Original Research

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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 2019 (COVID-19) crisis in Japan.

Methods: An online survey conducted from May 31 to June 6, 2020 resulted in 3073 responses obtained from mothers with infants < 12 mo.

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, ie, 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.

Japan has been affected by the coronavirus disease 2019 (COVID-19) pandemic as elsewhere, with the first case reported on December 31, 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. Studies 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 due to deterioration of the household economic situation, difficulties in work and study, loneliness, and lack of social interations.[1–3] Mothers with infants are one of the most vulnerable groups. In fact, depression during the first year after childbirth, frequently called as postpartum depression (PPD) is not uncommon and estimated to be around 13% worldwide,[4,5] 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 mo, 11.5% in 3-6 mo, and 11.5% in 6-12 mo after birth.[6][a] To understand the mechanisms of PPD, there are 2 main classical models, and a newly proposed one based on these classical models. First, 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.[9–11] Second, 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 of social support have been reported earlier.[12,13] Furthermore, 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.[12,13] More recently, the bio-psycho-socio-cultural model was proposed[7] that emphasizes the integrated role of

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[a]Definition of postpartum period has not yet gained consensus. In the past studies, it ranged from a few days to 12 months.[7] 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. Furthermore, we use the term postpartum depression to refer to depression occurring during that time. moreover, note that U.S. National Library Medicine [8] defines postpartum depression as it can begin anytime within the first year after childbirth.

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-socio-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 mothers with infants due to unexpected labor environment, including prohibited entry of family members or a partner into the delivery room, and change in hospitals for delivery.[b] 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 revealed 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,[15] 23.6% (EPDS >12) in Belgium,[16] and 30% (EPDS ≥ 10) in China.[17] Because these reports used a nonuniform definition of the point prevalence of depressive symptoms in terms of EPDS cutoff and the timing of the survey, comparison between the countries are difficult. However, it is important to note that the prevalence was consistently more than double the values in the pre-crisis period for each country. Notably, these countries differ in the severity of the infection spread. The study in Italy used the data from northeastern Italy, where the infection was a "hot spot", while China and Belgium used the data from a less severely infected area. One common thing in all the 3 countries was that they all experienced lockdown, and their results suggested the negative effects regardless of the infection rate. Japan experienced a low infection rate with mildly imposed lockdown, and studies in Japan also found negative impacts of COVID-19 on postpartum women.[18,19] The shortcomings of the previous studies were, however, they have not explored details of adverse events related to pregnancy/delivery/childcare, economic crisis and uncertainty during the crisis, and fear of the infection of COVID-19, which are important for policy implications.

PPD has a serious repercussion as a recent review, which included 122 studies, revealed that mothers with PPD may suffer prolonged depression/ depressive symptoms, have difficulties in their relationship with their partners, and have suicidal ideation. Infants are also affected, including poor health, and slow motor, cognitive, and language development. Mother-to-infant bonding is often negatively affected, which has long-term consequences.[20] Thus, the significance of this study is to explores the depressive symptoms in postpartum women during the coronavirus disease (COVID-19) crisis in Japan with focuses on crisis induced experiences they have undergone.

Methods

We used a cross-sectional study design, in which an online survey was conducted from May 31 to June 6, 2020, through 2 companies

[b]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.[14] Because of this tradition, we have included the experience 'Change in the place of delivery' due to COVID-19 as 1 of the variables here.

(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 nonactive and nontarget 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 approximately 1.3% of the participants accessed our survey Web page. Among those who accessed our survey Web page, approximately 74% replied (5650 replies). The respondents were from all prefectures, except Wakayama, corresponding to the population size of each prefecture.

