Title	Factors Associated With Smoking Relapse Among Women in Japan From Pregnancy to Early Parenthood
Author(s)	Mori, Miyuki; Ishii, Kayoko; Goto, Aya; Nakano, Hironori; Suzuki, Kohta; Ota, Misao; Yasumura, Seiji; Fujimori, Keiya
Citation	Journal of obstetric, gynecologic, and neonatal nursing : JOGNN. 51(4): 428-440
Issue Date	2022-07
URL	http://ir.fmu.ac.jp/dspace/handle/123456789/2482
Rights	Copyright © 2022 AWHONN, the Association of Women's Health, Obstetric and Neonatal Nurses. Published by Elsevier Inc. All rights reserved. This manuscript version is made available under the CC-BY-NC-ND 4.0 license https://creativecommons.org/licenses/by-nc-nd/4.0/
DOI	10.1016/j.jogn.2022.04.003
Text Version	author

1

Title	Factors Associated With Smoking Relapse Among Women in Japan From Pregnancy to Early Parenthood
Short title	Smoking Relapse Among Women in Japan From Pregnancy to Early Parenthood
Article type	Research
Authors	Miyuki Mori, Kayoko Ishii, Aya Goto, Hironori Nakano, Kohta Suzuki, Misao Ota, Seiji Yasumura, and Keiya Fujimori
Correspondence	Miyuki Mori Fukushima Medical University 1 Hikariga-oka, Fukushima City Fukushima 960-1295, Japan miyuki-m@fmu.ac.jp
Author Bios	Miyuki Mori, MSN, is a lecturer, Department of Midwifery and Maternal Nursing, Fukushima Medical University School of Nursing, Fukushima, Japan. Kayoko Ishii, PhD, is an assistant professor, Department of Midwifery and Maternal Nursing, Fukushima Medical University School of Nursing, Fukushima, Japan. Aya Goto, MD, PhD, MPH, is a professor, Center for Integrated Science and Humanities, Fukushima Medical University, Fukushima, Japan. Hironori Nakano, MSc, PhD, is an assistant professor, Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University, Fukushima, Japan. Kohta Suzuki, MD, PhD, MPH, is a professor, Department of Health and Psychosocial Medicine, Aichi Medical University School of Medicine, Nagakute, Japan.

| | Misao Ota, MSN, is a professor, Preparing Section for School of Midwifery, Fukushima Medical University, Fukushima, Japan.

Seiji Yasumura, MD, PhD, MPH, is a professor, Department of Public Health, Fukushima Medical University School of Medicine, Fukushima, Japan.

Keiya Fujimori, MD, PhD, is a professor, Department of Obstetrics and Gynecology, Fukushima Medical University School of Medicine, Fukushima, Japan. |
| --- | --- |
| | |
| | |
| | |
| Number of figures | 2 |
| Number of tables | 4 |
| Accepted | |
| Precis | Smoking relapse was associated with symptoms of depression when participants quit before pregnancy and with multiparity when they quit after pregnancy. |

2

3 **Abstract**

4 *Objective:* To identify factors, including mental health, associated with smoking relapse among

5 women in Japan from pregnancy to early parenthood.

6 *Design:* Secondary analysis of data from an ongoing cross-sectional study conducted between

7   2013 and 2016.

8   *Setting:* We mailed questionnaires to all women who received a maternal and child health

9   handbook from a municipality in Fukushima Prefecture or who underwent a maternal health

10 checkup and gave birth in Fukushima Prefecture.

11 *Participants:* Of the 28,562 women who responded to the questionnaire, 6,747 who previously

12 smoked and quit around the time they registered their pregnancies were included in the

13 analysis.

14 *Methods:* Participants were divided into groups according to smoking relapse status: non-

15 relapse group, including those who maintained smoking cessation, and relapse group, including

16 those who quit smoking but later relapsed. We further classified the latter group into those who

17 quit smoking before or after pregnancy registration. We used a logistic regression model with

18 forced entry was used to calculate adjusted odds ratios.

19 *Results:* Of the 6,747 participants who previously smoked, 881 (13.1%) relapsed. Regardless of

20 the timing of smoking cessation, younger age and living in a specific region of Fukushima

21 Prefecture were associated with smoking relapse. Relapse was associated with symptoms of

22 depression in women who quit smoking before registration and with multiparity in women who

23 quit smoking after registration of their pregnancies.

24 *Conclusions:* Support for women at risk of smoking relapse following pregnancy requires

25 consideration of regional characteristics and incorporation of family and mental health support

26 with a focus on young mothers.

27 *Keywords:* smoking, relapse, mothers, child health, depression

28 **Callouts**

29   1. With the progress of measures to prevent smoking in public places in Japan,

30   further efforts are needed to prevent smoking during and relapse after pregnancy.

31   2. Smoking cessation relapse was associated with younger age, region of residence,

32   multiparity, and symptoms of depression.

33   3. It is necessary to build a maternal and child health care system that addresses

34   regional characteristics and integrates smoking cessation and mental health

35   support.

36

37   Smoking among pregnant women harms the health of the woman, her fetus, and her

38   children via passive exposure. Negative effects include the risk of perinatal mortality, sudden

39   infant death syndrome (Pineles et al., 2016), middle ear disease, asthma, wheezing (Avşar et al.,

40   2021), and childhood obesity (Rayfield & Plugge, 2017). In addition to the effects of passive

41   smoking, infants are also at risk of exposure to nicotine through breastmilk (Primo et al., 2013).

42   Yamagata (2015) reported that the proportion of women in Japan who smoked during

43   pregnancy in 2013 was 3.8%, whereas 8.5% of women smoked when their children were 18

44   months old. In a longitudinal study of smoking status among women in Japan from pregnancy

45   to the postpartum period, Ueda et al. (2020) found that approximately 60% of women who

46   smoked before pregnancy and quit during pregnancy relapsed after giving birth. This finding

47   highlights the importance of support for women during pregnancy and the postpartum period to

48   continue smoking cessation.

