approved by the Institutional Review Boards of Epidemiological Studies of the Ministry of the Environment, Japan and by the Ethics Committees of all participating institutions. The JECS was conducted according to the Declaration of Helsinki and Japanese Ethical Guidelines for Epidemiological Research published by the Ministry of Education Culture, Sports, Science and Technology and the Ministry of Health, Labour, and Welfare, Japan. Written informed consent was obtained from all participants before their participation. The study was registered with the UMIN Clinical Trials Registry System.

### **Members of the Japan Environment and Children's Study (JECS) Group as of 2020**

Michihiro Kamijima (principal investigator, Nagoya City University, Nagoya, Japan), Shin Yamazaki (National Institute for Environmental Studies, Tsukuba, Japan), Yukihiro Ohya (National Center for Child Health and Development, Tokyo, Japan), Reiko Kishi (Hokkaido University, Sapporo, Japan), Nobuo Yaegashi (Tohoku University, Sendai, Japan), Koichi Hashimoto (Fukushima Medical University, Fukushima, Japan), Chisato Mori (Chiba University, Chiba, Japan), Shuichi Ito (Yokohama City University, Yokohama, Japan), Zentaro Yamagata (University of Yamanashi, Chuo, Japan), Hidekuni Inadera (University of Toyama, Toyama, Japan), Takeo Nakayama (Kyoto University, Kyoto, Japan), Hiroyasu Iso (Osaka University, Suita, Japan), Masayuki Shima (Hyogo College of Medicine, Nishinomiya, Japan), Youichi Kurozawa (Tottori University, Yonago, Japan), Narufumi

Suganuma (Kochi University, Nankoku, Japan), Koichi Kusuhara (University of Occupational and Environmental Health, Kitakyushu, Japan), and Takahiko Katoh (Kumamoto University, Kumamoto, Japan).

### **Availability of data and materials**

Data are unsuitable for public distribution due to ethical restrictions and the legal framework of Japan. It is prohibited by the Act on the Protection of Personal Information (Act No. 57 of 30 May 2003, amendment on 9 September 2015) to publicly deposit data containing personal information. Ethical Guidelines for Medical and Health Research Involving Human Subjects enforced by the Japan Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare also restrict the open sharing of the epidemiologic data. All inquiries about access to data should be sent to [jecs-en@nies.go.jp](mailto:jecs-en@nies.go.jp). The person responsible for handling inquiries sent to this email address is Dr. Shoji F. Nakayama, JECS Programme Office, National Institute for Environmental Studies.

## References

- Barr, R., Danziger, C., Hilliard, M. E., Andolina, C., & Ruskis, J. (2010). Amount, content and context of infant media exposure: A parental questionnaire and diary analysis. *International Journal of Early Years Education*, 18(2), 107–122.  
<https://doi.org/10.1080/09669760.2010.494431>
- Benesse Education Research and Development Institute. (2017). *Dainikai nyuyojino oyakono mediakatuyochosa (The 2nd survey of media use of infants and their parent)* [Lexical characteristics of Japanese language].
- Bernard, J. Y., Padmapriya, N., Chen, B., Cai, S., Tan, K. H., Yap, F., Shek, L., Chong, Y. S., Gluckman, P. D., Godfrey, K. M., Kramer, M. S., Saw, S. M., & Müller-Riemenschneider, F. (2017). Predictors of screen viewing time in young Singaporean children: The GUSTO cohort. *International Journal of Behavioral Nutrition and Physical Activity*, 14(1), 112. <https://doi.org/10.1186/s12966-017-0562-3>
- Dan, N. (2012). TV viewing of preschoolers and their mothers' attitudes toward childcare [in Japanese]. *Bulletin of Teikyo University of Science*, 8, 47–56.
- Duch, H., Fisher, E. M., Ensari, I., & Harrington, A. (2013). Screen time use in children under 3 years old: A systematic review of correlates. *International Journal of Behavioral Nutrition and Physical Activity*, 1–10.
- Furukawa, T. A., Kawakami, N., Saitoh, M., Ono, Y., Nakane, Y., Nakamura, Y., Tachimori, H., Iwata, N., Uda, H., Nakane, H., Watanabe, M., Naganuma, Y., Hata, Y., Kobayashi, M., Miyake, Y., Takeshima, T., & Kikkawa, T. (2008). The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *International Journal of Methods in Psychiatric Research*, 17(3), 152–158.  
<https://doi.org/10.1002/mpr.257>