Among the 5650 replies, 3406 were from women with babies under 12 mo of age. Among them, we used 3073 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 used to measure depressive symptoms.[21] 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 2 groups: primiparas and multiparas.[c] 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. The validity of the cutoff score being 9 has been validated by Okano,[21] and this is the commonly used one in Japan. 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,[23] 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 squares (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 cutoff 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 cutoff 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 3 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 5 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

[c]Primipara is defined as 'a woman who has been delivered only once of a foetus or foetuses born alive or dead with an estimated gestation duration of 20 or more weeks' and Multipara is defined as 'a woman who has completed 2 or more pregnancies with gestational ages at least 20 weeks'.[22]

Table 1. Summary statistics

Variable	Primipara (n=1741)				Multipara (n= 1332)			
	Percentage/ Mean	SD	Min	Max	Percentage/ Mean	SD	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								
COVID-19 related variables								
Experiences during COVID-19								
Changes of 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 mo								
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
Respondents' socio-demographic, -economic information								
Age of the respondents (mother's age)								
Age <25 y (1: age <25 y, 0: otherwise)	4.54%	0.21	0	1	3.15%	0.17	0	1
Age 25-29 y (1: 25 y<=age<30, 0: otherwise)	27.11%	0.44	0	1	13.96%	0.35	0	1
Age 30-34 y (1: 30 y<=age<35, 0: otherwise)	39.06%	0.49	0	1	41.14%	0.49	0	1
Age >=35 y (1: age >=35 y, 0: otherwise)	29.29%	0.46	0	1	41.74%	0.49	0	1
Baby's age 6-11 mo (1: 6 mo<=baby's age<=11 mo, 0: age<=5 mo)	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 y or more (1: >=16 y, 0:<16 y)	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

(*Continued*)

Table 1. (*Continued*)

Variable	Primipara (n=1741)				Multipara (n= 1332)			
	Percentage/ Mean	SD	Min	Max	Percentage/ Mean	SD	Min	Max
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 mo (We have specified the period as the past 2 mo 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
Number of household members (living with the respondent)	2.39	0.94	1	9	3.60	1.49	1	12

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 mo (37.2%) and the lowest was at 3 mo (20.7%), and a continuous and steady increase was observed after 6 mo up to 10 mo. For multiparas, there was an increasing trend after 3 mo of delivery, and it reached the highest at 11 mo (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 mo of delivery, the average percentage became higher for multiparas (29.2%) than for primiparas (27.7%). These results are shown in Figure 1.

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

[d]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.