49   As a part of the Japanese government's national health plan, the aim of the Healthy

50   Parents and Children 21 campaign is to reduce the smoking rate among pregnant women to 0%

51   by 2024. To meet this goal, support for women who smoke during pregnancy was developed. In

52   addition, the awarding of the 2020 Olympic and Paralympic Games to Tokyo further increased

53   the need to prevent passive smoking, which led to a revision of the Health Promotion Act in

54   2018 aimed at prohibiting indoor smoking (Ministry of Health, Labour and Welfare, 2018). The

55   revision of passive smoking prevention laws recently led to the passage of ordinances to

56   prevent passive smoking in different areas throughout Japan. The government of Fukushima

57   Prefecture, which is located in the Tohoku region of Japan and is the country's third largest

58   prefecture by area, is also taking steps to develop an ordinance to protect pregnant women and

59   children from smoking.

60   On March 11, 2011, Fukushima Prefecture was struck by the Great East Japan

61   Earthquake and was also affected by the accident at the Fukushima Daiichi Nuclear Power

62   Plant. After the accident, the Fukushima Health Management Survey (FHMS) was launched in

63   Fukushima Prefecture to assess the long-term effects of low-dose radiation exposure from the

64   accident (Yasumura et al., 2012). Since then, four focused surveys were conducted. The aims of

65   the Pregnancy and Childbirth Survey were to understand the physical and mental health of

66   pregnant women who will give birth and raise children in Fukushima, to alleviate their

67   concerns, and to provide them with necessary care. In the 2013 survey, the smoking rate was

68   3.8% during pregnancy and 6.7% in early parenthood. In the 2016 survey, the respective rates

69   were 3.0% and 5.5% (Fukushima Medical University Radiation Medical Science Center for the

70   Fukushima Health Management Survey, n.d.), which reflected the downward nationwide trend.

71   However, the national goal of a 0% smoking rate during pregnancy has not been reached, and

72   relapse also occurs in the postpartum period.

73   Smoking associated with psychological factors is more common in women than in men

74   (Scherman et al., 2018). Although pregnancy motivates many women to quit smoking, some

75 relapse occurs after pregnancy because of the burden of raising children (Fujioka & Kobayashi,

76 2015). Moreover, women who became pregnant and gave birth in Fukushima Prefecture may

77 also have been psychologically affected by the disaster of 2011. While Japan has made progress

78 in measures to prevent smoking in public places, further efforts that could potentially be

79 facilitated by health care providers at the family and individual levels are needed to prevent

80 smoking during the perinatal period. Therefore, the aim of our study was to identify factors,

81 including mental health, associated with smoking relapse among women in Japan from

82 pregnancy to early parenthood.

83   **Methods**

84 **Design**

85   We conducted a secondary analysis of cross-sectional data collected in ongoing

86 questionnaire-based surveys. This study was approved by the Fukushima Medical University

87 Institutional Review Board (No. 1317). The objective of the survey was clearly explained on

88 the survey form, the return of which constituted consent to participate in the study. All

89 Pregnancy and Childbirth Survey data were managed by the Radiation Medical Science Center

90 for the FHMS at Fukushima Medical University. We used anonymized data in the analysis.

91 **Survey Methods**

92   The protocol of the Pregnancy and Childbirth Survey was described previously

93 (Yasumura et al., 2012). The Pregnancy and Childbirth Survey of FHMS has been conducted

94 every year since 2011 (Fujimori et al., 2014). The questionnaires for each survey year were sent

95 to women who were issued maternal and child health handbooks in Fukushima Prefecture or

96 who were issued handbooks in other prefectures but gave birth in Fukushima Prefecture

97 between August 1 of the previous year and July 31 of the survey year. In Japan, all pregnant

98   women are required to register their pregnancies, and all pregnant women receive maternal and

99   child health handbooks. This registration system enables the provision of maternal and child

100   health services such as antenatal checkups. The maternal and child health handbook can be used

101   to record the health status of women and their children from pregnancy to infancy and allows

102   medical care providers and women to manage their health.

103   We identified the target participants using pregnancy registration information obtained

104   from municipalities in the prefecture. We sent a single questionnaire to each of the targeted

105   women from one month after their expected date of birth. We also added an explanatory note

106   asking participants to complete the questionnaire at least one month after they gave birth. The

107   survey included questions about the one-month child health checkup, after which participants

108   completed and returned the questionnaires. Data collection proceeded for approximately one

109   year in each survey year. With the aim of providing continuous support to women who need

110   assistance, we offered support by phone to those who answered "Yes" to both questions about

111   symptoms of depression and to those whose free responses indicated a need for support. We

112   categorized the content of those consultations and categorized the data collected.

113   **Participants**

114   Of the 14,516, 15,218, 15,125, 14,572, and 14,154 women identified for the annual

115   surveys conducted from 2012 to 2016, respectively, 7,181 (49.5%) returned their questionnaires

116   in 2012, 7,260 (47.7%) in 2013, 7,132 (47.2%) in 2014, 7,031 (48.3%) in 2015, and 7,326

117   (51.8%) in 2016 (Fig. 1). Of these women, we excluded 319 women whose pregnancies

118   resulted in miscarriage, abortion, or stillbirth; 414 women who were issued their maternal and

119   child health handbooks outside of Fukushima Prefecture; 2,667 women who provided multiple

120   responses; 261 whose answers were provided by someone other than themselves; and 114

121   women with missing values regarding smoking when they registered their pregnancies, during

122   pregnancy, or at the time of the survey (total 3,775 women). We then excluded 16,447 women

123   who responded that they never smoked before registering their pregnancies and 1,593 women

124   who responded that they continued smoking after they registered their pregnancies. We received

125   multiple responses from women who gave birth more than once from 2013 to 2016 and

126   responded to the survey for multiple pregnancies. In these cases, we used responses from the

127   first pregnancy only because second or later pregnancies were potentially affected by repeated

128   responses. In addition, because the risk group for smoking relapse during pregnancy and the

129   postpartum period consisted of only women who smoked previously and then quit, we excluded

130   those who never smoked before pregnancy and those who continued to smoke up to the time of

131   the survey. Finally, we included 6,747 women in our analyses.

132   **Measures**

133   ***Smoking Status***

134   In the survey, the participants were retrospectively asked about their smoking status at

135   three different points: at registration of the pregnancy, during pregnancy, and at the time of the

136   survey. The first question was "Were you smoking around the time you registered your

137   pregnancy?" Responses consisted of "I have never smoked," "I stopped before I realized I was

138   pregnant," "I stopped when I realized I was pregnant," and "Yes." The second question was

139   "Did you smoke during your pregnancy?" Responses consisted of "No" and "Yes." The third

140   question was "Do you currently smoke?" Responses consisted of "No" and "Yes."

