



Evaluation of depression at 6 and 12 months postpartum by examining depressive symptoms and self-harm ideation during the early postpartum period: Tohoku Medical Megabank Project Birth and Three-Generation Cohort Study

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Abstract

Aim: The aim of this study was to evaluate depression at 6 and 12 months postpartum, using the Edinburgh Postpartum Depression Scale (EPDS) total score and its subitem regarding self-harm ideation (SHI) at 1 month postpartum.

Methods: A sample of 12,358 postpartum women answered the EPDS and questionnaires at 1, 6, and 12 months postpartum longitudinally.

Results: For participants with postpartum depression (PPD; EPDS total score ≥ 9) and SHI (SHI sub-score ≥ 1) at 1 month postpartum, the risk of depression at 6 and 12 months postpartum (odds ratio [95% confidence interval] at 6 and 12 months postpartum: 20.03 [16.8–23.8] and 14.55 [12.3–17.2], respectively) was higher than for those with PPD but without SHI at 1 month postpartum (OR: 8.57 [7.36–10.0], and 6.24 [5.38–7.24], respectively). Additionally, SHI even without depressive symptoms at 1 month postpartum is also a risk for depression at 6 and 12 months postpartum. To support our longitudinal evaluation of depression at 6 and 12 months postpartum, these related factors were examined: traumatic events or relocations after the Great East Japan Earthquake, employment status, household income, personality traits, sleep status, psychological distress, and social networks. The result showed employment status, low household income and poor social networks were significantly associated with depression at 12 months postpartum but not at 6 months postpartum.

Conclusion: This study showed a high risk of depression at 6 and 12 months postpartum for those who had depressive symptoms with SHI at 1 month postpartum. Our findings

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may contribute to the precise evaluation of depression at 6 and 12 months postpartum while considering sleep status, psychological distress and social network during pregnancy.

KEYWORDS

longitudinal survey, mental health, postpartum check-up, postpartum depression, self-harm

INTRODUCTION

The prevalence of postpartum depression (PPD) for women has been reported to be approximately 10%–20% in high-income countries and 20%–40% in low- and middle-income countries,^{1–3} which are significant proportions. Furthermore, maternal depression is one of the major contributors to pregnancy-related mortality, including suicide.^{4,5} Furthermore, the suicide rate of postpartum women in Tokyo, Japan, at 8.7 per 100,000 births, is higher than that in Sweden and the United Kingdom.⁶ Against these backdrops, suicide prevention strategies for pregnant and postpartum women are an urgent issue in Japan. The Japanese Comprehensive Measures for Suicide Prevention positioned increasing support for women, including pregnant and postpartum women, as one of the critical strategies for suicide prevention.⁷ Due to this initiative, municipalities nationwide have been actively conducting health checkups for postpartum women that include assessments of their mental health and suicide-prevention measures using the Edinburgh Postpartum Depression Scale (EPDS) total score and its subitem regarding self-harm ideation (SHI).^{8,9}

During the postpartum check-ups, the Japanese manual regarding maternal mental health care recommends that high-risk postpartum women are evaluated as those with (1) an EPDS total score of ≥ 9 or (2) the presence of SHI (SHI sub-score ≥ 1).⁹ The SHI subscale of EPDS is positioned apart from the other nine questions of the EPDS, which are used to assess if postpartum women are at high risk of suicide, as stated in the manual on maternal mental health care.

However, there are differences in how municipalities deal with the presence or absence of SHI.¹⁰ It is different evaluation those with an EPDS score of ≤ 8 points but those who have SHI (e.g., borderline personality disorder, alcohol or substance use disorder)¹¹ depends on the municipalities. Therefore, some municipalities does not target as subjects in administrative follow-up. A previous study reported that suicide is a leading cause of death in the 1-year postpartum period.⁴ Another study showed that women reporting thoughts of self-harm in the postpartum period could be at risk of psychiatric morbidity, such as mood disorders, during a long-term follow-up period after delivery.¹² Therefore, it is essential to establish screening systems for postpartum women while using SHI at an early stage postpartum to implement the strategies for promoting mental health and suicide prevention over a long-term postpartum period. Unfortunately, to the best of our knowledge, there are no studies that have evaluated the longitudinal risks of depression at 6 and 12 months postpartum while combining data on PPD and SHI at 1 month postpartum.

Therefore, our study aimed to evaluate depression at 6 and 12 months postpartum by examining depressive symptoms and SHI at 1 month postpartum. We hypothesized that (1) women with PPD and SHI at 1 month postpartum are at a higher risk for depression at 6 and 12 months postpartum than those with PPD but without SHI at 1 month postpartum, and (2) having SHI but without depressive symptoms at 1 month postpartum is also a significant risk of depression at 6 and 12 months postpartum. Moreover, it has been shown that there are factors related to PPD, including low educational attainment, low socioeconomic status, sleep status, personality traits, and poor social support.^{1,2,13–15} To support our longitudinal evaluation of depression at 6 and 12 months postpartum, we also examined related factors.

