ORIGINAL PAPER

Nagoya J. Med. Sci. **87**. 498–508, 2025
doi:10.18999/nagjms.87.3.498

Association between maternal depression and smartphone use: a 1.5-year follow-up cohort study of Japanese mothers

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ABSTRACT

Maternal depression affects 17.7% of postpartum women and can emerge years after childbirth, impacting both mothers and their children. Social support plays an important role in preventing maternal depression. Family and community were traditional sources of social support, but the rise of digital media may impact social support and therefore maternal well-being. Mothers are accustomed to technology and often use digital devices for childcare and leisure activities. This study examined the association between screen time and the onset of depression two years postpartum. A cohort study was initiated in November 2020 (baseline) with follow-up in May-June 2022, employing an anonymous online questionnaire. Study participants were first-time mothers (n = 204) of children aged 5–8 months. Measures considered basic attributes, family environment, maternal depression (Edinburgh Postnatal Depression Scale [EPDS]), screen time, and sleep status. No baseline maternal depression (EPDS score < 9) was a requirement for participation. Maternal depression onset during a 1.5-year follow-up was the dependent variable. Screen time, sleep duration, and support services were independent variables. Their relationships were analyzed using Fisher's exact test, the Mantel-Haenszel test, and logistic regression. Twenty-six participants (12.7%) developed depression (EPDS ≥ 9) within two years of childbirth. Logistic regression revealed a significant association between smartphone use time and maternal depression (odds ratio [OR] = 1.89; 95% confidence interval [CI], 1.09–3.26). No association was found between social media or game use and maternal depression. Excessive smartphone use was related to depression two years after childbirth, indicating the need for health guidance on screen time for mothers.

Keywords: maternal depression, smartphone use, maternal health, screen time, Japanese mothers

Abbreviations:
OR: odds ratio
CI: confidence interval
EPDS: Edinburgh Postnatal Depression Scale

INTRODUCTION

Maternal depression is the leading cause of death among postpartum women and has a global

Received: September 28, 2024; Accepted: January 7, 2025
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prevalence of 17.7%.[1] Most women recover from maternal depression within weeks to months,[2] but some experience "later-onset" depression years after childbirth.[3,4] Santos et al[5] found that 14.1% of women experienced the onset of depression within one to two years postpartum. Putnick et al[6] reported increased depressive symptoms in 25% of women in the third year postpartum in the United States (US). Studies conducted in the United Kingdom (UK),[7] Australia,[8] Canada,[9] and France[10] also reported that 10% to 30% of women experienced prolonged maternal depression. This is linked to poor cognitive and behavioral development in children[11] and has significant long-term effects on mothers. Therefore, support for maternal depression must be tailored to different onset times and circumstances.[12,13] While there are many factors that influence maternal depression, social support is an important component.[14] In the past, social support was offered within families, friendships, and communities. However, with the recent surge in digital content consumption, the use of social media and other digital media may impact the availability of social support. Many postpartum women belong to a generation that witnessed the evolution of digital devices during their teenage years and experienced technology's integration into their education. Consequently, they are generally well-acquainted with digital devices, utilizing them for childcare, communication, hobbies, and entertainment. Additionally, since the onset of the COVID-19 pandemic, screen time has surged across all age groups, including mothers.[15]

Predominantly in adolescents, excessive Internet use negatively affects mental health and is moderately associated with depressive symptoms,[16] anxiety, and loneliness.[17] A large US study found that children and adolescents with seven or more hours of screen time per day were more likely to have depression, anxiety, or other mental illnesses.[18] A study of mothers with young children reported that personal computer (PC) or electronic device use time, as well as overall screen time, was significantly associated with anxiety scale scores and more.[19]

Excessive screen time can result in sleep deprivation, reduced exercise, impaired communication, and sedentary lifestyles.[20] The World Health Organization (WHO) guidelines[20] recommend limiting sedentary time, even during pregnancy and the postpartum period. Research on mother's screen time is limited. Previous studies have focused on specific population groups, such as children, adolescents, and young adults. Therefore, this study examined whether maternal depression with onset up to two years after childbirth is associated with screen time.

