＜ Review ＞

Overview of the pregnancy and birth survey section of the Fukushima Health Management Survey: Focus on mothers' anxieties about radioactive exposure

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Abstract

Objectives: The aims of this study are (1) to review the Pregnancy and Birth Survey section of the Fukushima Health Management Survey (FHMS); (2) to clarify the proportion of anxieties felt by mothers from Fukushima that relate to radiation exposure as a stigma in society, and also to identify associated factors; and (3) to explore the attitudes of future mothers from the region in regard to childbirth by developing a new scale, known as the "Fukushima Future Parents Attitude Measure (FPAM).

Methods: (1) We reviewed 11 studies that reported using the FHMS Pregnancy and Birth Survey to determine the health of infants and mothers. (2) To analyze levels of anxiety, we used the data from a 2011 baseline survey and its 2015 follow-up, ascertaining the mothers' subjective health, depressive symptoms, maternal confidence, and anxieties regarding radiation exposure. (3) Finally, to achieve our third aim, we distributed a questionnaire to all 310 students at a women's college in Fukushima Prefecture.

Results: (1) Analyses of FHMS data showed that the Fukushima nuclear accident did not affect pregnancy outcomes, but did affect maternal mental health. (2) An examination of the surveys of mothers' mental health revealed that 974 mothers (41.2%) reported having feelings of anxiety associated with the stigma of radiation exposure. In particular, maternal age, depressive symptoms, receiving antenatal care as scheduled, and post-quake medical history were significantly associated with a higher proportion of anxieties related to this stigma. (3) Exploratory and confirmatory factor analyses were conducted, allowing us to identify two

Factors: "caring for a baby" (three items) and "giving birth to a baby" (three items). Both factors correlated with the students' quality of life, self-efficacy, and self-esteem scales, and the factor, "giving birth to a baby," also correlated with radiation-related risk perception.

Conclusions: The FHMS highlighted the importance of providing mental health support to the mothers of young children. It should be particularly noted that over 40 percent of mothers in the follow-up study in 2015 had anxieties about being stigmatized for their radioactive exposure. In addition, young women's attitudes toward future pregnancy, as measured by the FPAM, are associated with their radiation risk perception.

keywords: Fukushima Health Management Survey, stigma, Fukushima nuclear accident, radiation, FPAM

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I. FHMS Pregnancy and Birth Survey

The Great East Japan Earthquake occurred on March 11, 2011, causing a tsunami to hit the Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant, which resulted in the leakage of radioactive material. Consequently, since this incident, many people in the area have lived in fear of radiation exposure. In the aftermath of this major nuclear power plant (NPP) disaster, mothers of young children were identified as one of the groups at greatest risk of experiencing negative emotional and mental health consequences [1].

1. Methods

After the Fukushima nuclear accident, the Fukushima Health Management Survey (FHMS) was planned and implemented to monitor the physical and psychological health status of all prefectural residents [2]. Respondents to the FHMS Pregnancy and Birth Survey were women who registered as being pregnant at a municipal office either in Fukushima Prefecture or in another prefecture and delivered their babies in Fukushima Prefecture on or after March 11, 2011. In Japan, every pregnant woman is required to register her pregnancy; she receives a maternal and child-health handbook, as well as antenatal and postnatal checkups and other services. The total number of women meeting these criteria in 2011–2015 was 14,516–16,001; of these, 6,866–9,316 returned the FHMS questionnaire (response proportion = 47.1–58.2%: Table 1).

The questionnaire, which can be seen on our website [3], was designed to obtain general demographic and perinatal outcome data, including maternal age, pregnancy and medical history, pregnancy outcome, gestational age at delivery, mode of delivery, and infant birth weight. We also sought to ascertain mothers' mental health status, maternal

confidence, and the child's health status. The questionnaire included a blank space for respondents to freely write their own opinions.

The Ethics Committee of Fukushima Medical University approved this study (No. 1317, 2333). The survey aims were explained to all participants in a cover letter that accompanied the questionnaire. By responding to the survey, participants were considered to have consented to participate.

