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Changes in the association between postpartum depression and mother-infant bonding by parity: Longitudinal results from the Japan Environment and Children's Study

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ABSTRACT

The results of several epidemiological studies have shown a moderate association between postpartum depression (PPD) and mother-infant bonding (MIB); however, associations and changes that longitudinally considered parity were not reported. We investigated the possible association between PPD and MIB at one month after birth, in addition, the changes of these indices by parity. From a dataset comprising 103,099 maternal registrations in The Japan Environment and Children's Study, the present study analyzed complete data on questionnaires for 76,363 women who participated once (cross-sectional group) and 3753 women who participated twice (follow-up subgroup). Edinburgh Postnatal Depression Scale (EPDS) scores and the Mother-to-Infant Bonding Scale-Japan (MIBS-J) scores were obtained one month after delivery. We identified the two factors of the MIBS-J, "lack of maternal feeling (LMF)" and "anxiety about caregiving (AC)" through confirmatory factor analysis. Associations between total EPDS and each factor of MIBS-J were evaluated using multiple regression analyses after adjusting for potential confounders. Total EPDS and both factors (LMF and AC) were positively related in the cross-sectional group (fully adjusted $\beta = 0.26$ and 0.39 for LMF and AC,

Abbreviations: PPD, Postpartum Depression; MIB, Mother-Infant Bonding; EPDS, Edinburgh Postnatal Depression Scale; MIBS-J, Mother-to-Infant Bonding Scale-Japan; LMF, Lack of Maternal Feeling; AC, Anxiety about Caregiving; JECS, The Japan Environment and Children's Study; EFA, Exploratory Factor Analysis; CFA, Confirmatory Factor Analysis; CFI, Comparative Fit Index; RMSEA, Root Mean Square Error of Approximation; MI, Multiple Imputation

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respectively), in the follow-up subgroup at first participation (0.24 and 0.40, respectively) and at the second participation (0.25 and 0.39, respectively). Multiple regression analyses revealed a robust, moderate relationship between postpartum depression and mother-infant bonding. PPD and MIB scores were shown to decrease from the first child to the second in the follow-up subgroup. Consequently, interventions which would increase a mother's child care experience and expertise would prevent PPD and improve MIB.

1. Introduction

Immediately after giving birth, most mothers experience a special surge of affection for their infants and automatically begin nursing them and keeping them clean. However, in some cases, the mother does not experience these feelings, or she may even feel an aversion to the child. Consequently, she is unable to bond with the child or provide it with adequate maternal care. Suggested risk factors include being unmarried or unemployed (Figueiredo et al., 2009), the social desirability and adult attachment (van Bussel et al., 2010), having a Caesarean section (Sockol et al., 2014) the trait anger of mother's personality (Kitamura et al., 2013), social support during pregnancy (Ohara et al., 2017, 2018), and a mother's perceptions of how she was reared as a child (Ohara et al., 2018). In addition, suggested child-related risk factors include crying at night (Yalcin et al., 2010) and, in cultures with a preference for boys, being a girl (Edhborg et al., 2011).

Much of this research has indicated an association between postpartum depression (PPD) and mother-infant bonding (MIB) difficulties (Dubber et al., 2015; Lefkovics et al., 2014; Muzik et al., 2013; O'Higgins et al., 2013; Ohoka et al., 2014; Sockol et al., 2014). Given that psychotherapy has been reported to be effective in treating PPD (Cuijpers et al., 2008; Dennis and Hodnett, 2007), such treatment may alleviate or prevent PPD and associated MIB difficulties. On the other hand, not all bonding difficulties are related to PPD, making it vital to better understand that relationship and other factors that may be involved.

Studies in Japan have shown that primipara women are at a significantly higher risk of PPD than multiparous women (Mori et al., 2016; Morikawa et al., 2015; Takehara et al., 2018) suggesting that, as the number of births increases, the frequency of PPD and its associated MIB difficulties may decrease. However, no studies have examined the effect of increasing parity on both PPD and MIB difficulties across births in the same mothers.

The Japan Environment and Children's Study (JECS) was a nationwide birth cohort study where 103,099 pregnant women registered to participate between 2011 and 2014. The first part of the present study took a cross-sectional look at the relationship between PPD and MIB in responses collected from these participants one month after giving birth. During the JECS's 2011–2014 recruitment period, it was possible for participants who became newly pregnant to re-register to participate again. Consequently, 5597 (5.4%) of the women participated in the study twice, and 48 (0.05%) participated three times. Taking the opportunity to do an unprecedented study on the effect of parity in the same mothers, the second part of the present study examined the relationship between PPD and MIB. In addition, the changes of these indices as parity increased was evaluated by comparing the first and second participation for women who gave birth twice during the study.