METHODS

Study design and duration

This longitudinal study employed two anonymous online questionnaires. The baseline survey was conducted from November 26–30, 2020, and the follow-up survey was conducted from May 26 to June 26, 2022.

Survey targets and methodology

The survey targeted first-time mothers with children aged 5–8 months (single births) who were smartphone owners. Approximately 40,000 mothers were randomly selected from 1.3 million respondents registered with Macromill, Inc, a Tokyo-based Internet research company. They were invited to participate in this study via e-mail. The inclusion criteria were met by 771 mothers who responded to the first survey. The second survey followed the same procedure but focused on the two-year postpartum period. It yielded 344 responses, corresponding to a follow-up response rate of 44.6%.

Participants received an e-mail including an outline of the survey and a URL to view the instructions. After reviewing the instructions online and providing their consent, responses were

collected. Patients were required to be able to answer the questionnaire in Japanese. Mothers who had multiple births or who had not experienced childbirth (eg, parents and children through special adoption) were excluded from the study. The final number of respondents was 339 (valid response rate, 98.5%) after excluding those with multiple children, adopted children, those not living with their children, and those unable to respond in Japanese.

When an infant is 5–8 months old, the head and neck are completely stabilized, and the infant begins to crawl but is not yet able to stand or walk. This middle period of physical development follows the most challenging period of the first four months of life. It is one of the indicators of continued depression after childbirth.[4,6]

Measurements

The survey items considered (1) basic attributes and family environment, (2) maternal depression (Edinburgh Postnatal Depression Scale [EPDS]), (3) screen time, and (4) sleep status.

Basic attributes and family environment. We collected basic information from participants, including their age and employment status. To gain insight into their family environments, we gathered information on issues during pregnancy or childbirth, medical history, childcare support, use of support services related to childcare, and potential abusive behaviors, including "emotionally hurting their children."[21] Support services related to childcare included daycare centers and nurseries, babysitting, postpartum care, and professional counseling.

Maternal depression. The Japanese version of the EPDS was used to assess maternal depression. Developed by Cox et al[22] and adapted by Okano et al,[23] the EPDS has been widely used in research involving participants from pregnancy to several years after childbirth.[24,25] It comprises 10 items rated on a four-point scale, asking respondents to reflect on their experiences over the past seven days. The reliability of the Japanese version is established (Cronbach's α = 0.78; sensitivity = 0.75; and specificity = 0.93 at a cutoff of 9 points).[23] The EPDS was utilized to assess maternal depression in both surveys. An EPDS score of 9 or higher indicated maternal depression.

Screen time. Participants were asked to estimate their average screen time when using smartphones and mobile applications. Actual usage data was requested by guiding participants to review the "weekly report function," which summarizes active device time on their smartphones. Both the overall and application-specific weekly average screen time were reported. A supplementary explanation of how to access this function was provided within the survey. Using the weekly report function reinforced external validity.

Sleep status. Guided by previous studies,[21] participants were asked about their sleep duration and whether they experienced insomnia. The Japanese version of the Athens Insomnia Scale (AIS-J) was used to assess insomnia. Scores were categorized as no concern, slight suspicion, suspicion, and consult a physician. The AIS-J has demonstrated reliability and validity in healthy adults.[26,27]

Statistical analysis

Participants. There were 204 out of 339 respondents with an EPDS score of 8 or less at baseline. These participants were analyzed further as the non-depression group.

