

# Influence of smoking on postpartum depression in Japan<sup>\*</sup>

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## ABSTRACT

**Aim:** To investigate the influence of smoking on postpartum depression. **Methods:** One thousand fifty-one women, in a rural city in Aomori Prefecture, Japan, prospectively fulfilled the selection criteria and completed self-reporting questionnaires on postnatal depression at 5 - 6 days, 1 month, 4 months, 7 months and 12 months after childbirth, using the Edinburgh Postnatal Depression Scale (EPDS) and a life and social events scales including smoking habits. **Results:** Seven hundred seventy-seven women were non-smokers. Among two hundred seventy-four women who were smokers before becoming pregnant (26% of pregnant women), 241 women quit smoking during pregnancy and 33 women continued smoking. Smoking habits were significantly associated with sociopsychological states and we found that EPDS scores of smokers were significantly higher than EPDS of non-smokers. The EPDS scores of both non-smokers and smokers were higher at 5 - 6 days, but were stable from 1 month to 12 months, after childbirth. Fifty-one women who quit smoking after childbirth resumed smoking during the 1 - 12 month periods after childbirth. The EPDS scores of 51 women who resumed smoking were significantly reduced after they resumed smoking. **Conclusion:** The EPDS scores of smokers were higher than those of non-smokers and a smok-

ing habit may help to alleviate postpartum depression.

**Keywords:** Smoking Habit; Stress; Childbirth; Edinburgh Postnatal Depression Scale; Sociopsychological State

## 1. INTRODUCTION

Many smokers are unable or unwilling to give up smoking, despite it being linked with serious disease in numerous studies [1-5]. Smoking habits may be influenced by mental disorders, including anxiety and depression [6], increased level of actual or perceived stress [7], reducing stress [8,9], or abuse-related post-traumatic stress disorder [10], and so on. Such factors suggest that, the effects of smoking on mental disorders have not been consistently reported, probably due to subtle effect on psychological performances in normal persons. Postpartum depression is thought to be a crisis period of woman's life cycle because of a combination of physiological factors (e.g. rapid changes in the level of hormones in the body), psychological factors (e.g. worries about childbirth and child care), and social factors (e.g. support systems for pregnant and parturient women) [11]. The prevalence of this disorder and its devastating consequences for the mother mean that postpartum depression has a significant public impact, and identifying the risk factors for postnatal depression is one of the major challenges of importance. As the postnatal period is known as one associated with the likely onset of mental health problems, it may therefore be more appropriate for a study on the

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effects of smoking on mental disorders.

In the present study, postnatal depression has been assessed using the Edinburgh Postnatal Depression Scale (EPDS) [12] and we examine how smoking habit might modify mental disorder in postnatal depression. To date, this is the first study to investigate effect of smoking on postpartum depression using the EPDS.

## 2. METHODS

We prospectively studied 1123 women who gave birth in a rural city in Aomori Prefecture, in the northern part of Japan (population: 174,000; number of birth from 2009 April to 2013 January: 4735), and who brought their infant for a check-up at 5 - 6 days after delivery at six different obstetrics departments. We did not include mothers who suffered from psychotic disorders and had consulted a psychiatrist. Mothers who had babies with a birth weight of <2000 g were also excluded from the study as they directly consulted pediatricians. Answers were obtained using self-reported questionnaires from women who agreed to participate in the study using self-reported questionnaires. One thousand fifty-one women, out of 1123 women approached, completed questionnaires at 5 - 6 days after childbirth, and were prospectively followed up at 1, 4, 7 and 12 months and adopted in the present analysis.

The EPDS, which has been used previously to screening for postpartum depression [12], is a 10-item self-reporting scale that seems to be especially valid for use with child-bearing women and it is highly effective from the viewpoint of sensitivity and specificity [13]. Each item is scored on four-point scale from 0 - 3, with the minimum and maximum total scores being 0 and 30 points, respectively. A Japanese version of the EPDS was used in the present study [14].