- Gutierrez, S. A., & Ventura, A. K. (2021). Associations between maternal technology use, perceptions of infant temperament, and indicators of mother-to-infant attachment quality. *Early Human Development*, 154, 105305.  
<https://doi.org/10.1016/j.earlhumdev.2021.105305>
- Hashimoto, Y., Ono, S., & Kubosumi, A. (2018). Survey on the use of digital information devices in infancy [in Japanese]. *Research survey reports in information studies. Interfaculty initiative in information studies. The University of Tokyo*, 34, 213–244.
- Hirokawa, K., Kimura, T., Ikehara, S., Honjo, K., Sato, T., Ueda, K., Iso, H., & Japan Environment & Children's Study Group (2019). Associations between broader autism phenotype (BAP) and maternal attachment are moderated by maternal postpartum depression when infants are one month old: A prospective study of the Japan environment & children's study. *Journal of Affective Disorders*, 243, 485–493.  
<https://doi.org/10.1016/j.jad.2018.09.060>
- Jago, R., Edwards, M. J., Urbanski, C. R., & Sebire, S. J. (2013). General and specific approaches to media parenting: A systematic review of current measures, associations with screen-viewing, and measurement implications. *Childhood Obesity*, 9(Suppl.), S51–S72. <https://doi.org/10.1089/chi.2013.0031>
- Kahn, M., Barnett, N., Glazer, A., & Gradisar, M. (2021). COVID-19 babies: Auto-videosomnography and parent reports of infant sleep, screen time, and parent well-being in 2019 vs 2020. *Sleep Medicine*, 85, 259–267.  
<https://doi.org/10.1016/j.sleep.2021.07.033>
- Kasamatsu, H., Tsuchida, A., Matsumura, K., Shimao, M., Hamazaki, K., Inadera, H., & Japan Environment and Children's Study Group. (2020). Understanding the relationship between postpartum depression one month and six months after delivery and mother–infant bonding failure one-year after birth: Results from the Japan Environment and

- Children's study (JECS). *Psychological Medicine*, 50(1), 161–169.  
<https://doi.org/10.1017/S0033291719002101>
- Kawakami, N., Kondo, K., Yanagida, K., & Furukawa, T. (2005). *Seijinkiniokeru jisatuyobono arikanikannsuru seishinhokenntekikennyu (Study of mental health for prevention of suicide among adults)* [Lexical characteristics of Japanese language]. (2004). *Ministry of Health, Labour and Welfare grants report*.
- Kessler, R. C., Barker, P. R., Colpe, L. J., Epstein, J. F., Gfroerer, J. C., Hiripi, E., Howes, M. J., Normand, S. L., Manderscheid, R. W., Walters, E. E., & Zaslavsky, A. M. (2003). Screening for serious mental illness in the general population. *Archives of General Psychiatry*, 60(2), 184–189. <https://doi.org/10.1001/archpsyc.60.2.184>
- Kostyrka-Allchorne, K., Cooper, N. R., & Simpson, A. (2017). The relationship between television exposure and children's cognition and behaviour: A systematic review. *Developmental Review*, 44, 19–58. <https://doi.org/10.1016/j.dr.2016.12.002>
- Madigan, S., McArthur, B. A., Anhorn, C., Eirich, R., & Christakis, D. A. (2020). Associations between screen use and child language skills: A systematic review and meta-analysis. *JAMA Pediatrics*, 174(7), 665-675.
- Michikawa, T., Nitta, H., Nakayama, S. F., Yamazaki, S., Isobe, T., Tamura, K., Suda, E., Ono, M., Yonemoto, J., Iwai-Shimada, M., Kobayashi, Y., Suzuki, G., Kawamoto, T., & Japan Environment and Children's Study Group. (2018). Baseline profile of participants in the Japan environment and children's study (JECS). *Journal of Epidemiology*, 28(2), 99–104. <https://doi.org/10.2188/jea.JE20170018>
- NHK Broadcasting Culture Research Institute. (2010a). *Television and Japanese Children: Longitudinal study from zero to twelve Interim report from zero to five*.

