

Depressive symptoms in mothers with infants: The quantitative evidence of the association of COVID-19 crisis-related factors in Japan

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Abstract

Objective: This study explores the depressive symptoms in postpartum women during the coronavirus disease (COVID-19) crisis in Japan.

Methods: An online survey conducted from 31 May to 6 June, 2020 resulted in 3,073 responses obtained from mothers with infants < 12 months.

Results: The point prevalence of the Edinburgh Postnatal Depression Scale (EPDS) score of ≥ 9 was 28.66% for primipara and 25.83% for multipara. Logistic regression analysis indicated a negative association between the COVID-19 crisis and EPDS ≥ 9 ; specifically, decreased social support and financial concern were identified as risk factors. The COVID-19 related experiences significantly increased the score of each factor of EPDS, i.e., anxiety, anhedonia, and depression.

Conclusions: During the COVID-19 crisis, the number of mothers who faced depreciation in social support and income had increased. Moreover, spending their perinatal period during the crisis increased the propensity of facing unexpected changes, such as changes of hospitals for delivery, or cancellation of parenting classes. These multiple factors were associated with an elevated risk of depression in postpartum women. In a prolonged crisis, postpartum mental health should be treated carefully with the prevention of infection.

Introduction

Similar to the rest of the world, Japan has been affected by the coronavirus disease (COVID-19) pandemic, with the first case reported on 31 December, 2019. Although COVID-19 related deaths have been relatively on a smaller scale, health and financial uncertainty coupled with the resulting social isolation have been severe, and the pandemic has turned into a crisis. Depression during the first year after childbirth is not uncommon and estimated to be around 13% worldwide,^{1,2} and according to a recent review from Japan based on studies published from January 1994 to December 2017, the prevalence of depression is 15.1% within the first month of delivery, 11.6% in 1–3 months, 11.5% in 3–6 months and 11.5% in 6–12 months after birth.^{3 [1]}

Two main models explain the mechanism of the occurrence of postpartum depression (PPD): the biological and psychological models. Classical biological models indicate the dramatic rise (before delivery) and drop (after delivery) of reproductive and stress hormones, which is hypothesised to trigger system dysregulation and depressive symptoms in a subset of vulnerable women.^{4,5,6} Psychological models focus more on socio-economic factors that raise the stress level of mothers. The deleterious effect of stressors, including financial strain and father abandonment, on mothers and the ameliorating role of social resources, such as social support have been reported earlier.^{7,8} Further, underlying cognitive vulnerabilities, negative attributional style for instance, and individual psychological resources, such as self-esteem would be harmful if it is lower or depreciated.^{7,8} More recently, the bio-psycho-social-cultural model was proposed⁹ that emphasizes the integrated role of biological and psychological factors and that stress can trigger depression in postpartum women with genetic, hormonal, and cognitive vulnerabilities, and that it may interact reciprocally with the social and cultural environment.

Based on the bio-psycho-social-cultural model, which suggests that the mechanism of PPD is dynamic and multidimensional, the COVID-19 crisis is speculated to have increased the risk for depression in new mothers. A study conducted to explore the psychological impact in a state of emergency (mild lockdown) on the general population reported a significantly higher proportion of people displaying psychological distress than that reported in previous national survey data. The contributing factors to severe psychological distress were COVID-19-related sleeplessness and anxiety, deterioration of the household economic situation, and difficulties in work and study in addition to loneliness and poor interpersonal relationships. Mothers with infants are not free from these factors. They may be even more vulnerable to elevated psychological distress due to unexpected labour, including prohibited entry of family members or a partner into the delivery room, and change in hospitals for delivery.^[2] Moreover, they are likely to be anxious regarding the risk this novel virus posed to them and their babies. Travel restrictions and self-quarantine results in lowered social support, both informal and formal, and are an extra mental and physical burden especially for mothers with infants who require constant attention.

Recent reports across the world reveal that mothers during the postpartum periods were found to show a higher percentage of depressive symptoms than before the crisis, indicated by the Edinburgh Postnatal Depression Scale (EPDS) as follows: 28.6% (EPDS >12) in Italy,¹² 23.6% (EPDS >12) in Belgium,¹³ and 30% (EPDS ≥ 10) in China.¹⁴ Because these reports use a non-uniform definition of the point prevalence of depressive symptoms in terms of EPDS cut-off and the timing of the survey, it is not appropriate to make a comparison between the countries, but it is important to note that the percentages of prevalence were consistently more than double the values that were present during the pre-crisis period for each country. Further, a study conducted in Japan examining the psychological status of postpartum women during the COVID-19 crisis found lower mother-infant bonding at 1 month after giving birth compared to those who gave birth during the same period in the previous year, which could be due to lowered mother's support due to the crisis.¹⁵

PPD has a serious repercussion on the health of mothers and babies and the mother's relationship to her children and partner, and it also contributes to perinatal mortality.⁹ A recent review, which included 122 studies, found that mothers with PPD may suffer prolonged depression/ depressive symptoms, and have difficulties in their relationship with their partners, and also have suicidal ideation. Infants are also affected, including poor health, and slow motor, cognitive, and language development.¹⁶ Mother-to-infant bonding is often negatively affected, which has long-term consequences.¹⁶

Considering these serious adverse effects and due to the waves of cases in this crisis, there is an urgent need to examine the well-being of postpartum women and the risk factors related to the COVID-19 crisis in Japan to discuss how society can protect women during the crisis. This study presents quantitative evidence of the situation after the mild lockdown to investigate the COVID-19 crisis-related risk factors in postpartum women in Japan.