To ascertain the sociopsychological state of child-rearing burnout of postpartum depression, four different kinds of questionnaire were asked regarding: first, social status: (age, educational level, and annual income), second, obstetric factors: (previous childbirth experience, *i.e.* (primiparas and multiparas), premature birth and/or abortion, the baby's weight at delivery and breast feeding or bottle feeding), third, physical status: (worries concerns baby care, smoking habit, smoking of both parents, and alcohol consumption), fourth, sociability: (playing a pinball game (pachinko), likelihood of communicating with others, a good relationship with husband, satisfied with childcare, and financial concerns). To confirm differences between the basic psychological characteristics of anxiety between smokers and non-smokers, a State Trait Anxiety Inventory (STAI) [15] was carried out by mail at one and a half years and 2 years after delivery, respectively.

The study protocol adhered to the recommendations of the Declaration of Helsinki (World Medical Association, 2000). Verbal informed consent was obtained and the participants' anonymity was preserved by the use of a coding system. Ethical approval was obtained from the Ethical Committee at Akita Nursing and Welfare University, Japan. The statistical differences of the sociopsychological state between of smokers and non-smokers were calculated by the Chi-square test. Multivariate regression was used for the EPDS versus sociopsychological state, where EPDS and age were entered as a continuous independent variable, with a level of educational level lower than high school and more higher than university corresponding to 1 and 2, yearly income of <300, 300 - 500 and >500 million yen corresponding to 1, 2 and 3, primiparas and multiparas corresponding to 1 and 2, experience of abortion (of yes and no) corresponding to 1 and 2, baby weight of <2500 g and >2500 g corresponded to 1 and 2, worries about baby care (of yes and no) corresponded to 1 and 2, smoker and non-smoker corresponding to 1 and 2, smoking habit of husband (of yes and no) corresponding to 1 and 2, habit of alcohol intake before pregnancy (of yes and no) corresponded to 1 and 2, activities of communication with others (of yes and no) corresponded 1 and 2, and worries about financial status (of yes and no) corresponded to 1 and 2, respectively. The statistical differences of EPDS and the State Trait Anxiety Inventory between smokers and non-smokers were determined by using the Mann-Whitney's U-test, respectively. Two-way ANOVA was performed for the EPDS scores between smokers and non-smokers, where a significant difference was found with the ANOVA, Tukey's test was used for the individual parameters. Differences between data obtained before and after resumption of smoking were assessed using the Wilcoxon signed-rank test. The data were expressed as means  $\pm$  SD, with the differences were regarded as statistically significant at  $p < 0.05$ .

## 3. RESULTS

Significant differences of the sociopsychological states between non-smokers ( $n = 777$ ) and smokers ( $n = 274$ , 26% of mothers) completing questionnaires at 5 - 6 days after childbirth are shown in **Table 1**. Smokers were of younger age, were less well educated state, had a lower yearly income, more primiparas, and were more likely to have a premature birth and/or abortion. Their babies were of lower baby weight, their husbands were more likely to smoking habit, and they drank more frequently alcohol. In addition, smokers played pinball (pachinko) more frequently, were less activities to communicate anybody, lower activities to talk with anybody, and had more worries about their financial situation than non-

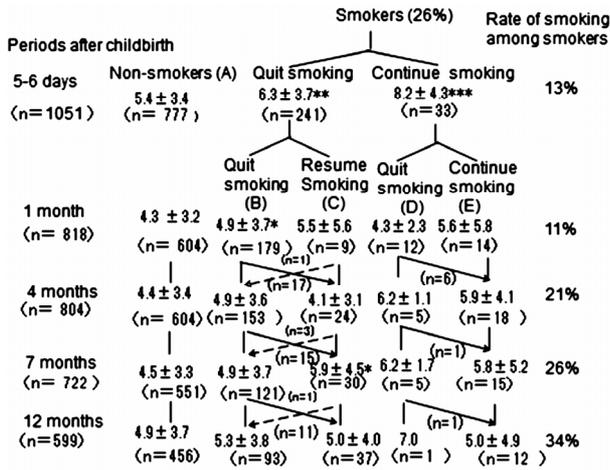
**Table 1.** Sociopsychological states of smokers and non-smokers.