METHODS

Study design

The Tohoku Medical Megabank Project (TMM) aimed to assist medical and health services to overcome the damages from the 2011 Great East Japan Earthquake (GEJE) by supporting survivors and implementing personalized healthcare. The GEJE struck on March 11, 2011. The 9.0 magnitude earthquake was the greatest earthquake in Japanese history and resulted in a large tsunami and significant damage to the Pacific Coast, with over 90% of the casualties being related to drowning. The earthquake also left 2520 people missing and 15,900 people dead. Following the GEJE, pregnant women experiencing psychological distress were more common in the disaster-affected area, particularly in the tsunami-affected coastal area.¹⁶

The Birth and Three-Generation (BirThree) Cohort Study, part of TMM, recruited approximately 73,000 participants, including pregnant women and their children, partners, and parents, at obstetric clinics or hospitals in Miyagi and part of the Iwate Prefecture in Japan from July 2013 to March 2017.^{17,18}

This study design was a longitudinal study analyzing the data from the TMM BirThree Cohort Study. A total of 22,493 pregnant women were recruited. Withdrawals from continuing follow-up surveys after initial participation totaled 1179 (e.g., due to abortion, stillbirth, and other reasons). Of the 21,314 postpartum women who agreed to complete the questionnaire, 12,520 answered all follow-up surveys at 1, 6, and 12 months postpartum. Consequently, 162 of the participants did not complete the EPDS questionnaire at 1 month postpartum. Finally, data from 12,358 postpartum women was analyzed (Figure 1).

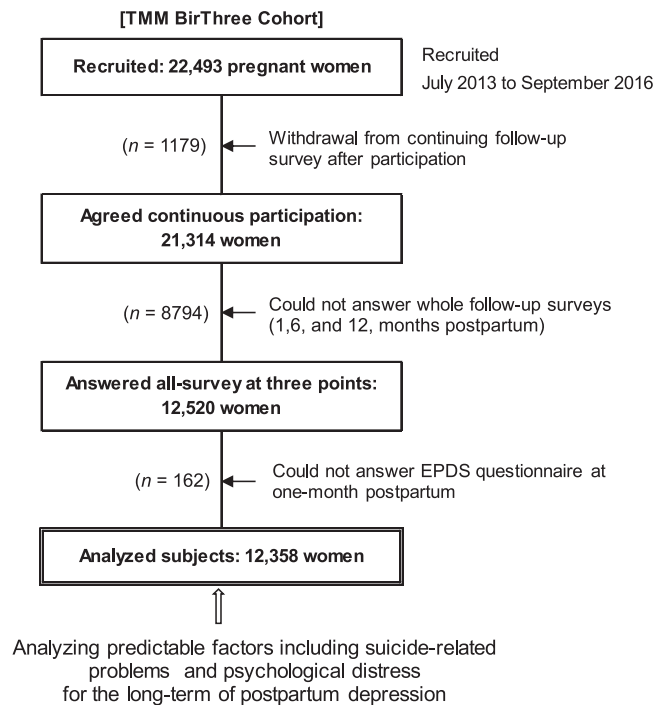


FIGURE 1 Participants of the Tohoku Medical Megabank Project (TMM) BirThree cohort and analyzed subjects.

Factors related to depression at 6 and 12 months postpartum

We determined the following factors related to depression at 6 and 12 months postpartum: the pregnant woman's age, birth experiences (primipara/multipara), marital status (married or unmarried, divorced, or bereaved), educational attainment (junior/high school, vocational school/junior college, or university/graduate school), employment status (childcare-leave, housewife, unemployed or employed), and number of traumatic events or relocations after GEJE were collected during the registry to the cohort. Data on household income (less than 4 million yen, 4–6 million yen, and 6 million yen or more per year), personality traits, sleep status, psychological distress, and social networks were collected during the middle phase of pregnancy.

We utilized the Japanese version of the short-form Eysenck Personality Questionnaire–Revised (EPQR–S) as an assessment of personality, collected during the middle phase of pregnancy. The EPQR–S has been examined for reliability and validity.¹⁹ The scores for each scale range from 0 to 12, with higher scores indicating a greater tendency to possess the personality trait represented by each scale.²⁰ Personality traits, especially neuroticism, are risk factors for depression and suicidality.²¹

The validated Japanese version of the K6 scale²² was utilized to screen for non-specific psychological distress.²³ For this scale, those who score 13–24 points are classified as having probable severe psychological distress.^{22,23}

Traumatic experiences of the GEJE were measured with the following questions: (1) “Did you experience a serious threat to your

life (a life-threatening experience) by the earthquake or tsunami?,” (2) “Did you witness another person's actual or threatened death by the earthquake or tsunami?,” and (3) “Did anybody close to you die or go missing by the earthquake or tsunami?” We then created a scale by summing the number of traumatic experiences in the GEJE.²⁴ Moreover, the number of relocations after the GEJE, including shelters and temporary housing, was asked,²⁵ and categorized into five groups: none, once, twice, three times, or four times and more.

We measured participants' social networks using two of the six questions from the Luben Social Network Scale–6 (LSNS–6)²⁶: “How many family members and relatives do you feel close to such that you could ask them for help?” and “How many friends do you feel at ease with that you can talk about private matters?” We considered these questions to be the best measurement of social networks among postpartum women.

Sleep status was assessed on a four-point scale. We categorized participants into two groups: “satisfied” and “dissatisfied.” The latter combined three answers: “a little dissatisfied,” “quite dissatisfied,” and “really dissatisfied or cannot sleep at all.”

Definition of postpartum depression

Using the EPDS²⁷ total score, PPD was defined as an EPDS score of ≥ 9 at 1 month postpartum.²⁸ The EPDS has been translated into Japanese.²⁹ It should be highlighted, nevertheless, that the DSM-5 (2013) criteria for major depressive disorder do not apply to PPD as defined by the EPDS, and that the EPDS is only a screening tool for PPD.

