

# Psychological stress among pregnant and puerperal women in Japan during the coronavirus disease 2019 pandemic

Soichiro Obata<sup>1</sup>, Etsuko Miyagi<sup>2</sup>, Yasuo Haruyama<sup>3</sup>, Takeshi Umazume<sup>4</sup>, Gen Kobashi<sup>3</sup>, Asuka Yoshimi<sup>5</sup>, Akitoyo Hishimoto<sup>5</sup>, Kentaro Kurasawa<sup>2</sup>, Yukio Suzuki<sup>2</sup>, Tomoaki Ikeda<sup>6</sup>, Tadashi Kimura<sup>7</sup> and Hideto Yamada<sup>8</sup>

<sup>1</sup>Perinatal Center for Maternity and Neonates, Yokohama City University Medical Center, Yokohama, Japan

<sup>2</sup>Department of Obstetrics and Gynecology, Yokohama City University Graduate School of Medicine, Yokohama, Japan

<sup>3</sup>Department of Public Health, Dokkyo Medical University School of Medicine, Tochigi, Japan

<sup>4</sup>Department of Obstetrics and Gynecology, Hokkaido University Graduate School of Medicine, Sapporo, Japan

<sup>5</sup>Department of Psychiatry, Yokohama City University Graduate School of Medicine, Yokohama, Japan

<sup>6</sup>Obstetrics and Gynecology, Mie University Graduate School of Medicine, Mie, Japan

<sup>7</sup>Department of Obstetrics and Gynecology, Osaka University Graduate School of Medicine, Osaka, Japan

<sup>8</sup>Department of Obstetrics and Gynecology, Teine Keijinkai Hospital, Sapporo, Japan

## Abstract

**Aim:** To evaluate psychological stress among pregnant and puerperal women in Japan during the coronavirus disease 2019 (COVID-19) pandemic.

**Methods:** In this cross-sectional study, we recruited pregnant women and puerperal women who delivered between January and September 2020 in Japan, using an online questionnaire. Participants were divided into low, middle, and high groups according to the degree of the epidemic in their region of residence. Related factors were analyzed using the chi-squared test. The relationship between COVID-19 epidemic regions and depression risks and anxiety using the Edinburgh Postnatal Depression Scale (EPDS) and Kessler 6 scale (K6) was evaluated using a univariate and multivariable logistic regression model.

**Results:** Overall, 7775 cases, including 4798 pregnant and 2977 puerperal women, were analyzed. The prevalence of high EPDS and K6 scores was significantly increased in pregnant women in the high than those in the low epidemic regions (EPDS: adjusted odds ratio [aOR] 1.453, 95% confidence interval [CI] 1.205–1.753; K6: aOR 1.601, 95% CI 1.338–1.918). There was no difference in EPDS score, but the prevalence of high K6 scores was significantly increased in puerperal women in the high than those in the low epidemic regions (aOR 1.342, 95% CI 1.066–1.690). Further, restriction on going to their hometown for delivery increased the prevalence of high EPDS scores among pregnant (aOR 1.663, 95% CI 1.296–2.133) and puerperal women (aOR 1.604, 95% CI 1.006–2.557).

**Conclusions:** Decreased support due to the COVID-19 pandemic affected the psychological status of pregnant and puerperal women; hence, investing medical resources in their healthcare essential.

**Key words:** anxiety, COVID-19, depression, postpartum period, pregnancy.

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### Correspondence

Etsuko Miyagi, Department of Obstetrics and Gynecology, Yokohama City University Hospital, 3-9, Fukuura, Kanazawa-ku, Yokohama, Kanagawa 236-0004, Japan.

Email: emiyagi@yokohama-cu.ac.jp

## Introduction

A stressful event is one of the risk factors for depression.<sup>1,2</sup> Pregnancy and childbirth are both stressful events, and hence, pregnant and puerperal women are at high risk for depression.<sup>3</sup> In 2020, the coronavirus disease 2019 (COVID-19) pandemic occurred; the measures imposed to curb the spread of COVID-19 forced people to change their lifestyle, putting them under tremendous stress. The COVID-19 pandemic has already had a large-scale, worldwide impact and has been defined as a “large-scale disaster.” Previous reports have asserted that the COVID-19 pandemic influences the psychological status of pregnant women.<sup>4–7</sup> However, the COVID-19 pandemic situation in Japan differed from that found in other countries, in terms of the urgency of action of the medical system and the numbers of critically ill and total infected patients. In Japan, the COVID-19 pandemic started in February 2020, and the first wave occurred in April 2020, with a peak of approximately 700 cases per day.<sup>8</sup> The Japanese government declared a state of emergency in Tokyo, Osaka, and five prefectures on April 7, 2020. The declaration was extended to the entire nation of Japan on April 16, 2020, and rescinded by late May 2020. During the state of emergency, the government encouraged people to stay at home and discouraged travel between cities, although there was no legally binding force. Despite the emergency declaration, the increase in newly infected cases, which triggered the second wave in July and August, forced people to change their lifestyle to prevent infection. The peak of COVID-19 cases in Japan in August at the time of the second wave was approximately 1600 cases per day.<sup>8</sup> This number is far less than that of the 32 883–67 823 (minimum-maximum during August 2020) in the United States during the same period.<sup>9</sup> In view of the World Health Organization (WHO) regional classification, the numbers of COVID-19 cases were far less in the Western Pacific region, including Japan, than in other regions of the world. The cumulative number of confirmed COVID-19 cases on August 31st in the western Pacific region was 5395 (Japan had 601 cases). In contrast, 31 536, 84 650, 11 811, and 6411 cases were found in Europe, Southeast Asia, Eastern Mediterranean, and Africa, respectively. Lifestyle modifications due to the measures imposed to curb the spread of COVID-19 may increase the burden on people, especially pregnant women, and on childcare during the pandemic. It is necessary to determine the problems people may face

and take appropriate measures to improve the situation.

The purpose of this study was to analyze the psychological stress and anxiety in pregnant and puerperal women in Japan during the COVID-19 pandemic in 2020. The results of this large-scale questionnaire study on the psychological effects among pregnant and puerperal women in Japan during the pandemic may aid national and local governments, medical facilities, and healthcare professionals in formulating appropriate measures while considering this population in the future.

## Methods

This cross-sectional study used data from a voluntary questionnaire survey. The survey was conducted for women >20 years old or married minors >16 years old who were pregnant or those who had given birth in 2020. The survey commenced between September 1 and 30th, 2020, using a leaflet delivered at medical facilities and social networking sites such as Facebook, Twitter, Line, and others. An online questionnaire survey was also conducted during the same period. Consent to participate in the research was obtained from the potential participants before answering the questionnaire. We used one of the most secure online questionnaire sites, “SurveyMonkey™.” The information sent on the internet was encrypted and converted into data through a secure server without individual information.