		Non-smokers	Smokers	
		N = 777	N = 274	P
Age (years)	>10	5	6	0.000
	29 - 20	325	165	
	39 - 30	422	110	
	49 - 40	25	3	
Education	High school	297	148	0.000
	University	480	124	
	Unknown	0	2	
Annual income (million yen)	<300	177	91	0.000
	301-	350	123	
	500-	247	55	
	Unknown	3	5	
Delivery	Primiparas	323	145	0.016
	Multiparas	453	129	
	Unknown	1	2	
Experience of abortion	Yes	241	115	0.000
	No	534	159	
	Unknown	2	0	
Birthweight (kg)	<2500	40	23	0.042
	>2500	737	251	
	Unknown	0	0	
Worries about baby care	Yes	150	66	0.049
	No	627	204	
	Unknown	0	4	
Smoking of husband	Yes	406	228	0.000
	No	371	46	
	Unknown	0	0	
Alcohol habit before pregnancy	Yes	471	213	0.000
	No	306	61	
	Unknown	0	0	
Playing pinball before pregnancy	Yes	78	87	0.000
	No	699	187	
	Unknown	0	0	
Often dislike to have a talk	Yes	151	76	0.000
	No	625	198	
	Unknown	1	0	
Worried about income	Yes	202	104	0.000
	No	574	170	
	Unknown	1	0	

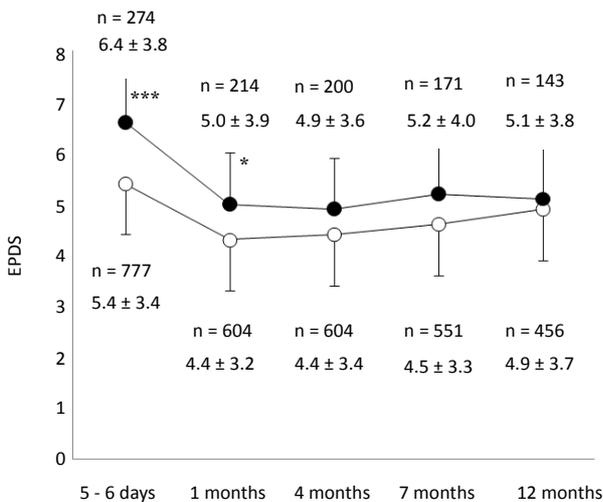
smokers. **Table 2** shows the relative impact of the EPDS scores versus sociopsychological states (smokers, yearly income, experience of delivery, worries about baby care, activities to talk with anybody and worries about financial condition) calculated using multiple logistic regression. Sequential changes of EPDS score and numbers of participants are shown in **Figure 1**. Two hundred forty-one smokers quit smoking and thirty-three smokers continued smoking during pregnancy. At 5 - 6 days after childbirth, the EPDS scores of non-smokers were significantly lower than both the EPDS scores of smokers who give up smoking ( $p < 0.01$ ) and the scores of smokers with continued smoking ( $p < 0.001$ ), respectively. At 1 month after childbirth, the two groups derived from mothers who smoked during pregnancy (*i.e.* who quit smoking or continued smoking 5 - 6 days after childbirth, as shown in **Figure 1**) were each divided into two groups. The “with quit smoking” group was split into those mothers who continued not to smoke (designated group B in **Figure 1**) and those who resumed smoking (group C in **Figure 1**). The group of mothers who continued smoking at 5 - 6 days after childbirth were separated into those who had given up smoking by 1 month after childbirth (group D in **Figure 1**) and those who continued smoking at 5 - 6 days after childbirth (group E in **Figure 1**), respectively. The original non-smokers are designated group A in **Figure 1**. Over the following period up to 12 months, there were further changes as either quit smoking or resumed smoking, according to their previous status and vice versa during 12 months. **Figure 2** shows sequential changes of EPDS scores in both smokers and non-smokers over the 12 months of the study. The scores of non-smokers were lower than EPDS score of smokers ( $p < 0.05$ ) and also lower than the scores of group B mothers ( $p < 0.05$ ) (data not shown), respectively. Overall, EPDS scores at 5 - 6 days after childbirth were higher than EPDS scores over the subsequent 1 to 12

**Table 2.** Multivariable model of the relationship between EPDS and sociopsychological states.

Risk variable	Regression coefficient	P Value
Smoking habit	-0.070	0.018
Yearly income	-0.088	0.004
Experience of delivery	-0.097	0.001
Concern about baby care	-0.131	0.000
Willingness to communicate with others	-0.291	0.000
Concern about finance	-0.137	0.000
Multiple correlation coefficient = 0.427, Adjusted R <sup>2</sup> = 0.182		