Four groups according to the combination of PPD and SHI at 1 month postpartum

In this study, SHI was assessed using the scores for the 10th item of the EPDS (“The thought of harming myself has occurred to me”), with the answer “never” coded as no SHI and the other answers (“quite often,” “sometimes,” and “hardly ever”) coded as the presence of SHI. Also, depression at 6 and 12 months postpartum was defined as an EPDS score of ≥ 9 when answered in the 6- and 12-month postpartum surveys. As an important independent variable for the evaluation of depression at 6 and 12 months postpartum, we defined Groups A, B, C, and D, which were combinations of present (+) or absent (–) PPD and SHI at 1 month postpartum: Group A, PPD (+) and SHI (+); Group B, PPD (+) and SHI (–); Group C, PPD (–) and SHI (+); and Group D, PPD (–) and SHI (–) (Figure 2).

Incidentally, based on the Japanese manual of maternal mental health,⁹ those who are categorized into Group A and B are provided support by an administrative follow-up system that includes telephone and home-visit consultations by public health nurses and midwives. On the other hand, while Group C may be provided support like Group A and B, women in some municipalities may not be eligible for support due to the evaluation of excluding SHI scores.⁹

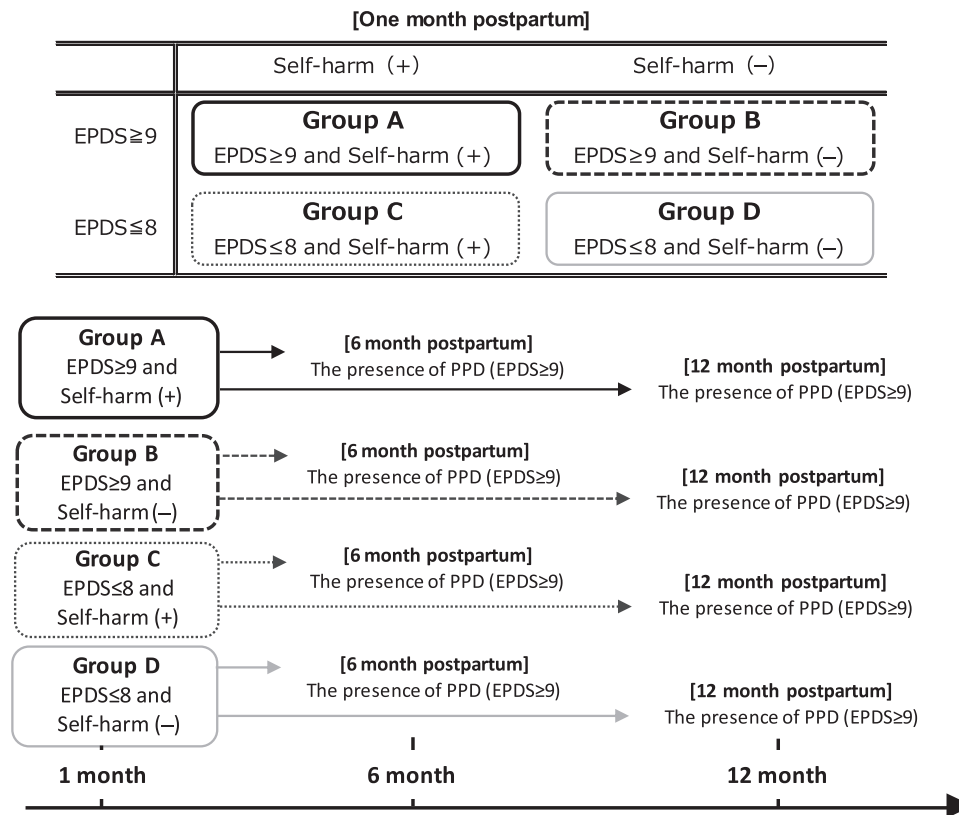


FIGURE 2 Definition of the combination postpartum depression (PPD) and self-harm ideation (SHI) at 1 month postpartum (Group A, B, C, and D) and longitudinal evaluation depression at 6 and 12 months postpartum.

Group D is not a target for mental health support but for general support.

Data analysis

First, we conducted a simple tabulation in each group using participants' basic characteristics. Then, we sorted participants according to whether they presented or were absent from depression at 6 and 12 months postpartum using simple tabulation. Finally, we conducted univariate and multivariate logistic regression analysis using the following: (1) the crude odds ratio (OR) of depression at 6 and 12 months postpartum, with the independent variables of Groups A, B, and C (reference: Group D); and (2) the OR including related factors, such as age, birth experiences, educational attainment, household income, sleep status, psychological distress, and social networks during the middle phase of pregnancy. In Japan, many municipalities support postpartum women with mental issues when their EPDS score (EPDS total score of ≥ 9) or SHI score (SHI sub-score ≥ 1) are over the cutoff; therefore, it is suitable to examine by binary outcomes as in this study.

Statistical significance was evaluated using two-sided, design-based tests with a 5% significance level using Stata 15 (StataCorp, 2017; Stata Statistical Software: Release 15: StataCorp LLC).

Ethical considerations

This study was approved by the Ethical Research Committee at Tohoku University Graduate School of Medicine (2013-4-103, approval date: May 10, 2013; latest revised 2023-4-040, approval date: June 21, 2023). Informed consent was also obtained from all participants in the TMM BirThree Cohort Study.

RESULTS

Basic characteristics of the four groups

The basic characteristics of the participants are shown in Table 1. The numbers of participants in Groups A (PPD [+], SHI [+]), B (PPD [+], SHI [-]), C (PPD [-], SHI [+]) and D (PPD [-], SHI [-]) were as follows: 673 (5.4%), 1010 (8.2%), 203 (1.6%), and 10,472 (84.7%), respectively. Age, birth experiences, educational attainment, marital status, employment status, household income, number of traumatic experiences, neurotic personality traits, sleep status, psychological distress, and the number of friends with whom they could consult about private matters were significantly different among the four groups. Being unmarried, divorced, or bereaved and having traumatic experiences, frequent relocation following GEJE, and no friends with whom they could consult about private matters were all

TABLE 1 Basic characteristics of the four groups with a combination of postpartum depression and self-harm ideation.