Methods. The non-depression group (n = 204) was evaluated for the rate of late-onset maternal depression, determined by examining depression status (EPDS score of 9 or more/less) two years after childbirth. Factors associated with depression onset were investigated: screen time, sleep duration, and the use of support services as independent variables. Statistical analysis was conducted using Fisher's exact test for categorical variables, the Mantel-Haenszel test for trend (stratified for categorical variables), and logistic regression. A result with $P < 0.05$ was considered

significant. The logistic regression model was used to calculate the adjusted odds ratio (OR) for depression onset associated with independent variables. A 95% confidence interval (CI) was reported. The logistic regression model was adjusted for age and problems during childbirth (as covariates). Three model structures were considered: independent variable (crude) and covariates (Model 1); smartphone use time, sleep duration, and covariates (Model 2); smartphone use time, use of support services, and covariates (Model 3); and smartphone use time, use of support services, sleep duration, and covariates (Model 4). IBM SPSS Statistics version 27.0 (IBM Corp) was used for the statistical analysis.

Ethical approval

This study was approved by the Bioethics Review Committee of Nagoya University Graduate School of Medicine (Approval No. 2020-0306, 21-134). Informed consent was obtained from all respondents before participation.

RESULTS

In the non-depression group (n = 204) with no maternal depression at baseline, 26 (12.7%) developed maternal depression two years after childbirth. Most participants used their smartphones for more than three hours: 14 (6.9%) for less than an hour, 43 (21.1%) for one to three hours, 78 (38.2%) for three to five hours, and 69 (33.8%) for five hours or more (Table 1).

Table 1 Characteristics of participants (n = 204)

Parameters	Mean/median	SD/IQR
Age for baseline survey (mean ± SD), (range 20–44)	30.7	4.6
EPDS score for baseline survey (median & IQR), (range 3–8)	6.0	4–7
EPDS score for follow-up survey (median & IQR), (range 0–18)	3.0	2–6
	n	%
EPDS score for baseline survey		
Maternal depression at follow-up	26	12.7%
No maternal depression at follow-up	178	87.3%
Employment status for baseline survey		
None	169	82.8%
Working	35	17.2%
Duration of smartphone use for baseline survey		
Less than 1 hour	14	6.9%
1–3 hours	43	21.1%
3–5 hours	78	38.2%
5 hours or more	69	33.8%

SD: standard deviation
IQR: inter-quartile range
EPDS: Edinburgh Postnatal Depression Scale

Considering all types of screen time, smartphone use time was significantly associated with the onset of depression two years after childbirth. No significant association was found between application-specific screen time and maternal depression, including games or social media (eg, Instagram, Facebook, and Twitter, officially known as X since July 2023). However, significant associations were identified between maternal depression two years after childbirth and sleep duration as well as the use of support services (Tables 2-1, 2-2).

Table 2-1 Relationship between the duration of smartphone use and late-onset maternal depression (n = 204)

		Total		Maternal depression at follow-up				
				No		Yes		
		n	%	n	%	n	%	P^a
Smartphone	Less than 1 hour	14	6.9%	13	7.3%	1	3.8%	**0.018** *
	1–3 hours	43	21.1%	41	23.0%	2	7.7%	
	3–5 hours	78	38.2%	69	38.8%	9	34.6%	
	5 hours or more	69	33.8%	55	30.9%	**14**	**53.8%**	
Instagram	Less than 1 hour	106	52.0%	95	53.4%	11	42.3%	0.278
	1–3 hours	55	27.0%	48	27.0%	7	26.9%	
	3–5 hours	15	7.4%	11	6.2%	4	15.4%	
	5 hours or more	28	13.7%	24	13.5%	4	15.4%	
Twitter (X)	Less than 1 hour	167	81.9%	144	80.9%	23	88.5%	0.370
	1–3 hours	26	12.7%	24	13.5%	2	7.7%	
	3–5 hours	7	3.4%	6	3.4%	1	3.8%	
	5 hours or more	4	2.0%	4	2.2%	0	0.0%	
Facebook	Less than 1 hour	198	97.1%	172	96.6%	26	100.0%	0.343
	1–3 hours	6	2.9%	6	3.4%	0	0.0%	
LINE (chat communication)	Less than 1 hour	106	52.0%	88	49.4%	18	69.2%	0.104
	1–3 hours	70	34.3%	64	36.0%	6	23.1%	
	3–5 hours	15	7.4%	14	7.9%	1	3.8%	
	5 hours or more	13	6.4%	12	6.7%	1	3.8%	
Browsing	Less than 1 hour	90	44.1%	80	44.9%	10	38.5%	0.862
	1–3 hours	71	34.8%	60	33.7%	11	42.3%	
	3–5 hours	21	10.3%	17	9.6%	4	15.4%	
	5 hours or more	22	10.8%	21	11.8%	1	3.8%	
Game	Less than 1 hour	145	71.1%	127	71.3%	18	69.2%	0.543
	1–3 hours	22	10.8%	20	11.2%	2	7.7%	
	3–5 hours	15	7.4%	13	7.3%	2	7.7%	
	5 hours or more	22	10.8%	18	10.1%	4	15.4%	
Viewing video	Less than 1 hour	151	74.0%	134	75.3%	17	65.4%	0.214
	1–3 hours	36	17.6%	31	17.4%	5	19.2%	
	3–5 hours	6	2.9%	4	2.2%	2	7.7%	
	5 hours or more	11	5.4%	9	5.1%	2	7.7%	

