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

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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 delivery with anesthesia, 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 anesthesia and postpartum depression at one-, six- and twelve-months after childbirth.

Results: At six months after childbirth, vaginal delivery with anesthesia was associated with a higher risk of postpartum depression (aOR: 1.233, 95% confidence interval: 1.079–1.409), compared with vaginal delivery without analgesia. Nevertheless, the risk dropped off one year after delivery. Among the pregnant women who requested delivery with anesthesia, 5.1% had a positive Kessler-6 scale (K6) score for depression before the first trimester ($p < 0.001$), which was significantly higher than the proportions in the vaginal delivery without analgesia (3.5%).

Conclusions: Our data suggested that the risk of postpartum depression at six months after childbirth tended to be increased after vaginal delivery with anesthesia, compared with vaginal delivery without analgesia. Requests for delivery with anesthesia 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 maternal environmental statuses.

Keywords: Anesthesia, Depression, Delivery, EPDS, Postpartum

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Background

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

Giving birth in a more relaxed state through the use of anesthesia 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 anesthesia; 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.

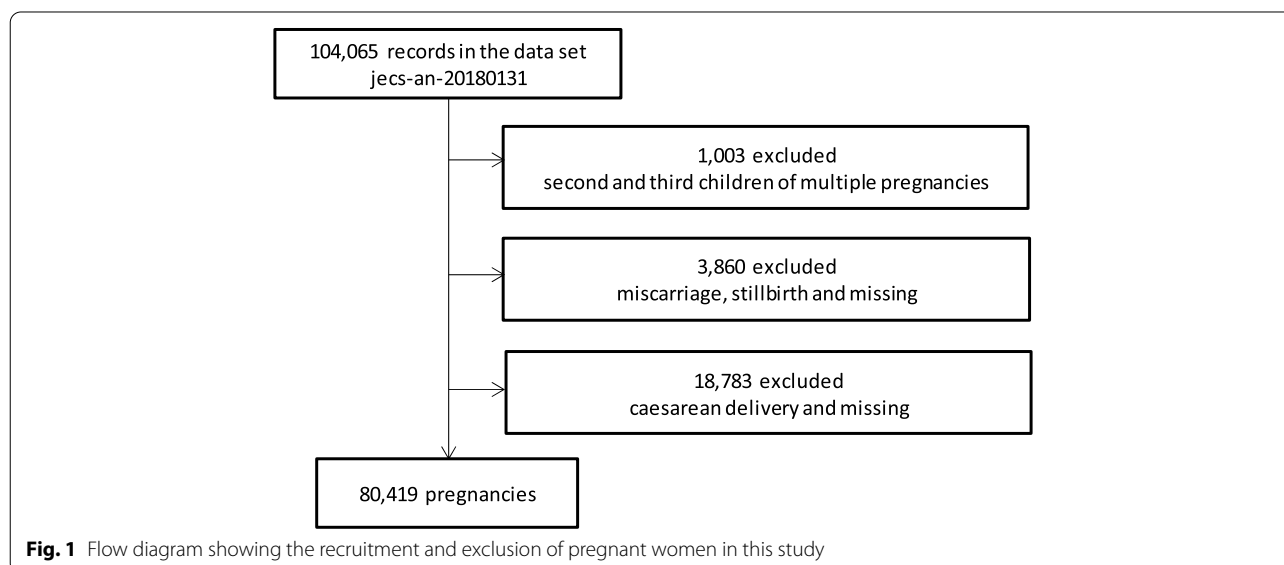
Severe labor pains are risk factor for postpartum depression in pregnant women, and early depression is associated with an increased risk of long-term depression [9]. Postpartum depression affects women who have given birth and is a common disorder for new mothers. Almost 10% to 15% of mothers may suffer 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 vaginal delivery with or without analgesia, 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 ($n=3,860$), and caesarean delivery or missing ($n=18,783$) were also excluded. Overall, 80,419 pregnancies were included in the analysis.