Footnotes:

[1] Definition of postpartum period has not yet gained consensus. In the past studies, it ranged from a few days to 12 months.⁹ Most previous studies we referred to use the term 'postpartum' and postpartum depression to indicate a mother of a baby up to 11 months, and depression in that period, respectively. We have used these terms whenever the original papers have used them. Thus, after referring to previous literature, we have included in this study a mother who has a baby up to 11 months. To ensure consistency, we also use the term postpartum to cover the duration after giving birth to 11 months' after the delivery. Further, we use the term postpartum depression to refer to depression occurring during that time. moreover, note that U.S. National Library Medicine (2020) defines postpartum depression as it can begin anytime within the first year after childbirth.¹⁰

[2] In Japan, there is a practice called *Satogaeri bunben*, which has emerged with an increase of nuclear family after the World War II. This is for mothers living as nuclear family in non-natal home return to the natal house ('*Satogaeri*') and give birth ('*bunben*'). The survey conducted in 2018 shows there were at least 50% of mothers who choose to do so.¹¹ Because of this tradition, we have included the experience 'Change in the place of delivery' due to COVID-19 as one of the variables here.

Methods

We used a cross-sectional study design, in which an online survey was conducted from 31 May to 6 June, 2020, through two companies (Karada note Inc. and baby calendar Inc.) that provided services to pregnant and postpartum women and mothers with children. We sent emails to all the users soliciting voluntary participation in our survey. Because users of the services of these companies included non-active and non-target groups, we could not calculate the exact percentage of respondents among the women to whom emails were sent. We sent 607,458 emails, among which about 1.3% of the participants accessed our survey web page. Among those who accessed our survey web page, approximately 74% replied (5,650 replies). The respondents were from all prefectures, except Wakayama, corresponding to the population size of each prefecture.

Among the 5,650 replies, 3,406 were from women with babies under 12 months of age. Among them, we used 3,073 responses of women who completed the entire survey for the present study.

Data Collection

We collected the data from the self-administered questionnaires. The Japanese version of the EPDS was employed to measure depressive symptoms.¹⁷ In this study, good internal consistency of the EPDS (10 items) was shown, with a Cronbach's alpha of 0.87. The questionnaires also included perceived risk with respect to COVID-19 infection and its negative consequences, unexpected experiences under the influence of this crisis, and socio-demographic and economic information.

Analyses

We divided our sample into two groups: primiparas and multiparas. Four procedures were conducted for each group. First, we calculated the total score and the percentage of women with an EPDS score of ≥ 9 each month after delivery. Second, factor scores of anhedonia (EPDS items 1 and 2), anxiety (EPDS items 3, 4, and 5), and depression (EPDS items 7, 8, and 9), which was validated by Kubota et al. similar to those in Western countries,¹⁸ were calculated. Third, logistic regression analysis was performed by setting the dependent variable as 1: EPDS score of ≥ 9 ; 0: EPDS score of < 9 . Fourth, Ordinary Least Square (OLS) regression analysis was conducted for each factor score after adjusting for the respondents' socio-demographic and economic backgrounds (Table 1, the list of covariates and their definitions). The latter analyses are important to explore risk factors in detail. Although the cut-off of EPDS score is useful to capture the general prevalence of depressive symptoms, it may not fully cover the risks associated with elevated unwellness of mental health among mothers because just below the cut-off does not mean the mother is free from depression risks. Thus, variables contributing to an increase in the score of each factor should not be overlooked.

As our focused variables, we included three COVID-19 crisis-related variables as follows: experiences during the COVID-19 crisis, perceived risk, and place of residence. Places of residence were grouped into five based on the day the state of emergency was lifted in their prefecture. The longest duration was in Tokyo/Kanagawa/Saitama/Chiba followed by Hokkaido, Osaka/Kyoto/Hyogo, and Aichi/Fukuoka. All statistical analyses were performed using STATA/MP 15.1.

This study was approved by the Research Ethics Committee of the University of Tsukuba (No. 2020-1), and no potential conflict of interest exists relevant to this research. To protect respondents from mental disturbance possibly caused by answering our questionnaires, the letter of request included a summary of the contents of our survey. Moreover, participants could withdraw from the survey anytime, and all questions were set as non-mandatory.

Results

The point prevalence of postpartum women with an EPDS score of ≥ 9 was 28.66% for primiparas and 25.83% for multiparas. Exploring the scores and the point prevalence for each month after delivery by groups, primiparas and multiparas, the depressive symptoms were prevalent throughout. For primiparas, the highest prevalence was at 1 month (37.2%) and the lowest was at 3 months (20.7%), and a continuous and steady increase was observed after 6 months up to 10 months. For multiparas, there was an increasing trend after 3 months of delivery, and it reached the highest at 11 months (36.8%). When comparing the average point prevalence of depressive symptoms, primiparas was higher than multiparas, showing 29.9% and 22.1%, respectively. Nevertheless, after 3 months of delivery, the average percentage became higher for multiparas (29.2%) than for primiparas (27.7%). These results are shown in Fig 1.

The trends for three factors are shown in Figure 2. For primipara, the lowest total EPDS scores at 3 months were 2.728 (anxiety), 0.315 (anhedonia), and 1.000 (depression), and the highest total EPDS scores at 1 month were 3.769 (anxiety), 0.500 (anhedonia), and 1.769 (depression). For multiparas, the lowest total EPDS scores at 2 months were 2.309 (anxiety), 0.573 (anhedonia), and 1.136 (depression), and the total EPDS scores at 11 months were 3.500 (anxiety), 0.789 (anhedonia), and 1.579 (depression). Among the three factors, the anxiety score was the highest, even when it was divided by the number of factors,^[3] and it showed a general increasing trend for mothers having older infants. At 11 months after delivery, the anxiety and anhedonia scores of multiparas were higher than for primiparas.

Seven types of experiences during the COVID-19 crisis were listed. The top three most frequently experienced unintended events during COVID-19 were as follows: for primiparas, lifestyle changes with a partner working from home (35.96%), the prohibition of visitors at hospitals (34.12%), and cancellation of planned formal support experienced (32.97%); and for multiparas, the prohibition of visitors at hospitals (46.02%), cancellation of planned formal support experienced (35.96%), and cancellation of parenting classes (34.01%). Although less than 3%, some mothers needed to change the place of delivery, and more than 15% of people were affected by the cancellation of informal support.

Another COVID-19-related variable was the perceived risk. The highest perceived risk pertained to not being able to receive formal childcare support, followed by COVID-19 infection, financial difficulties, and not being able to receive informal childcare support.