Maternal depression at follow-up has a cutoff value of 9 points.

[a] Mantel-Haenszel test for trend

* $P < 0.05$

Table 2-2 Relationship between lifestyles and late-onset maternal depression (n = 204)

		Total		Maternal depression at follow-up				
				No		Yes		
		n	%	n	%	n	%	P^b
Age	Under 25 years old	14	6.9%	13	7.3%	1	3.8%	0.459
	25–40 years old	183	89.7%	158	88.8%	25	96.2%	
	Over 40 years old	7	3.4%	7	3.9%	0	0.0%	
Employment status	None	169	82.8%	146	82.0%	23	88.5%	0.309
	Present	35	17.2%	32	18.0%	3	11.5%	
Results of 4-month health checkup	Normal	192	94.1%	166	93.3%	26	100.0%	0.185
	Some issues present	12	5.9%	12	6.7%	0	0.0%	
Problems for the child during childbirth	None	189	92.6%	166	93.3%	23	88.5%	0.295
	Present	15	7.4%	12	6.7%	3	11.5%	
Problems for the mother during childbirth	None	200	98.0%	174	97.8%	26	100.0%	0.577
	Present	4	2.0%	4	2.2%	0	0.0%	
Fertility treatment	None	163	79.9%	142	79.8%	21	80.8%	0.572
	Present	41	20.1%	36	20.2%	5	19.2%	
Emotions at the time of pregnancy discovery	Happy	193	94.6%	169	94.9%	24	92.3%	0.421
	Not happy	11	5.4%	9	5.1%	2	7.7%	
Medical history	None	179	87.7%	156	87.6%	23	88.5%	0.602
	Present	25	12.3%	22	12.4%	3	11.5%	
Daily childcare supporter	Present	186	91.2%	161	90.4%	25	96.2%	0.299
	None	18	8.8%	17	9.6%	1	3.8%	
Use of support services	Present	54	26.5%	51	28.7%	3	11.5%	**0.047** *
	None	150	73.5%	127	71.3%	23	88.5%	
Child-rearing confidence	None	144	70.6%	123	69.1%	21	80.8%	0.161
	Present	60	29.4%	55	30.9%	5	19.2%	
Suspect in abuse	None	200	98.0%	175	98.3%	25	96.2%	0.423
	Present	4	2.0%	3	1.7%	1	3.8%	
Athens Insomnia Scale score	No-insomnia (under 3 points)	72	35.3%	66	37.1%	6	23.1%	0.310
	Pre-insomnia (4–5 points)	54	26.5%	47	26.4%	7	26.9%	
	Insomnia (6 points or over)	78	38.2%	65	36.5%	13	50.0%	
Sleep duration	Less than 5 hours	36	17.6%	28	15.7%	8	30.8%	**0.006** *
	5–8 hours	161	78.9%	146	82.0%	15	57.7%	
	8 hours or more	7	3.4%	4	2.2%	3	11.5%	