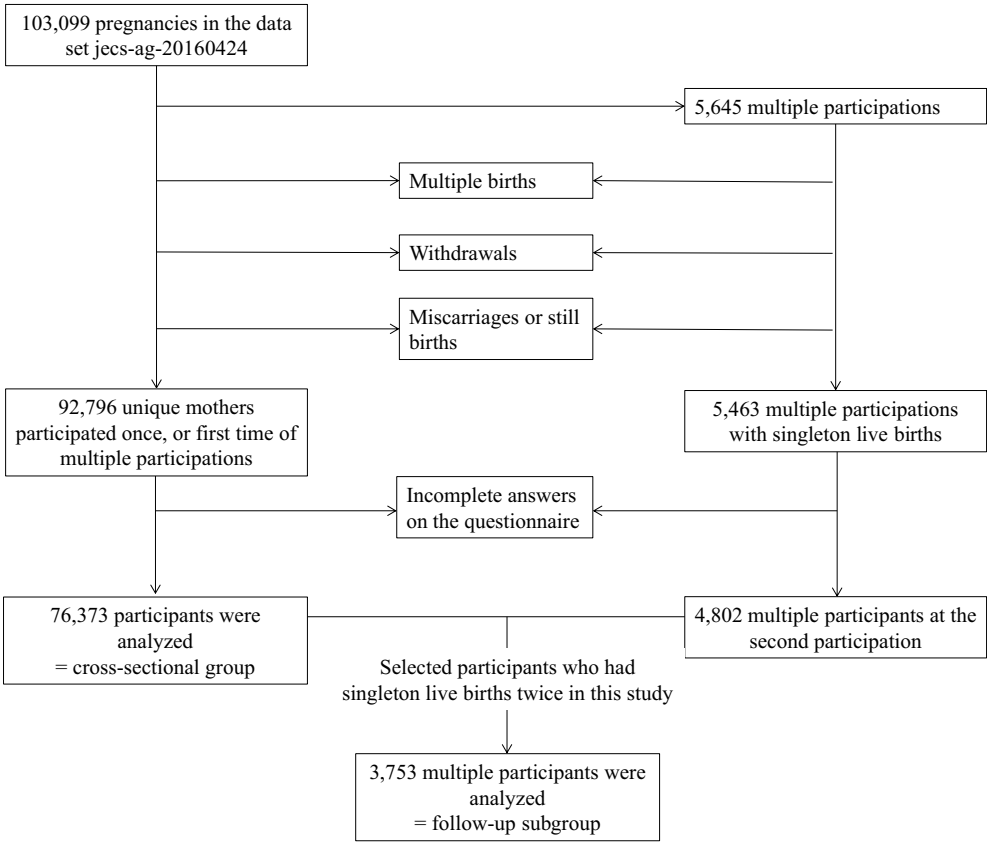

Fig. 1. Participant flow diagram.

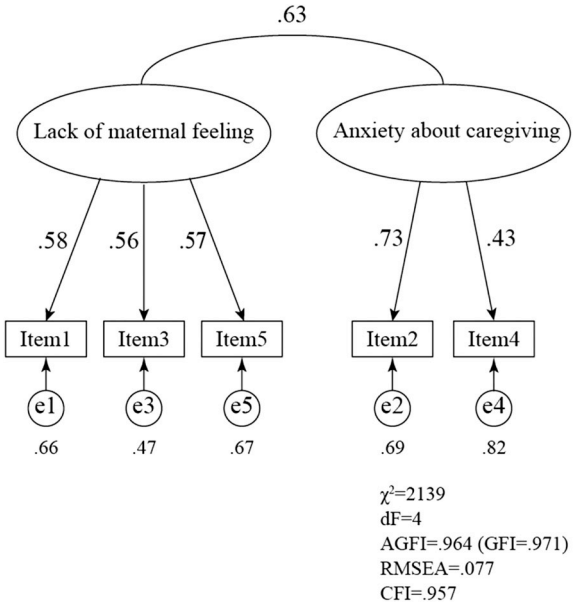

Fig. 2. Confirmatory factor analysis of the MIBS-J at one month after birth.