- NHK Broadcasting Culture Research Institute. (2010b). *Zerosaikaragosaino kodomoto terebiKodomo to terebi chukanhokoku (Television and Japanese Children: From zero to five Interim report from zero to five)* [Lexical characteristics of Japanese language].
- Sakurai, K., Nishi, A., Kondo, K., Yanagida, K., & Kawakami, N. (2011). Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. *Psychiatry and Clinical Neurosciences*, 65(5), 434–441.  
<https://doi.org/10.1111/j.1440-1819.2011.02236.x>
- Sugawara, M. (2015). Nyuyojikino. *Terebi • Bideosesshokuno jittai oyobi shakaijochoteki hattatutonokannrenn - 0sai • 1sai • 2saijitenchosakara* (Relation between infants' contact (exposure) with television/video and their social and emotional development – age of 0, 1 and 2 years) [Lexical characteristics of Japanese language].
- Tanimura, M., Takahashi, K., Kataoka, N., Tomita, T., Tanabe, I., Yasuda, T., Sugihara, S., & Seino, Y. (2004). Nyuyoji no Terebi Bideo shicho wa kikendesu (Television viewing for infants and toddlers is risky) [Lexical characteristics of Japanese language]. *Journal of the Japanese Pediatric Society*, 108, 709–712.
- Taylor, A., Atkins, R., Kumar, R., Adams, D., & Glover, V. (2005). A new Mother-to-Infant Bonding Scale: Links with early maternal mood. *Archives of Women's Mental Health*, 8(1), 45–51. <https://doi.org/10.1007/s00737-005-0074-z>
- Tsuchiya, S., Tsuchiya, M., Momma, H., Nagatomi, R., Arima, T., Yaegashi, N., ... & Katoh, T. (2022). Prospective association between maternal bonding disorders and child toothbrushing frequency: A cross-sectional study of the Japan Environment and Children's Study. *International Journal of Paediatric Dentistry*, 32(1), 56–65.
- Tooth, L., Moss, K., Hockey, R., & Mishra, G. D. (2019). Adherence to screen time recommendations for Australian children aged 0–12 years. *Medical Journal of Australia*, 211(4), 181–182. doi: <https://doi.org/10.5694/mja2.50286>

- World Health Organization. (2019). *WHO Guidelines on physical activity, sedentary behaviour* (pp. 1–4). Geneva: World Health Organization.
- Yamada, K., Kimura, T., Cui, M., Kubota, Y., Tanaka, E., Wakaizumi, K., ... & Iso, H. (2021). Antenatal pain, intimate partner violence, and maternal bonding disorder: Data from the Japan Environment and Children's Study. *Pain*, 162(3), 749–759.
- Yatagawa, R. (2010). Kodomojidainokeikenga konennioyobosueikyo -daigakuseikaramiru bengakubunkano renzokuseini chumokushite- (The influence of childhood experiences on later life: a university student's perspective on the continuity of study culture) [Lexical characteristics of Japanese language]. *Journal of Child Study*, 16, 45–58.
- Yoshida, K., Yamashita, H., Conroy, S., Marks, M., & Kumar, C. (2012). A Japanese version of Mother-to-Infant Bonding Scale: Factor structure, longitudinal changes and links with maternal mood during the early postnatal period in Japanese mothers. *Archives of Women's Mental Health (Japanese version)*, 15(5), 343–352.  
<https://doi.org/10.1007/s00737-012-0291-1>

## Notes on contributors

### Mai Fujii

Mai Fujii, (PHN, PhD) is a researcher at Center for Baby Science, Doshisha University, Japan. Her study using Japanese birth cohort data of the Japan Environment and Children's Study (JECS) focuses on children and media use or dwelling environment.

### Yasuyuki Kawanishi

Yasuyuki Kawanishi, M.D., Ph.D. is a researcher at the Center for Baby Science, Doshisha

University.

### **Fusako Niwa**

Fusako Niwa, MD, PhD is a Program-Specific associate Professor of the Kyoto Regional Centre for Japan Environment and Children's Study at Graduate School of Medicine, Kyoto University. She is also a neonatologist and pediatrician, and her research focuses on neonatal endocrinology related primarily to adrenal and thyroidal function as well as child development.

### **Kyoko Hirabayashi**

Kyoko Hirabayashi, Ph.D, is a Program-Specific Senior Lecturer at the Kyoto Regional Centre for Japan Environment & Childrens Study, Kyoto University. She has been working in this Centre for nearly ten years. Her research fields are social medical sciences, child studies, and peace studies.

### **Kumiko Tsuji Kanatani**

Kumiko T Kanatani, MD, MAS is a Lecturer in Kyoto University, where she engages in a national birth cohort, Japan Environment and Children's Study. Her research centers on the health effects of air pollution including Asian sand dust. She holds an M.A.S degree in Clinical Research from University of California, San Diego.

### **Takeo Nakayama**

Takeo Nakayama, MD, PhD, is a Professor of the Department of Health Informatics, School of Public Health, Kyoto University, Japan. His research interest is broad, especially epidemiology, evidence-based health care, and health communication. He is the chairperson of the steering committee of Minds Guideline Center at the Japan Council of Health Care Quality. He is also working as a program supervisor of the Japan Agency for Medical Research and Development.

### **Disclosure statement**

No potential conflict of interest was reported by the authors.

### **Acknowledgements**

We would like to thank all the participants who took time to complete the questionnaire during the years of this national cohort study.