Maternal depression at follow-up has a cutoff value of 9 points.
[b] Fisher's exact test
* $P < 0.05$

A hierarchical logistic regression analysis was conducted. Maternal depression at the follow-up survey was specified as the dependent variable. Smartphone use time, sleep duration, and use of support services were independent variables (Table 3). A significant association was found between the onset of maternal depression and smartphone use time (crude OR = 1.89 [95% CI, 1.09–3.26]). Interestingly, a similarly significant association was found after adjusting for sleep duration (OR = 1.94 [95% CI, 1.12–3.37]) and use of support services (OR = 2.09 [95% CI, 1.18–3.69]). Use of support services was also associated with the onset of maternal depression (OR = 3.82 [95% CI, 1.07–13.65]).

Table 3 Associated factors in the development of delayed maternal depression (n = 204)

	Model 1		Model 2		Model 3		Model 4	
	COR (95% CI)	*P*	AOR (95% CI)	*P*	AOR (95% CI)	*P*	AOR (95% CI)	*P*
Smartphone use time	**1.89 (1.09–3.26)**	**0.023** *	**1.94 (1.12–3.37)**	**0.019** *	**2.09 (1.18–3.69)**	**0.011** *	**2.12 (1.196–3.759)**	**0.010** *
Sleep duration	0.75 (0.30–1.89)	0.551	0.66 (0.26–1.69)	0.391			0.754 (0.300–1.891)	0.547
Use of support services (ref: present)	3.09 (0.89–10.77)	0.076			**3.82 (1.07–13.65)**	**0.039** *	**3.71 (1.034–13.306)**	**0.044** *

CI: confidence interval
COR: crude odds ratio
AOR: adjust odds ratio
Dependent variable: Follow-up survey with/without maternal depression (EPDS score >/< 9).
Independent variable: Smartphone use time, sleep duration, use of support services.
Covariates: Age, problems for the child during childbirth.
* $P < 0.05$

DISCUSSION

Excessive smartphone use was associated with depression in mothers two years after childbirth. This association was present even after adjusting for sleep duration, use of support services, and covariates related to postpartum depression symptoms. Long hours of screen time, primarily because of smartphone use, are known to worsen postpartum depression and postpartum mental health in women two years after childbirth. Smartphone use, including social media and video games, triggers the brain's reward pathway. This induces dopamine release and triggers completion and desire behaviors.[28] These devices are designed to keep people engaged and absorbed for extended periods. It is difficult to prevent these brain responses. Prolonged smartphone use can interfere with family, friendships, and sleep. It can also lead to irritability and difficulty concentrating. These symptoms are similar to depressive symptoms, and the present study suggests the possibility that similar patterns were observed during the postpartum period.

A meta-analysis by Liu et al[29] considering smartphone use and depression in the general population reported an 80% increased risk of depression when screen time was five hours or more compared to no screen time (estimated OR = 1.80; 95% CI, 1.60–2.02). The dose-response relationship was nonlinear; compared to those with zero hours of screen time, those with less than two hours per day had a decreased risk of depression, while those with two hours per day had approximately the same risk, and those with more than two hours per day had a linearly increasing risk of depression. In a meta-analysis by Wang et al,[30] screen-time-based sedentary behavior was associated with a higher risk of depression. This finding was true for

both adolescents and adults. Stratified by sex, the pooled OR was 1.18 for the female group. However, no significant association was observed between screen-time-based sedentary behavior and depression in the male group. Longer overall screen time is also associated with a higher risk of anxiety symptoms in mothers of young children.[19] Longer smartphone use (particularly exceeding five hours) is associated with an increased risk of depression, especially in women.[31,32] As suicidal thoughts can be a symptom of maternal depression,[12] it is important to prevent this mental health condition. Managing the amount of time spent using smartphones may be beneficial for preventing maternal depression.