		Group A (n = 673)		Group B (n = 1010)		Group C (n = 203)		Group D (n = 10,472)		p-value (ANOVA, χ^2 test)
		EPDS \geq 9 and SHI (+)		EPDS \geq 9 and SHI (-)		EPDS \leq 8 and SHI (+)		EPDS \leq 8 and SHI (-)		
Age	(mean, SD)	30.7	(5.06)	31.3	(4.84)	30.8	(4.67)	32.0	(4.78)	$p < 0.001$
Birth experience	Primipara (%)	403	(59.9)	646	(64.0)	96	(47.3)	4647	(44.5)	$p < 0.001$
	Multipara (%)	270	(40.1)	363	(36.0)	107	(52.7)	5802	(55.5)	
Single/Multiple birth	Single birth (%)	667	(99.1)	1007	(99.7)	203	(100.0)	10,394	(99.4)	$p = 0.291$
	Multiple birth (%)	6	(0.9)	3	(0.3)	0	(0.0)	78	(0.7)	
Marital status at 1 year postpartum	Married (%)	604	(89.9)	904	(89.6)	180	(89.1)	9708	(92.8)	$p < 0.001$
	Unmarried/divorced/ bereaved (%)	68	(10.1)	105	(10.4)	22	(10.9)	749	(7.2)	
Educational attainment	Junior/high school (%)	304	(45.5)	325	(32.8)	77	(38.5)	3241	(31.3)	$p < 0.001$
	Vocational school/ junior college (%)	210	(31.4)	405	(40.9)	64	(32.0)	4041	(39.0)	
	University/graduate school (%)	154	(23.1)	261	(26.3)	59	(29.5)	3068	(29.6)	
Employment status at 6 months postpartum	Childcare-leave (%)	104	(16.5)	183	(19.2)	39	(19.9)	1962	(19.9)	$p = 0.001$
	Housewife (%)	288	(45.7)	460	(48.4)	92	(46.9)	4312	(43.7)	
	Unemployed (%)	11	(1.7)	22	(2.3)	4	(2.0)	112	(1.1)	
	Employed (%)	227	(36.0)	286	(30.1)	61	(31.1)	3477	(35.3)	
Employment status at 12 months postpartum	Childcare-leave (%)	54	(8.6)	101	(11.0)	17	(8.9)	1063	(11.0)	$p = 0.020$
	Housewife (%)	255	(40.6)	420	(45.8)	83	(43.2)	3966	(41.1)	
	Unemployment (%)	10	(1.6)	12	(1.3)	2	(1.0)	79	(0.8)	
	Employed (%)	309	(49.2)	385	(41.9)	90	(46.9)	4534	(47.0)	
Household income	Less than 4 million yen (%)	316	(49.1)	386	(40.0)	89	(47.6)	3283	(32.8)	$p < 0.001$
	4–6 million yen (%)	198	(30.7)	336	(34.8)	56	(29.9)	3328	(33.2)	
	6 million yen or more (%)	130	(20.2)	243	(25.2)	42	(22.5)	3402	(34.0)	
Number of disaster experiences	0 (%)	366	(55.1)	552	(55.9)	108	(54.0)	6379	(61.9)	$p = 0.713$
	1 (%)	180	(27.1)	285	(28.8)	61	(30.5)	2655	(25.7)	
	2 (%)	89	(13.4)	102	(10.3)	22	(11.0)	957	(9.3)	
	3 (%)	29	(4.4)	49	(5.0)	9	(4.5)	320	(3.1)	
Number of relocations after GEJE	0 (%)	248	(37.9)	376	(38.1)	72	(36.2)	4126	(40.2)	$p = 0.115$
	1 (%)	179	(27.4)	307	(31.1)	55	(27.6)	2978	(29.0)	
	2 (%)	116	(17.7)	162	(16.4)	42	(21.1)	1811	(17.7)	
	3 (%)	64	(9.8)	82	(8.3)	18	(9.0)	852	(8.3)	
	4 or more (%)	47	(7.2)	59	(6.0)	12	(6.0)	490	(4.8)	
Personality traits	Neuroticism (mean, SD)	8.90	(2.47)	8.08	(2.70)	6.85	(2.98)	5.46	(2.95)	$p < 0.001$
Sleep status	Dissatisfaction (%)	498	(74.7)	724	(71.9)	131	(64.9)	5856	(56.0)	$p < 0.001$
Psychological distress	K6 score (mean, SD)	7.97	(5.28)	6.20	(4.58)	4.80	(4.22)	2.74	(3.21)	$p < 0.001$
	K6 \geq 13 score (%)	130	(19.5)	97	(9.7)	11	(5.4)	163	(1.6)	$p < 0.001$

(Continues)

TABLE 1 (Continued)

		Group A (n = 673)		Group B (n = 1010)		Group C (n = 203)		Group D (n = 10,472)		p-value (ANOVA, χ^2 test)
		EPDS \geq 9 and SHI (+)		EPDS \geq 9 and SHI (-)		EPDS \leq 8 and SHI (+)		EPDS \leq 8 and SHI (-)		
Number of family members and relatives who can be asked for help	0 (%)	23	(3.4)	21	(2.1)	10	(4.9)	51	(0.5)	$p < 0.001$
	1–2 (%)	267	(39.9)	379	(37.7)	84	(41.4)	2789	(26.7)	
	3–4 (%)	303	(45.2)	450	(44.8)	88	(43.3)	5239	(50.2)	
	5 or more (%)	77	(11.5)	154	(15.3)	21	(10.3)	2357	(22.6)	
Number of friends with whom the women could consult about private matters	0 (%)	148	(22.1)	193	(19.2)	39	(19.3)	1173	(11.3)	$p < 0.001$
	1–2 (%)	327	(48.7)	449	(44.7)	99	(49.0)	4254	(40.8)	
	3–4 (%)	157	(23.4)	297	(29.6)	55	(27.2)	3,864	(37.1)	
	5 or more (%)	39	(5.8)	65	(6.5)	9	(4.5)	1,130	(10.8)	