The respondents' socio-demographic/economic variables showed that nearly 40% were in the age range of 30–34 years with multipara being older in general, and nearly 98% were married. About 80% of the respondents had more than 16 years of education with a higher percentage among the primiparas. More than 40% had an annual income (including taxes) of above 5 million yen with a higher percentage among the multiparas. Regarding working status, approximately 55% and 45% of the primiparas and multiparas respectively, were working full-time.

Analysis of Primiparas

Table 2 shows the results of the analysis on primiparas. Logistic regression analysis for primiparas revealed the significant effects of COVID-19-related issues. Concerning experiences of unexpected changes, participants who had experienced cancellation of planned informal support and formal support had a higher risk of having depressive symptoms (odds ratio [OR], 1.358; 95% confidence interval [CI], 1.024–1.802 and OR, 1.292; CI, 1.013–1.647, respectively). For perceived risk variables, mothers perceiving higher risks of financial difficulties and those who were not able to receive informal childcare support were independently associated with an EPDS score of ≥ 9 (OR, 1.099; 95% CI, 1.030–1.173 and OR, 1.227; CI, 1.142–1.319, respectively). Postpartum mothers who lived in areas with a longer duration of the state of emergency had a higher probability of EPDS ≥ 9 than the regions that had the shortest duration of the state of emergency (OR, 1.405; 95% CI, 1.066–1.851 for Tokyo/Kanagawa/Saitama/Chiba). Except for COVID-19-related variables, only those with lower incomes were associated with a higher probability of having depressive symptoms.

For further analysis, anxiety, anhedonia, and depression were considered. Change in the place of delivery, the prohibition of permitting partner into the delivery room, cancellation of planned informal support, and living in Osaka/Kyoto/Hyogo were the variables that did not show significant associations with EPDS ≥ 9 . The coefficients suggested that women who experienced a change in the place of delivery were likely to demonstrate an increase in the anxiety and depression score by 0.854 and 1.433, respectively. These coefficients were larger than other variables of experience during the COVID-19 crisis. Other notable findings were: having a partner at home and having more people who were involved with childcare daily, which reduced the depression score. Additionally, anhedonia score decreased with an increase in the number of people engaged in childcare support, whereas being unemployed resulted in an increase in all the factor scores. Although not significant associated with EPDS ≥ 9 , the additional analysis suggested a higher risk for unemployed mothers.

Analysis of Multiparas

Table 3 shows the results of the analysis of multiparas. Logistic regression revealed that similar to primiparas, COVID-19-related variables had a significant association with elevated depression symptoms. Additionally, these associated variables could be categorized as childcare support and financial issues. Those who experienced cancellation of planned formal support and those who perceived higher risk of not receiving informal childcare support had a higher probability of exhibiting depressive symptoms (OR, 1.39; 95% CI, 1.017–1.815, and OR, 1.253; 95% CI, 1.146–1.369, respectively). Having a higher perceived risk of financial difficulties, lower income group, and being unemployed also contributed to having depressive symptoms (OR, 1.084; 95% CI, 1.002–1.173, OR, 1.377; 95% CI, 1.033–1.835, and OR, 3.142; 95% CI, 1.224–8.964, respectively). In addition to these variables, the variable, residential area, suggested that a mother living in Tokyo/ /Kanagawa/Saitama/Chiba had a higher probability of EPDS ≥ 9 (OR, 1.424; 95% CI, 1.030–1.969 for Tokyo). Furthermore, the dummy variable indicating the baby's age as being 6 months or over shows a higher probability of having depressive symptoms.

Analyses of factors added more evidence that COVID-19-related variables had a significant association with elevated anxiety, anhedonia, and depression; change in the place of delivery and cancellation of parenting classes both increased anxiety scores by 0.678 and 0.426, respectively. Cancellation of planned formal support increased anhedonia and depression scores by 0.141 and 0.241, respectively. As the results of logistic regression indicated, higher perceived risk towards financial difficulties and not receiving informal childcare support also increased all the factor scores. A lower income level was associated with anhedonia and depression, although it did not show a statistically significant association with anxiety. Compared to the never-married individuals, mothers who were either divorced, widowed, or in a different marital status had a lower score for anhedonia, and married women had a lower score for depression. Consistent with the results of logistic regression, mothers with older babies recorded higher scores for all the factors.

^[3] Each factor scores consist of the following: EPDS items 1 and 2 for anhedonia, EPDS items 3, 4, and 5 for anxiety, and EPDS items 7, 8, and 9 for depression.

Limitation

Our study has some limitations. Firstly, this study involved an online survey by sending e-mails to the registered users of two companies' maternal related services. Because registered users were not always the active users, and their e-mail may not be opened, we could obtain only an approximate response rate. In relation to that, representation of the sample needs to be carefully taken into consideration due to the nature of online survey. Secondly, there is no control group for this study. Considering the impossibility to overcome these limitation totally, more number of research to accumulate the evidence would be helpful.

Discussion

The percentage of postpartum women with depressive symptoms (EPDS \geq 9) was remarkably higher than that found during normal circumstances in Japan; it was even higher than that after the Great East Japan Earthquake (21.3%).¹⁹ There are two notable findings from our descriptive results. The first is that depressive symptoms were high even after a few months of delivery. According to Beck (2002),²⁰ in 25%–50% of women with PPD, the depressive symptoms last for 6 months or longer. Moreover, a meta-analysis of the prevalence of perinatal depression among Japanese women found that the highest point prevalence occurred within the first month (15.1%) and decreases to 11.5% in 6–12 months after birth.³ Our data further showed an increasing trend of the percentage of women with scores of EPDS \geq 9 after 2 months for primipara and after 3 months for multipara. Another important finding was that the risk of having depressive symptoms for primiparas and multiparas was not different, which is contradictory to previous findings.³ Further, a higher percentage of point prevalence of depressive symptoms for multiparas than for primiparas was found 3 months and onwards after delivery.

