

Relationship between painless delivery and postpartum depression: The Japan Environment and Children's Study (JECS)

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Research Article

Keywords: Analgesia, Depression, Delivery, EPDS, Painless, Postpartum

Posted Date: January 8th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-135960/v1>

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Version of Record: A version of this preprint was published at BMC Pregnancy and Childbirth on July 23rd, 2021. See the published version at <https://doi.org/10.1186/s12884-021-03996-y>.

Abstract

Background

Postpartum depression is one of the most commonly experienced psychological disorders for women after childbirth, usually occurring within one year. This study aimed to clarify whether women with painless delivery, including epidural analgesia, spinal-epidural analgesia, and paracervical block, had a decreased risk of postpartum depression after giving birth in Japan.

Methods

The Japan Environment and Children's Study (JECS) was a prospective cohort study that enrolled registered fetal records ($n = 104,065$) in 15 regions nationwide in Japan. Binomial logistic regression analyses were performed to calculate the adjusted odd ratios (aORs) for the association between mode of delivery with or without analgesia and postpartum depression at one-, six- and twelve-months after childbirth.

Results

At six months after childbirth, painless vaginal delivery was associated with a higher risk of postpartum depression (aOR: 1.218, 95% confidence interval: 1.067–1.391), compared with vaginal delivery without analgesia or cesarean section. Nevertheless, the risk disappeared one year after delivery. Among the pregnant women who requested painless delivery, 5.1% had a positive Kessler-6 scale (K6) score for depression before the first trimester ($p < 0.0001$), which was significantly higher than the proportions in the vaginal delivery without analgesia (3.5%) and cesarean delivery (3.5%) groups.

Conclusions

Our data suggested that the risk of postpartum depression at six months after childbirth tended to be increased after painless vaginal delivery, compared with vaginal delivery without analgesia or cesarean section. Requests for painless delivery continue to be relatively uncommon in Japan, and women who make such requests might be more likely to experience postpartum depressive symptoms because of underlying personality characteristics, including a tendency to worry.

Background

Analgesia during delivery is the most common and widely accepted method of pain relief during labor [1–3]. Although the proportion of pregnant women requesting painless delivery with analgesia varies internationally between 20%-70% [2, 3], the proportion in Japan continues to be relatively low. Nevertheless, the use of analgesia has recently been growing in popularity, and the proportion of women

who use analgesia during labor reportedly increased from 4.6% in 2014 to 6.1% in 2016 [4]. Since a common maternal myth in Japan is that labor pains are conducive to forming a strong maternal instinct [5], we assumed that this belief might be one of the reasons why delivery with analgesia is uncommon in Japan, compared with other countries.

Giving birth in a more relaxed state through the use of analgesia during delivery can be expected to confer benefits to both mother and baby. Even in healthy mothers, suppressing hyperventilation arising from pain and suppressing the deterioration in blood flow to the placenta as a result of the release of stress hormones are possible merits of epidural delivery. Analgesia and the accompanying reduction in childbirth stress might be particularly beneficial to mothers with chronic diseases, such as cardiovascular disease.

On the other hand, a recent report suggested increased risks in obstetric and neonatal outcomes among pregnant women with combined spinal-epidural analgesia during labor, compared with women without analgesia; these risks included a prolonged duration of labor, instrumental delivery, lower Apgar scores, and an umbilical arterial blood gas pH of less than 7.10 [4]. In contrast, several lines of evidence suggest that epidural analgesia is associated with a decreased risk for postpartum depression [6–8], although the sample sizes of some prospective cohorts were limited.

Severe labor pains are a risk factor of postpartum depression in pregnant women, and early depression is associated with an increased risk of long-term depression [9]. Postpartum depression affects women who have given birth and is a common disorder for new mothers. Almost 10–15% of mothers may suffer from postpartum depression within the first year after delivery [9]. Multiple factors may be involved in postpartum depression, and the causes have been difficult to understand.

The present study aimed to clarify whether the mode of delivery, particularly the use of analgesia during delivery, decreased the risk of postpartum depression after childbirth in Japan.