2. Overview of results

Eleven previous studies were found to have used FHMS Pregnancy and Birth Survey data [4-14] (as of November 2017; Table 2). Each of these studies focused on one of two main themes: (1) pregnancy outcomes, including stillbirth, preterm birth, low birth weight, and congenital anomalies; or (2) the mothers' mental health. In the 2011 data, the overall proportion of preterm (delivered at < 37 gestational weeks) and low birth weight (< 2,500 g) infants was almost the same as that reported in the national surveillance data [4,12,15] (Table 1); furthermore, the prevalence of congenital anomalies in singleton pregnancies across the five-year study period was almost the same as the 2–3% prevalence reported in the general Japanese population [12,16]. The earliest study of maternal mental health reported that, in 2011, 28% of mothers screened positive for depressive symptoms, measured using a two-item screening test [5]. Although the prevalence gradually decreased over our study period (27.1% in 2011; 25.5% in 2012; 24.5% in 2013; 23.4% in 2014; and 21.9% in 2015) [12], it remains higher than that reported, using the same questions, in other regions of Japan. For example, in Mishina et al.'s study, the proportion of mothers in Osaka (eastern metropolitan area) with postpartum depression was 19.8% at one month, and 1.4% at four months [17], while

Table 1 Survey population and characteristics of the infants

	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Survey Population	16,001	14,516	15,218	15,125	14,572
Response Proportion (%)	58.2	49.5	47.7	47.2	47.1
Preterm Delivery (%)					
Survey Data	4.8	5.7	5.4	5.4	5.7
Reference Data	5.7	5.7	5.8	5.7	5.6
Low Birth Weight (%)					
Survey Data	8.9	9.6	9.9	10.1	9.7
Reference Data	9.6	9.6	9.6	9.5	9.4
Congenital Anomalya (%)					
Survey Data	2.9	2.4	2.4	2.3	2.2
Reference Data	2.4	2.3	2.4	2.5	—

[a] Data from singleton pregnancies.
[b] Reference data relating to preterm deliveries and low-birth-weight infants were sourced from vital statistics recorded in Japan on an annual basis, whereas those relating to congenital anomalies were sourced from the World Health Organization and Cleaning House International Monitoring Center Japan Branch.

