



# Impact of intention and feeling toward being pregnant on postpartum depression: the Japan Environment and Children's Study (JECS)

Sachiko Baba<sup>1,2</sup> · Takashi Kimura<sup>3</sup> · Satoyo Ikehara<sup>3,4</sup> · Kaori Honjo<sup>5</sup> · Ehab S. Eshak<sup>3</sup> · Takuyo Sato<sup>6</sup> · Hiroyasu Iso<sup>3</sup> · Japan Environment & Children's Study Group

Received: 20 August 2018 / Accepted: 12 December 2018 / Published online: 27 December 2018  
© The Author(s) 2018

## Abstract

Pregnancy intention is reported to be associated with the risk of postpartum depression (PPD), but the impact of feelings toward being pregnant on PPD is unknown. We aimed to examine whether feelings toward being pregnant are associated with PPD at 1 month after childbirth. In our nationwide study between 2011 and 2014 in Japan, we used multivariate logistic regression analyses to examine the associations between pregnancy intention and feelings toward being pregnant with PPD [Edinburgh Postnatal Depression Scale (EPDS) score  $\geq 9$  or  $\geq 12$ ] among Japanese women. Among 92,431 women, 14.0 and 5.4% had PPD with EPDS scores  $\geq 9$  and  $\geq 12$ , respectively. Compared with women who felt very happy to be pregnant, those whose pregnancy was unintended but happy, unintended and confused, those who felt troubled, and those who felt no emotion toward being pregnant had increased risks of PPD [multivariable odds ratios (95% confidence intervals (CIs)) = 1.17 (1.11–1.22), 1.39 (1.29–1.49), 1.74 (1.42–2.14), and 1.58 (1.22–2.02), respectively, for EPDS score  $\geq 9$ ]. Those associations were more evident without antenatal possible mental illness (K6 score  $\leq 13$ ). Women whose pregnancy was unintended should be regarded as targets for the early detection and prevention of PPD irrespective of whether they felt happy or confused.

**Keywords** Unplanned pregnancy · Unwanted pregnancy · Emotion · Happiness · Postpartum depression

## Introduction

Postpartum depression (PPD) is a major concern in reproductive health (O'Hara and McCabe 2013). The prevalence of PPD differs by the diagnosis criteria and timing (O'Hara and Swain 1996) but is reported to be between 9 and 24% among Japanese women (Ministry of Health, Labour, and Welfare 2013; Norhayati et al. 2015) and between 10 and 15% among US women (Patel et al. 2012). Recently, the time period of diagnosis was stated in the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5), and PPD is defined as depressive episodes that occur during pregnancy and within 4 weeks of childbirth (American Psychiatric Association 2013). Thus, monitoring and evaluating the prevalence and risk factors for PPD according to the defined period are essential. PPD is associated with adverse health outcomes for infants (Stein et al. 1991; Kingston et al. 2012) as well as for mothers (van Wijngaarden et al.

✉ Sachiko Baba  
baba@cir.med.osaka-u.ac.jp

- <sup>1</sup> Bioethics and Public Policy, Department of Social Medicine, Osaka University Graduate School of Medicine, Yamadaoka 2-2, Suita, Osaka 565-0871, Japan
- <sup>2</sup> Center for International Relations, Osaka University Graduate School of Medicine, Yamadaoka 2-2, Suita, Osaka 565-0871, Japan
- <sup>3</sup> Public Health, Department of Social Medicine, Osaka University Graduate School of Medicine, Yamadaoka 2-2, Suita, Osaka 565-0871, Japan
- <sup>4</sup> Department of Hygiene and Public Health, Osaka Medical College, 2-7 Daigakumachi, Takatsuki-shi, Osaka 569-8686, Japan
- <sup>5</sup> Psychology and Behavioral Sciences, Faculty of Medicine, Faculty of Medicine, Osaka Medical College, Daigaku-machi 2-7, Takatsuki, Osaka 569-8686, Japan
- <sup>6</sup> Osaka Women's and Children's Hospital, 840 Murodo cho, Izumi 594-1101, Japan

2004; Pearlstein et al. 2009); therefore, efforts to detect and decrease the prevalence of PPD have been made (Ministry of Health, Labour, and Welfare 2013; Ko et al. 2017). In Japan, the national and municipal government began financially supporting postpartum assessment for PPD screening at 2 weeks and 1 month after childbirth (Japan Association of Obstetricians and Gynecologists 2017).