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 that 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 y with multipara being older in general, and nearly 98% were married. Approximately 80% of the respondents had more than 16 y 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
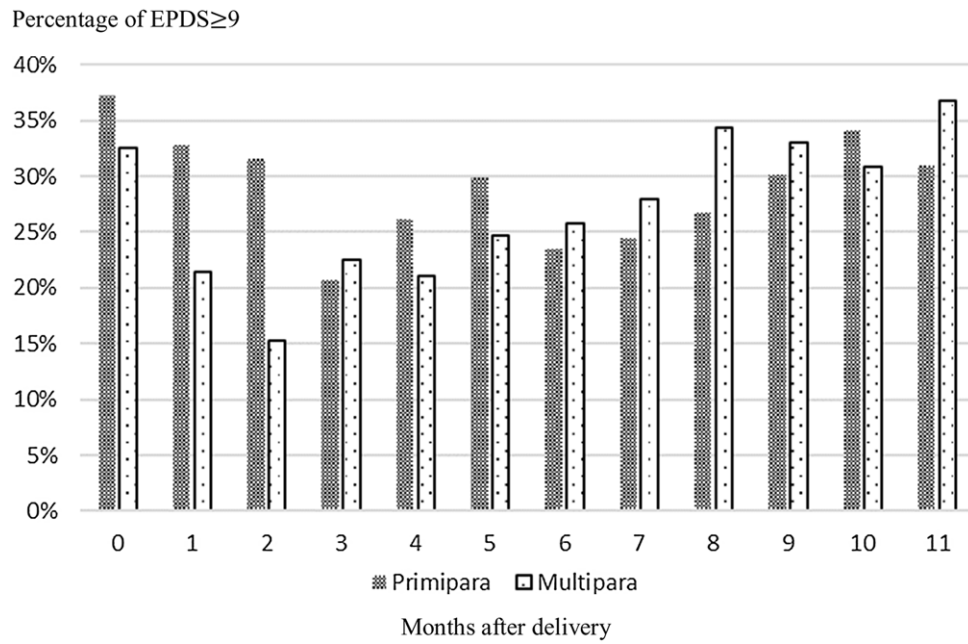
Figure 1. Point prevalence of EPDS ≥ 9 for each month.
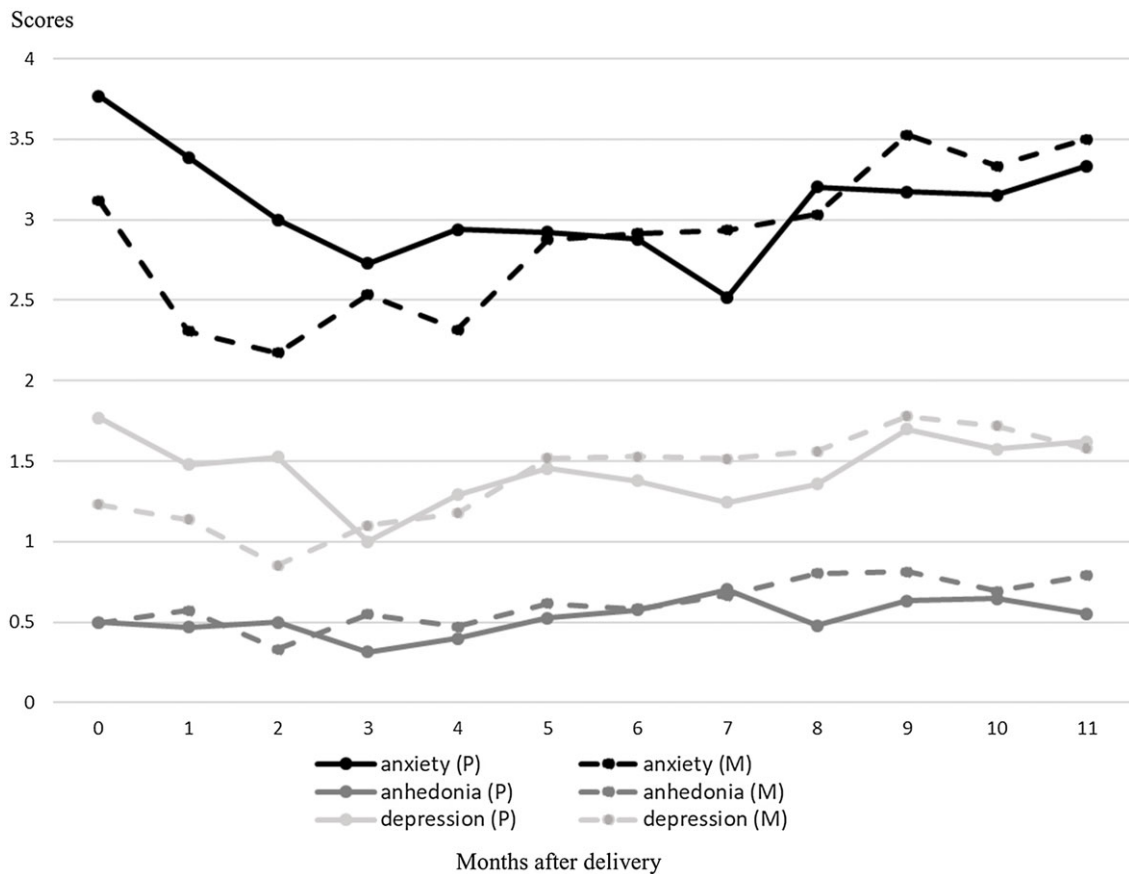
Figure 2. Factor scores for each month.