Based on the data acquired from the online questionnaire survey, psychological stress and anxiety were assessed using the Edinburgh Postnatal Depression Scale (EPDS)<sup>10,11</sup> and the Kessler 6 scale (K6).<sup>12,13</sup> In addition, maternal characteristics and background, including whether they planned/had their delivery at the location of residence or went to their hometown, the prefecture of residence, educational and working background, and marital and household status, were obtained.

According to the number of COVID-19 patients in the prefectures in Japan at the end of September,<sup>8</sup> the participants were divided into low, middle, and high epidemic regions as follows: <500, ≥500 but <3000, and ≥3000 patients (Table 1). Sociodemographic factors, pregnant and puerperal-related factors, COVID-19 factors, and depression and anxiety were analyzed using the chi-squared test among the three epidemic regions. To evaluate the accuracy of the responses to

**Table 1** Classification of the prefectures based on the number of COVID-19 patients

| Number of COVID-19 patients | Prefectures  |
|-----------------------------|--|
| ≥3000                       | Tokyo, Osaka, Kanagawa, Aichi, Fukuoka, Saitama, Chiba, Hyogo, Okinawa, Hokkaido, Kyoto  |
| ≥500 but <3000              | Ishikawa, Gunma, Ibaraki, Gifu, Kumamoto, Nara, Hiroshima, Shizuoka, Mie, Shiga, Tochigi, Toyama, Kagoshima, Nagano, Fukushima, Saga, Fukui, Wakayama, Nagasaki, Yamaguchi |
| <500                        | Yamanashi, Oita, Okayama, Shimane, Kochi, Ehime, Kagawa, Yamagata, Akita, Aomori, Tottori, Iwate   |

Abbreviation: COVID-19, Coronavirus disease 2019.

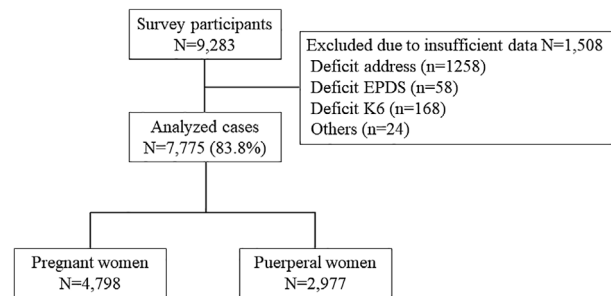
psychological stress in the current questionnaire, the correlation coefficient between EPDS and K6 scores was calculated. The relationship between the regions of COVID-19 epidemic and depression and anxiety in pregnant and puerperal women was evaluated using univariate and multivariable logistic regression models. The multivariable analysis was adjusted for potential confounding factors, such as sociodemographic factors and pregnant or puerperal-related factors.

All statistical analyses were performed using an assumed type I error rate of 0.05. Statistical analyses were performed using SPSS Statistics 26 for Windows (IBM Japan, Tokyo, Japan).

The present study was approved by the Institutional Ethics Committee of Yokohama City University (B 200800046), and all methods were performed in accordance with the Declaration of Helsinki. Consent to participate in the current study was obtained by confirmation from the participants at the start of the questionnaire responses.

## Results

The flow chart of the cases included in the current study is presented in Figure 1. The number of participants was 9283. Cases with insufficient data were excluded, and 7775 cases (83.8%), including 4798 pregnant women and 2977 puerperal women, were analyzed.



**Figure 1** Flow chart for the selection of the participants. EPDS, Edinburgh Postnatal Depression Scale; Kessler 6 scale

The characteristics and background of the participants are shown in Tables 2 and 3. The number of pregnant women from the high, middle, and low epidemic regions was 2859 (59.6%), 1088 (22.7%), and 851 (17.7%), respectively. The number of puerperal women from the high, middle, and low epidemic regions was 1793 (60.2%), 701 (23.5%), and 483 (16.2%), respectively. Among both pregnant and puerperal women, most participants were found to be in the high epidemic regions.

Moreover, age, educational level, household income, and the rate of full-time working were high among the participants from the high epidemic regions. In contrast, the rate of cases requiring therapy for threatened premature delivery was high in the low epidemic regions.

Approximately 35% of pregnant women hoped to go to their hometown for delivery, but >30% were unable to do so due to the safety measures imposed to curb the COVID-19 pandemic. In contrast, approximately 30% of puerperal women hoped to go to their hometown for the delivery, and 81.6% of them were able to do so.

In the univariate analysis of psychological stress, K6 scores tended to be higher among pregnant women in the high epidemic regions ( $p = 0.001$ ). The correlation between the EPDS and K6 scores in the current questionnaire is shown in Supporting Information, Figure S1(a) and (b). Positive correlations were observed in both pregnant ( $r = 0.788$ ) and puerperal women ( $r = 0.770$ ).

Table 4 shows the adjusted odds ratios (aORs) and 95% confidence intervals (CIs) of the relationship between the high score groups of EPDS and K6 and the COVID-19 pandemic in pregnant and puerperal women with reference to the low epidemic region. In addition, the results of the logistic regression analysis

**Table 2** Characteristics of pregnant women categorized by their residential prefectural COVID-19 epidemic status at the end of September 2020 in Japan