The factor scores are also worth noting. Similar to that seen in Western countries, anxiety, anhedonia, and depression exist in Japanese women during the postpartum period depression, and anxiety is a particularly important factor to understand depression during the postpartum period.¹⁸ In our study, the anxiety score was the highest, and it continued to be high across the postpartum period up to 11 months. Moreover, other factor scores were also elevated compared to those seen in previous study. For example, in the study by Takehara et al., for primipara, the factor scores were reported as 2.641 (anxiety), 0.465 (anhedonia), and 1.234 (depression) at the maximum.²¹ These scores were only slightly higher than our minimum score, and our maximum score exceeded these scores, and the anxiety score was particularly high with a value of 3.769, which is 1.4 times higher than that reported earlier.²¹ For multipara, an elevation in the factor scores was even more remarkable. In the earlier study, the highest scores were recorded at 20 weeks after the delivery as follows: 1.673 (anxiety), 0.156 (anhedonia), and 0.693 (depression). These were lower than the minimum score obtained in the present study at 2 months, and the highest score recorded in our analysis were 2, 5, and 2.3 times higher for anxiety, anhedonia, and depression, respectively.

Regarding the results of regressions, for both primiparas and multiparas, COVID-19 showed a significant impact on their mental health, including unexpected events before giving birth, such as a change in the place of delivery and cancellation of parenting classes; the women experienced elevated anxiety and depression. Our results are in line with previous findings that experiencing prenatal depression or negative shock during pregnancy increases the probability of the onset of depressive symptoms after giving birth.²² Regarding the experience and conditions after giving birth, we could summarize the risk factors into two key issues: decreased social support and economic uncertainty caused by the COVID-19 crisis. Since the earlier work by O'Hara, Rehm, and Campbell,¹ the critical role of social support for PPD has been discussed intensively, and its importance has been constantly recognized across different times and places, which was found to apply to our study. In our analysis, the experience of cancellation of planned formal support was independently correlated with depressive symptoms even after considering the number of family members who were involved in childcare daily during the past two months. In addition, a higher perceived risk of not receiving informal support for childcare increased the risk of depression, when all other factors were constant.

Financial difficulties have also been shown to be a fundamental risk factor for PPD as it elevates the mother's stress.²³ Our results showed a high OR for the lower income group and unemployed mothers. Moreover, the perceived risk of financial problems was strongly associated with EPDS \geq 9 and elevated all the factor scores, suggesting that economic uncertainty independently increased the risk. Another important implication from our findings was that unmarried mothers, specifically multiparas, faced an elevated risk of higher anhedonia and depression. Although the marital status did not show a statistically significant correlation with EPDS \geq 9, the rise in these factor scores cannot be ignored.

Although we divided our sample into primiparas and multiparas, the regression results revealed similar risk factors. Further, multiparas are at more risk when their babies are older. This is contradictory to previous findings that depressive symptoms subside after a few months of delivery. There is a possibility that mothers experience prolonged depression after delivery when the effects of biological factors are the strongest. For example, there is an earlier report that mothers who experience PPD are at high risk to develop prolonged depressive disorders.²⁴ Another possibility is that the mothers have depressive symptoms without any influence of hormones. Skipstein et al. emphasize the importance of social and financial resources when rearing young children; and maternal depression is not only particular to mothers with infants, it could occur in any mother when these resources depreciate.²⁵ During the COVID-19 crisis, schools, kindergartens were also closed. Therefore, mothers with more than one child faced more physical burden to care for the other child. Additionally, after 6 months, babies start complementary feeding which can increase the physical activity for mothers. Although this study could not identify whether depressive symptoms after 6 months of delivery were due to prolonged symptoms or newly developed symptoms, we found that mothers who had more than one child, hitherto not recognized as a risk group, exhibited an increase in depressive symptoms during the COVID-19 crisis.

Conclusion

We found a high prevalence rate of depression among mothers with a child less than 12 months old, negatively associated with the COVID-19 crisis-related variables. Given that the experience of pregnancy/becoming a mother can itself be considered a stressful event, the risk of depression after giving birth was intensified with additional stressors caused by the COVID-19 crisis, including voluntary social isolation and economic uncertainty. Moreover, these stressors

caused elevated depressive symptoms among multiparas, who were normally at lesser risk of depression. Further, depressive symptoms did not subside after the delivery. These findings emphasize the importance of continuous support for all mothers. Moreover, COVID-19 related factors contributing to elevated depressive symptoms are policy-relevant since they are exogenous shocks, including experiences that the mothers had during the crisis. Our study is not free from limitation as mentioned earlier; yet it sufficiently suggests the importance of the urgent need to expand support for perinatal women.

Declarations

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Conflicts of interest/Competing interests

The authors declare no conflicts of interest associated with this manuscript.

Consent to participate

Consent to participate for this study was obtained from participants.

Consent for publication

Consent for publication was obtained from participants.

Availability of data and material

Data can only be used by authors.

Code availability

No.

Authors' contributions

MM has conducted this research as a primary researcher doing all the following work; designed survey, managed and analyzed data, and write a paper.

HH co-authored this paper by designing survey, and revising a paper in collaboration with a primary researcher.