Methods

Study population

The design of the Japan Environment and Children's Study (JECS) has been described previously in detail [10–12]. The direct web link to the JECS is <https://www.env.go.jp/chemi/ceh/en/index.html>. This study followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement for observational studies. Briefly, pregnant women in Japan were recruited for the JECS between January 2011 and March 2014. Women who 1) lived in any of the Study Areas selected by the fifteen Regional Centers located in the country at the time of recruitment; 2) had an expected delivery date after August 1, 2011; and 3) were capable of understanding the Japanese language and completing a self-administered questionnaire were included in the study [10, 12].

The present study used the “jecs-ag-20180131” dataset, which was released in March 2018 and contains information on 104,065 fetal records (Fig. 1). Among women with multiple pregnancies during the study period, data for the second or third pregnancy was excluded ($n = 1,003$); pregnancies with miscarriages, stillbirths, or missing data ($n = 3,860$) were also excluded. Overall, 99,202 pregnancies were included in the analysis.

The JECS protocol was approved by the Ministry of the Environment’s Institutional Review Board on Epidemiological Studies (no. 100910001) and by the Ethics Committees of all the participating institutions. Written informed consent was obtained from all the study participants.

Data collection

The study participants completed questionnaires throughout their pregnancies and postpartum periods; i.e., during the first and second/third trimesters ($n = 92,550$), and at one-, six- and twelve-months after delivery. The medical records at the time of registration and just after vaginal delivery or cesarean section were transcribed by doctors, research coordinators, nurses, or midwives.

Information regarding maternal or paternal demographic factors was obtained from the questionnaires completed during pregnancy. Postpartum information was collected from the questionnaires completed during the six months after delivery.

Outcomes, exposure, and covariates

The primary outcome was the occurrence of postpartum depression. We used the postpartum Edinburgh Postnatal Depression Scores (EPDS) at one and six months after delivery and the postpartum K6 scores within one year after delivery as the primary outcomes [13,14]. The EPDS is a validated, standardized questionnaire consisting of 10 screening items that is commonly used to identify a risk of perinatal or postpartum depression. As the cutoff value for the EPDS, we used a score of ≥ 9 as a positive result for postpartum depression [15,16].

The K6 self-administered questionnaires were assessed using a five-category scale (4 = all the time, 3 = most of the time, 2 = some of the time, 1 = a little of the time, 0 = none of the time), with possible scores ranging from 0–24. According to a Japanese validation study for the K6 questionnaire in the general population, the performance of the K6 questionnaire using an optimal cutoff of ≥ 13 to indicate severe psychological distress was excellent when the performance was examined using an area under the receiver operating characteristic curve (AUC), with values as high as 0.94 (95% confidence interval (CI) = 0.88 to 0.99) [17].

The participants were divided according to mode of delivery into three categories: vaginal delivery without analgesia; painless vaginal delivery, including epidural analgesia, spinal-epidural analgesia, or paracervical block; and cesarean section.

The covariates included maternal age (categorized as <20, 20–29, 30–39, ≥40 years) , maternal body mass index (BMI, categorised as <18.5, 18.5–25.0, ≥25.0 kg/m²), maternal educational status (categorised as junior high school or high school, higher professional school or professional school, junior college or college, postgraduate college), annual income (categorised as <200, 200–400, ≥400–600, ≥600–800, ≥800–1,000 JPY × 10,000; 1 USD = 103.5 JPY, December 2020), recurrent miscarriage (yes vs. no), mode of pregnancy (natural conception vs. others), parity (never vs. ≥once), drinking history (categorised as never, abstinence before pregnancy, abstinence from this pregnancy, continuance drinking), maternal smoking history (categorised as never, abstinence before pregnancy, abstinence from this pregnancy, continuance smoking 1 - 10 cigarettes per day, continuance smoking 11 - 20 cigarettes per day, continuance smoking over 21 cigarettes per day), pre-K6 during first trimester and second/third trimesters (categorised as mentioned above), marriage status at second/third trimester (categorised as married, non-married, divorced, partners' death) and at six months after delivery (categorised as married, divorced, partners' death, others), sex of child (categorised as male, female, unclear), Apgar scores at 1 and 5 min (<7 vs. ≥8), inborn errors of metabolism (categorised as nothing, require recheck, require complete check-up, confirm the diagnosis), neonatal anomalies (yes vs. no), breast- or bottle-feeding, frequency of infant crying (categorised as cry well and keep crying, sometimes but stop soon, not too much), and cooperation of partner with nurturing at one month (categorised as always, sometimes, very little, nothing) and at one year after delivery (categorised as nothing, very little, sometimes, well, very well).