Table 2. Results of analysis of primiparas

	EPDS ≥ 9			Anxiety			Anhedonia			Depression		
	OR	95% CI		Coefficients	95% CI		Coefficients	95% CI		Coefficients	95% CI	
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 planed 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 planed 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 y)												
Age 25-29 y	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 y	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 y	0.645	0.370	1.124	−0.528	−1.133	0.077	0.055	−0.199	0.308	−0.365	−0.864	0.133
Baby's age 6-11 mo (Ref: age<=5 mo)	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
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
Educational attainment 16 y or more (Ref: < 16 y)	1.017	0.734	1.409	0.018	−0.289	0.325	0.042	−0.087	0.171	0.101	−0.151	0.354
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

(*Continued*)

Table 2. (*Continued*)

	EPDS ≥ 9			Anxiety			Anhedonia			Depression		
	OR	95% CI		Coeffi-cients	95% CI		Coeffi-cients	95% CI		Coeffi-cients	95% CI	
Number of family members who have been involved in childcare on a daily bases in the past 2 mo	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
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.

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 significantly 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 toward 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 with 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.

Limitation

Our study has some limitations. First, this study involved an online survey by sending e-mails to the registered users of 2 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 the online survey. Second, there is no control group for this study. Considering the impossibility to overcome these limitations totally, research to accumulate the evidence would be helpful.

Discussion

The percentage of postpartum women with depressive symptoms (EPDS ≥ 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%).[24] The factor scores suggest that the anxiety score was the highest, and it continued to be high across the postpartum period up to 11 mo. Moreover, other factor scores were too elevated compared with 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.[25] 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.[25] For multiparas, an elevation in the factor scores was even more remarkable. In the earlier study, the highest scores were recorded at 20 wk 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 mo, and the highest score recorded in our analysis were 2, 5, and 2.3 times higher for anxiety, anhedonia, and depression, respectively.

Table 3. Results of analysis of multiparas

	EPDS ≥ 9			Anxiety			Anhedonia			Depression		
	OR	95% CI		Coefficients	95% CI		Coefficients	95% CI		Coefficients	95% CI	
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 y)												
Age 25-29 y	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 y	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 y	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 mo (Ref: age<=5 mo)	1.705**	1.248	2.330	0.663***	0.384	0.942	0.207**	0.076	0.338	0.430***	0.197	0.663
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
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

(Continued)

Table 3. (*Continued*)

	EPDS ≥ 9			Anxiety			Anhedonia			Depression		
	OR	95% CI		Coefficients	95% CI		Coefficients	95% CI		Coefficients	95% CI	
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 y or more (Ref: < 16 y)	1.015	0.719	1.434	0.024	−0.290	0.337	−0.127	−0.276	0.023	−0.013	−0.275	0.250
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 mo	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		
	LR chi2(30)= 170.86***			F(29, 1302) = 6.93***			F(29, 1302) = 4.36***			F(29, 1302) = 4.80***		

Note: *** $P<0.001$, ** $P<0.01$, *$P<0.05$.
For OLS regression, we use robust standard errors. They are not shown for brevity.

Our descriptive statistics showed 2 notable characteristics during the crisis. First, depressive symptoms were high even after a few months of delivery. Second, the risk of having depressive symptoms for primiparas and multiparas was not different, which is contradictory to previous findings.[6] Furthermore, a higher percentage of point prevalence of depressive symptoms for multiparas than for primiparas was found 3 months and onward after delivery. Combined with the regression analyses, the reason behind this is considered a lack of both formal and informal social support. Since the earlier work by O'Hara et al.,[4] the critical role of social support for PPD has been recognized across different times and places. In our analysis, cancelling planned formal support was independently correlated with depressive symptoms after considering the number of family members involved in daily childcare during the past 2 mo. In addition, a higher perceived risk of not receiving informal support for childcare increased the risk of depression when all other factors were held constant. Schools and kindergartens were closed during the early times of the COVID-19 crisis. Therefore, mothers with more than 1 child were likely to face more physical burdens in caring for the other children. Additionally, babies start complementary feeding after 6 mo, increasing mothers' physical activity, especially if mothers have to look after the older children, contributing to the higher prevalence of depressive symptoms in mothers with older infants. These findings reveal the importance of childcare services in supporting mothers' mental health, and the need to keep service provision as consistent as possible with infection control.

Regression analysis also found that several additional factors directly related to COVID-19 negatively affecting mothers' mental well-being. These included a change in the place of delivery and cancellation of parenting classes. They affected both primiparas and multiparas to have elevated anxiety and depression, which are consistent findings with Tsuno et al.,[19] suggesting the direct negative impacts of adverse events during the COVID-19. It is recommended that service providers need to balance their services to mothers and infection control, considering the significant negative impact on mothers' mental well-being.