The J ECS 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, 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) as occurrence of postpartum depressive symptoms 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 evaluate for postpartum depressive symptoms. 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 two categories: vaginal delivery with and without anesthesia, including epidural analgesia, spinal-epidural analgesia, or paracervical block.

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 $\times 10,000$; 1 USD = 103.5 JPY, December 2020), recurrent miscarriage (yes vs. no), mode of pregnancy (natural conception vs. others), parity (never vs. \geq 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. ≥ 7), 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

Tables 1 and 2 summarize the characteristics of the prenatal, neonatal, and postpartum statuses and the maternal postpartum outcomes. Among the 80,419 pregnancies with vaginal deliveries who were included in the analysis, vaginal delivery without anesthesia occurred in 97.1% ($n=78,082$) and vaginal delivery with anesthesia in 2.9% (2,337).

As for the outcomes, a significant difference in the incidence of postpartum depressive symptoms at one month after delivery was observed according to the mode of delivery (vaginal delivery without analgesia: 14.0%, vaginal delivery with anesthesia: 16.7%, $p<0.001$). A similar trend was observed at six months after delivery (11.5% and 14.1%, respectively, $p<0.001$). The K6 scores for postpartum depression at one year after childbirth, however, did not differ significantly according to delivery mode ($p=0.542$).

With respect to the covariates, the distribution of categorized maternal ages was as follows: 1.2% with an age of < 20 years, 39.1% with an age of 20–29 years, 50.8% with an age of 30–39 years, and 2.7% with an age of ≥ 40 years. All the evaluated demographic characteristics differed significantly according to the vaginal delivery with or without anesthesia ($p<0.001$). Regarding the prenatal and neonatal statuses, among the women who requested pain control 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 ($p<0.001$). A similar trend was found during the second/third trimesters, with 5.2% of the women in the delivery with anesthesia, 3.1% of the women in the vaginal delivery without analgesia. As for the postpartum and childcare variables, the breastfeeding method, and frequency of infant crying differed significantly between the two groups (all $p<0.001$), whereas no significant differences in marriage status at six months after delivery ($p=0.279$) and partner's cooperation with nurturing at one month after birth and one

year after birth ($p=0.808$; $p=0.366$, respectively) were seen.

Association between delivery with anesthesia and occurrence of postpartum depressive symptoms

The association between delivery with anesthesia and postpartum depression is shown in Table 3. At six months after delivery, women who requested analgesia for delivery with anesthesia had a higher risk of occurrence of postpartum depressive symptoms (aOR: 1.233, 95% CI: 1.079–1.409, $q=0.004$), compared with vaginal delivery without analgesia. Nevertheless, the association dropped off 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 occurrence of postpartum depressive symptoms at six months among women who requested vaginal delivery with anesthesia in Japan. Little consensus exists regarding the effect of delivery with anesthesia 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 occurrence of postpartum depressive symptoms 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.