Table 2　Summary of the FHMS Pregnancy and Birth Survey

Study	Data	Number of analyzed subjects	Aim of study	Main findings
Fujimori et al. (2014)[4]	2011	8,602 mothers	to present some results sourced from a pregnancy and birth survey performed using questionnaires and conducted after a disaster.	The incidences of stillbirth, preterm birth, low birth weight, and congenital anomalies were 0.25%, 4.4%, 8.7%, and 2.72%, respectively. These incidences are similar to recent averages reported in other areas of Japan.
Goto et al. (2015)[5]	2011	8,196 mothers	to clarify depressive symptoms among new mothers, and their association with geographical region and interruptions in obstetrical care, who have experienced a disaster.	Of the 8,196 women, 2,262 (28%) screened positive for depressive symptoms. Both mothers in Soso, the region in which the nuclear power plant is located, and mothers that had changed obstetrical care facilities were significantly more likely to screen positive for depression.
Yoshida-Komiya et al. (2015)[6]	2011	61 miscarriages 5 abortions 22 stillbirths	to evaluate the mental health status of mothers who have experienced miscarriage, abortion, or stillbirth immediately after experiencing a disaster.	Among the three fetal-loss groups, the proportion of positive depression screens was significantly higher in the miscarriage and stillbirth group than in the childbirth group.
Ishii et al. (2016)[7]	2011	8,366 mothers	to assess the need for the provision of breastfeeding support after a disaster	The percentage of women who breastfed exclusively was 30.9%. The use of formula feeding because of concerns relating to radioactive contamination was significantly higher in women who had resided within the evacuation area and in those whose regular antenatal care had been interrupted.
Kyozuka et al. (2016)[8]	2011	1,706 newborns (Affected area: 836) (Less-affected area: 870)	to evaluate the effects disasters have on feeding methods and growth in infants born after such events.	There were no significant differences in the background characteristics of the newborns in these areas. When, to assess trends, birth dates were divided into four periods, no significant change in the exclusive breastfeeding rate was found; however, the exclusive formula-feeding rate was significantly different across time periods in the affected area.
Suzuki et al. (2016)[9]	2011	5,593 mothers who experienced an earthquake between the 4th and 37th weeks of their gestational period	to examine the association between changes, as a result of an earthquake, in medical institutions providing perinatal care and gestational duration.	Pregnant women who changed their perinatal checkup institution due to medical indication were found to be significantly associated with shorter gestational duration and preterm birth than women who visited only one institution.
Goto et al. (2017)[10]	2012 2013	6,686 mothers in 2012 6,423 mothers in 2013	to identify, at an early stage, the health problems of mothers and babies and to help mothers become confident in regard to parenting.	The proportions of mothers with lower self-confidence in regard to child rearing and who experienced depressive symptoms were 53% and 25% in 2012 and 55% and 24% in 2013, respectively. Evacuation and concern about radiation were significantly associated with depressive symptoms, but not lower maternal confidence, although these two outcomes were significantly associated.
Hayashi et al. (2017)[11]	2011	7,053 mothers who conceived during the nine months before and after the disaster	to evaluate the obstetric outcomes in mothers in Fukushima prefecture during and after the disaster.	During the nine months before and after the disaster, 138 (2.0%) and 102 (1.9%) women conceived using in vitro fertilization-embryo transfer (IVF-ET). Although IVF-ET was found to be associated with increased incidence of cesarean sections and low birth weight, there were no significant differences in obstetric outcomes between the periods before and after the disaster.
Ishii et al. (2017a)[12]	2011– 2014	—	to review the major findings from four annual surveys conducted from 2011 to 2014.	Overall rates of preterm deliveries, low-birth-weight infants, and congenital anomalies in the first year were almost the same as those reported in national surveillance data. Meanwhile, the prevalence of depressive symptoms among the mothers remained constant, at approximately 25%, over the four years. Regarding the content of parenting counseling, the proportion of mothers who voiced concerns about radiation decreased each year.
Ishii et al. (2017b)[13]	2011	8,358 mothers	to assess the health status of, and provide telephone counseling, to mothers living in Fukushima after the nuclear accident.	Significantly most of the mothers who received telephone counseling had experienced interruptions in antenatal care, high-risk pregnancies with complications and/or anomalies, or cesarean sections, or were primipara. The most frequent topic discussed in the counseling was "effects of radiation," followed by "mothers' health" and "childrearing."
Ito et al. (2017)[14]	2011– 2013	8,575 mothers in 2011 6,921 mothers in 2012 7,022 mothers in 2013	to clarify the frequency of, and temporal changes, in the content of mothers' freely written opinions obtained in the FHMS from 2011 to 2013.	Common to the top five codes across the three years were the "effect of radiation on the fetus and infant" and "information provision, including survey results." Participants who wrote free opinions were significantly more likely to be aged ≥ 30 years and to have depressive symptoms.

the Hamamatsu Birth Cohort reported a depression rate of 11% within one month, and 4% at 2–3 months postpartum [18]. As for the mothers who wrote their own comments on the questionnaire, during the first two years after the nuclear accident, many mothers expressed concerns about the health effects of radiation on their children; by the third year, their concerns had shifted more toward their own health and general parenting issues [14].