141   Participants who stopped smoking around the time (just before or just after) they

142   registered their pregnancies and maintained smoking cessation were classified as the non-

143   relapse group, whereas women who temporarily stopped smoking around the time they

144   registered their pregnancies but later resumed smoking were classified as the relapse group

145   (Fig. 2). For analysis, participants were also divided into two groups based on the timing of

146   smoking cessation: those who quit smoking before they realized they were pregnant were

147   classified as before pregnancy registration, whereas those who quit smoking once they realized

148   they were pregnant were classified as after pregnancy registration.

149   ***Basic Characteristics***

150   Basic characteristics consisted of the region in Fukushima Prefecture where the maternal

151   and child health handbook was issued, the mother's age, and family structure. The regions

152   included Hamadori (Pacific coast), Aizu (mountains near Niigata Prefecture), and Nakadori

153   (between the Hamadori and Aizu regions). Age was divided into four groups: 24 years or less,

154   25 to 29 years, 30 to 34 years, and 35 years or more. Family structure was divided into nuclear

155   family and extended family.

156   ***Pregnancy-Related Items***

157   Pregnancy-related items consisted of reproductive history and satisfaction with

158   pregnancy/childbirth care. Reproductive history was divided into primiparity and multiparity.

159   For satisfaction with pregnancy/childbirth care, participants responded to the question, "How

160   satisfied were you with the care you received throughout your pregnancy and during

161   childbirth?" on a 5-point scale from "Very satisfied" to "Not at all". We included participants

162   who responded "Very satisfied" or "Satisfied" in the "satisfied group," whereas we included

163   participants with other responses in the "unsatisfied group." Although the survey contained

164   other pregnancy and birth questions, such as complications and route of birth, these were not

165   deemed relevant to the current analysis on smoking relapse.

166   ***Health Status-Related Items***

167   Health status-related items consisted of symptoms of depression and self-rated health.

168   We asked about symptoms of depression with the questions, "During the past month, have you

169   often felt down, depressed, or hopeless?" "During the past month, have you often found little

170   interest or pleasure in doing things?" Participants who responded "Yes" to either question were

171   classified as having symptoms of depression. For self-rated health, participants responded to the

172   question, "Do you usually consider yourself to be healthy?" on a 4-point scale from "Very

173   healthy" to "Unhealthy"; participants who responded "Very healthy" or "Somewhat healthy"

174   were classified as having good self-rated health, whereas all others were classified as having

175   poor self-rated health.

176   ***Other Items***

177   Other items consisted of survey year and information from free-responses. The

178   information in the free text section of the questionnaire was categorized and coded by multiple

179   people, and this coding was double-checked. The coding consisted of eight categories: radiation

180   anxieties, radiation-related examination and surveys, opinions or complaints about this survey,

181   positive comments about this survey, request for health care/childcare service, financial

182   anxiety/needs, complaints about their own poor physical condition, and personal relationships.

183   The free-response text information was divided into "Yes" or "No," depending on whether or

184   not a response was entered for that category.

185   ***Phone Consultation***

186   Phone consultation content was divided into eight categories: mothers themselves,

187   children's illnesses, parenting, family, evacuation, radiation, nothing in particular, and unclear.

188   For each consultation, each content category was coded as either "Yes" or "No," depending on

189   whether that category was mentioned.

190   **Analysis**

191   We divided participants into a non-relapse group and a relapse group (Figure 2) and

192   compared them in terms of the timing of smoking cessation, survey year, basic characteristics,

193   and pregnancy/health-related items using the chi-squared test or Fisher's exact test. We

194   performed univariate and multivariate logistic regression analyses with smoking status as the

195   dependent variable and the following as moderator variables: survey year, region where

196   handbook was issued, age, and family structure as basic characteristics; symptoms of

197   depression and self-rated health as indicators of health status; and reproductive history and

198   satisfaction with pregnancy/birth care as perinatal factors. Using forced entry, we calculated the

199   odds ratio (OR) and 95% confidence interval (95% CI) for every item. We stratified participants

200   based on smoking cessation timing into "before pregnancy registration" and "after pregnancy

201   registration" for the same analysis described above. In addition, to clarify the behavioral

202   tendencies of women in the two groups, we compared free-response text information and phone

203   consultation content using the Chi-square test or Fisher's exact test. We performed all statistical

204   analyses using SPSS Statistics 25 (IBM, Armonk, NY) with the level of significance set at p

205    $< .05$.

206   **Results**

207   Of the 6,747 participants, 5,866 (86.9%) maintained smoking cessation and 881 (13.1%)

208   relapsed (see Table 1). In the non-relapse group, 2,021 (34.5%) were in the 30 to 34 year age

209   group and 2,243 (45.6%) were primiparous. In the relapse group, 275 (31.2%) were in 25 to 29

210   year age group and 272 (36.9%) were primiparous (see Table 1). Of the 3,235 participants who

211   ceased smoking before registering their pregnancy, 76 (2.3%) relapsed. Of the 3,512

212   participants who ceased smoking after registering their pregnancy, 805 (22.9%) relapsed.