|   | Total      |      | Regions based on COVID-19 epidemic status   |      |   |      |   |      | <i>p</i> -Value <sup>a</sup> |
|---|------------|------|---|------|---|------|---|------|------------------------------|
|   | (N = 4798) |      | Low epidemic<br>( <i>n</i> = 851,<br>17.7%) |      | Middle epidemic<br>( <i>n</i> = 1088,<br>22.7%) |      | High epidemic<br>( <i>n</i> = 2859,<br>59.6%) |      |                              |
|   | <i>n</i>   | %    | <i>n</i>                                    | %    | <i>n</i>  | %    | <i>n</i>                                      | %    |                              |
| Age group (years)                           |            |      |   |      |   |      |   |      |                              |
| ≤19   | 10         | 0.2  | 0   | 0.0  | 0   | 0.0  | 10  | 0.3  | 0.006                        |
| 20–29                                       | 1405       | 29.3 | 288   | 33.8 | 319   | 29.3 | 798   | 27.9 |                              |
| 30–39                                       | 3055       | 63.7 | 512   | 60.2 | 692   | 63.6 | 1851  | 64.7 |                              |
| 40–49                                       | 324        | 6.8  | 49  | 5.8  | 76  | 7.0  | 199   | 7.0  |                              |
| Unknown                                     | 4          | 0.1  | 2   | 0.2  | 1   | 0.1  | 1   | 0.0  |                              |
| Weeks of gestation                          |            |      |   |      |   |      |   |      |                              |
| 1st trimester (<14 weeks)                   | 644        | 13.4 | 110   | 12.9 | 150   | 13.8 | 384   | 13.4 | 0.979                        |
| 2nd trimester (14–27 weeks)                 | 1582       | 33.0 | 279   | 32.8 | 355   | 32.6 | 948   | 33.2 |                              |
| 3rd trimester (≥28 weeks)                   | 2572       | 53.6 | 462   | 54.3 | 583   | 53.6 | 1527  | 53.4 |                              |
| Number of children born before January 2020 |            |      |   |      |   |      |   |      |                              |
| 0   | 3061       | 63.8 | 531   | 62.4 | 654   | 60.1 | 1876  | 65.6 | 0.015                        |
| 1   | 1246       | 26.0 | 228   | 26.8 | 307   | 28.2 | 711   | 24.9 |                              |
| 2   | 387        | 8.1  | 76  | 8.9  | 90  | 8.3  | 221   | 7.7  |                              |
| ≥3  | 93         | 1.9  | 14  | 1.6  | 33  | 3.0  | 46  | 1.6  |                              |
| Unknown                                     | 11         | 0.2  | 2   | 0.2  | 4   | 0.4  | 5   | 0.2  |                              |
| Complications during pregnancy <sup>b</sup> |            |      |   |      |   |      |   |      |                              |
| Threatened premature delivery               | 369        | 7.7  | 94  | 11.0 | 86  | 7.9  | 189   | 6.6  | <0.001                       |
| Fetal disorder or fetal growth restriction  | 47         | 1.0  | 11  | 1.3  | 10  | 0.9  | 26  | 0.9  | 0.593                        |
| Placental malposition                       | 84         | 1.8  | 11  | 1.3  | 23  | 2.1  | 50  | 1.7  | 0.392                        |
| Multiple pregnancy                          | 69         | 1.4  | 17  | 2.0  | 19  | 1.7  | 33  | 1.2  | 0.120                        |
| Gestational hypertension                    | 26         | 0.5  | 5   | 0.6  | 8   | 0.7  | 13  | 0.5  | 0.551                        |
| Gestational diabetes mellitus               | 208        | 4.3  | 41  | 4.8  | 45  | 4.1  | 122   | 4.3  | 0.763                        |
| Other                                       | 880        | 18.3 | 132   | 15.5 | 226   | 20.8 | 522   | 18.3 | 0.012                        |
| Delivery at hometown                        |            |      |   |      |   |      |   |      |                              |
| No plan                                     | 3154       | 65.7 | 565   | 66.4 | 730   | 67.1 | 1859  | 65.0 | 0.107                        |
| Plan  | 1115       | 23.2 | 201   | 23.6 | 239   | 22.0 | 675   | 23.6 |                              |
| Refused by the facility                     | 39         | 0.8  | 6   | 0.7  | 6   | 0.6  | 27  | 0.9  |                              |
| Gave up plan by due to advice of facility   | 31         | 0.6  | 2   | 0.2  | 8   | 0.7  | 21  | 0.7  |                              |
| Gave up plan by self                        | 416        | 8.7  | 63  | 7.4  | 94  | 8.6  | 259   | 9.1  |                              |
| Unknown                                     | 43         | 0.9  | 14  | 1.6  | 11  | 1.0  | 18  | 0.6  |                              |
| Marital status                              |            |      |   |      |   |      |   |      |                              |
| Married and live together                   | 4539       | 94.6 | 800   | 94.0 | 1022  | 93.9 | 2717  | 95.0 | 0.104                        |
| Married and separated                       | 139        | 2.9  | 25  | 2.9  | 36  | 3.3  | 78  | 2.7  |                              |
| Unmarried with a partner                    | 55         | 1.1  | 12  | 1.4  | 10  | 0.9  | 33  | 1.2  |                              |
| Unmarried without a partner                 | 50         | 1.0  | 7   | 0.8  | 17  | 1.6  | 26  | 0.9  |                              |
| Divorced                                    | 3          | 0.1  | 2   | 0.2  | 1   | 0.1  | 0   | 0.0  |                              |
| Bereaved                                    | 3          | 0.1  | 2   | 0.2  | 0   | 0.0  | 1   | 0.0  |                              |
| Unknown                                     | 9          | 0.2  | 3   | 0.4  | 2   | 0.2  | 4   | 0.1  |                              |
| Nationality                                 |            |      |   |      |   |      |   |      |                              |
| Japanese                                    | 4745       | 98.9 | 846   | 99.4 | 1078  | 99.1 | 2821  | 98.7 | 0.380                        |
| Other                                       | 40         | 0.8  | 3   | 0.4  | 8   | 0.7  | 29  | 1.0  |                              |
| Unknown                                     | 13         | 0.3  | 2   | 0.2  | 2   | 0.2  | 9   | 0.3  |                              |
| Education                                   |            |      |   |      |   |      |   |      |                              |
| Junior high school                          | 80         | 1.7  | 16  | 1.9  | 18  | 1.7  | 46  | 1.6  | <0.001                       |
| High school                                 | 713        | 14.9 | 162   | 19.0 | 183   | 16.8 | 368   | 12.9 |                              |
| College                                     | 794        | 16.5 | 164   | 19.3 | 194   | 17.8 | 436   | 15.3 |                              |
| Junior college                              | 418        | 8.7  | 101   | 11.9 | 109   | 10.0 | 208   | 7.3  |                              |
| University                                  | 2411       | 50.3 | 366   | 43.0 | 497   | 45.7 | 1548  | 54.1 |                              |

(Continues)