Abbreviations: ANOVA, analysis of variance; EPDS, Edinburgh Postpartum Depression Scale; GEJE, Great East Japan Earthquake; SD, standard deviation; SHI, self-harm ideation.

comparatively lower in Group D than in the other three groups. On the other hand, having a childcare-leave employment status and a higher household income were proportionately higher in this group than in the other three groups. Groups A and B had higher mean scores for the neurotic personality trait than the other groups, and Group A had larger percentages of sleep dissatisfaction and severe psychological distress during the middle phase of pregnancy.

Longitudinal evaluation of depression at 6 and 12 months postpartum

In total, the prevalence of depression at 6 and 12 months postpartum was 11.3% and 12.8%, respectively. Among those who were categorized into Groups A, B, C, or D at 6 months postpartum, the prevalence of depression was 56.0%, 35.2%, 21.5%, and 6.0%, respectively. At 12 months postpartum, the prevalence of depression among each of the four groups showed a minor difference from that at 6 months postpartum, including the prevalence of SHI (Table 2).

At 6 months postpartum, women with depression tended to be those with a junior or high school educational level, a household income of less than 4 million yen per year, traumatic experiences, neurotic personality traits, dissatisfaction with sleep during the middle phase of pregnancy, and poor social networks. Moreover, among the women who had depression at 6 months postpartum, 53.3% had severe psychological distress during the middle phase of pregnancy. Incidentally, at 12 months postpartum, the basic characteristics were not so different compared with those at 6 months postpartum (Table 3).

Logistic regression analysis at 6 and 12 months postpartum

In the univariate logistic regression analysis, for participants categorized into Group A (with PPD and SHI at 1 month postpartum), the

risk of depression at 6 and 12 months postpartum, OR (95% confidence interval [CI]) at 6 and 12 months postpartum: 20.03 (16.8–23.8) and 14.55 (12.3–17.2), respectively, was higher than for Group B (with PPD but without SHI at 1 month postpartum), OR (95%CI): 8.57 (7.36–10.0) and 6.24 (5.38–7.24), respectively. Additionally, Group C (with SHI but without depressive symptoms at 1 month postpartum) also had a significant risk for depression at 6 and 12 months postpartum compared with participants categorized to Group D (without PPD and without SHI), OR (95%CI) at 6 and 12 months postpartum: 4.32 (3.05–6.11), and 3.77 (2.71–5.25), respectively.

In the multivariate logistic regression analysis, participants in Groups A, B, and C were also more significantly related to depression at 6 months postpartum compared with Group D, OR (95%CI): 8.53 (6.87–10.6), 4.56 (3.76–5.52), 2.29 (1.46–3.59), respectively. Moreover, women who were unmarried, divorced or bereaved and/or had a higher number of traumatic experiences, frequent relocations after GEJE, neurotic personality trait, sleep dissatisfaction, and severe psychological distress during the middle phase of pregnancy, as well as having no friends with whom they could consult about private matters were more significantly associated with depression at 6 months postpartum.

At 12 months postpartum, the results were almost equivalent to those at 6 months postpartum. However, the following factors showed a significant association with depression at 12 months postpartum, though no significant association was found at 6 months postpartum: employment status of housewife, unemployed or employed; household income; and having no family members who could help (Table 4).

DISCUSSION

Although this study area is a disaster-stricken area by the GEJE, the prevalence of depression at 6 and 12 months postpartum was similar to a previous study targeting the Japanese general population.^{30,31} It

TABLE 2 Longitudinal evaluation of postpartum depression at 6 and 12 months postpartum.

	[1 month postpartum]							
	Group A (n = 673) EPDS ≥ 9 and SHI (+)		Group B (n = 1010) EPDS ≥ 9 and SHI (-)		Group C (n = 203) EPDS ≤ 8 and SHI (+)		Group D (n = 10,472) EPDS ≤ 8 and SHI (-)	
EPDS ≥ 9	371/673	(56.0)	353/1002	(35.2)	43/200	(21.5)	622/10,472	(6.0)
SHI (+)	283	(76.3)	127	(36.0)	39	(90.7)	275	(44.2)
SHI (-)	88	(23.7)	226	(64.0)	4	(9.3)	347	(55.8)
EPDS ≤ 8	292/673	(44.0)	649/1002	(64.8)	157/200	(78.5)	9805/10,472	(94.0)
SHI (+)	40	(13.7)	16	(2.5)	33	(21.0)	219	(2.2)
SHI (-)	252	(86.3)	633	(97.5)	124	(79.0)	9,586	(97.8)
EPDS ≥ 9	368/668	(55.1)	346/1004	(34.5)	49/203	(24.1)	811/10,429	(7.8)
SHI (+)	278	(75.5)	137	(39.6)	38	(77.6)	346	(42.7)
SHI (-)	90	(24.5)	209	(60.4)	11	(22.4)	465	(57.3)
EPDS ≤ 8	300/668	(44.9)	658/1004	(65.5)	154/203	(75.9)	9618/10,429	(92.2)
SHI (+)	37	(12.3)	16	(2.4)	25	(16.2)	215	(2.2)
SHI (-)	263	(87.7)	642	(97.6)	129	(83.8)	9403	(97.8)

Abbreviations: EPDS, Edinburgh Postpartum Depression Scale; SHI, self-harm ideation.

may be influential that more than half of the participants in this study have traumatic experiences with the GEJE, whereas the situation would be similar in high-income countries.