Data analysis

The maternal and postpartum demographic characteristics of the participants were shown with the proportion for discrete data. The Fisher exact test was used to compare the association between the outcome and each variable. Binomial logistic regression analyses were performed by adding all the covariates to calculate the adjusted ORs (aORs) for the association between mode of delivery and postpartum depression. Since missing data can potentially undermine the scientific credibility of causal conclusions, we applied a multiple imputation method to reduce the potential non-response bias created by missing data and to improve the precision of the estimates when calculating the aORs [18,19]. A total of 20 models, in which all the available variables were used as predictors and outcomes, were created to estimate the aORs. To prevent multiple comparisons possibly yielding false-positive findings, we adopted the Benjamini-Hochberg method and assessed statistical significances by obtaining the *q*-values adjusted for false discovery rate. All the statistical analyses were performed using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp., Japan).

Results

Characteristics of prenatal, neonatal, and postpartum statuses and maternal postpartum outcomes

Table 1 summarizes the characteristics of the prenatal, neonatal, and postpartum statuses and the maternal postpartum outcomes. Among the 99,202 pregnancies who were included in the analysis, the

mode of delivery was vaginal delivery without analgesia in 78.7% ($n = 78,082$), painless vaginal delivery in 2.4% (2,337), and cesarean section in 18.8% (18,657). The mode of delivery was unknown in 126 cases (0.1%).

As for the outcomes, a significant difference in the incidence of postpartum depression at one month after delivery was observed according to the mode of delivery (vaginal delivery without analgesia: 14.0%, painless vaginal delivery: 16.7%, and cesarean section: 15.0%, $p < 0.0001$). A similar trend was observed at six months after delivery (11.5%, 14.1% and 11.9%, respectively, $p = 0.0007$). The K6 scores for postpartum depression at one year after childbirth, however, did not differ significantly according to delivery mode ($p = 0.5599$).

With respect to the covariates, the distribution of categorized maternal ages was as follows: 1.1% with an age of <20 years, 37.1% with an age of 20-29 years, 52.2% with an age of 30-39 years, and 3.3% with an age of ≥ 40 years. All the evaluated demographic characteristics differed significantly according to the mode of delivery ($p < 0.0001$). Regarding the prenatal and neonatal statuses, among the women who requested painless delivery, 5.1% had a positive K6 score for depression during the first trimester, compared with 3.5% in each of the vaginal delivery without analgesia and cesarean delivery groups ($p < 0.0001$). A similar trend was found during the second/third trimesters, with 5.2% of the women in the painless delivery, 3.1% of the women in the vaginal delivery without analgesia, and 3.7% of the women in the cesarean delivery groups having a positive K6 score for depression ($p < 0.0001$). All the prenatal and neonatal status variables except for the child's sex differed significantly according to the mode of delivery ($p = 0.0049$). As for the postpartum and childcare variables, the breast-feeding method, frequency of infant crying, and partner's cooperation with nurturing at one month after delivery differed significantly among the three groups (all $p < 0.0001$), whereas no significant differences in marriage status at six months after delivery ($p = 0.371$) and partner's cooperation with nurturing at one year after delivery ($p = 0.431$) were seen.

Association between painless delivery and postpartum depression

The association between painless vaginal delivery and postpartum depression is shown in Fig. 2. In addition, the supplemental figure shows the estimated association without using the multiple imputation method (Suppl Fig. 1). At six months after delivery, women who requested analgesia for painless delivery had a higher risk of postpartum depression (aOR: 1.218, 95% CI: 1.067-1.391, $q = 0.022$), compared with vaginal delivery without analgesia. Nevertheless, the association disappeared at one year after delivery. Although no significant difference in the point estimates with or without using the multiple imputation method was seen, the confidence intervals for the aORs calculated using multiple imputation were narrower than those calculated without multiple imputation.