Table 1 Characteristics of maternal, prenatal and neonatal status

	Total (n = 80,419)	Vaginal delivery without anesthesia (n = 78,082)	Vaginal delivery with anesthesia (n = 2,337)	P value
Demographic characteristics				
Maternal age at registration				p < 0.001
< 20	936 1.2 %	926 1.3%	10 0.5%	
20 - 29	31481 39.1 %	30850 42.1%	631 29.4%	
30 - 39	40846 50.8 %	39457 53.8%	1389 64.7%	
≥ 40	2209 2.7 %	2092 2.9%	117 5.4%	
Missing	4947 6.2 %			
Maternal BMI				p = 0.023
< 18.5	9304 11.6 %	9064 11.9%	240 10.5%	
18.5 - < 25.0	59579 74.1 %	57843 75.8%	1736 75.7%	
≥ 25.0	9758 12.1 %	9441 12.4%	317 13.8%	
Missing	1778 2.2 %			
Maternal educational status				p < 0.001
Junior high school or high school	28513 35.5 %	27776 36.4%	737 32.3%	
Higher professional school or professional school	32867 40.9 %	31934 41.8%	933 40.9%	
Junior college or college	16146 20.1 %	15584 20.4%	562 24.6%	
Postgraduate college	1125 1.4 %	1074 1.4%	51 2.2%	
Missing	1768 2.2 %			
Annual income (JPY × 10,000)				p < 0.001
< 200	4098 5.1 %	4029 5.7%	69 3.2%	
200 - < 400	25518 31.7 %	24927 35.0%	591 27.6%	
400 - < 600	24347 30.3 %	23605 33.1%	742 34.7%	
600 - < 800	11596 14.4 %	11194 15.7%	402 18.8%	
800 - < 1,000	4794 6.0 %	4606 6.5%	188 8.8%	
≥ 1000	3058 3.8 %	2910 4.1%	148 6.9%	
Missing	7008 8.7 %			
Prenatal and neonatal status				
Recurrent miscarriage				p = 0.986
No	77018 95.8 %	74769 99.1%	2249 99.1%	
Yes	687 0.9 %	667 0.9%	20 0.9%	
Missing	2714 3.4 %			
Mode of pregnancy				p < 0.001
Natural conception	75481 93.9 %	73377 94.4%	2104 90.3%	
Others	4544 5.7 %	4319 5.6%	225 9.7%	
Missing	394 0.5 %			
Parity				p < 0.001
0	31619 39.3 %	30501 40.0%	1118 48.7%	
≥ 1	46870 58.3 %	45690 60.0%	1180 51.3%	
Missing	1930 2.4 %			
Drinking history				p = 0.232
Never	26366 32.8 %	25628 33.6%	738 32.4%	
Abstinence before pregnancy	13337 16.6 %	12941 17.0%	396 17.4%	
Abstinence from this pregnancy	36495 45.4 %	35407 46.5%	1088 47.8%	
Continuance drinking	2239 2.8 %	2186 2.9%	53 2.3%	
Missing	1982 2.5 %			
Maternal smoking history				p = 0.012
Never	46017 57.2 %	44732 58.7%	1285 56.8%	
Abstinence before pregnancy	17694 22.0 %	17114 22.5%	580 25.6%	
Abstinence from this pregnancy	11426 14.2 %	11124 14.6%	302 13.3%	
Continuance smoking (1 - 10 cigarettes per day)	2619 3.3 %	2541 3.3%	78 3.4%	
Continuance smoking (11 - 20 cigarettes per day)	661 0.8 %	642 0.8%	19 0.8%	
Continuance smoking (over 21 cigarettes per day)	37 0.0 %	37 0.0%	0 0.0%	
Missing	1965 2.4 %			
Pre-K6 (first trimester)				p < 0.001
< 13	76297 94.9 %	74158 96.5%	2139 94.9%	
≥ 13	2768 3.4 %	2652 3.5%	116 5.1%	
Missing	1354 1.7 %			
Pre-K6 (second/third trimesters)				p < 0.001
< 13	76381 95.0 %	74211 96.9%	2170 94.8%	
≥ 13	2508 3.1 %	2389 3.1%	119 5.2%	
Missing	1530 1.9 %			
Marriage status at first trimester				p = 0.010
Married	75526 93.9 %	73362 95.6%	2164 96.2%	
Non-married	2851 3.5 %	2787 3.6%	64 2.8%	
Divorced	625 0.8 %	606 0.8%	19 0.8%	
Partners' death	13 0.0 %	11 0.0%	2 0.1%	
Missing	1404 1.7 %			
Child's sex				p = 0.965
Male	41217 51.3 %	40024 51.3%	1193 51.0%	
Female	39198 48.7 %	38054 48.7%	1144 49.0%	
Unclear	1 0.0 %	1 0.0%	0 0.0%	
Missing	3 0.0 %			
Apgar score 1min				p < 0.001
< 8	26000 32.3 %	25042 32.8%	958 41.7%	
≥ 8	52629 65.4 %	51291 67.2%	1338 58.3%	
Missing	1790 2.2 %			
Apgar score 5min				p = 0.239
< 8	3235 4.0 %	3130 4.2%	105 4.7%	
≥ 8	73172 91.0 %	71053 95.8%	2119 95.3%	
Missing	4012 5.0 %			
Inborn error of metabolism				p = 0.826
Nothing	76992 95.7 %	74763 99.0%	2229 98.8%	
Require recheck	511 0.6 %	494 0.7%	17 0.8%	
Require complete checkup	79 0.1 %	76 0.1%	3 0.1%	
Confirm the diagnosis	164 0.2 %	158 0.2%	6 0.3%	
Missing	2673 3.3 %			
Neonatal anomalies				p < 0.001
No	74257 92.3 %	72136 94.2%	2121 91.9%	
Yes	4602 5.7 %	4414 5.8%	188 8.1%	
Missing	1560 1.9 %			