II. Follow-up Study of the FHMS Pregnancy and Birth Survey

In Fukushima, there is a growing interest in the public stigma and self-stigmatization associated with radioactive exposure [19]. For example, many young women in Fukushima Prefecture worry that others might view them negatively, making assumptions about the effects of radiation on their future pregnancies or genetic inheritance [20]. Consequently, evacuees often try to conceal the fact that they lived in Fukushima [20]. Prior research has shown that self-stigmatization is often associated with public stigma [21], increased hopelessness [22], poorer self-esteem [22,23], reduced self-efficacy [22,23], and decreased quality of life (QOL) [22]. Despite these findings, little has been done to address the public stigmatization of pregnant women in Fukushima. In 2015, the FHMS conducted a follow-up study on the women who contributed to the baseline study in 2011, seeking to determine the ongoing state of maternal anxiety associated with radiation exposure, including perceptions of stigmatization. In this section, we examine the factors associated with the mothers' anxiety about stigmatization, using data from this follow-up study.

1. Methods
This study has used data from the baseline survey performed in 2011 and the follow-up conducted in 2015. The follow-up questionnaire was sent to 7,252 women who responded to the baseline survey, where both mother and child were confirmed as still living. In this later survey, we sought to ascertain the mothers' subjective health status, depressive symptoms, maternal confidence, and anxieties concerning radiation exposure (water, food, playing outside, the child health's, the stigma, genetic effects, and more).

To perform a statistical analysis, we first calculated the tetrachoric correlation coefficients for the mothers' anxiety about the effects of radiation, and we also examined the relationship between this anxiety and the other items. Next, the associations between the anxieties declared in 2015 and the mothers' background characteristics from 2011 were examined using univariate and multivariate logistic regression analyses. The Ethics Committee of Fukushima Medical University approved this study (No. 1317, 2333).

2. Results
Of the 7,252 women targeted, 2,554 returned the questionnaires (response proportion = 27.6%) and data from 2,365 women were analyzed; 189 participants were excluded on the following grounds: delivering their babies before March 11, 2011 (n = 96); and answers provided by another person (n = 93). Of the valid responses, 974 mothers (41.2%) reported feeling anxious about the stigma. The results of the tests for correlations between the anxieties regarding radiation and parenting concerns are shown in Table 3. In particular, water of the anxieties concerning radiation exposure showed medium and large correlations with food ($\phi = 0.84$), playing outside ($\phi = 0.65$), and child health ($\phi = 0.41$). Meanwhile, food showed medium and large correlations with playing outside ($\phi = 0.62$) and child health ($\phi = 0.40$). Child health showed a medium correlation with genetic influence ($\phi = 0.41$) and disease in children ($\phi = 0.46$). Finally, maternal age, depressive symptoms, receiving antenatal care as scheduled, and post-quake medical history were found to be significantly associated with a higher level of anxiety about the stigma (Table 4).

Table 3 Correlations between anxieties concerning radiation effects (follow-up data from 2011)

		n	%	1	2	3	4	5	6	7	8
1	Water	969	41.0	-							
2	Food	1,121	47.4	0.84	-						
3	Playing outside	883	37.3	0.65	0.62	-					
4	Child health	1,772	74.9	0.41	0.40	0.37	-				
5	Stigma	974	41.2	0.02	-0.01	0.08	-0.02	-			
6	Genetic influence	773	32.7	0.31	0.28	0.29	0.41	0.25	-		
7	Mental and physical development of children	935	39.5	0.11	0.14	0.18	0.28	0.10	0.20	-	
8	Disease in children	953	40.3	0.29	0.28	0.27	0.46	0.06	0.30	0.23	-
9	Children's lifestyle	637	26.9	0.13	0.14	0.19	0.20	0.13	0.18	0.29	0.17

* tetrachoric correlation

Table 4 Characteristics of the anxieties relating to stigma concerning radioactive exposure (data from 2011)