On the other hand, half of all pregnancies have been reported as unintended in both low- and high-income countries (Sedgh et al. 2014; Finer and Zolna 2016). Previous studies have shown the association of unintended pregnancies with PPD. A multi-center study conducted with 290 Japanese women reported that women not desiring to be pregnant had a higher proportion of major depressive episodes during pregnancy and at three postpartum months (Kitamura et al. 2006); however, they did not examine the association between the desire for pregnancy and major depressive episodes probably because of the small number of participants. A hospital-based study conducted with 2076 Korean women reported the association of unintended pregnancy with the risk of PPD at 1, 4, 12, and 24 postpartum months, but they did not include information on the antenatal possible mental illness of the studied women (Bahk et al. 2015). Another hospital-based study conducted with 688 US women has revealed the association of unintended pregnancy with the risk of PPD at 3 and 12 postpartum months (Mercier et al. 2013). However, besides its moderate sample size, pregnancy intention was examined during the second trimester in that study, which might have led to a recall bias.

According to the literatures mentioned above, unintended pregnancy is a risk factor for PPD; however, not all unintended pregnancies are regarded as unhappy. In a study conducted on pregnant women in the USA, half of the unintended pregnancies were perceived as happy (Sable and Libbus 2000). There might be ambiguous feelings toward being pregnant. Therefore, it might be difficult to dichotomously express feelings (intended or unintended, happy or unhappy), and combined categories of feelings may be useful to reflect the actual emotional status of pregnant women. To the best of our knowledge, no study has evaluated the association of feelings toward being pregnant with PPD at one postpartum month with a large sample size.

The Japan Environment and Children's Study (JECS) assessed information about feelings toward being pregnant, including pregnancy intention and PPD at 1 month after childbirth using large nationwide population samples. Using these data, we compared the risk of PPD among women who felt very happy to be pregnant, and those whose pregnancy was unintended but felt happy, unintended and felt confused, felt troubled, and those who felt no emotion toward being pregnant.

## Materials and methods

### Study population

The JECS is a nationwide government-funded birth cohort study that began recruiting expectant mothers in January 2011. Fifteen Regional Centers (Hokkaido, Miyagi, Fukushima, Chiba, Kanagawa, Koshin, Toyama, Aichi, Kyoto, Osaka, Hyogo, Tottori, Kochi, Fukuoka, and South Kyushu/Okinawa) were selected. Women were recruited during early pregnancy at obstetrics clinics/hospitals and/or local municipal offices issuing mother and child health handbooks. Recruitment started in January 2011 and continued until March 2014. The JECS protocol has been published elsewhere (Kawamoto et al. 2014; Michikawa et al. 2018). The details of the JECS have been described in previous studies (Michikawa et al. 2015; Suzuki et al. 2016). The study included data measured at enrollment during the first trimester, at pregnancy checkup examination during the second trimester, at delivery, and at postpartum 1 month by pregnant women and obstetricians.

### Participants

Among 103,099 pregnancies, we only included those with a live singleton infant ( $n = 98,259$ ). The complete information on pregnancy intention and their feelings toward being pregnant, and PPD status was available for 92,431 pregnancies out of the 98,259 recruited pregnancies (94.1%).

### Ethical issues

The JECS protocol was reviewed and approved by the Ministry of the Environment's Institutional Review Board on Epidemiological Studies and by the Ethics Committees of all participating institutions. The JECS was conducted in accordance with the Declaration of Helsinki and other nationally valid regulations and guidelines.

### Variables

Data on women's feelings toward being pregnant, including pregnancy intention, were collected at the time of the registration generally during the first trimester. Data were primarily combined and categorized into five groups according to the women's answers to the question "When you recognized the current pregnancy, how did you feel?" (1) Very happy, (2) unintended but happy, (3) unintended and confused, (4) troubled, and (5) no emotion.