Discussion

The present study found an increased risk of postpartum depression at six months among women who requested painless vaginal delivery in Japan. Little consensus exists regarding the effect of painless

delivery on postpartum depression, since the results of previous studies are inconsistent. A recent report suggested that epidural analgesia during labor is not associated with a decreased risk of developing postpartum depression [20]. In contrast, Riazanova et al. reported that postpartum depression was diagnosed at six weeks after delivery in 4.67% of women who requested epidural analgesia, compared with 6.79% among women without analgesia during delivery [21]. Several lines of evidence have suggested that the risk of postpartum depression is reduced in women who receive epidural analgesia, compared with those without analgesia [22,23]. Liu et al. reported that the use of neuraxial analgesia during labor was associated with a reduced risk of postpartum depression at two years after delivery [9].

One possible reason for the conflicting reports mentioned above might be due to the nature of the evaluation period for assessing postpartum depression. Postpartum depression is defined as a form of major depression beginning within 4 weeks after delivery and potentially lasting for months or years. In previous studies, the association between postpartum depression and mode of delivery was assessed at time points ranging from a few weeks to as long as two years after delivery. An assessment of the temporal trajectory of postpartum depression using a longitudinal study, rather than cross-sectional assessments at specific time periods, is thus needed.

Another explanation might be the use of different screening tools to evaluate postpartum depression in the previous studies. Both the K6 and the EPDS are commonly used universal screening tools for the diagnosis of postpartum depression. A systematic review validating the EPDS in postpartum women reported that the sensitivity of the tool ranged widely from 34% to 100%, while the specificity ranged from 44% to 100% [24]. A study comparing the performances of mental health screening tools showed that the EPDS had the highest area under the curve value [25], meaning a high sensitivity for the detection of postpartum depression, while the K6 showed a good balance between sensitivity (74%) and specificity (85%), reaching a sufficient positive predictive value. However, the cutoff values depended on the language of translation, and such differences might be responsible for the discrepant results.

Next, special attention should be paid to the personality traits of women or the presence of psychological distress before or during early pregnancy and the relations between such factors and the selection of painless delivery. In Japan, the number of women who request painless delivery is relatively small, whereas the rates of painless delivery with analgesia range between 20% and 70% internationally [7]. Thus, we think that the results of the present study may differ from those of comparable international studies. As mentioned in the Introduction, labor with analgesia is uncommon in Japan because of the popular belief that enduring the pain of labor is virtuous. Recently, however, both the number of elderly pregnancies and the number of pregnant women requesting painless delivery have been increasing in Japan. In the present study, the proportion of women with a positive K6 score during their first trimester was higher in the painless vaginal delivery group (5.1%) than in the vaginal delivery without analgesia (3.5%) and cesarean delivery (3.5%) groups. This finding suggests that women with high levels of anxiety might have been more likely to request epidural analgesia. However, the current study adjusted for the possibility of such an effect on the association between the mode of delivery and postpartum depression using logistic regression analyses (Fig. 2). Additionally, as a practical implication, it should be noted that

pregnant women who requested painless delivery had higher K6 scores for depression during the first trimester, compared with women in the other two delivery groups.

Depression is the most common psychological disorder in women after childbirth, occurring in 9.0% of pregnant women in Japan (Ministry of Health, Labour and Welfare, 2015 [26]). A national project to prevent postpartum depression has been started in Japan, and postpartum depression is regarded as an essential health issue. Olieman et al. reported that women who underwent elective cesarean sections had significantly higher symptom levels of posttraumatic stress disorder and depression than women undergoing vaginal delivery without analgesia [27]. Such discrepancies persist, and health professionals should pay careful attention to all postpartum women, regardless of the mode of delivery or the use of analgesia.

Strengths And Limitations

The JECS, with 100,000 participants, is the largest nationwide birth cohort study to be conducted in Japan and is considered to be representative of the general population [10,28]. The outcome measurements were reliable because pregnancy and delivery information were based on medical records transcribed by doctors, research coordinators, nurses, and midwives. Furthermore, the risk estimates for the effect of painless delivery on postpartum depression were calculated using multiple imputations, providing a high level of scientific credibility and reducing the potential non-response bias created by missing data.

The present study had some limitations. As stated above, two different indexes, the EPDS and the K6 score, were used to evaluate postpartum depression. Since the researchers were unable to implement the use of appropriate indicators for individual studies in their own surveys, the same screening tool could not be used at each measurement point. Although previous studies have shown that the cutoff values for both indicators were appropriate [25], this may have created a potential for systematic bias.