2. Methods

2.1. Study design

The JECS is a birth cohort study, which investigated the links between environmental factors and childhood health. Recruitment for the study occurred across fifteen regional centers within Japan from 2011 to 2014. Participant recruitment involved a face-to-face explanation of the survey to mothers, and self-administered informed consent was obtained. The details of the JECS design are well documented (Kawamoto et al., 2014; Michikawa et al., 2018).

The JECS protocol received approval from the Ethics Committees of all participating institutions and the Ministry of the Environment.

2.2. Study data

The present study used the dataset jecs-ag-20160424, which was released in June 2016 and revised in October 2016, along with the supplementary dataset jecs-ag-20160424-sp1. To arrive at the number of unique mothers who had a singleton live birth, from the data for the 103,099 registrants, we eliminated the data for the second and third births of the 5645 who had participated more than once, the data from 29 participants who withdrew from the study, the data from 949 participants who had multiple births, and the data from 3680 participants whose pregnancies ended in miscarriages or still births. Consequently, data from 92,796 mothers remained. After eliminating cases with insufficiently complete responses, the data from 76,373 mothers were analyzed as the "cross-sectional group" for the first analysis. Further, women who participated twice or more (n = 3753) formed the "follow-up subgroup" (Fig. 1).

2.3. Measurements

A self-administered questionnaire was administered to the mothers on 3 occasions—the first trimester, the second/third trimester, and one month after delivery—to collect demographics, medical and obstetric history, physical and mental health, lifestyle, occupation, and socioeconomic status. Questionnaires at one month after delivery were distributed by our staff to participants, then collected at the maternity hospital by our staff when participants visited for their one-month-old's health check-up. If the questionnaires could not be collected at that time, they were returned by post.

Questionnaires at one month after delivery included the Edinburgh Postnatal Depression Scale (EPDS) Japanese version (Okano et al., 1996) and 5 items from the Japanese version of the Mother-to-Infant Bonding Scale (MIBS-J) (Yoshida et al., 2012).

The EPDS consisted of 10 items, which were answered using a four-point scale (range = 0–30). We regarded a total EPDS score ≥9 as being indicative of PPD. This cut-off score of nine has been validated as the optimal threshold for the Japanese population when screened for minor and major depressive episodes among postpartum women, and has been found to have a sensitivity of 75% and 82% for minor and major depressive episodes and a specificity of 93% and 95%, respectively (Okano et al., 1996; Yamashita et al., 2000). Further, a score ≥9 has previously been used to indicate PPD in various prospective studies in Japan (Ishikawa et al., 2011; Kubota et al., 2014; Takehara et al., 2018). Previous research has shown that the EPDS has a three-factor structure that includes anxiety, depression, and anhedonia among Japanese mothers (Kubota et al., 2014). We referred to the factors and used the sum of the relevant items to represent "anxiety" (EPDS item 3, 4, and 5), "depression" (Item 7, 8, and 9), and "anhedonia" (Item 1 and 2) symptoms.

We used five items from the MIBS-J to assess mother-infant bonding. The five items of MIBS-J that have been commonly used by Japanese public health nurses to assess mother-infant bonding (Hirokawa et al., 2018) include the following: Item 1, "I feel loving towards my baby" (reversed scored); Item 2, "I feel scared or panicky when I have to do something for my baby"; "Item 3, "I feel nothing for my baby"; Item 4, "I enjoy doing things with my baby" (reversed scored); and Item 5, "I wish I did not have my baby." Item 2, Item 3 and Item 5 were rated on a four-point scale (0, not at all; 1, slightly, some of the time; 2, very much so, some of the time; and 3, very much so, most of the time). The scores were reversed for Item 1 and Item 4.

We examined the factor structure of the five items of MIBS-J by an exploratory factor analysis (EFA). The factor structure derived from the EFA data was confirmed by a confirmatory factor analysis (CFA). Our two factors structure (the $\chi^2/df = 5.3$, CFI = 0.954, and RMSEA = 0.077) had a similar fit to the two factors structure that was previously reported by Yoshida et al. (the $\chi^2/df = 6.1$, CFI = 0.912, and RMSEA = 0.077) (Yoshida et al., 2012). The factor analysis indicated a two factors model consisting of three items (Item 1, 3 and 5), and two items (Item 2 and 4). We named the former factor "lack of maternal feeling (LMF)" and the latter factor "anxiety about caregiving (AC)". Each factor was estimated by summing of their item scores (Fig. 2).

2.4. Statistical analysis

Data were expressed as means ± standard deviation or medians unless stated otherwise.