**Figure 1.** Sequential follow up of EPDS of non-smokers (A) and four groups of smokers after childbirth: those mothers who quit smoking and continued not to smoke (B); those who quit smoking during pregnancy but resumed smoking followed by quit smoking during pregnancy (C); those who continued smoking through pregnancy until 5 - 6 days after childbirth but had not quit smoking by 1 month after childbirth (D); and those who continued smoking during pregnancy throughout the study period (E). Continuous lines show subjects who resumed smoking after quitting smoking (n = 51) and dotted lines show opposite situation (n = 4). \* ( $p < 0.05$ ), \*\* ( $p < 0.01$ ), and \*\*\* ( $p < 0.001$ ) show statistical differences in EPDS scores between the A and B, C, D and E groups, respectively.



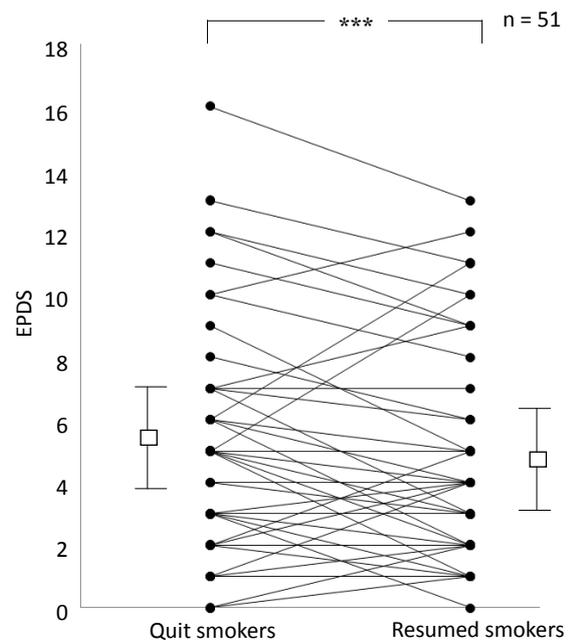
**Figure 2.** Sequential changes in EPDS scores of smokers (●) and non-smokers (○), respectively. \* ( $p < 0.05$ ) and \*\*\* ( $p < 0.001$ ) show statistical differences between smokers and non-smokers at 5 - 6 day and 1 month, respectively. §§§ ( $p < 0.001$ ) shows statistical differences between EPDS scores at 5 - 6 days and 1, 4, 7, and 12 months in both smokers and non-smokers, respectively.

months in both smokers and non-smokers, respectively ( $p < 0.001$ ). There were no systematic variables of EPDS from 1 to 12 months after childbirth in both smokers and non-smokers. Of those mothers whose EPDS score re-

mained stable over 1 - 12 month period following childbirth, fifty one changed status from quit smoking to resumed smoking: for the participants who resumed smoking, a change in EPDS score was noted (Figure 3). There was significant decrease in EPDS scores in those mothers who after resumed smoking than compared to those remaining in the “quit smoking” category ( $p < 0.001$ ). A change from breast feeding to bottle feeding was the only factor of sociophysiological state to show a significant difference in the 51 mothers who resumed smoking from quit smoking ( $p < 0.01$ ), but there were no relationships between bottle feeding and EPDS score among either non-smokers and/or smokers as a whole (data not shown). Continuous follow up during 1.5 and 2 years after delivery showed no systematic differences in STAI between smokers and non-smokers for either State and/or Trait Anxieties, respectively (Table 3).

#### 4. DISCUSSION

The numbers of conflicting results come out about the effects of smoking on stress. Smokers will suffer from increased stress when they quit smoking [8]. This model states that smokers are calmed by smoking, yet they report high levels of stress [9]. On the other hand, longitudinal studies have demonstrated that giving up smoking leads to reduced feeling of stress [7]. Cessation of smoking will lead to a period of increased stress, followed by a return to baseline, because acute nicotine deprivation



**Figure 3.** Changes in EPDS scores from quit smoking to resumed smoking from 1 to 12 months after childbirth (n = 51). Means ± SD are shown by open square and bars, respectively. \*\*\* ( $p < 0.001$ ) shows statistical difference between quit smoking and resumed smoking categories.

**Table 3.** State Trait Anxiety Inventory (STAI) Score of smokers and non-smokers at 1.5 years and 2 years after delivery.