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Tables

TABLE 1. Summary Statistics

	Primipara (n=1741)				Multipara (n= 1332)			
Variable	Percentage/Mean	Std. Dev.	Min	Max	Percentage/Mean	Std. Dev.	Min	Max
Dependent Variable								
EPDS>=9 (1: EPDS>=9, 0: EPDS<9)	28.66%	0.45	0	1	25.83%	0.44	0	1
Independent Variables								
<u>COVID-19 related variables</u>								
Experiences during COVID-19								
Changes in place of delivery (1: Yes - 0: No)	1.03%	0.10	0	1	2.33%	0.15	0	1
Cancellation of parenting classes (1: Yes - 0: No)	29.06%	0.45	0	1	34.01%	0.47	0	1
Prohibition of visitors at hospitals (before and after the delivery) (1: Yes - 0: No)	34.12%	0.47	0	1	46.02%	0.50	0	1
Prohibition of an entry of a partner into delivery room (1: Yes - 0: No)	20.62%	0.40	0	1	31.98%	0.47	0	1
Cancellation of planed informal support (1: Yes - 0: No)	19.07%	0.39	0	1	16.89%	0.37	0	1
Cancellation of planed formal support (1: Yes - 0: No)	32.97%	0.47	0	1	35.96%	0.48	0	1
Life style changes with a partner working from home (1: Yes - 0: No)	35.96%	0.48	0	1	27.85%	0.45	0	1
Perceived risk (COVID-19 related) : How respondents think that she will be directly affected by following things in the next 6 months.								
Financial difficulties (1: Not at all likely - 7: Very likely)	3.48	1.86	1	7	3.58	1.82	1	7
COVID-19 infection (1: Not at all likely - 7: Very likely)	4.00	1.57	1	7	3.96	1.55	1	7
Not receiving formal childcare support (1: Not at all likely - 7: Very likely)	4.61	1.89	1	7	4.39	1.87	1	7
Not receiving informal childcare support (1: Not at all likely - 7: Very likely)	3.47	2.01	1	7	3.36	1.93	1	7
Place of residence : Mothers were grouped into following category based on the day ended the state of emergency. The longest duration was Tokyo/Kanagawa/Saitama/Chiba followed by Hokkaido, Osaka/Kyoto/Hyogo, and Aichi/Fukuoka.								
Tokyo/Kanagawa/Saitama/Chiba (1: Tokyo/Kanagawa/Saitama/Chiba 0: otherwise)	35.38%	0.48	0	1	30.48%	0.46	0	1
Osaka/Kyoto/Hyogo (1: Osaka/Kyoto/Hyogo 0: otherwise)	15.05%	0.36	0	1	13.51%	0.34	0	1
Aichi/Fukuoka (1: Aichi/Fukuoka 0: otherwise)	11.43%	0.32	0	1	13.44%	0.34	0	1
Hokkaido (1: Hokkaido 0: otherwise)	2.93%	0.17	0	1	2.63%	0.16	0	1
Other prefectures (1: other prefectures 0: otherwise)	35.21%	0.48	0	1	39.94%	0.49	0	1
<u>Respondents' socio-demographic, -economic information</u>								
Age of the respondents (mother's age)								
Age <25 years (1: age <25 years, 0: otherwise)	4.54%	0.21	0	1	3.15%	0.17	0	1
Age 25-29 years (1: 25 years<=age<30, 0: otherwise)	27.11%	0.44	0	1	13.96%	0.35	0	1
Age 30-34 years (1: 30 years<=age<35, 0: otherwise)	39.06%	0.49	0	1	41.14%	0.49	0	1
Age >=35 years (1: age >=35 years, 0: otherwise)	29.29%	0.46	0	1	41.74%	0.49	0	1
Baby's age 6-11 months (1: 6 months<=baby's age<=11 months, 0: age<=5 months)	37.62%	0.48	0	1	39.56%	0.49	0	1
Household annual total income including tax								
Lower income group (1: < 5 million yen 0: >= 5 million yen)	41.13%	0.49	0	1	44.89%	0.50	0	1
Working/full-time housewife status								
Full-time employed worker (1: full-time employed worker, 0: otherwise)	54.85%	0.50	0	1	44.89%	0.50	0	1
Full-time housewife/student (1: full-time housewife/student, 0: otherwise)	27.80%	0.45	0	1	33.03%	0.47	0	1
Working for family business/ freelance (1: working for family business/ freelance, 0: otherwise)	1.84%	0.13	0	1	3.15%	0.17	0	1
Contracted/Part-time employed worker (1: contracted/part-time employed worker, 0: otherwise)	14.19%	0.35	0	1	17.34%	0.38	0	1
Unemployed (under job search) (1: unemployed, 0: otherwise)	1.32%	0.11	0	1	1.58%	0.12	0	1
Highest educational attainment								
Educational attainment 16 years or more (1: >=16 years, 0:<16 years)	84.78%	0.36	0	1	77.93%	0.41	0	1
Marital status								
Married (1: married, 0: otherwise)	97.47%	0.16	0	1	97.45%	0.16	0	1
Unmarried (1: unmarried, 0: otherwise)	1.61%	0.13	0	1	1.43%	0.12	0	1
Divorced, widowed, the others (1: divorced, widowed, the others, 0: otherwise)	0.92%	0.10	0	1	1.13%	0.11	0	1
Number of family members who have been involved in childcare on a daily bases Number of family members who have been involved in childcare on a daily bases in the past 2 months (We have specified the period as the past 2 months since it was the time most people have faced closure of childcare support center/nursery/kindergarten)	1.88	1.43	0	13	2.08	1.62	0	11