We collected a Japanese-language Edinburgh Postnatal Depression Scale (EPDS) score at 1 month after childbirth. EPDS (Cox et al. 1987), which comprises 10 items listed in a four-point Likert scale from 0 to 3 according to the

**Table 1** Characteristics of participants

Characteristics	Number of women <i>n</i>	Postpartum depression (EPDS $\geq 9$ )		Postpartum depression (EPDS $\geq 12$ )	
		<i>n</i>	Proportion (%)	<i>n</i>	Proportion (%)
Total	92,431	12,943	14.0	4951	5.4
Pregnancy intention and feeling of being pregnant					
Very happy	61,045	7369	12.1	2584	4.2
Unintended but happy	23,997	3879	16.2	1598	6.7
Unintended and confused	6425	1411	22.0	613	9.5
Troubled	535	186	34.8	112	20.9
No emotion	429	98	22.8	44	10.3
Age, year					
< 20	737	181	24.6	84	11.4
20–29	33,772	5507	16.3	2205	6.5
30–39	53,737	6720	12.5	2442	4.5
40+	4185	535	12.8	220	5.3
Parity					
Primiparous	36,259	6505	17.9	2502	6.9
Multiparous	54,048	6054	11.2	2308	4.3
Missing	2124	384	18.1	141	6.6
Marital status					
Married	88,186	11,900	13.5	4463	5.1
Never (not yet)	3126	738	23.6	321	10.3
Divorced	734	206	28.1	114	15.5
Widowed	15	4	26.7	2	13.3
Missing	370	95	25.7	51	13.8
Smoking					
Never	53,721	6,623	12.3	2428	4.5
Former	21,795	3,021	13.9	1107	5.1
Quit smoking	12,028	2248	18.7	939	7.8
Continued smoking	4254	934	22.0	429	10.1
Missing	633	117	18.5	48	7.6
Education					
Junior high school	4233	940	22.2	457	10.8
High school	28,682	4681	16.3	1929	6.7
Vocational school	22,509	2961	13.2	1060	4.7
Junior college	16,155	1961	12.1	668	4.1
University and higher	19,907	2243	11.3	757	3.8
Missing	945	157	16.6	80	8.5
Family income (equivalent income)					
Q1 (lowest)	24,921	3895	15.6	1616	6.5
Q2	13,069	2279	17.4	890	6.8
Q3	28,508	3513	12.3	1236	4.3
Q4 (highest)	18,855	2034	10.8	686	3.6
Missing	7078	1222	17.3	523	7.4
Intimate partner violence					
None	80,857	9934	12.3	3563	4.4
Rarely	7461	1761	23.6	776	10.4
Sometimes	3128	906	29.0	430	13.7
Often	689	274	39.8	143	20.8
Missing	296	68	23.0	39	13.2
Antenatal possible mental illness (K6 score)					
No (K6 < 13)	89,306	11,211	12.6	3905	4.4
Yes (K6 > 13)	3125	1732	55.4	1046	33.5
History of antidepressant use					
No	87,755	11,291	12.9	4072	4.6
Yes	4676	1652	35.3	879	18.8

increasing severity of symptoms, ranges from “Yes, most of the time,” “Yes, sometimes,” “Not very often,” to “No, not at all.” Okano et al. translated the EPDS into Japanese, back-translated the scale, conducted the test–retest method to examine reliability, and calculated Cronbach’s  $\alpha$  (0.78) (Okano et al. 1996). Okano et al. reported that the appropriate cutoff point for detecting PPD was 9 or higher, with 75% sensitivity and 93% specificity (Yamaoka et al. 2016; Muchanga et al. 2017), whereas 12 or higher is generally used as the cutoff

point worldwide (Cox et al. 1987). A recent study on Japanese women has shown the optimal cutoff of EPDS score for major depressive episode during pregnancy as 12 (Usuda et al. 2017). We, therefore, used both cutoff points  $\geq 9$ , and  $\geq 12$ , in this study.

The covariates included women’s age, parity, marital status, smoking habit, education, annual family equivalent income, intimate partner verbal violence at pregnancy (IPV), possible mental illness during a month prior to enrollment,

history of antidepressant use for the past 1 year, and residential area. Marital status, smoking habit, IPV, and antenatal possible mental illness were obtained using the medical records at the registration; education and income during the second trimester; parity at delivery from the obstetrician, and age were obtained from the obstetrician's record 1 month after childbirth. The information in the medical records was transcribed by physicians, midwives/nurses, or research coordinators. Women's age was categorized as 5-year age groups; parity as primiparous or multiparous; marital status as married, never (not yet), divorced, and widowed; smoking as never smokers, former smokers who previously smoked but quit before pregnancy, quit smokers who stopped smoking during pregnancy, and continued smokers who continued to smoke during pregnancy; education as junior high school, high school, vocational school, junior college, and university and higher; and IPV as none, rarely, sometimes, and often. Equivalent income was calculated by dividing the average amount in 6-scale family income categories by the square root of the number of family members and re-categorized into quartiles.