This study found no significant association between social media use (Instagram, Twitter, and Facebook) and depression during the two-year period after childbirth. This finding differs from previous studies.[31-33] Most participants spent less than one hour on social media, but 13.7% spent more than five hours on Instagram, and a further 10.8% of participants spent more than five hours on other platforms. These results align with previous studies describing social media addiction rates of 1–15% in the UK and 0–11% in the US.[34] Social media addiction is evaluated by the amount of time spent using social media, as well as by agitation, irritation, and interference with daily life. Susceptibility to addictive states has been shown to vary depending on the individual, and the amount of time spent engaging in a behavior is not necessarily related to the incidence of addiction.[35] While this survey only investigated screen time, susceptibility to addiction may be connected to depression. Additionally, it may be essential to consider what the time spent on each application signifies. For instance, the Fear of Missing Out (FOMO) has been associated with increased Internet use and worsening depressive symptoms.[36] Motivations and stimulation for social media use may be more complex than time spent online. In addition, mothers raising infants must remain focused on their children to prevent accidents and ensure their safety. However, because of consuming digital content, such as social media in small increments when their children were sleeping or playing quietly, overall screen time accumulated. Future research is needed to explore these associations in greater depth.

The results of this study showed that the use of support services and time spent on smartphones were significantly associated with depression. Mothers' major postpartum needs and challenges include meeting their own basic needs related to personal care, such as bathing, eating, and sleeping, as well as obtaining emotional support, such as being listened to and receiving words of encouragement. Support is associated with improved maternal mental health.[37] In recent years, social media has become a common source of social support. Mothers describe obtaining social support (emotional and instrumental) from ongoing participation in online groups.[38] Support obtained through social media is also beneficial. Hence, social media use is more complex than considerations of screen time alone. Nevertheless, the motivation for social media use is intricately related to depression and the tendency for excessive smartphone use.

This study has several limitations. First, its survey-based design may have introduced response bias, leading to recall and social desirability biases. Second, sampling bias may have been present. The representativeness of the survey results was a concern due to the selection process and limited information regarding survey participants and respondents. The online survey likely attracted respondents who were proficient in using electronic devices. This was supported by the fact that respondents spent more time using smartphones than the general population. Hence, the study may have limited generalizability. The incidence of excessive smartphone use reported in this study may be more severe than in a wider population. Furthermore, these behaviors may be associated with higher rates of postpartum depression than would be observed for the average mother. As such, sampling bias may have influenced this study and perhaps intensified the association between maternal depression and smartphone use that this study investigated. Third, maternal depression (EPDS score) was higher than average, suggesting that the survey attracted

relatively anxious mothers. The online survey method and the impact of the COVID-19 pandemic on the child-rearing environment might have influenced these results. Moreover, the longitudinal survey was restricted by the low response rate and small number of participants in the analysis. Future studies need to examine long-term changes in maternal depression with larger sample sizes.

Despite these limitations, this study provides a novel and significant perspective on screen time and maternal depression.

Conclusions

Excessive smartphone use was related to depression emerging in women two years after childbirth. This is a health issue that worsens the mental health of postpartum women. Therefore, these findings emphasize the need for health guidance and support regarding managing screen time for postpartum women.

AUTHOR CONTRIBUTIONS

HT conceived the study, and HT and NN designed it. HT conducted the survey, analyses, and HT and NN contributed to interpreting the results. HT drafted the manuscript, and NN critically reviewed it. Both authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FUNDING

This work was supported by JST SPRING (Grant Number JPMJSP2125), the Japan Internet Safety Promotion Association (JISPA), and JSPS KAKENHI (Grant Numbers JP19K24195 and 23KJ1060).

ACKNOWLEDGMENTS

HT would like to take this opportunity to thank the “Interdisciplinary Frontier Next-Generation Researcher Program of Tokai Higher Education and Research System.” She would also like to express her gratitude to Hisataka Sakakibara, PhD, professor emeritus from Nagoya University, for consultation on this research as part of her doctoral dissertation.

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