Another finding with policy implications is that 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 ≥ 9 and elevated all the factor scores for both primiparas and multiparas, suggesting that economic uncertainty independently increased the risk. This finding is consistent with previous literature suggesting the robust negative impacts of poverty on maternal mental health.[26] Mothers' characteristics showed that unmarried mothers, specifically multiparas, faced an increased risk of higher anhedonia and depression. Single parents might face reduced social support because there is no partner and higher poverty risk. Shu[27] reported that female workers faced greater risk of dismissal and termination of contracts during the COVID-19 crisis, and the impact was particularly severe for contract workers, including many single mothers. Moreover, being a single mother with more children increases the likelihood of more financial burdens and anxiety, leading to depression. These findings have important implications for public policy as these economic impacts result from the government's COVID-19 containment policy. Although containment is important, the balance between economic activities and the risk of infection

spread must be carefully examined. Moreover, more attention should be given to this issue because the negative economic impact on females, particularly single mothers, might be larger than the others.

Conclusions

We found a high prevalence rate of depression among mothers with a child less than 12 mo 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. Furthermore, 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 because 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 during this prolonged COVID-19 pandemic.

References

1. **Fukase Y, Ichikura K, Murase H, et al.** Depression, risk factors, and coping strategies in the context of social dislocations resulting from the second wave of COVID-19 in Japan. *BMC Psychiatry.* 2021;21(1):33. doi: 10.1186/s12888-021-03047-y.
2. **Horita R, Nishio A, Yamamoto M.** Lingering effects of COVID-19 on the mental health of first-year university students in Japan. *PLoS One.* 2022;17(1):e0262550. doi: 10.1371/journal.pone.0262550
3. **Odani S, Shinozaki T, Shibuya K, et al.** Economic hardships and self-reported deterioration of physical and mental health under the COVID-19 pandemic: a cross-sectional study, 2020, *Japan. J Epidemiol.* 2022;32(4):195-203. doi: 10.2188/jea.JE20210268
4. **O'Hara MW, Rehm LP, Campbell SB.** Postpartum depression. A role for social network and life stress variables. *J Nerv Ment Dis.* 1983;171(6):336-341.
5. **O'Hara MW, Swain AM.** Rates and risk of postpartum depression—a meta-analysis. *Int Rev Psychiatry.* 1996;8(1):37-54. doi: 10.3109/09540269609037816
6. **Tokumitsu K, Sugawara N, Maruo K, et al.** Prevalence of perinatal depression among Japanese women: a meta-analysis. *Ann Gen Psychiatry.* 2020;19(1):41. doi: 10.1186/s12991-020-00290-7
7. **Halbreich U.** Postpartum disorders: multiple interacting underlying mechanisms and risk factors. *J Affect Disord.* 2005;88(1):1-7. doi: 10.1016/j.jad.2005.05.002
8. **US National Library Medicine.** Postpartum depression. 2020. Accessed December 1, 2020. https://medlineplus.gov/postpartumdepression.html
9. **Douma SL, Husband C, O'Donnell ME, et al.** Estrogen-related mood disorders: reproductive life cycle factors. *ANS Adv Nurs Sci.* 2005;28(4):364-375. doi: 10.1097/00012272-200510000-00008
10. **Glynn LM, Sandman CA.** Evaluation of the association between placental corticotrophin-releasing hormone and postpartum depressive symptoms. *Psychosom Med.* 2014;76(5):355-362. doi: 10.1097/PSY.0000000000000066