Women's possible mental illness during the past month prior to enrollment was assessed using a Japanese version of the Kessler 6 (K6) scale. The K6 score is originally used for screening "serious mental illness" (Kessler et al. 2003) or mood and anxiety disorders (Furukawa et al. 2003) in the general population, with a cutoff point of 13 or higher (Kessler et al. 2003; Furukawa et al. 2003). A Japanese version of K6 was developed and validated with a similar cutoff point (12/13) (Furukawa et al. 2008) Therefore, we regarded K6 score  $\geq 13$  as possible mental illness. The history of antidepressant use was determined by a question regarding the use of antidepressants in the past year. Residential areas were represented by the locations of the 15 Regional Centers where the data were collected.

## Statistical analyses

Multivariable logistic regression analyses were used to estimate the association between feelings toward being pregnant and the risk of PPD. Odds ratios (ORs) and 95% confidence

intervals (CIs) were calculated after adjusting for potential confounders. Using the category of women with a "very happy" feeling as the reference group, we estimated the risk of PPD (EPDS score  $\geq 9$  and  $\geq 12$ ) among women whose pregnancy was unintended but happy, unintended and confused, felt troubled, and those who had no emotion toward being pregnant. We also used multivariable logistic regression analyses stratified by women's antenatal possible mental illness to examine whether the antenatal possible mental illness modifies the association between the feelings toward being pregnant and PPD (EPDS score  $\geq 9$  and  $\geq 12$ ). All analyses were performed using Statistical Analysis Software version 9.4 (SAS Institute, Inc., Cary, NC, USA).

## Results

Table 1 shows the characteristics of 92,431 women. Among them, 14.0 and 5.4% had PPD with EPDS scores  $\geq 9$  and  $\geq 12$ , respectively. Women who regarded their pregnancy as unintended and confused, felt troubled, and those who felt no emotion toward being pregnant had higher proportions of PPD than those who regarded their pregnancy as very happy. High proportions of PPD were also seen in younger, in primiparous, in never married, divorced, or widowed women, in women who quit or continued smoking when pregnant, in women with lower education, in women who experienced IPV, in women with a mental illness (K6 score  $\geq 13$ ), and in women with a history of antidepressant use.

Compared with women who felt very happy to be pregnant, women who felt their pregnancy was unintended but happy, unintended and confused, or those who felt no emotion toward being pregnant had an increased risk of PPD: OR (95% CI) = 1.25 (1.20–1.31), 1.64 (1.53–1.76), and 1.67 (1.30–2.13), respectively, for EPDS score  $\geq 9$ , and OR (95% CI) = 1.36 (1.27–1.46), 1.67 (1.51–1.85), and 1.78 (1.26–2.50), respectively, for EPDS score  $\geq 12$  (Table 2). Women who felt their pregnancy was troubled had the largest risk of PPD compared with those with other feelings: OR (95% CI) = 2.25 (1.83–2.75) for EPDS score  $\geq 9$  and 2.85 (2.23–3.64) for EPDS score  $\geq 12$ .

**Table 2** Multivariate odds ratios (ORs) of postpartum depression (PPD) according to feeling toward being pregnant

	PPD (EPDS score > 9) Multivariable <sup>a</sup> OR (95% CI)	PPD (EPDS score > 12) Multivariable <sup>a</sup> OR (95% CI)
Very happy	Ref	Ref
Unintended but happy	1.25 (1.20–1.31)	1.36 (1.27–1.46)
Unintended and confused	1.64 (1.53–1.76)	1.67 (1.51–1.85)
Troubled	2.25 (1.83–2.75)	2.85 (2.23–3.64)
No emotion	1.67 (1.30–2.13)	1.78 (1.26–2.50)

<sup>a</sup> Adjusted for mother's age, parity, marital status, smoking, mother's education, household income, intimate partner violence, antenatal possible mental illness (K6), history of antidepressant use, and residential area