Multiple regression analyses were performed to examine the association between the factors from MIBS-J and total EPDS scores, adjusting for parity in Model 1, also adjusting for parity, mother age, highest educational level, annual household income, marital status, alcohol intake, smoking status, physical activity, history of anxiety disorder, history of anxiety, history of depression, history of schizophrenia, diagnostic record of mental disorder during pregnancy, infants' anomaly, infants' sex, and intensity and frequency of infants' crying in Model 2. See Supplementary Methods for details about covariates in Model 2.

Little's Missing Completely at Random test was found to be significant ($p < .001$) for the cross-sectional data set before exclusion of cases due to incomplete responses (N = 92,796), supporting the theory that the data was considered missing not at random (Little, 1988). Multiple imputation (MI) was used to account for incomplete answers. The 18 variables included in Model 2 of multiple regression analysis were used in imputation based on chained equations (van Buuren,

2007); 200 imputed data sets were constructed. We compared the standardized beta from multiple regression models applied to the imputed data (N = 92,796) and the data of complete cases across the all covariates (N = 76,373).

Statistically significant differences were determined by Welch's *t*-test or paired *t*-tests to compare means. Two-tailed *p*-values < .05 were considered statistically significant. Data were analyzed using SAS version 9.4 software (SAS Institute Inc., Cary, NC) and IBM SPSS Statistics, version 25 (IBM, Armonk, NY).

3. Results

3.1. Prevalence of PPD and characteristics of participants

Table 1 shows demographic and obstetric characteristics for the cross-sectional group (N = 76,373). In the cross-sectional group, 10,551 (13.8%) mothers had an EPDS score ≥ 9. Further, analysis of the 3753 participants in the follow-up subgroup showed that 541 (14.4%) and 383 (10.2%) had scores ≥ 9 after the first and second participation, respectively (See Supplementary Table 1).

The mean of maternal age and the rate of married about the follow-up subgroup increased from the first to the second participation, as expected. Moreover, the highest educational level, alcohol intake, smoking status, history of anxiety disorder, history of depression and history of anxiety disorder were almost same rate of the first and the second participation.

3.2. Multivariable regression for PPD and MIB

Table 2 shows the results of multiple regression analyses performed to look at the relationship between total EPDS scores and total MIBS-J, LMF or AC scores. Total EPDS scores and these scores were positively related in the unadjusted model and the adjusted models. In the complete case analysis based on 76,373 cases, the relationship between total EPDS and LMF scores were almost unchanged among the unadjusted model, Model 1, and Model 2 (β = 0.27, 0.27 and 0.26, respectively). On the other hand, the standardized-betas from the regression model between total EPDS and AC scores were changed by adjusted parity (β = 0.43 and 0.39, respectively). However, there was no change by adjusted parity or fully adjusted (β = 0.39 and 0.39, respectively).

In the multiple imputation analysis based on 92,769 cases, the relationship between total EPDS and LMF scores are almost unchanged among the unadjusted model, Model 1 and Model 2 (β = 0.29, 0.29 and 0.28, respectively). On the other hand, the standardized betas from the regression model between total EPDS and AC scores are the same as the complete case analysis. For follow-up subgroup scores after the first and second participations, total EPDS and the factor's scores were positively related. Further, the fully adjusted standardized beta values for the first and second participation scores were virtually unchanged.

3.3. The difference between EPDS score and MIBS-J scores between the first and second participation of the follow-up subgroup

Table 3 shows the means and standard deviations for the total EPDS scores, the three factors scores from the EPDS (e.g., anxiety, depression and anhedonia), total MIBS-J scores, the LMF scores, and the AC scores for the first and second participation scores in the follow-up subgroup. The total EPDS scores, anxiety scores, depression scores, total MIBS-J scores, LMF scores, and AC scores were lower in mothers at the time of their second participation than at their first participation.

4. Discussion

4.1. Prevalence of PPD and characteristics of participants

The number of women in the cross-sectional group who had depressive tendencies was consistent with the occurrence found in a systematic review of studies performed in Western countries (around 11% at approximately 1–3 months postpartum; Carroll, Daly and Begley, 2016) and it fell within the range of 10–15% found in Japanese studies (Choi et al., 2010; Kitamura et al., 2006; Kokubu et al., 2012).

In the follow-up subgroup, some maternal characteristics like the highest educational level, alcohol intake, smoking status and their history of illness are theoretically not changed from the first to the second participation because they are the same person's characteristics. There were small differences between the first and the second participation in these characteristics, however they were not statistically differences. This showed almost all participants in the follow-up subgroup appropriately answered.