11. **Moses-Kolko EL, Berga SL, Kalro B, et al.** Transdermal estradiol for postpartum depression: a promising treatment option. *Clin Obstet Gynecol.* 2009;52(3):516-529. doi: 10.1097/GRF.0b013e3181b5a395
12. **Pearlin LI, Lieberman MA, Menaghan EG, et al.** The stress process. *J Health Soc Behav.* 1981;22(4):337-356.
13. **O'Hara MW, Rehm LP, Campbell SB.** Predicting depressive symptomatology: cognitive-behavioral models and postpartum depression. *J Abnorm Psychol.* 1982;91(6):457-461. doi: 10.1037//0021-843x.91.6.457
14. **Mitsubishi UFJ Research & Consulting.** Research Report on Collaborative Work of Health Care Sectors for Pregnant and Postpartum Women's Mental Health. 'Ninsanpu ni Taisuru Mental Care no tameno Hoken/Iryo no Renkei Taisei ni kansuru Chosa Kenkyu Hokokusho'. 2018. Accessed December 1, 2020. https://www.mhlw.go.jp/content/11900000/000520478.pdf
15. **Zanardo V, Manghina V, Giliberti L, et al.** Psychological impact of COVID-19 quarantine measures in northeastern Italy on mothers in the immediate postpartum period. *Int J Gynecol Obstet.* 2020;150(2):184-188. doi: 10.1002/ijgo.13249
16. **Ceulemans M, Hompes T, Foulon V.** Mental health status of pregnant and breastfeeding women during the COVID-19 pandemic: a call for action. *Int J Gynecol Obstet.* 2020;151(1):146-147. doi: 10.1002/ijgo.13295
17. **Liang P, Wang Y, Shi S, et al.** Prevalence and factors associated with postpartum depression during the COVID-19 pandemic among women in Guangzhou, China: a cross-sectional study. *BMC Psychiatry.* 2020;20(1):557. doi: 10.1186/s12888-020-02969-3
18. **Suzuki S.** Psychological status of postpartum women under the COVID-19 pandemic in Japan. *J Matern Fetal Neonatal Med.* 2020;35(9):1798-1800. doi: 10.1080/14767058.2020.1763949
19. **Tsuno K, Okawa S, Matsushima M, et al.** The effect of social restrictions, loss of social support, and loss of maternal autonomy on postpartum depression in 1 to 12-months postpartum women during the COVID-19 pandemic. *J Affect Disord.* 2022;307:206-214. doi: 10.1016/j.jad.2022.03.056
20. **Slomian J, Honvo G, Emonts P, et al.** Consequences of maternal postpartum depression: a systematic review of maternal and infant outcomes. *Womens Health (Lond).* 2019;15:1745506519844044. doi: 10.1177/1745506519844044
21. **Okano T.** Validation and reliability of Japanese version of EPDS. *Arch Psychiatr Diagn Clin Eval.* 1996;7:525-533.
22. **Cunningham FG, Leveno KJ, Dashe JS, et al.** *Williams Obstetrics.* 26th ed. Mcgraw-Hill Education 2022;1304.
23. **Kubota C, Inada T, Nakamura Y, et al.** Stable factor structure of the Edinburgh Postnatal Depression Scale during the whole peripartum period: Results from a Japanese prospective cohort study. *Sci Rep.* 2018;8(1):17659. doi: 10.1038/s41598-018-36101-z
24. **Nishigori H, Sugawara J, Obara T, et al.** Surveys of postpartum depression in Miyagi, Japan, after the great east Japan earthquake. *Arch Womens Ment Health.* 2014;17(6):579-581. doi: 10.1007/s00737-014-0459-y
25. **Takehara K, Tachibana Y, Yoshida K, et al.** Prevalence trends of pre-and postnatal depression in Japanese women: a population-based longitudinal study. *J Affect Disord.* 2018;225:389-394. doi: 10.1016/j.jad.2017.08.008
26. **Robertson E, Grace S, Wallington T, et al.** Antenatal risk factors for postpartum depression: a synthesis of recent literature. *Gen Hosp Psychiatry.* 2004;26(4):289-295. doi: 10.1016/j.genhosppsych.2004.02.006
27. **Shu E.** Corona Shock to Jyosei no Koyo Kiki [COVID-19 Shock and Crisis of Female Employment Conditions] *JILPT Discussion Paper* 2021;21-09. https://www.jil.go.jp/institute/discussion/2021/documents/DP21-09.pdf