**Table 3** Adjusted odds ratios of postpartum depression (PPD) according to feeling toward being pregnant, stratified by antenatal possible mental illness (K6 score)

	No. at risk	PPD (EPDS score $\geq 9$ )		PPD (EPDS score $\geq 12$ )	
		No. of PPD	Multivariable <sup>a</sup> OR (95% CI)	No. of PPD	Multivariable <sup>a</sup> OR (95% CI)
No antenatal possible mental illness (K6 score < 13) (n = 89,306)					
Very happy	59,564	6608	Ref	2153	Ref
Unintended but happy	23,017	3321	1.26 (1.20–1.32)	1257	1.38 (1.28–1.49)
Unintended and confused	5905	1081	1.65 (1.54–1.78)	404	1.69 (1.51–1.90)
Troubled	429	120	2.55 (2.04–3.18)	60	3.21 (2.41–4.29)
No emotion	391	81	1.85 (1.43–2.38)	31	1.87 (1.28–2.74)
Antenatal possible mental illness (K6 score $\geq 13$ ) (n = 3125)					
Very happy	1481	761	Ref	431	Ref
Unintended but happy	980	558	1.13 (0.95–1.34)	341	1.19 (0.99–1.43)
Unintended and confused	520	330	1.44 (1.16–1.79)	209	1.47 (1.18–1.83)
Troubled	106	66	1.25 (0.81–1.91)	52	1.97 (1.30–3.00)
No emotion	38	17	0.74 (0.37–1.47)	13	1.24 (0.60–2.55)

<sup>a</sup> Adjusted for mother's age, parity, marital status, smoking, mother's education, household income, intimate partner violence, history of antidepressant use, and residential area

The associations between feelings toward being pregnant and the risk of PPD stratified by antenatal possible mental illness are shown in Table 3. Those associations were generally stronger among women without possible mental illness (K6 score < 13). In those with possible mental illness (K6 score  $\geq 13$ ), increased risks for PPD were observed only among women who felt their pregnancy as unintended and confused.

## Discussion and conclusions

In this nationwide study, we found that women who felt their pregnancy was unintended but happy, those who felt their pregnancy was unintended and confused, and those who felt no emotion toward being pregnant had increased risks of PPD (EPDS score  $\geq 9$  and  $\geq 12$ ) after adjusting for demographic, socioeconomic, and antenatal mental factors. We also found that women who felt troubled with their pregnancy had the highest risk of PPD. The risks of PPD with EPDS score  $\geq 12$  were generally higher than those of PPD with EPDS score  $\geq 9$ .

Our result that unintended pregnancy was associated with increased risk of PPD was consistent with previous findings in Japan and other high-income countries (Mercier et al. 2013; Kitamura et al. 2006; O'Hara and McCabe 2013; Bahk et al. 2015; Beck 2001).

In the present study, we unexpectedly found an increased risk of PPD among women who felt their pregnancy was unintended but happy. There was a previous report in African-American and Latin populations stating that pregnancy intentions and happiness were strongly associated, but happiness was a better predictor of reduced PPD rather than intention (Blake et al. 2007). Our finding did not meet this notion possibly due to differences in ethnicity, culture, and participants' characteristics.

In the analysis stratified by antenatal possible mental illness, the associations were weaker among women with possible mental illness, which implies that antenatal possible mental illness modified the association between their feelings toward being pregnant and risk of PPD.

The biological mechanism underlying PPD remains unclear (Patel et al. 2012). Changes in the levels of several hormones after delivery have been suggested to induce PPD, but the findings were inconsistent (Soares and Zitek 2008; Patel et al. 2012; O'Hara and McCabe 2013). In contrast, regarding psychological mechanisms, the feeling toward being pregnant plays a role in PPD; in addition to history of depression and antenatal possible mental illness, antenatal anxiety, perinatal stress, feeling pessimistic during the antenatal period, and fear of childbirth have been considered to be predictors of PPD (O'Hara et al. 1991; Kitamura et al. 2006; Beck 2001, Condon and Watson 1987; Räisänen et al. 2013). Regarding the mechanism by



which negative feelings or antenatal possible mental illnesses may affect the risk of PPD, the bonding of mother to fetus may play a role. An association between anxiety during pregnancy and risk of PPD was shown to be mediated by bonding failure (Kokubu et al. 2012). Considering mother-to-infant bonding, which comprises two factors; “anger and rejection” and “lack of affection” (Cattell 1966; Taylor et al. 2005), feeling troubled by being pregnant may correspond to “anger and rejection” component, and feeling no emotion may correspond to “lack of affection” component. Bonding failure between mother and fetus may persist after childbirth.