BMI, body mass index; JPY, Japanese yen; K6, Kessler-6 scale

BMI Body mass index, JPY Japanese yen, K6 Kessler-6 scale Total Vaginal

Table 2 Postpartum status/childcare and primary outcomes

	Total		Vaginal delivery without anesthesia		Vaginal delivery with anesthesia		P value
	(n = 80,419)		(n = 78,082)		(n = 2,337)		
Postpartum status and childcare							
Breast-feeding method							p < 0.001
Only breast milk	34330	42.7 %	33627	44.1%	703	31.0%	
Mixed feeding	43148	53.7 %	41630	54.6%	1518	66.8%	
Bottle-feeding	1035	1.3 %	985	1.3%	50	2.2%	
Missing	1906	2.4 %					
Frequency of infant crying							p < 0.001
Cry well and keep crying	13293	16.5 %	12842	16.9%	451	19.9%	
Sometimes but stop soon	61464	76.4 %	59764	78.6%	1700	75.2%	
Not too much	3555	4.4 %	3444	4.5%	111	4.9%	
Missing	2107	2.6 %					
Cooperation of partner to nurturing at 1 month after birth							p = 0.808
Always	29818	37.1 %	28958	38.4%	860	38.3%	
Sometimes	36205	45.0 %	35142	46.6%	1063	47.3%	
Very little	9070	11.3 %	8821	11.7%	249	11.1%	
Nothing	2548	3.2 %	2473	3.3%	75	3.3%	
Missing	2778	3.5 %					
Marriage status at 6 month after birth							p = 0.279
Married	73169	91.0 %	71032	98.1%	2137	98.7%	
Divorced	606	0.8 %	594	0.8%	12	0.6%	
Partners' death	31	0.0 %	30	0.0%	1	0.0%	
Others	734	0.9 %	719	1.0%	15	0.7%	
Missing	5879	7.3 %					
Cooperation of partner to nurturing at 1 year after birth							p = 0.366
Nothing	1303	1.6 %	1265	1.8%	38	1.8%	
Very little	3460	4.3 %	3345	4.8%	115	5.5%	
Sometimes	19041	23.7 %	18516	26.5%	525	25.1%	
Well	24643	30.6 %	23934	34.3%	709	33.9%	
Very well	23472	29.2 %	22770	32.6%	702	33.6%	
Missing	8500	10.6 %					
Primary outcomes							
EPDS score (1 month after delivery)							p < 0.001
< 9	66670	82.9 %	64799	86.0%	1871	83.3%	
≥ 9	10886	13.5 %	10512	14.0%	374	16.7%	
Missing	2863	3.6 %					
EPDS score (6 month after delivery)							p < 0.001
< 9	65430	81.4 %	63588	88.5%	1842	85.9%	
≥ 9	8586	10.7 %	8284	11.5%	302	14.1%	
Missing	6403	8.0 %					
K6 score (one year after delivery)							p = 0.542
< 13	70661	87.9 %	68617	97.3%	2044	97.1%	
≥ 13	1928	2.4 %	1868	2.7%	60	2.9%	
Missing	7830	9.7 %					

EPDS, Edinburgh Postnatal Depression Scores

EPDS Edinburgh Postnatal Depression Scores Total Vaginal

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 occurrence

of postpartum depressive symptoms. 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