Table 2 Continued

|   | Total      |      | Regions based on COVID-19 epidemic status |      |                                   |      |                                 |      | p-Value <sup>a</sup> |
|---|------------|------|---|------|-----------------------------------|------|---------------------------------|------|----------------------|
|   | (N = 4798) |      | Low epidemic (n = 851, 17.7%)             |      | Middle epidemic (n = 1088, 22.7%) |      | High epidemic (n = 2859, 59.6%) |      |                      |
|   | n          | %    | n   | %    | n                                 | %    | n                               | %    |                      |
| Graduate school (Masters)                   | 309        | 6.4  | 34  | 4.0  | 72                                | 6.6  | 203                             | 7.1  |                      |
| Graduate school (Doctorate)                 | 51         | 1.1  | 7   | 0.8  | 9                                 | 0.8  | 35                              | 1.2  |                      |
| Unknown                                     | 22         | 0.5  | 1   | 0.1  | 6                                 | 0.6  | 15                              | 0.5  |                      |
| Household income (JP¥)                      |            |      |   |      |                                   |      |                                 |      |                      |
| <1 million                                  | 26         | 0.5  | 7   | 0.8  | 4                                 | 0.4  | 15                              | 0.5  | <0.001               |
| 1–3.99 million                              | 553        | 11.5 | 141                                       | 16.6 | 150                               | 13.8 | 262                             | 9.2  |                      |
| 4–6.99 million                              | 1674       | 34.9 | 354                                       | 41.6 | 430                               | 39.5 | 890                             | 31.1 |                      |
| 7–9.99 million                              | 1234       | 25.7 | 185                                       | 21.7 | 247                               | 22.7 | 802                             | 28.1 |                      |
| ≥10 million                                 | 869        | 18.1 | 68  | 8.0  | 143                               | 13.1 | 658                             | 23.0 |                      |
| Unknown                                     | 442        | 9.2  | 96  | 11.3 | 114                               | 10.5 | 232                             | 8.1  |                      |
| Current employment status                   |            |      |   |      |                                   |      |                                 |      |                      |
| Full-time                                   | 2034       | 42.4 | 322                                       | 37.8 | 417                               | 38.3 | 1295                            | 45.3 | <0.001               |
| Part-time                                   | 439        | 9.1  | 96  | 11.3 | 104                               | 9.6  | 239                             | 8.4  |                      |
| On leave                                    | 880        | 18.3 | 152                                       | 17.9 | 181                               | 16.6 | 547                             | 19.1 |                      |
| Unemployed                                  | 65         | 1.4  | 15  | 1.8  | 20                                | 1.8  | 30                              | 1.0  |                      |
| Housewife or student                        | 1342       | 28.0 | 253                                       | 29.7 | 359                               | 33.0 | 730                             | 25.5 |                      |
| Unknown                                     | 38         | 0.8  | 13  | 1.5  | 7                                 | 0.6  | 18                              | 0.6  |                      |
| Edinburgh Postnatal Depression Scale scores |            |      |   |      |                                   |      |                                 |      |                      |
| <9  | 3191       | 66.5 | 590                                       | 69.3 | 719                               | 66.1 | 1882                            | 65.8 | 0.091                |
| ≥9 but <13                                  | 905        | 18.9 | 156                                       | 18.3 | 219                               | 20.1 | 530                             | 18.5 |                      |
| ≥13   | 702        | 14.6 | 105                                       | 12.3 | 150                               | 13.8 | 447                             | 15.6 |                      |
| Kessler 6 scale scores                      |            |      |   |      |                                   |      |                                 |      |                      |
| <5  | 2887       | 60.2 | 556                                       | 65.3 | 660                               | 60.7 | 1671                            | 58.4 | 0.001                |
| ≥5 but <10                                  | 1279       | 26.7 | 215                                       | 25.3 | 276                               | 25.4 | 788                             | 27.6 |                      |
| ≥10   | 632        | 13.2 | 80  | 9.4  | 152                               | 14.0 | 400                             | 14.0 |                      |

Abbreviation: COVID-19, Coronavirus disease 2019.; <sup>a</sup>Chi-squared test. and <sup>b</sup>Multiple answers.

adjusted for characteristics and backgrounds, which are shown in Tables 2 and 3 were also analyzed. Among pregnant women, participants with a high EPDS score were more commonly observed in the middle (aOR, 95% CI 1.266 [1.021–1.570]) and high (aOR, 95% CI 1.453 [1.205–1.753]) epidemic regions than in the low epidemic regions. Moreover, participants with high K6 scores were also more commonly observed in the middle (aOR, 95% CI 1.320 [1.074–1.623]) and high (aOR, 95% CI 1.601 [1.338–1.918]) epidemic regions than in the low epidemic regions.

In contrast to the pregnant women, there was no difference in the rate of high EPDS scores between the low, middle (aOR, 95% CI 1.114 [0.843–1.472]), and high epidemic (aOR, 95% CI 1.216 [0.950–1.556]) regions among puerperal women. Moreover, the rate of high K6 scores also did not differ in the low and middle epidemic regions (aOR, 95% CI 1.081 [0.833–

1.404]), but was higher in the high epidemic regions (aOR, 95% CI 1.342 [1.066–1.690]).

Table 5 shows the results of the logistic regression analysis of the relationship between the prevalence of high EPDS and K6 scores and delivery at hometown. The aORs and 95% CIs were adjusted for maternal characteristics and background. Among pregnant women, high EPDS scores were observed more among those who could not go to their hometown for the delivery (refused by the hospital, gave up according to the obstetrician's instructions, or gave up voluntarily due to the COVID-19 pandemic) than in those who could go to their hometown for the delivery (aOR, 95% CI 1.663 [1.296–2.133]). Similarly, higher K6 scores were observed in those who could not go to their hometown for the delivery (aOR, 95% CI 1.650 [1.294–2.103]), compared to those who could do so. Among puerperal women, high EPDS scores

**Table 3** Characteristics of puerperal women characterized by the residential prefectural COVID-19 epidemic status at the end of September in Japan