213   **Associations of Smoking Status with Variables According to Time of Smoking Cessation**

214   After confirming that the timing of smoking cessation was strongly associated with

215   smoking relapse, we conducted analyses stratified by the timing of smoking cessation. In

216   univariate analysis of participants who ceased smoking before registering their pregnancies, the

217   following factors were significantly associated with smoking relapse compared with the non-

218   relapse group: being issued a maternal and child health handbook in the Aizu region (*OR* 2.3,

219   95% CI [1.3–3.9]), age 24 years or less (*OR* 5.1, 95% CI [2.4–10.6]), age 25 to 29 years (*OR*

220   2.1, 95% CI [1.1–3.9]), extended family (*OR* 1.8, 95% CI [1.1–2.8]), and symptoms of

221   depression (*OR* 1.8, 95% CI [1.1–2.9]). In multivariate analysis, age 24 years or less (*OR* 6.1,

222   95% CI [2.7–13.6]), age 25 to 29 years (*OR* 2.5, 95% CI [1.2–4.9]), symptoms of depression

223   (*OR* 1.7, 95% CI [1.03–2.95]), and being issued a maternal and child health handbook in the

224   Aizu region (*OR* 2.0, 95% CI [1.1–3.7]) were significantly associated with smoking relapse (see

225   Table 2).

226   In univariate analysis of participants who ceased smoking after registering their

227   pregnancies, the following factors were significantly associated with smoking relapse compared

228   with the non-relapse group: taking the survey in 2015 and 2016 (*OR* 0.7, 95% CI [0.5–0.8], and

229   *OR* 0.8, 95% CI [0.6–0.9], respectively), age 24 years or less (*OR* 2.0, 95% CI [1.6–2.5]),

230   symptoms of depression (*OR* 1.3, 95% CI [1.0–1.4]), poor self-rated health (*OR* 1.4, 95% CI

231   [1.02–1.99]), and multiparity (*OR* 1.8, 95% CI [1.5–2.2]). In multivariate analysis, age 24 years

232   or less (*OR* 2.1, 95% CI [1.5–2.7]), multiparity (*OR* 2.0, 95% CI [1.6–2.4]), and being issued a

233   maternal and child health handbook in the Hamadori region (*OR* 1.2, 95% CI [1.01–1.52]) were

234   significantly associated with smoking relapse (see Table 2).

235   **Associations Between Smoking Status and Free-Response Variables According to Time of**

Smoking Cessation

When participants ceased smoking before registering their pregnancies, free-response text information associated with personal relationships was significantly more common in the relapse group than in the non-relapse group ($p = .007$). Among participants who ceased smoking after registering their pregnancies, we found no significant associations (see Table 3).

Associations Between Smoking Status and Phone Consultation Content According to Time of Smoking Cessation

Among participants who ceased smoking before registering their pregnancies, we found no significant associations with any categories of phone consultation content. Among participants who ceased smoking after registering their pregnancies, the relapse group demonstrated significant trends in consultations related to children's illnesses ($p = .067$) and parenting ($p = .058$) compared with the non-relapse group (see Table 4).

Discussion

We used data from all of Fukushima Prefecture to compare women who did not relapse to smoking with those who relapsed to smoking. We found that 13.1% of the 6,747 participants relapsed to smoking within one month to one year after giving birth. Regardless of the timing of smoking cessation, younger age and region of residence within the Prefecture were associated with smoking relapse. In the group that quit smoking before pregnancy registration, relapse was also associated with symptoms of depression. In the group that quit smoking after pregnancy registration, relapse was also associated with multiparity.

When we examined factors that were associated with smoking relapse, we found that women who relapsed were younger and concentrated in certain regions of the Prefecture regardless of whether they ceased smoking before or after registering their pregnancy. In our

259   examination of the association between residential regions and smoking relapse, perinatal

260   factors (reproductive history and satisfaction with care) were negative confounders. Failing to

261   adjust for such confounders may result in underestimation of an important factor associated

262   with smoking relapse (Choi et al., 2008). We identified that region of residence was associated

263   with smoking relapse independent of perinatal and other factors, which suggests community-

264   based efforts to prevent smoking relapse are needed.

265   Miyazaki et al. (2015) reported that there were differences in the number of women who

266   relapsed to smoking depending on their region of residence. Regional differences may be

267   affected by the age distribution of the population, lifestyle habits, and cultural traditions of the

268   residents in a given region. Smoking cessation is affected by an individual's lifestyle

269   background (Barnett et al., 2019), whereas lifestyle habits at the level of individual behaviors

270   are affected by regional cultural traditions. Passage and implementation of a passive smoking

271   prevention ordinance would be effective strategies at the community and regional levels (Faber

272   et al., 2017). Further, two regions in our study in which participants had higher relapse rates

273   also have a lower number of obstetric care facilities. Therefore, the opportunities for public

274   health nurses and midwives working at health centers in these regions to intervene to influence

275   women's smoking behaviors are critical.

276   Other researchers have reported that young adulthood (age less than 24 years) is a factor

277   in early smoking relapse in the postpartum period (Miyazaki et al., 2015; Orton et al., 2018). In

278   their 2014 Japanese nationwide survey on children's health and the environment, Miyazaki et

279   al. (2015) reported high postpartum smoking relapse rates among women in their twenties.

280   These findings suggest the need for smoking relapse prevention measures aimed at young

281   pregnant women. Smoking behaviors in young people are easily influenced by the smoking

282   behaviors of their friends and family (Fujioka & Kobayashi, 2015). Several researchers have

283   reported an association between smoking relapse prevention interventions for pregnant women

284   and smoking cessation by their partners (Miyazaki et al., 2015; Scheffers-van Schayck et al.,

285   2019). In a study using the Reasons for Smoking Assessment Scale, Fujioka and Kobayashi

286   (2015) found that smoking habits such as "I find myself smoking" and "I feel comfortable

287   smoking" were associated with postpartum smoking relapse. Thus, women may be motivated

288   by pregnancy to cease smoking, but cessation may be only temporary.

289   In addition to the factors that were common to women who ceased smoking before and

290   after registering their pregnancies, we found that participants who ceased smoking before

291   registering their pregnancy were 1.7 times more likely to relapse if they had symptoms of

292   depression. Many participants wrote about "personal relationships" in their free-text responses.

293   Fujita et al. (2021) reported an association between smoking and depression. Ooka et al. (2019)

294   reported a lack of counselors and peers, and a lack of participation in maternal and child health

295   services were significantly associated with maternal smoking during pregnancy. These studies

296   suggest that the parenting environment in which pregnant women find themselves may cause

297   smoking relapse. In Japan, owing to increasing cases of child abuse (Ministry of Health, Labour

298   and Welfare, 2016) and high rates of maternal suicide (Takeda, 2016) due to postpartum

299   depression, support for postpartum depression has recently been strengthened. Therefore, it is

300   necessary to construct a system to promote smoking cessation within the context of postpartum-

301   depression support.