Table 3 Association of delivery with anesthesia and postpartum depression

	One month after delivery			Six months after delivery			One year after delivery		
	OR	95% CI	q-value	OR	95% CI	q-value	OR	95% CI	q-value
Model 1	1.232	(1.101 - 1.379)	0.001	1.258	(1.112 - 1.424)	0.001	1.078	(0.831 - 1.400)	0.662
Model 2	1.057	(0.911 - 1.226)	0.662	1.249	(1.062 - 1.469)	0.014	1.075	(0.777 - 1.487)	0.662
Model 3	1.232	(1.101 - 1.379)	0.001	1.258	(1.112 - 1.424)	0.001	1.078	(0.831 - 1.400)	0.624
Model 4	1.069	(0.946 - 1.209)	0.429	1.233	(1.079 - 1.409)	0.004	0.932	(0.702 - 1.236)	0.624

OR, odds ratio; 95% CI, 95% confidence interval. Model 1, crude model (not adjusted); Model 2, 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 6 month after birth), child gender, apgar score 1min and 5min, inborn error of metabolism, neonatal anomalies, breast- or bottle-feeding, frequency of infant crying and cooperation of partner to nurturing (at 1 month and 1 year after birth); Model 3, pooled analysis of Model1; Model 4, pooled analysis of Model2.

OR Odds ratio, 95% CI 95% confidence interval. Model 1, crude model (not adjusted); Model 2, 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 (atsecond/third trimester and 6 month after birth), child gender, apgar score 1 min and 5 min, inborn error of metabolism, neonatalanomalies, breast- or bottle-feeding, frequency of infant crying and cooperation of partner to nurturing (at 1 month and 1 year after birth); Model 3, pooled analysis of Model1; Model 4, pooled analysis of Model2

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 presence of psychological distress before or during early pregnancy and the relations between such factors and the selection of delivery with anesthesia. In Japan, the number of pregnant women who request pain control is relatively small, whereas the rates of 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, although not accounting for history of depression should be thought as a weakness of the study. 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 women of advanced maternal age and the number of pregnant women requesting delivery with anesthesia 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 vaginal delivery with anesthesia (5.1%) than in

the vaginal delivery without analgesia (3.5%) groups. 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. Additionally, as a practical implication, it should be noted that pregnant women who requested delivery with anesthesia had higher K6 scores for depression during the first trimester, compared with women in the delivery without anesthesia.

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. In contrast, 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 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 delivery with anesthesia 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. It is possible that the women included in this study may have experienced more depressive symptoms before delivery or felt unprepared and, thus, unsuccessful when they requested pain relief.

Given the significantly lower numbers of epidural anesthesia in the study country of origin compared to others (such as the United States), one has to consider whether or not there is a cultural attitude or bias towards this decision. It may be possible women feel ashamed or weak at having made this request. If women feel that they somehow “failed” by making the request for anesthesia, they could be at increased risk for postpartum depression. Overall, the findings in this study may not be generalizable would be generalizable to a country with a higher epidural anesthesia rate, given the potential differences in cultural attitudes/normalization toward this request.

Conclusion

Delivery with anesthesia was associated with an increased risk for postpartum depressive symptoms at six months after delivery among pregnant women in Japan. Further analysis of maternal environmental statuses and comparing older and younger women who request delivery with anesthesia are needed to determine in which situations might epidural delivery be desirable. Because of prevailing maternal myths, Japan may represent a special environment where deliveries with anesthesia are extremely rare. Unlike in other countries, a higher proportion of women with occurrence of postpartum depressive symptoms at six months after delivery was seen among women requesting delivery with anesthesia; the importance of follow up and screening for postpartum depressive symptoms at 6 months postpartum is thus important for these women.

Abbreviations

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

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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. The authors read and approved the final manuscript.

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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.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the ethics committee of the Japan Environment and Children's Study (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. Written informed consent was obtained from all the study participants. All the experiment protocol for involving human data was in accordance with the guidelines of national/international/institutional or Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors have no conflicts of interest to declare.

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