The major strengths of this study include a cohort study with a large sample size, in which the information on pregnancy intention and antenatal possible mental illness was collected during early pregnancy, precluding the possibility of recall bias. We adjusted for potential confounding variables such as maternal demographic characteristics, socioeconomic factors, and antenatal possible mental illness. Another strength is that the outcome was shown as both PPD with EPDS scores  $\geq 9$  and  $\geq 12$ , and was evaluated during postpartum 1 month. The findings of this study may be useful to prevent and control PPD through the early detection of high-risk individuals. Antenatal screening for PPD through a questionnaire on feelings toward being pregnant is possible using antenatal regular check-ups at obstetrics clinics/hospitals or at local municipal offices issuing mother and child health handbooks.

This study is one of the few studies that demonstrate the association between feelings toward being pregnant and risk of PPD. However, several limitations should be addressed. First, the intention and feelings were not assessed separately. The questionnaire had missed some combinations such as unintended but very happy pregnancies, and intended but troubled pregnancies. Second, the questionnaire on pregnancy intention and feelings toward being pregnant was not validated. However, it is logically difficult because of no measurement golden standards for the comparison. Third, our measurements, EPDS and K6, are self-reported and not diagnosed by psychiatrists. However, EPDS and K6 are commonly used in research and are well-validated, reliable measurement; therefore, the impact of this error is expected to be small. Fourth, residual confounding could have occurred from unmeasured confounding variables, such as mothers’ chronic diseases.

In conclusion, our findings show that women whose pregnancy was unintended but felt happy had an increased risk of PPD. Women who regarded their pregnancies as unintended and felt confused, felt troubled, or had no specific emotion were also associated with an increased risk of PPD. These high-risk women should be regarded as targets for the early detection and prevention of PPD.

**Acknowledgments** We are grateful to all participants who have taken part in the JECS. We would like to also thank all staff members of the JECS.

Members of the Japan Environment and Children’s Study (JECS), as of 2017 (principal investigator, Toshihiro Kawamoto), are as follows: Hirohisa Saito (National Center for Child Health and Development, Tokyo, Japan), Reiko Kishi (Hokkaido Regional Center for JECS, Hokkaido University, Hokkaido, Japan), Nobuo Yaegashi (Miyagi Regional Center for JECS, Tohoku University, Sendai, Japan), Koichi Hashimoto (Fukushima Regional Center for JECS, Fukushima Medical University, Fukushima, Japan), Chisato Mori (Chiba Regional Center for JECS, Chiba University, Chiba, Japan), Shuichi Ito (Kanagawa Regional Center for JECS, Yokohama City University, Kanagawa, Japan), Zentaro Yamagata (Koshin Regional Center for JECS, University of Yamanashi, Yamanashi, Japan), Hidekuni Inadera (Toyama Regional Center for JECS, University of Toyama, Toyama, Japan), Michihiro Kamijima (Aichi Regional Center for JECS, Nagoya City University, Aichi, Japan), Takeo Nakayama (Kyoto Regional Center for JECS, Kyoto University, Kyoto, Japan), Hiroyasu Iso (Osaka Regional Center for JECS, Osaka University, Osaka, Japan), Masayuki Shima (Hyogo Regional Center for JECS, Hyogo College of Medicine, Hyogo, Japan), Yasuaki Hirooka (Tottori Regional Center for JECS, Tottori University, Yonago, Japan), Narufumi Sukanuma (Kochi Regional Center for JECS, Kochi University, Kochi, Japan), Koichi Kusuhara (Fukuoka Regional Center for JECS, University of Occupational and Environmental Health, Kitakyushu, Japan), and Takahiko Katoh (South Kyushu/Okinawa Regional Center for JECS, Kumamoto University, Kumamoto, Japan).

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

## Compliance with ethical standards

**Conflict of interest** Author Sachiko Baba, Author Takashi Kimura, Author Satoyo Ikehara, Author Kaori Honjo, Author Ehab S Eshak, Author Takuyo Sato, and Author Hiroyasu Iso declare that they have no conflict of interest.