TABLE 2. Results of Analysis of Primiparas

	EPDS \geq 9			Anxiety			Anhedonia			Depression		
	Odds Ratio	[95% Conf. Interval]		Coefficients	[95% Conf. Interval]		Coefficients	[95% Conf. Interval]		Coefficients	[95% Conf. Interval]	
Experiences during COVID-19												
Changes in place of delivery	1.481	0.539 - 4.069		0.854 *	0.070 - 1.638		0.250	-0.189 - 0.689		1.433 *	0.128 - 2.737	
Cancellation of parenting classes	1.293	0.973 - 1.717		0.229	-0.040 - 0.497		0.068	-0.037 - 0.173		0.167	-0.053 - 0.388	
Prohibition of visitors at hospitals (before and after the delivery)	0.980	0.690 - 1.393		0.199	-0.127 - 0.524		-0.079	-0.207 - 0.049		-0.059	-0.327 - 0.210	
Prohibition of an entry of a partner into delivery room	1.271	0.876 - 1.844		0.187	-0.161 - 0.534		0.127	-0.013 - 0.268		0.324 *	0.022 - 0.625	
Cancellation of planned informal support	1.358 *	1.024 - 1.802		0.505 ***	0.222 - 0.787		0.055	-0.071 - 0.181		0.308 *	0.051 - 0.566	
Cancellation of planned formal support	1.292 *	1.013 - 1.647		0.323 **	0.091 - 0.555		0.108 *	0.007 - 0.209		0.352 ***	0.155 - 0.550	
Life style changes with a partner working from home	0.803	0.631 - 1.023		-0.145	-0.368 - 0.078		-0.027	-0.118 - 0.065		-0.210 *	-0.385 - -0.034	
Perceived risk (COVID-19 related)												
Financial difficulties	1.099 **	1.030 - 1.173		0.119 ***	0.055 - 0.183		0.029 **	0.004 - 0.053		0.113 ***	0.062 - 0.163	
COVID-19 infection	1.027	0.946 - 1.115		0.002	-0.077 - 0.082		-0.007	-0.038 - 0.024		-0.022	-0.084 - 0.041	
Not receiving formal childcare support	0.988	0.912 - 1.069		0.018	-0.054 - 0.091		0.016	-0.009 - 0.041		-0.025	-0.081 - 0.032	
Not receiving informal childcare support	1.227 ***	1.142 - 1.319		0.146 ***	0.077 - 0.216		0.080 ***	0.053 - 0.106		0.177 ***	0.123 - 0.231	
Place of residence (Ref: Other provinces)												
Tokyo/Kanagawa/Saitama/Chiba	1.405 *	1.066 - 1.851		0.593 ***	0.339 - 0.848		0.115 *	0.013 - 0.218		0.226 *	0.020 - 0.431	
Osaka/Kyoto/Hyogo	1.199	0.848 - 1.696		0.453 **	0.121 - 0.784		0.089	-0.047 - 0.225		0.271 *	0.003 - 0.539	
Aichi/Fukuoka	0.878	0.588 - 1.310		-0.018	-0.373 - 0.336		0.007	-0.113 - 0.128		0.140	-0.143 - 0.423	
Hokkaido	1.890	0.996 - 3.586		0.161	-0.424 - 0.746		0.276 *	0.010 - 0.542		0.410	-0.054 - 0.875	
Age of the respondents (Ref: Age <25 years)												
Age 25-29 years	0.656	0.379 - 1.135		-0.334	-0.926 - 0.259		-0.039	-0.288 - 0.209		-0.250	-0.740 - 0.241	

Age 30-34 years	0.618	0.358	-	1.067	-0.406	-0.999	-	0.186	-0.004	-0.255	-	0.247	-0.348	-0.841	-	0.144			
Age >=35 years	0.645	0.370	-	1.124	-0.528	-1.133	-	0.077	0.055	-0.199	-	0.308	-0.365	-0.864	-	0.133			
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Baby's age 6-11 months (Ref: age<=5 months)	0.982	0.751	-	1.283	0.090	-0.155	-	0.334	0.135	*	0.030	-	0.239	0.118	-0.085	-	0.322		
Lower income group (Ref: >= 5 million yen)	1.558	**	1.212	-	2.002	0.490	***	0.252	-	0.728	0.091	-0.002	-	0.185	0.268	**	0.078	-	0.459
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Working/full-time housewife status (Ref: Full-time employed worker)																			
Full-time housewife/student	0.870	0.664	-	1.141	-0.092	-0.348	-	0.163	-0.023	-0.124	-	0.079	-0.069	-0.265	-	0.126			
Working for family business/freelance	0.765	0.313	-	1.866	-0.139	-1.023	-	0.744	-0.166	-0.375	-	0.044	-0.347	-0.939	-	0.245			
Contracted/Part-time employed worker	0.947	0.675	-	1.328	0.189	-0.123	-	0.502	0.004	-0.129	-	0.138	0.008	-0.261	-	0.277			
Unemployed (under job search)	2.069	0.851	-	5.032	1.047	*	0.155	-	1.939	0.635	*	0.137	-	1.132	1.176	*	0.139	-	2.213
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Educational attainment 16 years or more (Ref: < 16 years)	1.017	0.734	-	1.409	0.018	-0.289	-	0.325	0.042	-0.087	-	0.171	0.101	-0.151	-	0.354			
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Marital status (Ref: Unmarried (never married))																			
Married	0.710	0.309	-	1.629	0.266	-0.577	-	1.109	-0.332	-0.886	-	0.222	-0.192	-1.008	-	0.625			
Divorced, widowed, the others	1.204	0.320	-	4.525	0.023	-1.334	-	1.380	-0.264	-1.161	-	0.633	0.214	-0.980	-	1.407			
Number of family members who have been involved in childcare on a daily bases in the past 2 months	0.930	0.851	-	1.015	-0.050	-0.126	-	0.026	-0.029	*	-0.055	-	-0.004	-0.067	*	-0.124	-	-0.010	
Number of household members (living with the respondent)	1.055	0.935	-	1.190	-0.035	-0.148	-	0.078	0.042	-0.008	-	0.092	0.072	-0.026	-	0.170			
Constant	0.163	**	0.053	-	0.505	1.484	*	0.354	-	2.614	0.114	-0.512	-	0.740	0.467	-0.565	-	1.499	
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Number of observation: 1741																			
Log likelihood= -957.59428				R-squared = 0.1146				R-squared = 0.0967				R-squared = 0.1255							
LR chi2(30)= 170.86***				F(29, 1711) = 8.40***				F(29, 1711) = 5.26***				F(29, 1711) = 6.64***							

Note: *** p<0.001, ** p<0.01, *p<0.05

For OLS regression, we use robust standard errors. They are not shown for brevity.