The simple tabulation findings in Table 1 show that Group D's features were not the same as those of Group A, B, or C. Groups A, B, and C may be more susceptible to depression due to these related factors' mutual interactions, even though the exact mechanism of action for each group is unknown.

For risk factors of depression at 6 and 12 months postpartum, dissatisfaction with sleep and severe psychological distress during the middle phase of pregnancy showed a significant association with depression at 6 and 12 months postpartum. Sleep status and psychological distress can change depending on the situation during pregnancy and postpartum. However, even during pregnancy, those who are dissatisfied with sleep and have severe psychological distress tend to show depression at 6 and 12 months postpartum.³² Neuroticism had a significant association with depression at 6 and 12 months postpartum. In a previous study, it was mentioned that neuroticism is the personality trait most widely studied in relation to depression.¹⁵ Although there are many challenges to implementing personality trait tests during postpartum checkups, and subsequently providing adequate counseling support for women with neurotic traits, screening for neurotic personality traits may lead to a more precise evaluation of depression at 6 and 12 months postpartum. Regarding the disaster-related variables, having many traumatic experiences²⁴ and frequent relocations after the GEJE²⁵ could be risk factors for postpartum depression. Therefore, we should note the mental health status of pregnant women, especially in the context of disasters.

Notably, employment status, lower household income and poor social networks were significantly associated with depression at

12 months postpartum but not at 6 months postpartum. In previous studies, depression for the long-term period after delivery is related to work-related stress,³³ low economic status and financial burden,^{34,35} and low social support.^{33,35-39} According to our study, 46% of postpartum women are working at 12 months postpartum, and the proportion of employees increased from 6 months postpartum. We assume that employees among postpartum women have a higher risk of developing PPD because it could be related to workplace-related stress³³ and less social support from the community.³³ The childcare leave system is permitted until their child is 1 year old under the regulation from the Ministry of Health, Labour, and Welfare, Japan; after that, parents have to leave their child in a nursery, which will increase their financial burden. Postpartum women with a low household income are more likely to experience financial burdens (e.g., the cost of putting their children in the nursery) and, subsequently, could develop depression.³⁵ Postpartum women are also likely to experience stress in the absence of adequate social support, particularly from their families.³⁵ As a result, the period of 12 months postpartum, when nearly half of them are employed, may mark changes in their immediate surroundings, which could lead to an increase in stress, particularly for those who lack social support. Therefore, postpartum women require a great deal of substantial and emotional support from their families.^{38,39} Hence, it is essential to pay careful attention to women's social background at 12 months postpartum.

Regarding the advantages of the combination of PPD and SHI for the evaluation of depression at 6 and 12 months postpartum, Group A (with PPD and SHI at 1 month postpartum) showed a higher risk for depression at 6 and 12 months postpartum than Group B (with PDD but without SHI at 1 month postpartum). Incidentally, among the combined Group A and B (Reference: Group D), 43.5% of participants

TABLE 3 Basic characteristics of women with depression at 6 and 12 months postpartum.