Conclusion

Painless delivery was associated with an increased risk of postpartum depression at six months after delivery among pregnant women in Japan. Social support after delivery for mothers who select painless delivery is thus necessary. Further analysis of maternal personality types and environmental statuses and comparing older and younger women who request painless vaginal delivery are needed to determine in which situations might epidural delivery be desirable. Because of prevailing maternal myths, Japan may represent a special environment where painless deliveries are extremely rare and are selected mainly by women who are susceptible to depression. Unlike in other countries, a higher proportion of women with postpartum depression at six months after delivery was seen among women requesting painless delivery; continuous postnatal care is thus important for these women.

Abbreviations

EPDS: Edinburgh Postnatal Depression Scores; JECS: The Japan Environment and Children's Study; K6: Kessler-6 scale

Declarations

Acknowledgements

The authors are grateful to the JECS participants. 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.

Appendix

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Authors' Contributions

N.S., T.E., H.T.: Analyzed data and co-wrote the paper; T.M., H.S., S.K.: Performed bioinformatic analyses.; S.S.: Supervised the research.; M.K., M.S-O.: Supervised the research and co-wrote the paper.

Funding

The JECS is funded by the Ministry of the Environment, Japan.

Availability of data and materials

Regarding data of the paper publication (<http://www.env.go.jp/chemi/ceh/en/index.html>).

Data availability: Data are unsuitable for public deposition due to ethical restrictions and legal framework of Japan. It is prohibited by the Act on the Protection of Personal Information (Act No. 57 of 30 May 2003, amendment on 9 September 2015) to publicly deposit the data containing personal information. Ethical Guidelines for Medical and Health Research Involving Human Subjects enforced by the Japan Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labour and Welfare also restricts the open sharing of the epidemiologic data. All inquiries about access to data

should be sent to: jecs-en@nies.go.jp. The person responsible for handling enquiries sent to this e-mail address is Dr Shoji F. Nakayama, JECS Programme Office, National Institute for Environmental Studies.

Ethics approval and consent to participate

The study protocol was approved by the ethics committee of the JECS. The JECS protocol was approved by the Ministry of the Environment's Institutional Review Board on Epidemiological Studies (no. 100910001) and by the Ethics Committees of all the participating institutions.

Consent for publication

Not applicable.

Competing interests

The authors have no conflicts of interest to declare.

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References

1. Salameh KM, Paraparambil VA, Sarfrazul A, Hussain HL, Thyvilayil SS, Mahmoud Effects of labor epidural analgesia on short term neonatal morbidity. *Int J Womens Health*.2020;12:59-70.
2. Törnell S, Ekéus C, Hultin M, Håkansson S, Thunberg J, Högberg Low Apgar score, neonatal encephalopathy and epidural analgesia during labour: a Swedish registry-based study. *Acta Anaesthesiol Scand*. 2015;59(4):486-95.
3. Anim-Somuah M, Smyth RM, Jones L. Epidural versus non-epidural or no analgesia in labour. *Cochrane Database Syst Rev*. 2011;12:CD000331.
4. Kurakazu M, Umehara N, Nagata C, Yamashita Y, Sato M, Sago H. Delivery mode and maternal and neonatal outcomes of combined spiral-epidural analgesia compared with no analgesia in spontaneous labor: A single-center observational study in Japan. *J Obstet Gynaecol Res*. 2020; 46: 425-33.
5. Niwa A, Yoda T. The formation of the myth of motherhood in Japan. *Japan American Wem J*. 1993; 4:70-82.
6. Ding T, Wang D, Qu Y, Chen Q, Zhu S. Epidural labor analgesia is associated with a decreased risk of postpartum depression: a prospective cohort study. *Anesth Analg*. 2014; 119: 383-92.
7. Lim G, Farrell LM, Facco FL, Gold MS. Labor analgesia as a predictor for reduced postpartum depression scores: A retrospective observational study. *Anesth Analg*. 2018;126:1598-605.