TABLE 3. Results of Analysis of Multiparas

	EPDS ≥ 9			Anxiety			Anhedonia			Depression		
	Odds Ratio	[95% Conf.	Interval]	Coefficients	[95% Conf.	Interval]	Coefficients	[95% Conf.	Interval]	Coefficients	[95% Conf.	Interval]
Experiences during COVID-19												
Changes in place of delivery	1.293	0.586 -	2.855	0.678 *	0.030 -	1.325	-0.121	-0.500 -	0.257	0.478	-0.206 -	1.162
Cancellation of parenting classes	1.249	0.889 -	1.755	0.426 **	0.123 -	0.728	-0.022	-0.146 -	0.102	0.141	-0.095 -	0.376
Prohibition of visitors at hospitals (before and after the delivery)	1.031	0.670 -	1.586	-0.075	-0.474 -	0.325	0.011	-0.151 -	0.173	0.038	-0.277 -	0.353
Prohibition of an entry of a partner into delivery room	1.224	0.816 -	1.835	-0.038	-0.402 -	0.326	0.018	-0.134 -	0.169	-0.016	-0.306 -	0.274
Cancellation of planed informal support	0.919	0.637 -	1.326	-0.032	-0.357 -	0.294	-0.027	-0.179 -	0.125	-0.152	-0.420 -	0.116
Cancellation of planed formal support	1.359 *	1.017 -	1.815	0.102	-0.157 -	0.361	0.141 *	0.019 -	0.263	0.241 *	0.031 -	0.450
Life style changes with a partner working from home	0.918	0.679 -	1.242	-0.146	-0.413 -	0.122	-0.015	-0.138 -	0.108	0.058	-0.169 -	0.286
Perceived risk (COVID-19 related)												
Financial difficulties	1.084 *	1.002 -	1.173	0.141 ***	0.070 -	0.212	0.039 *	0.004 -	0.073	0.103 ***	0.047 -	0.160
COVID-19 infection	1.000	0.907 -	1.102	-0.002	-0.093 -	0.089	0.007	-0.037 -	0.051	-0.019	-0.096 -	0.057
Not receiving formal childcare support	0.970	0.881 -	1.068	0.050	-0.034 -	0.134	-0.003	-0.039 -	0.034	-0.038	-0.106 -	0.029
Not receiving informal childcare support	1.253 ***	1.146 -	1.369	0.165 ***	0.085 -	0.246	0.091 ***	0.055 -	0.127	0.170 ***	0.108 -	0.232
Place of residence (Ref: Other provinces)												
Tokyo/Kanagawa/Saitama/Chiba	1.424 *	1.030 -	1.969	0.400 **	0.105 -	0.696	0.144 *	0.011 -	0.277	0.216	-0.024 -	0.456
Osaka/Kyoto/Hyogo	1.343	0.895 -	2.015	0.257	-0.096 -	0.610	0.107	-0.057 -	0.271	0.272	-0.028 -	0.571
Aichi/Fukuoka	0.838	0.537 -	1.308	-0.121	-0.473 -	0.232	0.010	-0.146 -	0.166	-0.216	-0.483 -	0.050
Hokkaido	1.640	0.739 -	3.639	0.558	-0.169 -	1.286	-0.044	-0.414 -	0.326	0.161	-0.547 -	0.869

Age of the respondents (Ref: Age <25 years)

Age 25-29 years	1.140	0.516	-	2.516	0.158	-0.601	-	0.918	0.199	-0.133	-	0.531	0.111	-0.568	-	0.791
Age 30-34 years	0.826	0.383	-	1.779	-0.243	-0.957	-	0.470	0.084	-0.217	-	0.384	-0.106	-0.747	-	0.534
Age >=35 years	0.599	0.276	-	1.301	-0.578	-1.292	-	0.137	0.064	-0.232	-	0.359	-0.288	-0.926	-	0.350

Baby's age 6-11 months (Ref: age<=5 months)	1.705	**	1.248	-	2.330	0.663	***	0.384	-	0.942	0.207	**	0.076	-	0.338	0.430	***	0.197	-	0.663
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Lower income group (Ref: >= 5 million yen)	1.377	*	1.033	-	1.835	0.075	-0.176	-	0.325	0.161	**	0.047	-	0.274	0.217	*	0.014	-	0.420
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Working/full-time housewife status (Ref: Full-time employed worker)

Full-time housewife/student	0.838	0.609	-	1.152	-0.082	-0.351	-	0.188	-0.086	-0.206	-	0.033	-0.180	-0.400	-	0.040	
Working for family business/freelance	1.589	0.763	-	3.312	0.169	-0.581	-	0.919	0.020	-0.323	-	0.364	-0.197	-0.793	-	0.399	
Contracted/Part-time employed worker	1.180	0.811	-	1.719	-0.045	-0.387	-	0.297	0.042	-0.114	-	0.199	-0.172	-0.437	-	0.092	
Unemployed (under job search)	3.142	*	1.224	-	8.064	0.868	-0.156	-	1.892	0.410	-0.098	-	0.919	0.525	-0.343	-	1.393

Educational attainment 16 years or more (Ref: < 16 years)	1.015	0.719	-	1.434	0.024	-0.290	-	0.337	-0.127	-0.276	-	0.023	-0.013	-0.275	-	0.250
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Marital status (Ref: Unmarried (never married))

Married	0.375	0.131	-	1.070	-0.683	-1.834	-	0.467	-0.349	-0.942	-	0.245	-1.724	**	-3.015	-	-0.434	
Divorced, widowed, the others	0.237	0.046	-	1.227	-1.075	-2.802	-	0.651	-0.884	**	-1.494	-	-0.274	-1.755	-3.558	-	0.048	
Number of family members who have been involved in childcare on a daily bases in the past 2 months	0.927	0.848	-	1.013	-0.033	-0.115	-	0.049	-0.016	-0.051	-	0.019	-0.006	-0.073	-	0.062		
Number of household members (living with the respondent)	1.027	0.932	-	1.131	-0.036	-0.119	-	0.047	0.019	-0.025	-	0.063	0.008	-0.064	-	0.079		
Constant	0.221	0.052	-	0.947	2.130	**	0.641	-	3.620	0.212	-0.498	-	0.922	2.060	**	0.529	-	3.591

Number of observation: 1332

Log likelihood= -957.59428

R-squared = 0.1216

R-squared = 0.0941

R-squared = 0.1105

Note: *** p<0.001, ** p<0.01, *p<0.05

For OLS regression, we use robust standard errors. They are not shown for brevity.