	Anxiety concerning stigma (n = 974)		No anxiety concerning stigma (n = 1391)		Univariate analysis[a]					Multivariate analysis[b]				
	n	%	n	%	OR	95% CI Lower	-	Upper	P value	OR	95% CI Lower	-	Upper	P value
Mother's age at the time of pregnancy (years; mean and SD)[c]	32.1	4.6	31.4	4.9	1.03	1.01	-	1.05	0.001	1.03	1.01	-	1.05	0.001
Region														
Kenpoku (North region)	259	26.6	376	27.0	1				0.000	1				0.003
Kenchu (Middle region)	297	30.5	364	26.2	1.19	0.95	-	1.48	0.132	1.13	0.90	-	1.42	0.285
Kennan (South region)	64	6.6	89	6.4	1.04	0.73	-	1.49	0.814	1.09	0.76	-	1.57	0.629
Soso (Coastal region)	118	12.1	118	8.5	1.45	1.08	-	1.96	0.015	1.29	0.94	-	1.76	0.115
Iwaki (Coastal region)	143	14.7	262	18.8	0.79	0.61	-	1.03	0.077	0.74	0.57	-	0.97	0.027
Aizu, Minamiaizu (Mountainous region)	93	9.5	182	13.1	0.74	0.55	-	1.00	0.048	0.77	0.57	-	1.04	0.083
Birth														
0 (First-time mother)	671	72.2	938	71.0	1									
≥ 1	259	27.8	384	29.0	0.94	0.78	-	1.14	0.536					
Breast-feeding on March 11														
No	930	97.3	1,307	95.8	1									
Yes	26	2.7	57	4.2	0.64	0.40	-	1.03	0.064					
Depressive symptoms														
Negative	821	85.4	1,222	89.4	1					1				
Positive	140	14.6	145	10.6	1.44	1.12	-	1.84	0.004	1.34	1.04	-	1.73	0.024
Continuation of perinatal care and delivery														
Yes	744	76.7	1,135	82.4	1									
No	226	23.3	243	17.6	1.42	1.16	-	1.74	0.001					
Attendance of antenatal care as scheduled														
Yes	769	79.0	1,164	84.3	1					1				
No	204	21.0	216	15.7	1.43	1.16	-	1.77	0.001	1.40	1.12	-	1.74	0.003
Prepregnancy disease														
No	855	87.9	1,234	89.2	1									
Yes	118	12.1	149	10.8	1.14	0.88	-	1.48	0.308					
Disease between pregnancy and disaster														
No	816	84.0	1,185	85.6	1									
Yes	155	16.0	200	14.4	1.13	0.90	-	1.41	0.309					
Post-quake disease														
No	753	78.0	1,145	83.5	1					1				
Yes	212	22.0	226	16.5	1.43	1.16	-	1.76	0.001	1.36	1.10	-	1.68	0.005
Sex[d]														
Boy	493	51.2	701	51.1	1									
Girl	469	48.8	672	48.9	0.99	0.84	-	1.17	0.927					
Birth weight														
2500 g or higher	909	94.2	1,265	92.1	1									
Less than 2500 g (low birth weight)	56	5.8	108	7.9	0.72	0.52	-	1.01	0.055					
Congenital anomaly														
No	909	97.3	1,300	98.0	1									
Yes	25	2.7	27	2.0	1.32	0.76	-	2.30	0.317					
Feeding method														
Breast feeding only	316	32.4	405	29.2	1				0.186					
Mix method	604	62.0	911	65.7	0.85	0.71	-	1.02	0.075					
Bottle feeding only	54	5.5	71	5.1	0.98	0.66	-	1.43	0.896					

[a] Univariate logistic regression analysis by forced entry method.

[b] In the multiple logistic regression analysis (forward selection: likelihood ratio), the independent variables featured items that, through univariate logistic regression analysis, were found to have p values of less than 0.05: mother's age at the time of pregnancy, region, depressive symptoms, continuation of perinatal care and delivery, attendance of obstetric exams as scheduled, and post-quake disease; Cox-Snell R^2 = 0.024; Nagelkerke R^2 = 0.033.

[c] Age on April 2, 2011.

[d] This analysis excluded data relating to twins (n = 20).

III. Young Women's Attitude towards Future Childbirth in Fukushima

In addition to assessing current mothers' anxiety using FHMS, we further aimed to explore future mothers' attitude towards childbirth; to achieve this we developed a new scale, called the "Fukushima Future Parents Attitude Measure" (FPAM).