		1.5 years		2 years	
State Anxiety	Non-smokers	38.2 ± 9.4	NS	Non-smokers	37.4 ± 9.8
	n = 211			n = 193	
	Smokers	37.5 ± 8.4	NS	Smokers	38.0 ± 9.9
	n = 80			n = 71	
Trait Anxiety	Non-smokers	40.9 ± 10.7	NS	Non-smokers	40.5 ± 10.4
	n = 211			n = 194	
	Smokers	39.8 ± 9.0	NS	Smokers	40.8 ± 9.3
	n = 76			n = 71	

NS: not significant

(*i.e.* between cigarettes) is stressful. Then, the former smoker no longer suffers from the adverse mood effects of acute nicotine depletion. However, it has not been established whether or not quitting smoking leads to reduced stress or not in terms of sociopsychological status of individual; for example, a person experiencing a stressful sociopsychological states smokers might not be reduced stress level even after long term cessation of smoking. Thus, it has been reported that as compared to non-smokers of mothers, smokers of mothers who have exhibited a more stressful sociopsychological state (higher levels of perceived stress, depression, neuroticism, and negative paternal support) were associated with rate of being a smoker than a non-smoker [16]. Smokers differed from non-smokers in all demographic risk factors, including of being African American, being pregnant as a teenager, having lower income and less education, and living in high-crime areas [8]. Our data showed that high EPDS scores were associated with smoking, income, anxiety about children, and multiparas. Higher EPDS scores were observed in smokers during the year after following childbirth. Even after quitting smoking, EPDS scores of former smokers remained higher than EPDS scores of non-smokers after delivery. During prospective follow up using EPDS, we found that among smokers, a certain numbers of mothers changed from quit smoking to resume smoking and their EPDS scores subsequently decreased after resumed smoking in these mothers. Despite this effect, such mothers would be expected to smoke to reduce EPDS but a relatively elevated EPDS score would not be lightened unless their sociopsychological states being improved.

This is the first prospective report of the effect of smoking on postpartum depression using EPDS. Of mothers in rural area of northern part of Japan, 21% were smokers, which was about double of the average rate for young Japanese women [17]. Among smokers of mothers

who smoked, 13% continued smoking after pregnancy and the percentages of smoking were 11%, 21%, 26%, and increased up to 34% at 1, 4, 7, and 12 months, respectively. It might be the case that smoking would decrease stress for mothers experiencing postpartum depression and, if so, the number of smokers would be expected to increase during one year following childbirth [18,19]. It is a serious challenge to decrease rate of smoking among mothers and thereby reduce the health risks to mothers themselves and prevent various influences on their children [20,21]. One strategy would be to ameliorate sociopsychological state factors [22,23], and other might be to develop handy novel replacement to tolerate stress which could be used freely, for example, handy harmless tobacco, similar to non-alcohol beer for alcoholism, because there are too many smokers to treat with medicines like nicotine patches [24] or nicotine replacement therapy [25]. Mothers who resumed smoking were associated with a switch to bottle feeding from breast feeding, which suggested smoking offered a means of relaxation from the stress of caring, feeding and not being able to go outside the home (because as mothers who smoke did not tend to favor to communicate with socialize). Husbands of smokers were more frequently smoked, which increased temptation of mothers to smoke, and therefore if the husband could also quit smoking, the mothers would be successful in giving up smoking herself [26,27]. Work style (*i.e.* shift work) was critically associated with cigarette smoking in Japanese female workers [28]. Reducing the stress of caring for the baby might also allow mothers to avoid smoking, because when husband's cooperation is more involved in baby care, EPDS scores are lower [29]. Alcohol consumption is also correlated with smoking and therefore avoiding alcohol might help mothers to quit smoking [30,31].

One of the potential limitations of the present study was that smokers and non-smokers exhibited differences

of behavior and personality; for example, because smokers were reported to be heterogeneous in terms of psychoticism [32]. However, we found that both State and Trait Anxiety scores of smokers did not differ significantly from those of non-smokers and, moreover, behavior and personality would not be a factor to a difference in EPDS results between smokers and non-smokers. The numbers of participants were sequentially decreased over the period of the study, which might affect the results. However, rates of sequentially decreased numbers of subjects were similar between smokers and non-smokers, which would bring similar results as all participants completed. Ninety-four percent of subjects agreed to participate, which suggested enough quality of protocol of the present study to analysis.

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