|   | Total      |      | Regions of COVID-19 epidemic status |       |  |      |                                       |      | <i>p</i> -Value <sup>a</sup> |
|---|------------|------|-------------------------------------|-------|--|------|---------------------------------------|------|------------------------------|
|   | (N = 2977) |      | Low epidemic<br>(n = 483,<br>16.2%) |       | Middle epidemic<br>(n = 701,<br>23.5%) |      | High epidemic<br>(n = 1793,<br>60.2%) |      |                              |
|   | <i>n</i>   | %    | <i>n</i>                            | %     | <i>n</i>                               | %    | <i>n</i>                              | %    |                              |
| Age group (years)                           |            |      |                                     |       |  |      |                                       |      |                              |
| ≤19   | 4          | 0.1  | 1                                   | 0.2   | 1                                      | 0.1  | 2                                     | 0.1  | 0.001                        |
| 20–29                                       | 896        | 30.1 | 180                                 | 37.3  | 238                                    | 34.0 | 478                                   | 26.7 |                              |
| 30–39                                       | 1881       | 63.2 | 269                                 | 55.7  | 418                                    | 59.6 | 1194                                  | 66.6 |                              |
| 40–49                                       | 195        | 6.6  | 33                                  | 6.8   | 44                                     | 6.3  | 118                                   | 6.6  |                              |
| Unknown                                     | 1          | 0.0  | 0                                   | 0.0   | 0                                      | 0.0  | 1                                     | 0.1  |                              |
| Days after childbirth                       |            |      |                                     |       |  |      |                                       |      |                              |
| <42 (6 weeks)                               | 684        | 23.0 | 117                                 | 24.2  | 158                                    | 22.5 | 409                                   | 22.8 | 0.822                        |
| 42–183 (6 weeks to 6 months)                | 1825       | 61.3 | 293                                 | 60.7  | 424                                    | 60.5 | 1108                                  | 61.8 |                              |
| 184–266 (6 months or more)                  | 468        | 15.7 | 73                                  | 15.1  | 119                                    | 17.0 | 276                                   | 15.4 |                              |
| Number of children born before January 2020 |            |      |                                     |       |  |      |                                       |      |                              |
| 0   | 1798       | 60.4 | 281                                 | 58.2  | 420                                    | 59.9 | 1097                                  | 61.2 | 0.180                        |
| 1   | 931        | 31.3 | 151                                 | 31.3  | 212                                    | 30.2 | 568                                   | 31.7 |                              |
| 2   | 200        | 6.7  | 44                                  | 9.1   | 53                                     | 7.6  | 103                                   | 5.7  |                              |
| ≥3  | 46         | 1.5  | 7                                   | 1.4   | 15                                     | 2.1  | 24                                    | 1.3  |                              |
| Unknown                                     | 2          | 0.1  | 0                                   | 0.0   | 1                                      | 0.1  | 1                                     | 0.1  |                              |
| Complications during pregnancy <sup>b</sup> |            |      |                                     |       |  |      |                                       |      |                              |
| Threatened premature delivery               | 410        | 13.8 | 83                                  | 17.2  | 105                                    | 15.0 | 222                                   | 12.4 | 0.014                        |
| Fetal disorder or fetal growth restriction  | 63         | 2.1  | 7                                   | 1.4   | 14                                     | 2.0  | 42                                    | 2.3  | 0.466                        |
| Placental malposition                       | 102        | 3.4  | 18                                  | 3.7   | 20                                     | 2.9  | 64                                    | 3.6  | 0.625                        |
| Multiple pregnancy                          | 28         | 0.9  | 3                                   | 0.6   | 6                                      | 0.9  | 19                                    | 1.1  | 0.652                        |
| Gestational hypertension                    | 181        | 6.1  | 34                                  | 7.0   | 37                                     | 5.3  | 110                                   | 6.1  | 0.454                        |
| Gestational diabetes mellitus               | 179        | 6.0  | 29                                  | 6.0   | 34                                     | 4.9  | 116                                   | 6.5  | 0.311                        |
| Other                                       | 361        | 12.1 | 54                                  | 11.2  | 86                                     | 12.3 | 221                                   | 12.3 | 0.784                        |
| Delivery at hometown                        |            |      |                                     |       |  |      |                                       |      |                              |
| No plan                                     | 2097       | 70.4 | 345                                 | 71.4  | 486                                    | 69.3 | 1266                                  | 70.6 | 0.687                        |
| Performed                                   | 718        | 24.1 | 112                                 | 23.2  | 171                                    | 24.4 | 435                                   | 24.3 |                              |
| Refused by the facility                     | 16         | 0.5  | 5                                   | 1.0   | 2                                      | 0.3  | 9                                     | 0.5  |                              |
| Gave up plan due to advice of facility      | 9          | 0.3  | 0                                   | 0.0   | 3                                      | 0.4  | 6                                     | 0.3  |                              |
| Gave up plan by self                        | 86         | 2.9  | 14                                  | 2.9   | 24                                     | 3.4  | 48                                    | 2.7  |                              |
| Unknown                                     | 51         | 1.7  | 7                                   | 1.4   | 15                                     | 2.1  | 29                                    | 1.6  |                              |
| Marital status                              |            |      |                                     |       |  |      |                                       |      |                              |
| Married and live together                   | 2874       | 96.5 | 462                                 | 95.7  | 675                                    | 96.3 | 1737                                  | 96.9 | 0.242                        |
| Married and separated                       | 51         | 1.7  | 14                                  | 2.9   | 13                                     | 1.9  | 24                                    | 1.3  |                              |
| Unmarried with a partner                    | 19         | 0.6  | 3                                   | 0.6   | 7                                      | 1.0  | 9                                     | 0.5  |                              |
| Unmarried without a partner                 | 25         | 0.8  | 2                                   | 0.4   | 6                                      | 0.9  | 17                                    | 0.9  |                              |
| Divorce                                     | 6          | 0.2  | 2                                   | 0.4   | 0                                      | 0.0  | 4                                     | 0.2  |                              |
| Bereaved                                    | 2          | 0.1  | 0                                   | 0.0   | 0                                      | 0.0  | 2                                     | 0.1  |                              |
| Nationality                                 |            |      |                                     |       |  |      |                                       |      |                              |
| Japanese                                    | 2961       | 99.5 | 483                                 | 100.0 | 698                                    | 99.6 | 1780                                  | 99.3 | 0.318                        |
| Other                                       | 13         | 0.4  | 0                                   | 0.0   | 3                                      | 0.4  | 10                                    | 0.6  |                              |
| Unknown                                     | 3          | 0.1  | 0                                   | 0.0   | 0                                      | 0.0  | 3                                     | 0.2  |                              |
| Education                                   |            |      |                                     |       |  |      |                                       |      |                              |
| Junior high school                          | 72         | 2.4  | 15                                  | 3.1   | 15                                     | 2.1  | 42                                    | 2.3  | <0.001                       |
| High school                                 | 460        | 15.5 | 107                                 | 22.2  | 136                                    | 19.4 | 217                                   | 12.1 |                              |
| College                                     | 495        | 16.6 | 92                                  | 19.0  | 122                                    | 17.4 | 281                                   | 15.7 |                              |
| Junior college                              | 250        | 8.4  | 53                                  | 11.0  | 64                                     | 9.1  | 133                                   | 7.4  |                              |
| University                                  | 1469       | 49.3 | 191                                 | 39.5  | 319                                    | 45.5 | 959                                   | 53.5 |                              |
| Graduate school (Masters)                   | 201        | 6.8  | 21                                  | 4.3   | 38                                     | 5.4  | 142                                   | 7.9  |                              |
| Graduate school (Doctorate)                 | 23         | 0.8  | 3                                   | 0.6   | 6                                      | 0.9  | 14                                    | 0.8  |                              |

(Continues)