302   In addition to the factors common to participants who ceased smoking before and after

303   registering their pregnancies, those who ceased smoking after registering their pregnancies

304   were 2.0 times more likely to relapse if they were multiparous. In studies conducted in the

305   United States and the Netherlands, researchers also found that multiparous women have a high

306   risk of postpartum smoking relapse (Mumford et al., 2014; Scheffers-van Schayck et al., 2019).

307   For multiparous women, there is a high probability that smoking relapse exposes their older

308   children to second-hand smoke. For infants, second-hand smoke exposure is associated with

309   conditions such as asthma, sudden infant death syndrome, and otitis media (Avşar et al., 2021).

310   Primary prevention of children's exposure to second-hand smoke in the home is an important

311   area for intervention to promote their short and long-term health. Participants in the smoking

312   relapse group had a relatively high frequency of phone consultation content about children's

313   illness and parenting, which suggests that these consultations could be an opportunity to

314   support smoking cessation through the maternal and child health services that are widely

315   available in Japan.

316   **Implications**

317   The results of our analyses stratified by the timing of smoking cessation can help to

318   clarify which smoking cessation measures should be used at different points (e.g., before

319   pregnancy registration and after pregnancy registration). In the United States, behavioral

320   interventions are recommended as a way to effectively decrease smoking rates among pregnant

321   women. These non-pharmacological interventions include ongoing counseling and motivational

322   interviewing (Siu et al., 2015). In Japan, maternal and child health services are mandated under

323   the Maternal and Child Health Act and are provided by hospitals, maternity homes, and health

324   centers. In hospitals, health checkups for women are conducted regularly during pregnancy, and

325   health checkups are also conducted at one month postpartum followed by child health

326   checkups. Obstetricians-gynecologists and midwives are in unique and important positions to

327   provide continual healthcare support for women and their families in the prepregnancy,

328   pregnancy, and postpartum periods.

329   At these medical service encounters, it is advisable to check not only the smoking

330   history and status of the woman but also whether there are any smokers in her home. If so,

331   support for smoking cessation should also be provided to the family. In Japan, support for

332   postpartum depression has been strengthened in recent years, and it may be effective to

333   combine such efforts with anti-smoking measures. Furthermore, women who are breastfeeding

334   may be more responsive to smoking relapse interventions (Gilbert et al., 2015; Logan et al.,

335   2017). Therefore, it may be effective to use breastfeeding as a motivation for women to quit

336   smoking. We believe it is necessary to incorporate anti-smoking measures in childrearing

337   support as a whole.

338   **Limitations**

339   The participants in our study were limited to Fukushima Prefecture and the survey

340   response rate was only about 50%, meaning that the data did not represent the smoking

341   histories of all women who gave birth during the survey years. In addition, because the survey

342   used a self-reporting format, women may have underreported their smoking status owing to

343   social norms. Furthermore, educational background, income, and partner's smoking habits were

344   not collected in the questionnaire, all of which may be related to smoking relapse and should be

345   collected in future research as potential confounders (Orton et al., 2018). However, by using

346   data from surveys targeting all pregnant women in Fukushima Prefecture conducted over

347   multiple years and by considering maternal mental health, we obtained practical and useful

348   suggestions for support targets and methods to prevent smoking relapse among women during

349   pregnancy and the postpartum period.

350   **Conclusions**

351   The associations of younger age and region of residence in the Prefecture with smoking

352   relapse indicate the need to provide support for young pregnant women as well as the need to

353   build a regional system that can maintain support not only during pregnancy but also after

354   childbirth. Since symptoms of depression were associated with an increased likelihood of

355   smoking relapse among women who ceased smoking before registering their pregnancies, it is

356   important to promote smoking cessation as part of the support for mitigating the development

357   of postpartum depression. Further, the association of multiparity with an increased likelihood of

358   smoking relapse among women who ceased smoking after registering their pregnancies

359   highlights the need to provide support not only for pregnant women but also for the members of

360   their families to create personal environments without smokers. Midwives and nurses can play

361   the following roles in smoking cessation efforts: 1) intervening with women during pregnancy

362   and the postpartum period in a comprehensive manner to provide smoking cessation and

363   parenting support, 2) promoting smoking cessation as part of perinatal mental health care, and

364   3) providing support not only to women during pregnancy and the postpartum period but also to

365   their families.

References

Avşar, T. S., McLeod, H., & Jackson, L. (2021). Health outcomes of smoking during pregnancy and the postpartum period: an umbrella review. *BMC Pregnancy and Childbirth*, *21*(1), 254. https://doi.org/10.1186/s12884-021-03729-1

Barnett, M. J., Fealy, S., & Wilson, A. (2019). Barriers and enablers for smoking cessation amongst pregnant women: An Umbrella Review. *Women and Birth*, *32*(4), 310–317. https://doi.org/10.1016/j.wombi.2018.10.007

Choi, A. L., Cordier, S., Weihe, P., & Grandjean, P. (2008). Negative confounding in the evaluation of toxicity: the case of methylmercury in fish and seafood. *Critical Reviews in Toxicology, 38*(10), 877–893. https://doi.org/10.1080/10408440802273164

Faber, T., Kumar, A., Mackenbach, J. P., Millett, C., Basu, S., Sheikh, A., & Been, J. V. (2017). Effect of tobacco control policies on perinatal and child health: A systematic review and meta-analysis. *The Lancet. Public Health*, *2*(9), e420–e437. https://doi.org/10.1016/S2468-2667(17)30144-5

Fujimori, K., Kyozuka, H., Yasuda, S., Goto, A., Yasumura, S., Ota, M., Ohtsuru, A., Nomura, Y., Hata, K., Suzuki, K., Nakai, A., Sato, M., Matsui, S., Nakano, K., & Abe, M. (2014). Pregnancy and birth survey after the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant accident in Fukushima prefecture. *Fukushima Journal of Medical Science*, *60*(1), 75–81. https://doi.org/10.5387/fms.2014-9

Fujioka, N., & Kobayashi, T. (2015). Ninshin wo keikitosita ninpu no kituenkoudouhenyou ni oyobosu shakaiteki youin to kituen kankyo [When the subjects became pregnant, the social factors and the smoking situations to influence their change to nonsmoking]. *Nihon Bosei Eisei, 56*(2), 320–329.

https://mol.medicalonline.jp/library/journal/download?GoodsID=cu2mater/2015/005602

/010&name=0320-0329j&UserID=202.251.224.100&base=jamas_pdf

Fujita, Â., Rodrigues-Junior, A. L., Gomes, N. C., Martinis, B. S., & Baddini-Martinez, J. A.