**Open Access** This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

## References

- American Psychiatric Association (ed) (2013) Diagnostic and Statistical Manual of Mental Disorders, 5th edn. American Psychiatric Association, Washington, DC
- Bahk J, Yun SC, Kim YM, Khang YH (2015) Impact of unintended pregnancy on maternal mental health: a causal analysis using follow up data of the Panel Study on Korean Children (PSKC). *BMC Pregnancy Childbirth* 15:85
- Beck CT (2001) Predictors of postpartum depression: an update. *Nurs Res* 50:275–285
- Blake SM, Kiely M, Gard CC, el-Mohandes AAE, el-Khorazaty MN, the NIH-DC Initiative (2007) Pregnancy intentions and happiness among pregnant black women at high risk for adverse infant health outcomes. *Perspect Sex Reprod Health* 39:194–205

- Cattell RB (1966) The scree test for the number of factors. *Multivar Behav Res* 1:245–276
- Condon JT, Watson TL (1987) The maternity blues: exploration of a psychological hypothesis. *Acta Psychiatr Scand* 76:164–171
- Cox JL, Holden JM, Sagovsky R (1987) Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 150:782–786
- Finer LB, Zolna MR (2016) Declines in unintended pregnancy in the United States, 2008–2011. *N Engl J Med* 374:843–852
- Furukawa TA, Kessler RC, Slade T, Andrews G (2003) The performance of the K6 and K10 screening scales for psychological distress in the Australian National Survey of Mental Health and Well-Being. *Psychol Med* 33:357–362
- Furukawa TA, Kawakami N, Saitoh M, Ono Y, Nakane Y, Nakamura Y, Tachimori H, Iwata N, Uda H, Nakane H, Watanabe M, Naganuma Y, Hata Y, Kobayashi M, Miyake Y, Takeshima T, Kikkawa T (2008) The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *Int J Methods Psychiatr Res* 17:152–158
- Japan Association of Obstetricians and Gynecologists (2017) The expected practice of postpartum women's health checkup. <http://www.jaog.or.jp/wp/wp-content/uploads/2017/02/sanpukenkoukensa.pdf>, Accessed 12 May 2017
- Kawamoto T, Nitta H, Murata K et al (2014) Rationale and study design of the Japan Environment and Children's Study (JECS). *BMC Public Health* 14:25
- Kessler RC, Barker PR, Colpe LJ, Epstein JF, Gfroerer JC, Hiripi E, Howes MJ, Normand SLT, Manderscheid RW, Walters EE, Zaslavsky AM (2003) Screening for serious mental illness in the general population. *Arch Gen Psychiatry* 60:184–189
- Kingston D, Tough S, Whitfield H (2012) Prenatal and postpartum maternal psychological distress and infant development: a systematic review. *Child Psychiatry Hum Dev* 43:683–714
- Kitamura T, Yoshida K, Okano T, Kinoshita K, Hayashi M, Toyoda N, Ito M, Kudo N, Tada K, Kanazawa K, Sakumoto K, Satoh S, Furukawa T, Nakano H (2006) Multicentre prospective study of perinatal depression in Japan: incidence and correlates of antenatal and postnatal depression. *Arch Womens Ment Health* 9:121–130
- Ko JY, Rockhill KM, Tong VT, Morrow B, Farr SL (2017) Trends in postpartum depressive symptoms—27 states, 2004, 2008, and 2012. *MMWR* 66:153–158
- Kokubu M, Okano T, Sugiyama T (2012) Postnatal depression, maternal bonding failure, and negative attitudes towards pregnancy: a longitudinal study of pregnant women in Japan. *Arch Womens Ment Health* 15:211–216
- Mercier RJ, Garrett J, Thorp J, Siega-Riz AM (2013) Pregnancy intention and postpartum depression: secondary data analysis from a prospective cohort. *BJOG* 120:1116–1122
- Michikawa T, Nitta H, Nakayama SF, Ono M, Yonemoto J, Tamura K, Suda E, Ito H, Takeuchi A, Kawamoto T (2015) The Japan Environment and Children's Study (JECS): a preliminary report on selected characteristics of approximately 10 000 pregnant women recruited during the first year of the study. *J Epidemiol* 25:452–458