4.2. The relationship between PPD and MIB

The relationship was calculated between the total EPDS, “lack of maternal feeling” (LMF), and “anxiety about caregiving” (AC) discovered by factor analysis based on the five items from MIBS-J. The results suggest that the PPD (EPDS scores) and bonding scores have a

Table 1
Demographic and obstetric characteristics of participants.

Characteristics	Cross-sectional group (N = 76,373)	
	Mean/n	(SD/%)
Maternal age, mean (SD)	31.5	(4.9)
Postpartum depression, n (%)	10,551	(13.8)
Previous deliveries, n (%)		
Nullipara	32,342	(42.4)
Multipara	44,031	(57.7)
Highest educational level (year), n (%)		
< 13	26,587	(34.8)
13-14	32,524	(42.6)
≥15	17,262	(22.6)
Annual household income (JPY), n (%)		
< 4 million yen	30,288	(39.7)
4–5.9 million yen	25,425	(33.3)
≥6 million yen	20,660	(27.1)
Marital status, n (%)		
Married (including common law marriage)	73,423	(96.1)
Single (never married)	2337	(3.1)
Divorced or widowed	613	(0.8)
Alcohol intake, n (%)		
Never drinker	69,707	(91.3)
Ex drinker	3450	(4.5)
Current drinker	3216	(4.2)
Smoking status, n (%)		
Never smoker	44,985	(58.9)
Ex smoker	28,286	(37.0)
Current smoker	3102	(4.1)
Physical activity, yes (%)	54,974	(72.0)
History of anxiety disorder, yes (%)	2144	(2.8)
History of depression, yes (%)	2258	(3.0)
History of schizophrenia, yes (%)	127	(0.2)
Diagnostic record of mental disorder during pregnancy, yes (%)	589	(0.8)
Infant's anomaly, yes (%)	1522	(2.0)
Infant's gender, n (%)		
Male	39,106	(51.2)
Female	37,267	(48.8)
Intensity and frequency of infant's crying, n (%)		
Quite often and long	12,844	(16.8)
Sometimes and short	60,000	(78.6)
Hardly	3529	(4.6)

Table 2
Results of multiple regression analyses between postpartum depression (total EPDS score) and bonding factors from MIBS-J at one-month after birth for cross-sectional group.

	Cross-sectional group				Follow-up subgroup			
	Complete case analysis (N = 76,373)		Multiple imputation analysis (N = 92,796)		First participation (n = 3,753)		Second participation (n = 3,753)	
	Standardized-beta	*p*	Standardized-beta	*p*	Standardized-beta	*p*	Standardized-beta	*p*
Total MIBS-J								
Crude	0.45	< .0001	0.45	< .0001	0.44	< .0001	0.40	< .0001
Model1	0.41	< .0001	0.42	< .0001	0.42	< .0001	0.40	< .0001
Model2	0.41	< .0001	0.41	< .0001	0.41	< .0001	0.41	< .0001
Lack of maternal feeling								
Crude	0.27	< .0001	0.29	< .0001	0.25	< .0001	0.25	< .0001
Model1	0.27	< .0001	0.29	< .0001	0.24	< .0001	0.25	< .0001
Model2	0.26	< .0001	0.28	< .0001	0.24	< .0001	0.25	< .0001
Anxiety about caregiving								
Crude	0.43	< .0001	0.43	< .0001	0.43	< .0001	0.39	< .0001
Model1	0.39	< .0001	0.39	< .0001	0.41	< .0001	0.39	< .0001
Model2	0.39	< .0001	0.39	< .0001	0.40	< .0001	0.39	< .0001

Model 1: adjusted for parity.
Model 2: adjusted for parity, mother's age, highest educational level, annual household income, marital status, alcohol intake, smoking status, physical activity, history of anxiety disorder, history of anxiety, history of depression, history of schizophrenia, diagnostic record of mental disorder during pregnancy, infant's anomaly, infant's sex, intensity and frequency of infant's crying.

Table 3
Means (SD) of EPDS score and bonding score in the follow-up subgroup.