(2021). Socio-demographic and psychological features associated with smoking in

pregnancy. *Jornal Brasileiro de Pneumologia*, *47*(5), e20210050.

https://doi.org/10.36416/1806-3756/e20210050

Fukushima Medical University Radiation Medical Science Center for the Fukushima Health

Management Survey. (n.d.). *Ninsanpu ni kansuru chousa no kekka [Results of previous

surveys on pregnant and nursing mothers]*. http://fukushima-mimamori.jp/pregnant-

survey/result/

Gilbert, N. L., Nelson, C. R., & Greaves, L. (2015). Smoking cessation during pregnancy and

relapse after childbirth in Canada. *Journal of Obstetrics and Gynaecology

Canada, 37*(1), 32–39. https://doi.org/10.1016/s1701-2163(15)30360-1

Logan, C. A., Rothenbacher, D., & Genuneit, J. (2017). Postpartum smoking relapse and breast

feeding: Defining the window of opportunity for intervention. *Nicotine & Tobacco

Research, 19*(3), 367–372. https://doi.org/10.1093/ntr/ntw224

Ministry of Health, Labour and Welfare. (2016, August). *Heisei 27 nendo jidousoudanjyo deno

jidougyakutai soudan taiou kensu [Numbers of child abuse consultations at child

consultation centers in fiscal year 2016]*.

http://www.mhlw.go.jp/stf/houdou/0000132381.html

Ministry of Health, Labour and Welfare. (2018, March). *Jyudou kituen taisaku [Measures

against passive smoking]*.

https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000189195.html

Miyazaki, Y., Hayashi, K., & Imazeki, S. (2015). Smoking cessation in pregnancy:

Psychosocial interventions and patient-focused perspectives. *International Journal of

Women's Health*, *7*, 415–427. https://doi.org/10.2147/IJWH.S54599

Mumford, E. A., Hair, E. C., Yu, T. C., & Liu, W. (2014). Women's longitudinal smoking

patterns from preconception through child's kindergarten entry: Profiles of biological

mothers of a 2001 US birth cohort. *Maternal and Child Health Journal*, *18*(4), 810–820.

https://doi.org/10.1007/s10995-013-1305-y

Ooka, T., Akiyama, Y., Shinohara, R., Yokomichi, H., & Yamagata, Z. (2019). Individual and

regional characteristics associated with maternal smoking during pregnancy in Japan:

Healthy Parents and Children 21. *International journal of environmental research and

public health*, *17*(1), 173. https://doi.org/10.3390/ijerph17010173

Orton, S., Coleman, T., Coleman-Haynes, T., & Ussher, M. (2018). Predictors of postpartum

return to smoking: A systematic review. *Nicotine & Tobacco Research*, *20*(6), 665–673.

https://doi.org/10.1093/ntr/ntx163

Pineles, B. L., Hsu, S., Park, E., & Samet, J. M. (2016). Systematic review and meta-analyses

of perinatal death and maternal exposure to tobacco smoke during pregnancy. *American

Journal of Epidemiology*, *184*(2), 87–97. https://doi.org/10.1093/aje/kwv301

Primo, C. C., Ruela, P. B., Brotto, L. D., Garcia, T. R., & Lima, E. (2013). Effects of maternal

nicotine on breastfeeding infants. *Revista Paulista de Pediatria*, *31*(3), 392–397.

https://doi.org/10.1590/S0103-05822013000300018

Rayfield, S., & Plugge, E. (2017). Systematic review and meta-analysis of the association

between maternal smoking in pregnancy and childhood overweight and obesity. *Journal

of Epidemiology and Community Health*, *71*(2), 162–173. https://doi.org/10.1136/jech-

2016-207376

Scheffers-van Schayck, T., Tuithof, M., Otten, R., Engels, R., & Kleinjan, M. (2019). Smoking

behavior of women before, during, and after pregnancy: Indicators of smoking, quitting,

and relapse. *European Addiction Research*, *25*(3), 132–144.

https://doi.org/10.1159/000498988

Scherman, A., Tolosa, J. E., & McEvoy, C. (2018). Smoking cessation in pregnancy: A

continuing challenge in the United States. *Therapeutic Advances in Drug Safety*, *9*(8),

457–474. https://doi.org/10.1177/2042098618775366

Siu, A. L., & U.S. Preventive Services Task Force (2015). Behavioral and pharmacotherapy

interventions for tobacco smoking cessation in adults, including pregnant women: U.S.

preventive services task force recommendation statement. *Annals of Internal*

Medicine, *163*(8), 622–634. https://doi.org/10.7326/M15-2023

Takeda, S. (2016). Ninsanpusibo "zero" heno chousen [Challenge of reaching "zero" maternal

deaths]. *Nihon Sanfujinka Gakkai*, *68*(9), 1815–1822.

https://dl.ndl.go.jp/view/download/digidepo_10733753_po_ART0010600167.pdf?conte

ntNo=1&alternativeNo=

Ueda, K., Kitano, N., & Suzuki, K. (2020). Description of maternal smoking status before and

after pregnancy: A longitudinal, community-based cohort study. *Journal of*

Epidemiology, *30*(7), 295–300. https://doi.org/10.2188/jea.JE20180187

Yamagata, Z. (2015). *Heisei 26 nendo kouseiroudou kagaku kenkyuhi hojyokin sokatu-buntan*

kenkyu houkokusho: sukoyaka oyako 21 no saishuhyoka-kadaibunseki oyobi jiki

kokumin kenko undou no suisin ni kansuru kenkyu [2014-2015 Health and labor

sciences research grant study report: final assessment and analysis of Healthy Parents

and Children 21 and promotion of the next national health campaign].

http://sukoyaka21.jp/expert/yamagata-report

Yasumura, S., Hosoya, M., Yamashita, S., Kamiya, K., Abe, M., Akashi, M., Kodama, K., &

Ozasa, K. (2012). Study protocol for the Fukushima Health Management

Survey. *Journal of Epidemiology*, *22*(5), 375–383.