		[6 months postpartum]				[12 months postpartum]			
		Depression (+) (n = 1389)		Depression (-) (n = 10,903)		Depression (+) (n = 1574)		Depression (-) (n = 10,730)	
Age	(mean, SD)	30.9	(5.08)	32.0	(4.76)	30.7	(5.07)	32.1	(4.75)
Birth experience	Primipara (%)	698	(50.3)	5065	(46.6)	784	(49.8)	4994	(46.6)
	Multipara (%)	690	(49.7)	5815	(53.4)	789	(50.2)	5713	(53.4)
Marital status	Married (%)	1234	(88.8)	10,102	(92.8)	1409	(89.5)	9939	(92.8)
	Unmarried/divorced/ bereaved (%)	155	(11.2)	783	(7.2)	165	(10.5)	773	(7.2)
Educational attainment	Junior/high school (%)	553	(40.2)	3372	(31.3)	638	(41.1)	3293	(31.0)
	Vocational school/junior college (%)	485	(35.3)	4205	(39.1)	553	(35.6)	4146	(39.1)
	University/graduate school (%)	337	(24.5)	3191	(29.6)	361	(23.3)	3171	(29.9)
Employment status	Childcare-leave	229	(17.6)	2048	(19.9)	114	(7.9)	1118	(11.3)
	Housewife	617	(47.4)	4508	(43.9)	639	(44.5)	4071	(41.1)
	Unemployed	22	(1.7)	124	(1.2)	19	(1.3)	83	(0.8)
	Employed	435	(33.4)	3599	(35.0)	664	(46.2)	4632	(46.8)
Household income	Less than 4 million yen (%)	603	(45.5)	3449	(33.1)	720	(48.4)	3336	(32.5)
	4–6 million yen (%)	401	(30.3)	3494	(33.5)	443	(29.8)	3460	(33.7)
	6 million yen or more (%)	320	(24.2)	3480	(33.4)	324	(21.8)	3477	(33.8)
Number of disaster experiences	0 (%)	500	(36.8)	4302	(40.3)	578	(37.5)	4226	(40.2)
	1 (%)	374	(27.5)	3125	(29.3)	426	(27.7)	3083	(29.3)
	2 (%)	245	(18.0)	1,875	(17.6)	283	(18.4)	1,839	(17.5)
	3 (%)	131	(9.6)	875	(8.2)	143	(9.3)	868	(8.3)
Number of relocations after GEJE	0 (%)	500	(36.8)	4302	(40.3)	578	(37.5)	4226	(40.2)
	1 (%)	374	(27.5)	3125	(29.3)	426	(27.7)	3083	(29.3)
	2 (%)	245	(18.0)	1875	(17.6)	283	(18.4)	1839	(17.5)
	3 (%)	131	(9.6)	875	(8.2)	143	(9.3)	868	(8.3)
	4 or more (%)	108	(8.0)	496	(4.6)	110	(7.1)	492	(4.7)
Personality traits	Neuroticism (mean, SD)	8.72	(2.51)	5.52	(2.95)	8.57	(2.51)	5.49	(2.96)
Sleep status	Dissatisfaction (%)	1,047	(75.5)	6,120	(56.2)	1,164	(74.0)	6,006	(56.1)
	Satisfaction (%)	339	(24.5)	4,765	(43.8)	408	(26.0)	4,705	(43.9)
Psychological distress	K6 score (mean, SD)	7.44	(5.06)	2.80	(3.24)	7.26	(5.08)	2.75	(3.18)
	K6 ≥ 13 score (%)	211	(15.3)	185	(1.7)	237	(15.1)	161	(1.5)
	K6 ≤ 12 score (%)	1,168	(84.7)	10,658	(98.3)	1,328	(84.9)	10,510	(98.5)
Number of family members and relatives who can be asked for help	0 (%)	38	(2.7)	66	(0.6)	43	(2.7)	61	(0.6)
	1–2 (%)	558	(40.3)	2,940	(27.1)	634	(40.5)	2,869	(26.8)
	3–4 (%)	607	(43.8)	5,441	(50.1)	693	(44.2)	5,359	(50.1)
	5 or more (%)	182	(13.1)	2,415	(22.2)	197	(12.6)	2,403	(22.5)
Number of friends with whom the women can consult about private matters	0 (%)	317	(22.9)	1,220	(11.2)	321	(20.5)	1,225	(11.5)
	1–2 (%)	626	(45.3)	4,479	(41.3)	744	(47.6)	4,362	(40.8)
	3–4 (%)	360	(26.0)	3,998	(36.8)	421	(26.9)	3,935	(36.8)
	5 or more (%)	79	(5.7)	1,153	(10.6)	78	(5.0)	1,158	(10.8)

TABLE 4 Univariate or multivariate logistic regression analysis at 6 and 12 months postpartum.

		[6 months postpartum] EPDS ≥ 9/EPDS ≤ 8				[12 months postpartum] EPDS ≥ 9/EPDS ≤ 8			
		Crude OR	95%CI	OR with related factors	95%CI	Crude OR	95%CI	OR with related factors	95%CI
Category at 1 month postpartum	Group A (PPD [+] and SHI [+]) (%)	20.03	[16.8–23.8]	8.41	[6.73–10.5]	14.55	[12.3–17.2]	6.32	[5.07–7.86]
	Group B (PDD [+] and SHI [-]) (%)	8.57	[7.36–10.0]	4.57	[3.75–5.56]	6.24	[5.38–7.24]	2.76	[2.26–3.37]
	Group C (PPD [-] and SHI [+]) (%)	4.32	[3.05–6.11]	2.38	[1.51–3.75]	3.77	[2.71–5.25]	2.18	[1.42–3.33]
	Group D (PPD [-] and SHI [-]) (%)	1.00		1.00		1.00		1.00	
Age				0.98	[0.96–1.001]			0.97	[0.95–0.98]
Birth experience	Primipara			0.89	[0.75–1.03]			0.84	[0.72–0.97]
	Multipara			1.00				1.00	
Marital status	Married			1.00				1.00	
	Unmarried/ divorced/bereaved			1.39	[1.07–1.80]			0.99	[0.76–1.29]
Educational attainment	Junior/high school			1.08	[0.87–1.32]			1.00	[0.82–1.21]
	Vocational school/ junior college			0.98	[0.80–1.18]			1.06	[0.88–1.27]
	University/ graduate school			1.00				1.00	
Employment status	Childcare-leave			1.00				1.00	
	Housewife			1.01	[0.81–1.25]			1.52	[1.15–2.00]
	Unemployed			0.77	[0.40–1.46]			1.69	[0.82–3.42]
	Employed			1.10	[0.88–1.37]			1.60	[1.21–2.09]
Household income	Less than 4 million yen			0.96	[0.78–1.17]			1.27	[1.04–1.53]
	4–6 million yen			0.89	[0.72–1.08]			1.03	[0.84–1.24]
	6 million yen or more			1.00				1.00	
Number of traumatic experiences	0			1.00				1.00	
	1			1.19	[0.997–1.41]			1.06	[0.89–1.24]
	2			1.53	[1.20–1.94]			1.33	[1.06–1.67]
	3			1.08	[0.71–1.61]			1.09	[0.74–1.59]
Number of relocations after GEJE	0			1.00				1.00	
	1			0.99	[0.81–1.19]			1.05	[0.87–1.25]
	2			1.16	[0.93–1.44]			1.08	[0.88–1.32]
	3			1.17	[0.89–1.54]			1.15	[0.88–1.48]
	4 or more			1.59	[1.16–2.16]			1.20	[0.88–1.63]
Personality traits	Neuroticism			1.33	[1.28–1.37]			1.29	[1.25–1.33]
Sleep status	Dissatisfaction			1.36	[1.14–1.61]			1.32	[1.92–3.40]
	Satisfaction			1.00				1.00	
Psychological distress	K6 ≥ 13 score			1.91	[1.42–2.55]			2.56	[1.88–3.26]