8. Sun J, Xiao Y, Zou L, Liu D, Huang T, Zheng Z, et al. Epidural labor analgesia is associated with a decreased risk of the Edinburgh Postnatal Depression Scale in trial of labor after Cesarean: a multicenter, prospective cohort study. *BioMed Res Int.* 2020; ID 2408063.
9. Liu Z, He S, Deng C, Ding T, Xu M, Wang L, et al. Neuraxial labour analgesia is associated with a reduced risk of maternal depression at 2 years after childbirth. *Eur J Anaesthesiol.* 2019; 36: 745-54.
10. Kawamoto T, Nitta H, Murata K, Toda E, Tsukamoto N, Hasegawa M, et al. Working Group of the Epidemiological Research for Children's Environmental Health. Rationale and study design of the Japan environment and children's study (JECS). *BMC Public Health.* 2014;14:25.
11. Ishitsuka K, Nakayama SF, Kishi R, Mori C, Yamagata Z, Ohya Y, et al. Japan Environment and Children's Study: backgrounds, activities, and future directions in global perspectives. *Environ Health Prev Med.* 2017;22:61.
12. Suzumori N, Ebara T, Matsuki T, Yamada Y, Kato S, Omori T, Saitoh S, Kamijima M, Sugiura-Ogasawara M. Japan Environment & Children's Study Group. Effects of long working hours and shift work during pregnancy on obstetric and perinatal outcomes: A large prospective cohort study-Japan Environment and Children's Study. 2020;47:67-79.
13. Prochaska JJ, Sung HY, Max W, Shi Y, Ong M. Validity study of the K6 scale as a measure of moderate mental distress based on mental health treatment need and utilization. *Int J Methods Psychiatr Res.* 2012;21:88-97.
14. Okano T, Murata M, Masuji F. Validation and reliability of Japanese version of EPDS (Edinburgh Postnatal Depression Scale). *Arch Psychiatr Diagn Clin Eval.* 1996;7:525-33.
15. Yoshida K, Yamashita H, Ueda M, Tashiro N. Postnatal depression in Japanese mothers and the reconsideration of 'Satogaeri bunben'. *Pediatr Int.* 2001;43:189-93.
16. Susukida R, Usuda K, Hamazaki K, Tsuchida A, Matsumura K, Nishi D, et al. Association of prenatal psychological distress and postpartum depression with varying physical activity intensity: Japan Environment and Children's Study (JECS). *Sci Rep.* 2020;10:6390.
17. Furukawa TA, Kawakami N, Saitoh M, Ono Y, Nakane Y, Nakamura Y, et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *Int J Methods Psychiatr Res.* 2008;17:152-8.
18. Little RJ, D'Agostino R, Cohen ML, Dickersin K, Emerson SS, Farrar JT, et al. The prevention and treatment of missing data in clinical trials. *N Engl J Med.* 2012;367(14):1355-60.
19. O'Neill RT, Temple R. The prevention and treatment of missing data in clinical trials: an FDA perspective on the importance of dealing with it. *Clin Pharmacol Ther.* 2012;91(3):550-4.
20. Kountanis J, Vahabzadeh C, Bauer S, Muzik M, Cassidy R, Aman C, et al. Labor epidural analgesia and the risk of postpartum depression: A meta-analysis of observational studies. *J Clin Anesth.* 2020;61:109658.
21. Riazanova OV, Alexandrovich YS, Ioscovich AM. The relationship between labor pain management, cortisol level and risk of postpartum depression development: A prospective nonrandomized observational monocentric trial. *Rom J Anaesth Intensive Care.* 2018;25:123-30.

22. Hiltunen P, Raudaskoski T, Ebeling H, Moilanen I. Does pain relief during delivery decrease the risk of postnatal depression? *Acta Obstet Gynecol Scand*. 2004;83:257-61.
23. Wisner KL, Stika CS, Clark CT. Double duty: Does epidural labor analgesia reduce both pain and postpartum depression? *Anesth Analg*. 2014;119:219-21.
24. Gibson J, McKenzie-McHarg K, Shakespeare J, Price J, Gray R. A systematic review of studies validating the Edinburgh Postnatal Depression Scale in antepartum and postpartum women. *Acta Psychiatr Scand*. 2009;119(5):350-64.
25. van Heyningen T, Honikman S, Tomlinson M, Field S, Myer L. Comparison of mental health screening tools for detecting antenatal depression and anxiety disorders in South African women. *PLoS One*. 2018;13(4):e0193697.
26. Ministry of Health, Labour and Welfare, 2015. Final report of Healthy Parents and Children
27. [Cited 15 Feb, 2017.]
28. Olieman RM, Siemonsma F, Bartens MA, Garthus-Niegel S, Scheele F, Honig A. The effect of an elective cesarean section on maternal request on peripartum anxiety and depression in women with childbirth fear: A systematic review. *BMC Pregnancy Childbirth*. 2017;17:195.
29. 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; Japan Environment and Children's Study Group. Baseline Profile of Participants in the Japan Environment and Children's Study (JECS). *J Epidemiol*. 2018;28(2):99-104.