Table 3 Continued

|   | Total      |      | Regions of COVID-19 epidemic status |      |  |      |                                       |      | <i>p</i> -Value <sup>a</sup> |
|---|------------|------|-------------------------------------|------|--|------|---------------------------------------|------|------------------------------|
|   | (N = 2977) |      | Low epidemic<br>(n = 483,<br>16.2%) |      | Middle epidemic<br>(n = 701,<br>23.5%) |      | High epidemic<br>(n = 1793,<br>60.2%) |      |                              |
|   | <i>n</i>   | %    | <i>n</i>                            | %    | <i>n</i>                               | %    | <i>n</i>                              | %    |                              |
| Unknown                                     | 7          | 0.2  | 1                                   | 0.2  | 1                                      | 0.1  | 5                                     | 0.3  |                              |
| Household income (JP¥)                      |            |      |                                     |      |  |      |                                       |      |                              |
| <1 million                                  | 20         | 0.7  | 3                                   | 0.6  | 6                                      | 0.9  | 11                                    | 0.6  | <0.001                       |
| 1–3.99 million                              | 354        | 11.9 | 100                                 | 20.7 | 99                                     | 14.1 | 155                                   | 8.6  |                              |
| 4–6.99 million                              | 1111       | 37.3 | 206                                 | 42.7 | 298                                    | 42.5 | 607                                   | 33.9 |                              |
| 7–9.99 million                              | 775        | 26.0 | 100                                 | 20.7 | 169                                    | 24.1 | 506                                   | 28.2 |                              |
| ≥10 million                                 | 506        | 17.0 | 36                                  | 7.5  | 71                                     | 10.1 | 399                                   | 22.3 |                              |
| Unknown                                     | 211        | 7.1  | 38                                  | 7.9  | 58                                     | 8.3  | 115                                   | 6.4  |                              |
| Current employment status                   |            |      |                                     |      |  |      |                                       |      |                              |
| Full-time                                   | 665        | 22.3 | 100                                 | 20.7 | 125                                    | 17.8 | 440                                   | 24.5 | <0.001                       |
| Part-time                                   | 113        | 3.8  | 21                                  | 4.3  | 31                                     | 4.4  | 61                                    | 3.4  |                              |
| On leave                                    | 1150       | 38.6 | 184                                 | 38.1 | 254                                    | 36.2 | 712                                   | 39.7 |                              |
| Unemployed                                  | 57         | 1.9  | 9                                   | 1.9  | 10                                     | 1.4  | 38                                    | 2.1  |                              |
| Housewife or student                        | 973        | 32.7 | 165                                 | 34.2 | 279                                    | 39.8 | 529                                   | 29.5 |                              |
| Unknown                                     | 19         | 0.6  | 4                                   | 0.8  | 2                                      | 0.3  | 13                                    | 0.7  |                              |
| Edinburgh Postnatal Depression Scale scores |            |      |                                     |      |  |      |                                       |      |                              |
| <9  | 2110       | 70.9 | 351                                 | 72.7 | 495                                    | 70.6 | 1264                                  | 70.5 | 0.501                        |
| ≥9 but <13                                  | 495        | 16.6 | 67                                  | 13.9 | 119                                    | 17.0 | 309                                   | 17.2 |                              |
| ≥13   | 372        | 12.5 | 65                                  | 13.5 | 87                                     | 12.4 | 220                                   | 12.3 |                              |
| Kessler 6 scale scores                      |            |      |                                     |      |  |      |                                       |      |                              |
| <5  | 1817       | 61.0 | 305                                 | 63.1 | 436                                    | 62.2 | 1076                                  | 60.0 | 0.371                        |
| ≥5 but <10                                  | 745        | 25.0 | 116                                 | 24.0 | 160                                    | 22.8 | 469                                   | 26.2 |                              |
| ≥10   | 415        | 13.9 | 62                                  | 12.8 | 105                                    | 15.0 | 248                                   | 13.8 |                              |

Abbreviation: COVID-19: Coronavirus disease 2019.; <sup>a</sup>Chi-squared test. and <sup>b</sup>Multiple answers.

were observed in those who could not go to their hometown for the delivery (aOR, 95% CI 1.604 [1.006–2.557]); however, there was no difference in the prevalence of high K6 scores (aOR, 95% CI 1.392 [0.892–2.173]).

## Discussion

Due to the COVID-19 pandemic, psychological stress found in pregnant and puerperal women in Japan was higher than that previously reported.<sup>14</sup> Psychological stress tended to be higher in the regions with a high prevalence of the disease than in those with a low prevalence of the disease. In addition, decreased support from the partner and family due to the pandemic affected the psychological status of pregnant and puerperal women. Therefore, it is important to build a support system for this population.

In a large study, which included 92 796 puerperal women before the COVID-19 pandemic,<sup>14</sup> only 12 819

women (17.8%) had a high EPDS score (≥9), and only 26 308 women (28.4%) had a high K6 score (score of 5 or higher). In the current study, the rates of prevalence of high EPDS and K6 scores among pregnant women were 33.5% and 39.9%, respectively and in puerperal women were 29.1% and 38.9%, respectively. These rates are higher than that reported in a previous study,<sup>14</sup> indicating that the psychological stress in pregnant and puerperal women in Japan during the COVID-19 pandemic was higher than that before the pandemic. This tendency must be considered immediately as stressful events are risk factors for postpartum depression.<sup>1</sup> Zanardo et al.<sup>7</sup> reported that the EPDS score was significantly higher after the COVID-19 pandemic, and the rate of patients with high EPDS scores tended to be higher. Wu et al.<sup>4</sup> also reported a significant increase in a high EPDS score after the COVID-19 pandemic in a larger study (26.0% vs. 29.6%, *p* = 0.02). The results of the current study are consistent with those of previous studies and suggest that the COVID-19 pandemic increases psychological stress. However, unlike in other

**Table 4** Relationship between the residential prefectural COVID-19 epidemic status and depression or anxiety among pregnant and puerperal women