https://doi.org/10.2188/jea.je20120105

Table 1

Demographic Characteristics (N = 6,747)

Characteristics	Non-relapse group (n = 5,866)		Relapse group (n = 881)		p value
	n	%	n	%	
Smoking cessation timing					
Before	3,159	53.9	76	8.6	<0.001
After	2,707	46.1	805	91.4	
Survey year					
2013	1,771	30.2	289	32.8	0.066
2014	1,561	26.6	246	27.9	
2015	1,277	21.8	159	18.1	
2016	1,257	21.4	187	21.2	
Residential regions[a]					
Nakadori	3,627	61.8	508	57.7	0.060
Hamadori	1,471	25.1	244	27.7	
Aizu	768	13.1	129	14.6	
Age (years)					
24 or younger	569	9.7	207	23.5	<0.001

25–29	1,701	29.0	275	31.2	
30–34	2,021	34.5	231	26.2	
35 or older	1,575	26.8	168	19.1	
Family structure					
Nuclear	4,041	68.9	561	63.7	0.002
Extended	1,825	31.1	320	36.3	
Symptoms of depression					
No	4,399	75.2	603	68.8	<0.001
Yes	1,453	24.8	273	31.2	
Self-rated health					
Good	5,587	95.4	824	93.6	0.027
Poor	272	4.6	56	6.4	
Reproductive history					
Primiparous	2,243	45.6	272	36.9	<0.001
Multiparous	2,674	54.4	465	63.1	
Satisfaction with pregnancy/obstetrical care					
Satisfied	5,074	86.7	731	83.1	0.004
Unsatisfied	781	13.3	149	16.9	

[a] Region where maternal and child health handbook was issued.

Table 2

Factors Associated With Smoking Relapse Stratified by Smoking Cessation Timing

			Univariate (stratified)				Multivariate (stratified)			
	Univariate		Before pregnancy registration (n = 3,235)		After pregnancy registration (n = 3,512)		Before pregnancy registration (n = 2,738)		After pregnancy registration (n = 2,889)	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Smoking cessation timing										
Before	1.0									
After	12.4	[9.72, 15.7]*								
Survey year										
2013	1.0		1.0		1.0		1.0		1.0	
2014	1.0	[0.80, 1.16]	1.0	[0.57, 1.69]	0.9	[0.75, 1.13]	0.9	[0.47, 1.70]	1.0	[0.76, 1.32]
2015	0.8	[0.62, 0.94]*	0.6	[0.31, 1.24]	0.7	[0.52, 0.82]*	0.6	[0.27, 1.33]	0.8	[0.58, 1.04]
2016	0.9	[0.75, 1.11]	0.7	[0.36, 1.40]	0.8	[0.61, 0.94]*	0.6	[0.26, 1.35]	0.9	[0.65, 1.16]
Residential regions[a]										
Nakadori	1.0		1.0		1.0		1.0		1.0	

Hamadori	1.2	[1.01, 1.40]*	0.9	[0.46, 1.57]	1.2	[0.97, 1.39]	1.0	[0.54, 1.90]	1.2	[1.01, 1.52]*
Aizu	1.2	[0.97, 1.48]	2.3	[1.32, 3.91]*	1.1	[0.86, 1.39]	2.0	[1.11, 3.75]*	1.1	[0.86, 1.46]
Age (years)									
24 or younger	3.2	[2.58, 3.92]*	5.1	[2.49, 10.6]*	2.0	[1.60, 2.53]*	6.1	[2.74, 13.66]*	2.1	[1.59, 2.71]*
25–29	1.4	[1.17, 1.70]*	2.1	[1.11, 3.91]*	1.1	[0.90, 1.35]	2.5	[1.29, 4.94]*	1.2	[0.96, 1.51]
30–34	1.0		1.0		1.0		1.0		1.0	
35 or older	0.9	[0.76, 1.15]	1.4	[0.75, 2.72]	1.0	[0.82, 1.32]	1.4	[0.71, 2.83]	1.0	[0.77, 1.28]
Family structure									
Nuclear	1.0		1.0		1.0		1.0		1.0	
Extended	1.3	[1.09, 1.47]*	1.8	[1.14, 2.87]*	1.1	[0.92, 1.28]	1.5	[0.90, 2.49]	1.0	[0.85, 1.24]
Symptoms of depression									
No	1.0		1.0		1.0		1.0		1.0	
Yes	1.4	[1.17, 1.60]*	1.8	[1.14, 2.99]*	1.3	[1.05, 1.49]*	1.7	[1.03, 2.95]*	1.2	[0.94, 1.41]
Self-rated health									
Good	1.0		1.0		1.0		1.0		1.0	
Poor	1.4	[1.04, 1.88]*	1.4	[0.57, 3.57]	1.4	[1.02, 1.99]*	1.1	[0.41, 2.92]	1.3	[0.91, 1.99]
Reproductive history									

Primiparous	1.0		1.0		1.0		1.0		1.0	
Multiparous	1.4	[1.22, 1.68]*	1.5	[0.88, 2.50]	1.8	[1.54, 2.20]*	1.6	[0.84, 2.99]	2.0	[1.63, 2.43]*
Satisfaction with pregnancy/ obstetrical care										
Satisfied	1.0		1.0		1.0		1.0		1.0	
Unsatisfied	1.6	[1.30, 1.87]*	1.4	[0.78, 2.63]	1.2	[0.99, 1.52]	1.4	[0.73, 2.80]	1.2	[0.90, 1.48]

Note. *$p < 0.05$. CI = confidence interval, OR = odds ratio.

[a] Region where maternal and child health handbook was issued.