Tables

Due to technical limitations, table 1 is only available as a download in the Supplemental Files section.

Figures

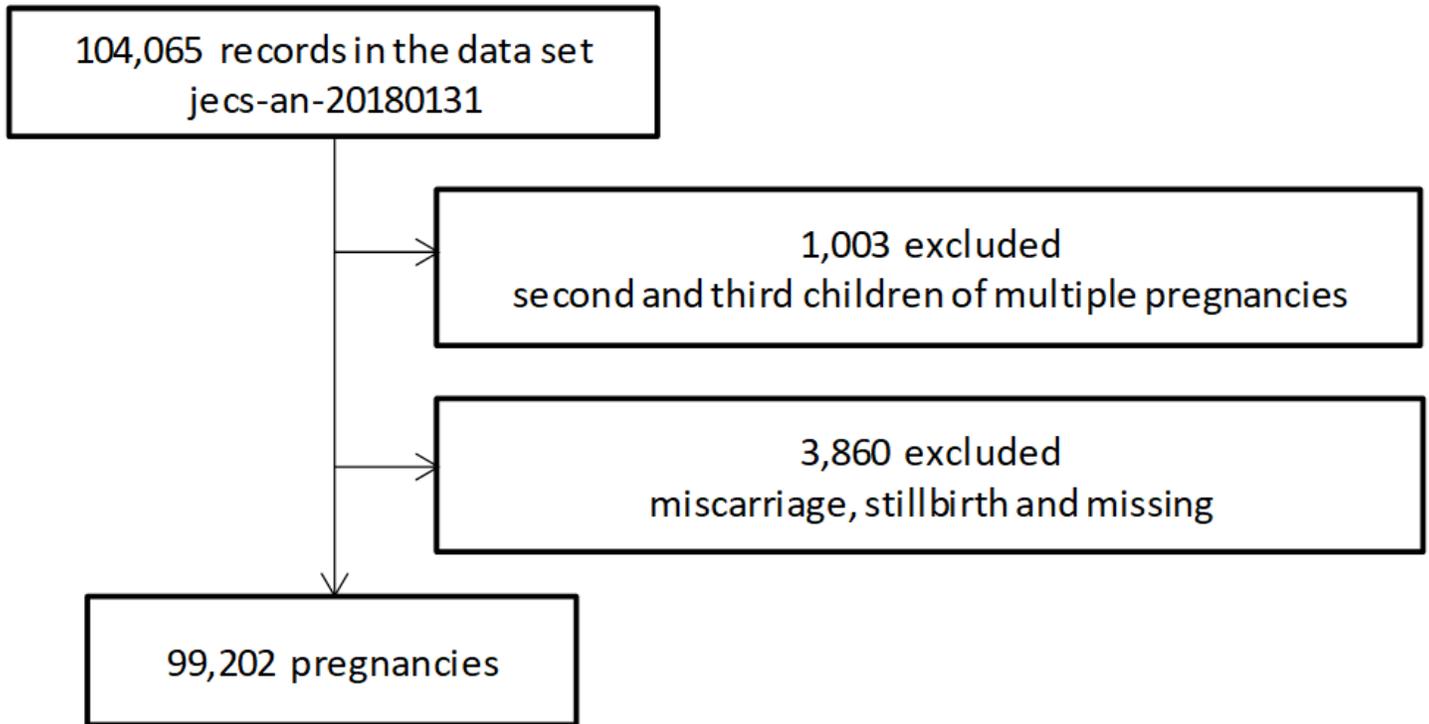


Figure 1

Flow diagram showing the recruitment and exclusion of pregnant women in this study.