|                               | Regions based on their COVID-19 epidemic status |      |                 |                    |                              |               |                    | <i>p</i> for trend test |                              |
|-------------------------------|---|------|-----------------|--------------------|------------------------------|---------------|--------------------|-------------------------|------------------------------|
|                               | Low epidemic                                    |      | Middle epidemic |                    | <i>p</i> -Value <sup>a</sup> | High epidemic |                    |                         | <i>p</i> -Value <sup>a</sup> |
| Pregnant women, <i>n</i> , %  | 732   | 17.1 | 956             | 22.4               |                              | 2585          | 60.5               |                         |                              |
| EPDS scores ≥9                |   |      |                 |                    |                              |               |                    |                         |                              |
| Crude odds ratio, 95% CI      | Ref.  |      | 1.180           | 0.958–1.453        | 0.120                        | <b>1.214</b>  | <b>1.015–1.451</b> | <b>0.033</b>            | <b>0.048</b>                 |
| Adjusted odds ratio, 95% CI   | Ref.  |      | <b>1.266</b>    | <b>1.021–1.570</b> | <b>0.032</b>                 | <b>1.453</b>  | <b>1.205–1.753</b> | <b>&lt;0.001</b>        | <b>&lt;0.001</b>             |
| K6 scores ≥5                  |   |      |                 |                    |                              |               |                    |                         |                              |
| Crude odds ratio, 95% CI      | Ref.  |      | <b>1.262</b>    | <b>1.032–1.543</b> | <b>0.023</b>                 | <b>1.386</b>  | <b>1.167–1.646</b> | <b>&lt;0.001</b>        | <b>&lt;0.001</b>             |
| Adjusted odds ratio, 95% CI   | Ref.  |      | <b>1.320</b>    | <b>1.074–1.623</b> | <b>0.008</b>                 | <b>1.601</b>  | <b>1.338–1.918</b> | <b>&lt;0.001</b>        | <b>&lt;0.001</b>             |
| Puerperal women, <i>n</i> , % | 433   | 16.0 | 628             | 23.3               |                              | 1639          | 60.7               |                         |                              |
| EPDS scores ≥9                |   |      |                 |                    |                              |               |                    |                         |                              |
| Crude odds ratio, 95% CI      | Ref.  |      | 1.077           | 0.821–1.412        | 0.593                        | 1.071         | 0.846–1.355        | 0.568                   | 0.634                        |
| Adjusted odds ratio, 95% CI   | Ref.  |      | 1.114           | 0.843–1.472        | 0.446                        | 1.216         | 0.950–1.556        | 0.121                   | 0.108                        |
| K6 scores ≥5                  |   |      |                 |                    |                              |               |                    |                         |                              |
| Crude odds ratio, 95% CI      | Ref.  |      | 1.040           | 0.807–1.342        | 0.761                        | 1.176         | 0.944–1.465        | 0.148                   | 0.093                        |
| Adjusted odds ratio, 95% CI   | Ref.  |      | 1.081           | 0.833–1.404        | 0.557                        | <b>1.342</b>  | <b>1.066–1.690</b> | <b>0.012</b>            | <b>0.004</b>                 |

Abbreviations: 95% CI, 95% confidence interval; COVID-19, coronavirus disease 2019; EPDS, Edinburgh Postnatal Depression Scale; K6, Kessler 6 scale; Ref., Reference.; <sup>a</sup>Using a univariate logistic model for the crude odds ratio and a multivariable logistic model after adjustment for age, weeks of gestation or days after childbirth, children, complications during pregnancy, homecoming delivery, marital status, nationality, education, household income, and employment status, but excluding unknown (*n* = 525 in pregnant women and *n* = 277 in puerperal women). and Data with a P-value of less than 0.05 and a 95% confidence interval not crossing 1 are shown in bold.

countries where there are strong social restrictions and lockdowns, the Japanese government only recommended people refrain from moving across prefectures, and the restrictions were relatively lax without legal penalties. In addition, the total numbers of COVID-19 cases were low when compared to other countries,<sup>9</sup> and the medical system has not been overburdened so far in Japan. Therefore, the situation is quite different from other countries where previous reports have been published. The COVID-19 pandemic is still not under control, and the number of patients is increasing. The epidemic situation in Japan

could worsen in the future, as in the case of other countries, and the psychological stress in pregnant and puerperal women could be higher.

To the best of our knowledge, this is the first study to compare psychological stress in pregnant and puerperal women according to the degree of the COVID-19 pandemic on a large scale. The results showed that psychological stress increased more in the middle and high epidemic regions than in the low epidemic regions during the same period. This suggests that if the COVID-19 pandemic becomes more severe, the number of pregnant and puerperal women suffering



**Table 5** Relationship between delivery in the hometown and depression or anxiety among pregnant and puerperal women

|                               | Delivery at hometown |      |              |                    | <i>p</i> -Value <sup>a</sup> |
|-------------------------------|----------------------|------|--------------|--------------------|------------------------------|
|                               | Plan                 |      | Gave up      |                    |                              |
| Pregnant women, <i>n</i> , %  | 1007                 | 69.4 | 445          | 30.6               |                              |
| EPDS scores ≥9                |                      |      |              |                    |                              |
| Crude odds ratio, 95% CI      | Ref.                 |      | <b>1.542</b> | <b>1.223–1.942</b> | <b>&lt;0.001</b>             |
| Adjusted odds ratio, 95% CI   | Ref.                 |      | <b>1.663</b> | <b>1.296–2.133</b> | <b>&lt;0.001</b>             |
| K6 scores ≥5                  |                      |      |              |                    |                              |
| Crude odds ratio, 95% CI      | Ref.                 |      | <b>1.554</b> | <b>1.240–1.947</b> | <b>&lt;0.001</b>             |
| Adjusted odds ratio, 95% CI   | Ref.                 |      | <b>1.650</b> | <b>1.294–2.103</b> | <b>&lt;0.001</b>             |
| Puerperal women, <i>n</i> , % | Performed            |      | Gave up      |                    | <i>p</i> -Value <sup>a</sup> |
| EPDS scores ≥9                | 664                  | 86.7 | 102          | 13.3               |                              |
| Crude odds ratio, 95% CI      | Ref.                 |      | 1.436        | 0.932–2.213        | 0.101                        |
| Adjusted odds ratio, 95% CI   | Ref.                 |      | <b>1.604</b> | <b>1.006–2.557</b> | <b>0.047</b>                 |
| K6 scores ≥5                  |                      |      |              |                    |                              |
| Crude odds ratio, 95% CI      | Ref.                 |      | 1.309        | 0.860–1.993        | 0.209                        |
| Adjusted odds ratio, 95% CI   | Ref.                 |      | 1.392        | 0.892–2.173        | 0.145                        |

Abbreviations: 95% CI, 95% confidence interval; COVID-19, coronavirus disease 2019; EPDS, Edinburgh Postnatal Depression Scale; K6, Kessler 6 scale; Ref., Reference.; <sup>a</sup>Using a univariate logistic model for the crude odds ratio and a multivariable logistic model after adjustment for age, weeks of gestation or days after childbirth, children, complications during pregnancy, marital status, COVID-19 epidemic region, nationality, education, household income, and employment status, but excluding unknown (*n* = 149 in pregnant women and *n* = 63 in puerperal women). and Data with a *P*-value of less than 0.05 and a 95% confidence interval not crossing 1 are shown in bold.

from anxiety and depression will increase. Therefore, as the COVID-19 pandemic does not appear to be under control, it is necessary to build an advanced and efficient system for psychological stress care for pregnant and puerperal women and increase the availability of medical resources.

Racine et al.<sup>15</sup> asserted the importance of partner and family support for psychological stress during pregnancy and the postpartum period. Going to their hometown for the delivery is a unique culture in Japan, in which a pregnant woman returns to her hometown, where her parents live, to deliver her baby to get support from her family during pregnancy and the postpartum period. The Tokyo Midwives Association conducted an online survey of 2872 pregnant women in Tokyo during the outbreak of COVID-19 in April.<sup>16</sup> It was suggested that being advised to refrain from going to other prefectures from Tokyo for the delivery at hometown might increase psychological stress among pregnant women.<sup>16</sup> Consistent with this report, the results of the current study indicated that restrictions on visiting their hometown for the delivery increased psychological stress in pregnant and puerperal women.