Name of the scores	Follow-up subgroup (n = 3,753)				
	First participation		Second participation		*P
	mean	(SD)	mean	(SD)	
Total EPDS	**5.10**	**3.51**	**4.31**	**3.42**	**< .0001**
Anxiety	**2.95**	**1.96**	**2.37**	**1.90**	**< .0001**
Anheadnia	0.17	0.55	0.17	0.57	0.94
Depression	**0.65**	**1.07**	**0.52**	**1.04**	**< .0001**
Total MIBS-J	**1.51**	**1.37**	**0.97**	**1.22**	**< .0001**
Lack of maternal feeling	**0.20**	**0.60**	**0.18**	**0.60**	**0.04**
Anxiety about caregiving	**1.31**	**1.05**	**0.79**	**0.88**	**< .0001**

*P from paired T-test. Bold indicates significance ($p < 0.05$).

moderate relationship with Japanese multiparous women. Furthermore, it was revealed that robust results were shown even when adjusted for various modulators without changing the relationship (Table 2).

When conducting the complete case analysis, 20,473 cases were excluded out of 92,796; 92,796 were examined using MI. Compared with the complete case analysis the standardized-beta increased for LMF by approximately 0.02. However, there was no change in the relationship to AC, which suggests that excluding 20,473 cases did not substantially influence the results. Regarding AC, if adjusted by parity, the standardized-beta decreased by 0.04 points, and there is no variation in the fully adjusted scores. Therefore, AC appears to be slightly influenced by parity, but a moderate relationship between PPD and AC remains. As described above, the relationship of PPD and the two factors of MIBS-J showed that the relationship is at the moderate level, which is consistent with prior studies where the relationship was examined one month after birth (Ohoka et al., 2014; Taylor et al., 2005).

A multiple linear regression analysis was also conducted with the same participants for the first and second participations. The results of this study suggest that the score of each factor for PPD and bonding was slightly improved by parity in the first participations. However, PPD and bonding clearly showed moderate degree of relationships in the first and second participations of the follow-up subgroup as well.

4.3. The changed scores of EPDS items and MIBS-J items by parity

Comparing the average scores of each EPDS and MIBS-J by parity, all items of the EPDS and MIBS-J decreased except for item 7 of the EPDS (Supplementary Table 2). Also, in the follow-up subgroup, the second participation scores of the same participants decreased compared with those of the first participation (Table 3).

In Japan, it became clear that the risk of PPD is significantly higher for primipara women than multiparous women (Mori et al., 2016; Morikawa et al., 2015; Takehara et al., 2018). The findings that the multiparous women showed better scores and the same participants improved in the second participation supported the results of previous studies. According to the factor analysis conducted based on the responses to the EPDS Japanese version, three factors were found; anhedonia from items 1 and 2; anxiety from items 3, 4, and 5; and depression from items 7, 8, and 9 (Kubota et al., 2014). In this study, the factors that helped improve the second participation scores with the same participants were anxiety and depression, and the AC scores were also improved in the MIBS-J. This might imply that Japanese people feel less anxiety and depression by going through the birth experience. Prior studies overseas report that multiparous women tend to fall into anxiety and depression more frequently as compared to primiparas (Figueiredo and Conde, 2011), so improved PPD by parity might be associated with Japanese cultural factors (Morikawa et al., 2015).

The results of this study might indicate that Japanese primipara women are subject to suffer from anxiety and depression. Consequently, interventions for primiparas which would increase a child care experience would be a promising way to prevent or mitigate PPD and improve MIB.

In the future, we wish to perform additional follow-up studies over time after birth; however, in addition, other types of research such as intervention studies are needed to examine cause and effect relationships on this topic.

4.4. Limitation

Selective bias may have occurred in the follow-up subgroup. To be entered into the JECS study twice, the participants must have been pregnant during the recruitment period of 2011–2014, visited affiliated medical institutions for both pregnancies, and agreed to participate in the survey. It is possible that some participants experienced depressive symptoms with the first birth and did not consent to the survey with

their second pregnancy. In addition, when the second survey was completed by the follow-up subgroup, the responses of some participants might have been influenced by the memory of their first responses or social desirability (Kitamura et al., 1994; Windle, 1954, 1955). It is possible that scores might have been changed in EPDS and MIBS-J because of the influence of their memory of completing the survey from the first time.

4.5. Strength

The data used for the analyses came from a very large sample of women from all over Japan; therefore, our results could be represented the Japanese general population (Michikawa et al., 2018). We were also able to make comparisons between data for 2 consecutive births for the same women.

5. Conclusions

Our study revealed a robust, moderate relationship between PPD and MIB despite the influences of parity. However, many multiparous mothers' PPD and MIB scores decreased with the additional birth.

Declarations of interest

None.

Conflicts of interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2018.11.022.

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