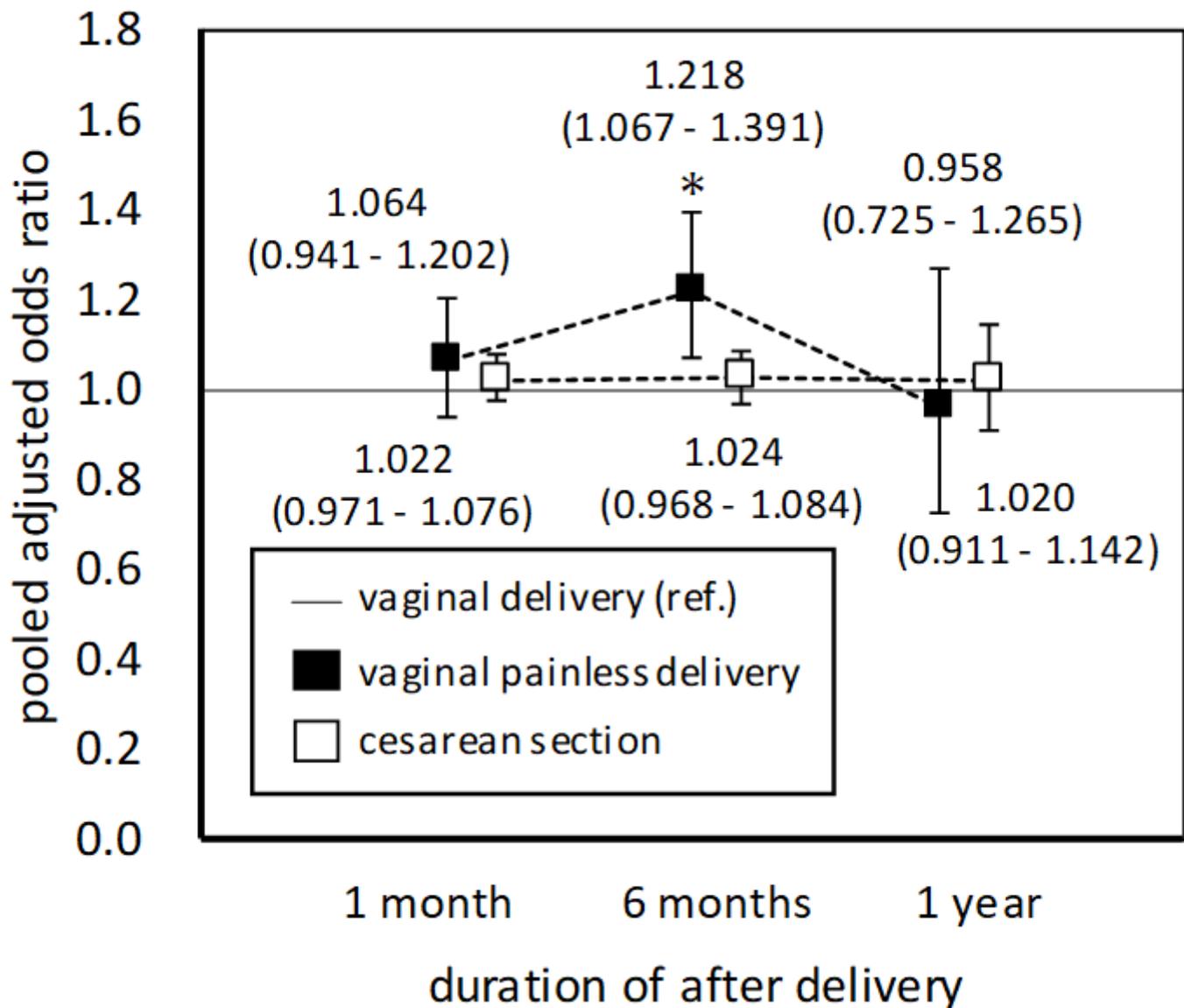


Figure 2

Association between painless delivery and postpartum depression. Adjusted for maternal age, maternal body mass index, maternal educational status, annual income, recurrent miscarriage, mode of pregnancy, parity, drinking history, maternal smoking history, pre-K6 (first trimester and second/third trimesters), marriage status (at second/third trimester and at 6 months after birth), sex of child, Apgar score at 1 min and at 5 min, inborn error of metabolism, neonatal anomalies, breast- or bottle-feeding, frequency of infant crying and partner's cooperation with nurturing (at 1 month and at 1 year after birth). * $q = 0.022$, obtained by Benjamini-Hochberg method. Error bars showed 95% CI.

Supplementary Files

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