- Michikawa T, Nitta H, Nakayama SF, Yamazaki S, Isobe T, Tamura K, Suda E, Ono M, Yonemoto J, Iwai-Shimada M, Kobayashi Y, Suzuki G, Kawamoto T, the Japan Environment and Children's Study Group (2018) Baseline profile of participants in the Japan Environment and Children's Study (JECS). *J Epidemiol* 28:99–104
- Ministry of Health, Labour, and Welfare (2013) Final evaluation of “Health parents and children 21”, reported on 28, Nov 2013. <http://www.mhlw.go.jp/stf/houdou/0000030389.html>. Accessed 20 Feb. 2017 (in Japanese)
- Muchanga SMJ, Yasumitsu-Lovell K, Eitoku M, Mbelambela EP, Ninomiya H, Komori K, Tozin R, Maeda N, Fujieda M, Sukanuma N (2017) Preconception gynecological risk factors of postpartum depression among Japanese women: the Japan Environment and Children's Study (JECS). *J Affect Disord* 217:34–41
- Norhayati MN, Hazlina NHN, Asrenee AR, Emilin WMAW (2015) Magnitude and risk factors for postpartum symptoms: a literature review. *J Affect Disord* 175:34–52
- O'Hara MW, McCabe JE (2013) Postpartum depression: current status and future directions. *Annu Rev Clin Psychol* 9:379–407
- O'Hara MW, Schlechte JA, Lewis DA, Varner MW (1991) Controlled prospective study of postpartum mood disorders: psychological, environmental, and hormonal variables. *J Abnorm Psychol* 100:63–73
- O'Hara MW, Swain AM (1996) Rates and risk of postpartum depression—a meta-analysis. *Int Rev Psychiatry* 8:37–54
- Okano T, Murata M, Musuji F et al (1996) Validation and reliability of Japanese version of EPDS (Edinburgh Postnatal Depression Scale). *Arch Psychiatr Diagn Clin Eval* 7:523–533
- Patel M, Bailey RK, Jabeen S, Ali S, Barker NC, Osiezagha K (2012) Postpartum depression: a review. *J Health Care Poor Underserved* 23:534–542
- Pearlstein T, Howard M, Salisbury A, Zlotnick C (2009) Postpartum depression. *Am J Obstet Gynecol* 200:357–364
- Räsänen S, Lehto SM, Nielsen HS, Gissler M, Kramer MR, Heinonen S (2013) Fear of childbirth predicts postpartum depression: a population-based analysis of 511 422 singleton births in Finland. *BMJ Open* 3:e004047
- Sable MR, Libbus MK (2000) Pregnancy intention and pregnancy happiness: are they different? *Matern Child Health J* 4:191–196
- Sedgh G, Singh S, Hussain R (2014) Intended and unintended pregnancies worldwide in 2012 and recent trends. *Stud Fam Plan* 45:301–314
- Soares CN, Zitek B (2008) Reproductive hormone sensitivity and risk for depression across the female life cycle: a continuum of vulnerability? *J Psychiatry Neurosci* 33:331–343
- Stein A, Gath DH, Bucher J, Bond A, Day A, Cooper PJ (1991) The relationship between post-natal depression and mother-child interaction. *Br J Psychiatry* 158:46–52
- Suzuki K, Shinohara R, Sato M, Otawa S, Yamagata Z (2016) Association between maternal smoking during pregnancy and birth weight: an appropriately adjusted model from the Japan Environment and Children's Study. *J Epidemiol* 26:371–377
- Taylor A, Atkins R, Kumar R, Adams D, Glover V (2005) A new Mother-to-Infant Bonding Scale: links with early maternal mood. *Arch Womens Ment Health* 8:45–51
- Usuda K, Nishi D, Okazaki E, Makino M, Sano Y (2017) Optimal cut-off score of the Edinburgh Postnatal Depression Scale for major depressive episode during pregnancy in Japan. *Psychiatry Clin Neurosci* 71:836–842. <https://doi.org/10.1111/pcn.12562>
- van Wijngaarden B, Schene AH, Koeter MWJ (2004) Family caregiving in depression: impact on caregivers' daily life, distress, and help seeking. *J Affect Disord* 81:211–222
- Yamaoka Y, Fujiwara T, Tamiya N (2016) Association between maternal postpartum depression and unintentional injury among 4-month-old infants in Japan. *Matern Child Health J* 20:326–336