(Continues)

TABLE 4 (Continued)

		[6 months postpartum] EPDS \geq 9/EPDS \leq 8		[12 months postpartum] EPDS \geq 9/EPDS \leq 8	
		Crude OR	OR with related factors	Crude OR	OR with related factors
		OR	95%CI	OR	95%CI
	K6 \leq 12 score		1.00		1.00
Number of family members and relatives who can be asked for help	0		1.23 [0.64–2.37]		2.24 [1.20–4.14]
	1–2		1.24 [0.97–1.58]		1.51 [1.19–1.90]
	3–4		1.14 [0.90–1.42]		1.23 [0.98–1.52]
	5 or more		1.00		1.00
Number of friends with whom the woman can consult about private matters	0		1.90 [1.32–2.73]		1.76 [1.23–2.50]
	1–2		1.33 [0.95–1.85]		1.57 [1.13–2.15]
	3–4		1.17 [0.84–1.64]		1.43 [1.03–1.98]
	5 or more		1.00		1.00

Abbreviations: EPDS, Edinburgh Postpartum Depression Scale; CI, confidence interval; GEJE, Great East Japan Earthquake; OR, odds ratio; PPD, postpartum depression; SD, standard deviation; SHI, self-harm ideation.

presented depressive symptoms, and the risk of depression at 6 months postpartum was significant but lower than that of Group A (see Tables S1 and S2). In addition, we confirmed that Group C (with SHI but without PDD at 1 month postpartum) had a risk for depression at 6 and 12 months postpartum. The evaluation criteria for SHI among postpartum women are not standardized among different municipalities in Japan, so in some municipalities, postpartum women categorized into Group C may not be evaluated as high-risk.⁹ However, our results show that the combination of the EPDS total scores and sub-score for SHI can allow for a clearer evaluation of the mental health of women at 6 and 12 months postpartum.

Finally, considering applications to postpartum checkups, if postpartum women have an EPDS total score \geq 9 and a sub-score for SHI \geq 1 during current postpartum checkups, practitioners should consider them at high risk for depression at 6 and 12 months postpartum. In the case of the SHI \geq 1 even with an EPDS total score \leq 8, collecting detailed information about other risk factors would be required. Furthermore, even during the middle phase of pregnancy, sleep status and psychological distress are significant evaluable factors for depression at 6 and 12 months postpartum. Additionally, a poor social network, especially having no family members or relatives who can help or friends with whom one can consult about private matters, is a risk factor for depression, especially at 12 months postpartum. Therefore, it is considered essential to link information between prenatal and postnatal checkups and collect information about sleep status, psychological distress, and social networks during pregnancy. These initiatives can contribute to a more precise evaluation of depression at 6 and 12 months postpartum and to a solid follow-up system for postpartum women with mental health issues.

Despite this longitudinal study evaluating depressive symptoms at 6 and 12 months postpartum with a large population, this study has several limitations. First, the study lacked information on whether individuals with PPD were seeing psychiatrists, attending hospitals

and/or taking medication; however, this information must be a crucial factor in assessing depression at 6 and 12 months postpartum. The second limitation is the lack of external validation of this study area, which has been devastated by the GEJE. Therefore, in order to generalize our findings, more research will be needed. Third, the study featured serial dependence bias where current answers could be biased towards prior answers, which might affect the results of EPDS. Fourth, household income and social networks, which were significantly associated with depression at 12 months postpartum, were collected only in the middle of pregnancy, and this study was unable to collect several important related factors (e.g., sleep status) at 1, 6, and 12 months postpartum, which prevented us from evaluating sleep problem persistence or recurrence pattern. Finally, there may have been non-response bias since 41.3% (8794/21,314) of participating women could not answer three consecutive surveys (at 1, 6, and 12 months postpartum), and 162 women could not complete the EPDS questionnaire.

CONCLUSION

This study showed a higher risk of depression at 6 and 12 months postpartum for those who had depressive symptoms with SHI at 1 month postpartum than women with depressive symptoms but without SHI. Additionally, SHI even without depressive symptoms is also a risk factor for depression at 6 and 12 months postpartum. When linking information about sleep status, psychological distress, and social networks during pregnancy, these findings may contribute to improving the precise evaluation of depression at 6 and 12 months postpartum.

AUTHOR CONTRIBUTIONS

Masatsugu Orui conceptualized and designed this study, conducted the initial analyses, drafted the initial manuscript, and revised the

manuscript. Saya Kikuchi conceptualized, designed, and organized the BirThree Cohort Study and reviewed the manuscript. Mana Kogure, Hirohito Metoki, Taku Obara, Noriyuki Iwama, Mami Ishikuro, Keiko Murakami, Aoi Noda, and Genki Shinoda managed the implementation of the BirThree Cohort Study and reviewed the manuscript. Hiroaki Tomita, Shinichi Kuriyama, Natsuko Kobayashi, Atsushi Hozawa, Naoki Nakaya, Mana Kogure, Rieko Hatanaka, Kumi Nakaya, and Ippei Chiba reviewed the manuscript critically. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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CONFLICT OF INTEREST STATEMENT

Keiko Murakami is an employee of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT). The remaining authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data used to support the findings may be released upon application to the Tohoku Medical Megabank Organization.

ETHICS APPROVAL STATEMENT

This study was approved by the Ethical Research Committee at Tohoku University Graduate School of Medicine (2013-4-103, approval date: May 10, 2013; latest revised 2023-4-040, approval date: June 21, 2023).

PATIENT CONSENT STATEMENT

N/A

CLINICAL TRIAL REGISTRATION

N/A

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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