Table 3

Associations of Smoking Status With Free-response Text Information According to Smoking Cessation Timing

Variable	Before pregnancy registration (n = 3,235)					After pregnancy registration (n = 3,512)				
	Non-relapse group		Relapse group		p value	Non-relapse group		Relapse group		p value
	n	%	n	%		n	%	n	%	
Radiation anxieties										
Yes	73	2.3	1	1.3	>.999	47	1.7	12	1.5	0.634
No	3,086	97.7	75	98.7		2,660	98.3	793	98.5	
Radiation-related examination and surveys										
Yes	38	1.2	1	1.3	0.607	26	1.0	8	1.0	0.932
No	3,121	98.8	75	98.7		2,681	99.0	797	99.0	
Opinions or complaints about this survey										
Yes	44	1.4	1	1.3	>.999	22	0.8	6	0.7	0.850
No	3,115	98.6	75	98.7		2,685	99.2	799	99.3	
Positive comments about this survey										
Yes	14	0.4	0	0.0		10	0.4	0	0.0	
No	3,145	99.6	76	100.0	>.999	2,697	99.6	805	100.0	0.130

Request for health care/childcare services

Yes	188	6.0	6	7.9		153	5.7	42	5.2	
No	2,971	94.0	70	92.1	0.459	2,554	94.3	763	94.8	0.636

Financial anxiety/requests

Yes	26	0.8	1	1.3		26	1.0	9	1.1	
No	3,133	99.2	75	98.7	0.475	2,681	99.0	796	98.9	0.693

Complaints about their own poor physical health

Yes	80	2.5	4	5.3		45	1.7	12	1.5	
No	3,079	97.5	72	94.7	0.133	2,662	98.3	793	98.5	0.735

Personal relationships

Yes	14	0.4	3	3.9		14	0.5	6	0.7	
No	3,145	99.6	73	96.1	0.007	2,693	99.5	799	99.3	0.430

Table 4

Associations Between Smoking Status and Phone Consultation Content According to Smoking

Cessation Timing

	Before pregnancy registration ($n = 483$)				After pregnancy registration ($n = 515$)				
	Non-relapse group		Relapse group		p value	Non-relapse group		Relapse group		p value
Variable	n	%	n	%		n	%	n	%	
Mothers themselves										
Yes	232	49.9	9	50.0	0.993	182	48.7	72	51.1	0.627
No	233	50.1	9	50.0		192	51.3	69	48.9	
Children's illnesses										
Yes	87	18.7	3	16.7	>.999	50	13.4	28	19.9	0.067
No	378	81.3	15	83.3		324	86.6	113	80.1	
Parenting										
Yes	185	39.8	6	33.3	0.583	128	34.2	61	43.3	0.058
No	280	60.2	12	66.7		246	65.8	80	56.7	
Family										
Yes	95	20.4	2	11.1	0.548	78	20.9	39	27.7	0.100
No	370	79.6	16	88.9		296	79.1	102	72.3	
Evacuation										
Yes	6	1.3	0	0.0	>.999	0	0.0	1	0.7	0.274
No	459	98.7	18	100.0		374	100.0	140	99.3	
Radiation										
Yes	44	9.5	2	11.1	0.686	31	8.3	9	6.4	0.471
No	421	90.5	16	88.9		343	91.7	132	93.6	
Nothing in particular										
Yes	25	5.4	0	0.0	0.615	25	6.7	7	5.0	0.471

No	440	94.6	18	100.0			349	93.3	134	95.0
Unclear										
Yes	119	25.6	5	27.8	0.788		92	24.6	29	20.6	0.336
No	346	74.4	13	72.2			282	75.4	112	79.4

Figure 1 *Flowchart of Participant Enrolment*

* Refers to women who delivered more than once from 2013 to 2016 and responded to the survey each time; only responses from the first survey were used.
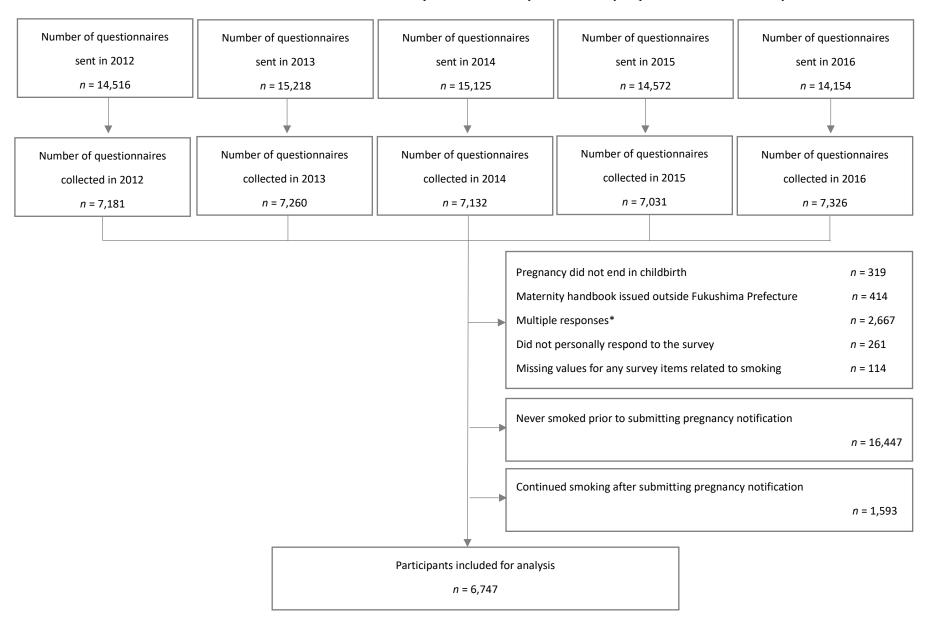

| Number of questionnaires sent in 2012 *n* = 14,516 | Number of questionnaires sent in 2013 *n* = 15,218 | Number of questionnaires sent in 2014 *n* = 15,125 | Number of questionnaires sent in 2015 *n* = 14,572 | Number of questionnaires sent in 2016 *n* = 14,154 |

| Number of questionnaires collected in 2012 *n* = 7,181 | Number of questionnaires collected in 2013 *n* = 7,260 | Number of questionnaires collected in 2014 *n* = 7,132 | Number of questionnaires collected in 2015 *n* = 7,031 | Number of questionnaires collected in 2016 *n* = 7,326 |

Pregnancy did not end in childbirth — *n* = 319
Maternity handbook issued outside Fukushima Prefecture — *n* = 414
Multiple responses* — *n* = 2,667
Did not personally respond to the survey — *n* = 261
Missing values for any survey items related to smoking — *n* = 114

Never smoked prior to submitting pregnancy notification — *n* = 16,447

Continued smoking after submitting pregnancy notification — *n* = 1,593

Participants included for analysis — *n* = 6,747

Figure 2   *Conceptual Diagram of Analysis*