Figures

Percentage of EPDS \geq 9

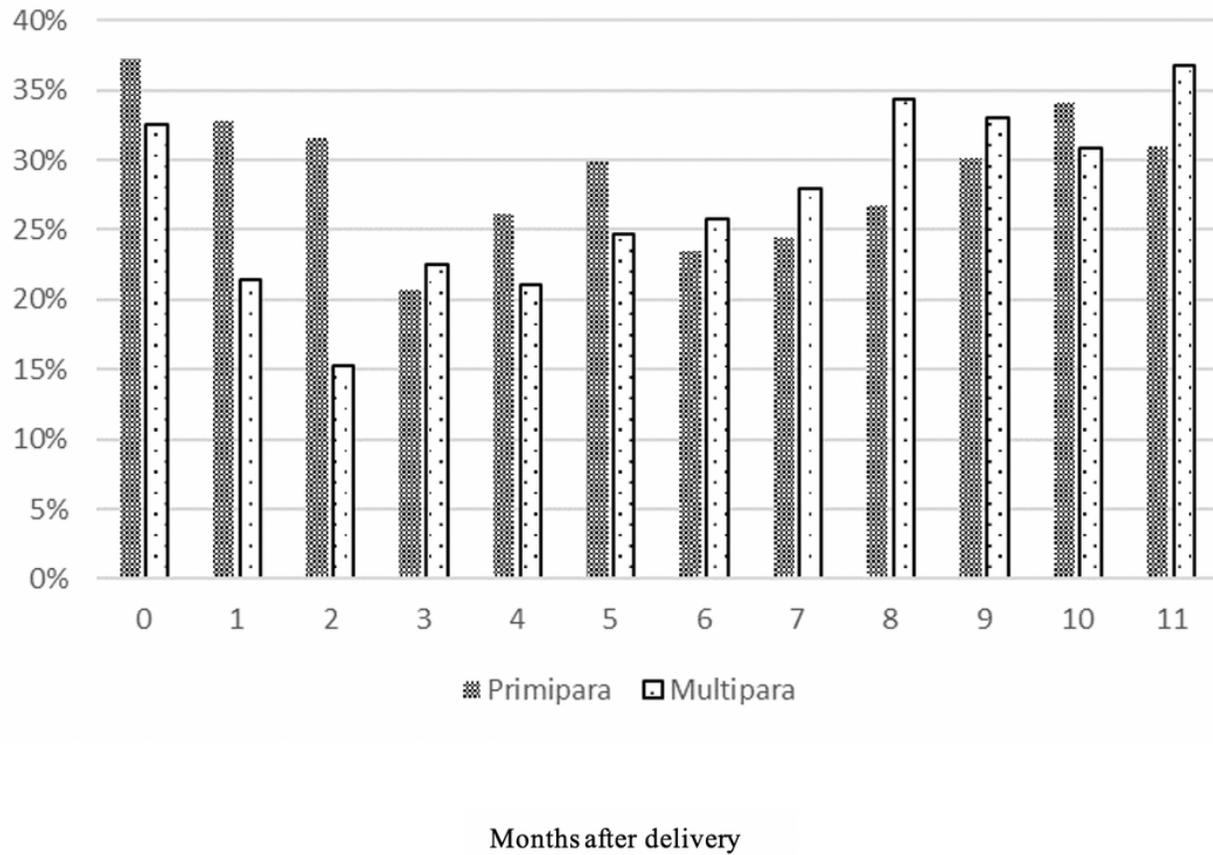


Figure 1

Point prevalence of EPDS \geq 9 for each month

Scores

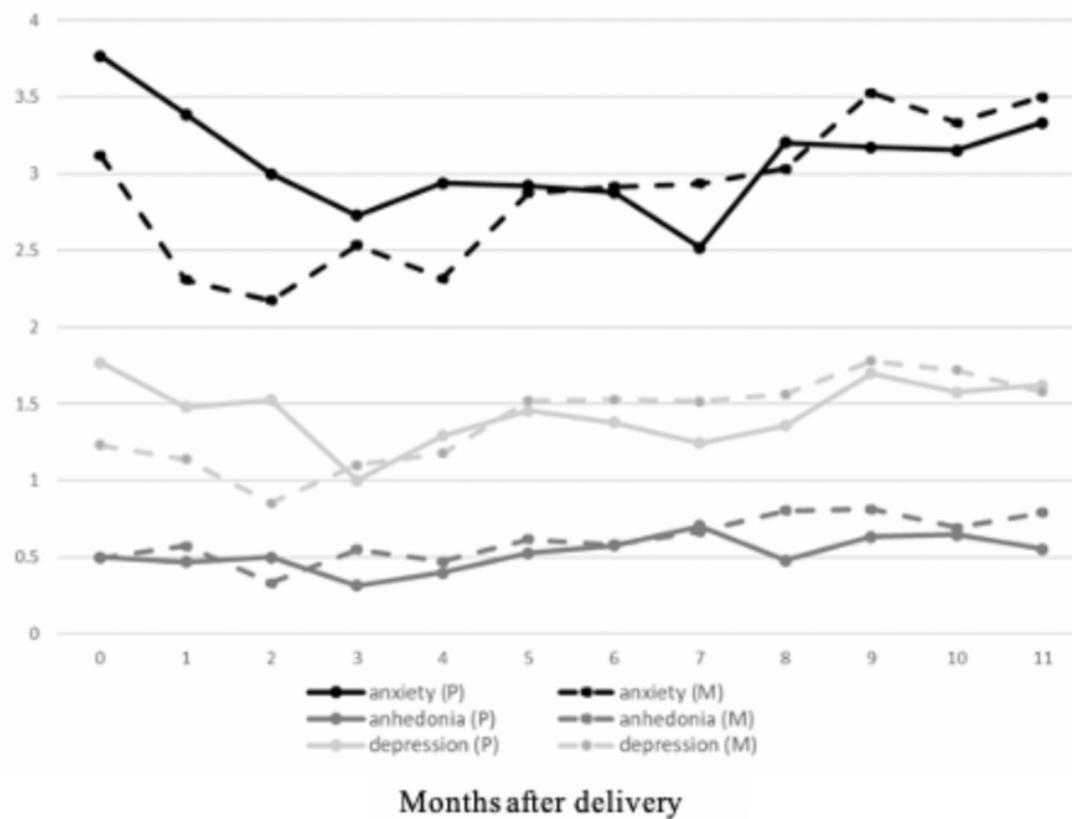


Figure 2

Factor scores for each month