In Japan, it is estimated that restrictions on delivery at hometown could lead to insufficient support for pregnancy and puerperal women. The present study showed that psychological stress was higher in

pregnant women who could not go to their hometown for the delivery due to the COVID-19 pandemic than in pregnant women who could go to their hometown for the delivery as planned. In this study, more than 30% of pregnant and puerperal women wanted to go to their hometown for the delivery. However, 30% of the pregnant women who hoped to go to their hometown for the delivery could not do so because of the COVID-19 pandemic; these groups were more stressed than those who planned to come to their hometown for the delivery as scheduled. In contrast, no significant difference was observed among the puerperal women, but only 18.4% of them were unable to return to their hometown for the delivery. This may be because going to their hometown for the delivery was more widely restricted at the time of the current survey than at the beginning of the COVID-19 pandemic. Therefore, as the COVID-19 pandemic continues, it is expected that the number of puerperal women who cannot go to their hometown for delivery will increase, and a significant difference may emerge in psychological stress in the future.

There are several limitations of the present study. Since this was a cross-sectional study, we were unable to evaluate changes in psychological stress before and after the COVID-19 pandemic among the same participants. The epidemic regions are a relative definition, as COVID-19 is currently pandemic, and its morbidity

changes daily. Further, we could not analyze the difference between the city center and the suburbs in the same prefectures. In addition, the accuracy of each response cannot be guaranteed because the survey was based on questionnaires that were not administered face-to-face or referred from medical records. Further, most of the participants were from a high epidemic region, and the possibility of a selection bias could not be ruled out. However, this was a cross-sectional study of a large scale that has not been reported before. Moreover, because there was a positive correlation between the EPDS and K6 scores (Figure S1(a) and (b)), the accuracy of the data could be sufficiently guaranteed for analysis. Therefore, the findings obtained from this study are significant and reliable.

In summary, we proved that the COVID-19 pandemic affected psychological status of pregnant and puerperal women. The infection status of the place of residence and the restrictions on traditional delivery at their hometown because of the COVID-19 pandemic led to insufficient support for pregnant and puerperal women in Japan. These were significant risk factors for increased psychological stress. As the COVID-19 pandemic spreads and continues, psychological stress in this population is likely to increase. Therefore, building an appropriate medical care system and investing medical resources in mental healthcare for pregnant and puerperal women is an urgent task that needs to be addressed.

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## Conflict of interest

The authors declare no conflict of interest.

## Author contributions

Soichiro Obata wrote the initial draft of the manuscript as the first author and contributed to creating the questionnaire and finalizing the manuscript. Etsuko Miyagi designed the study protocol and contributed to finalizing the manuscript. Yasuo Haruyama contributed to the statistical analysis. Takeshi Umazume and Yukio Suzuki contributed to creating the questionnaire. Gen Kobashi, Asuka Yoshimi, Akitoyo Hishimoto, and Kentaro Kurasawa contributed to the review of the questionnaire. Tomoaki Ikeda, Tadashi Kimura, and Hideto Yamada contributed to supervising the protocol, and reviewed and approved the manuscript. Hideto Yamada obtained the grant. All authors contributed to the interpretation of the results.

## Data availability statement

Research data are not shared.

## References

1. The American College of Obstetricians and Gynecologists Committee Opinion no. 630. Screening for perinatal depression. *Obstet Gynecol.* 2015;**125**:1268–71.
2. Bittner A, Goodwin RD, Wittchen HU, Beesdo K, Höfler M, Lieb R. What characteristics of primary anxiety disorders predict subsequent major depressive disorder? *J Clin Psychiatry.* 2004;**65**:618–26. quiz 730.
3. Howard LM, Molyneaux E, Dennis CL, Rochat T, Stein A, Milgrom J. Non-psychotic mental disorders in the perinatal period. *Lancet.* 2014;**384**:1775–88.
4. Wu Y, Zhang C, Liu H, et al. Perinatal depressive and anxiety symptoms of pregnant women during the coronavirus disease 2019 outbreak in China. *Am J Obstet Gynecol.* 2020;**223**:240.e1–9.
5. Moyer CA, Compton SD, Kaselitz E, Muzik M. Pregnancy-related anxiety during COVID-19: a nationwide survey of 2740 pregnant women. *Arch Womens Ment Health.* 2020;**23**:757–65.
6. Medina-Jimenez V, Bermudez-Rojas ML, Murillo-Bargas H, et al. The impact of the COVID-19 pandemic on depression and stress levels in pregnant women: a national survey during the COVID-19 pandemic in Mexico. *J Matern Fetal Neonatal Med.* 2020;1–3. <https://doi.org/10.1080/14767058.2020.1851675>.
7. Zanardo V, Manghina V, Giliberti L, Vettore M, Severino L, Straface G. Psychological impact of COVID-19 quarantine measures in northeastern Italy on mothers in the immediate postpartum period. *Int J Gynaecol Obstet.* 2020;**150**:184–8.
8. Ministry of Health, Labour and Welfare of Japan. 2020. [Cited 24 March 2021]. Available from URL: <https://www.mhlw.go.jp/stf/covid-19/kokunainohasseijoukyou.html>.
9. World Health Organization. WHO Coronavirus Disease (COVID-19) Dashboard. 2020. [Cited 24 March 2021]. Available from URL: <https://covid19.who.int>.

10. Kozinszky Z, Dudas RB. Validation studies of the Edinburgh postnatal depression scale for the antenatal period. *J Affect Disord.* 2015;**176**:95–105.
11. Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression. Development of the 10-item Edinburgh postnatal depression scale. *Br J Psychiatry.* 1987;**150**:782–6.
12. Sakurai K, Nishi A, Kondo K, Yanagida K, Kawakami N. Screening performance of K6/K10 and other screening instruments for mood and anxiety disorders in Japan. *Psychiatry Clin Neurosci.* 2011;**65**:434–41.
13. 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.
14. Susukida R, Usuda K, Hamazaki K, 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.
15. Racine N, Plamondon A, Hentges R, Tough S, Madigan S. Dynamic and bidirectional associations between maternal stress, anxiety, and social support: the critical role of partner and family support. *J Affect Disord.* 2019;**252**:19–24.
16. Haruna M, Nishi D. Perinatal mental health and COVID-19 in Japan. *Psychiatry Clin Neurosci.* 2020;**74**:502–3.

## Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Figure S1** Correlation between EPDS and K6 score in the (a) pregnant women ( $n = 4798$ ), and (b) puerperal women ( $n = 2977$ )