1. Methods

(1) Study design and participants

This cross-sectional survey was distributed to all 310 students at a women's college in Fukushima Prefecture, Japan, in December 2015. Twenty-one participants were excluded on the following grounds: being married (n = 3); providing the same response to all of the questions (n = 1); scoring at least 9 out of 10 on the Social Desirability Scale (n = 9) [24,25]; and neglecting to report social desirability scale values (n = 8). Consequently, a total of 289 participants were included in the final analysis.

(2) Scale development procedure

The items included in the FPAM were selected from the following scales: the Perceived Devaluation and Discrimination Scale [26,27]; the Internalized Stigma of Mental Illness (ISMI) scale (Tanabe, personal communication, 2015) [28,29]; the BRCA Self-Concept Scale [30]; the Boston University Empowerment Scale [31]; and the Prenatal Self-Evaluation Questionnaire [32,33]. The selection criteria were that the scales were (1) globally used, and (2) had established reliability and validity. Four experts (one psychiatrist, one clinical psychologist, and two educational experts) participated in the item selection; an item was selected when at least three of the four experts independently estimated that it would be useful, resulting in the selection of 27 items. The experts then independently rated the usefulness of the items using a nine-point Likert scale (where 1 = extremely useful, 5 = neither useful nor useless, and 9 = extremely useless). Items that were rated between 1 and 5 on this scale were then collected, and the experts chose the 10 they considered most useful. When the experts judged that an item should be expressed differently, one psychologist, one clinical psychologist, and one public health physician revised the wording of the item.

The 10 FPAM items are rated on a four-point Likert scale ranging from 1 (agree) to 4 (disagree). Before responding to the items, participants are provided with the following instruction: "Please answer the following questions. Please assume that you will live and raise a family in Fukushima Prefecture."

(3) Indicators of FPAM validity

To evaluate the validity of the FPAM, we used the following measures: the World Health Organization-Five Well-Being Index (WHO-5) [34]; the Rosenberg Self-Esteem Scale (RSES) [35,36]; the General Self-Efficacy Scale (GSES) [37]; the Social Desirability Scale; and items for assessing perceptions of radiation-related health-effect risks [4,38]. In addition, perceptions of risks relating to the effects of radiation on health were evaluated using two items sourced from screening measures included in a mental health and lifestyle survey, developed as part of the Fukushima Health Management Survey [2,38]. Specifically, these two items are: "What do you think is the likelihood of damage to your health (e.g., cancer) in later life as a result of your current level of radiation exposure?" and "What do you think is the likelihood that the health of your future (i.e., as yet unborn) children and grandchildren will be affected as a result of your current level of radiation exposure?"

(4) Statistical analysis

A five-step analysis of the results was conducted. First, to identify the factor structure of the FPAM among participants, we conducted an exploratory factor analysis with promax rotation, using maximum likelihood as the estimation method. Criteria for the retention of factors were based on a scree plot and factor interpretability; for each of the identified dimensions, scale items with loadings greater than 0.40 were retained and used to construct the scale. Second, to assess the goodness-of-fit of the factor model identified through the exploratory factor analysis, a series of confirmatory factor analyses were performed; again, the maximum likelihood procedure was used to obtain estimates. Consequently, seven fit statistics were used to determine the best model fit [39]. Third, to evaluate the reliability of its internal consistency, we calculated Cronbach's alpha coefficients. Fourth, to verify criterion-related validity, Pearson's or Spearman's correlations between the FPAM and each measure were calculated, as appropriate. Finally, we conducted a multiple regression analysis or an ordered probit analysis, using the forced entry method. An ordered probit analysis is analogous to a multiple regression analysis; however, in ordered probit, the dependent variable is scored on an ordinal scale, whereas in multiple regression, the dependent variable is scored on an interval scale. The full and two-item versions of the FPAM were the dependent variables, and the WHO-5, RSES, and GSES were the independent variables; Mplus version 3.0 (Muthén and Muthén, Los Angeles, CA) was used for the confirmatory factor analysis and ordered probit analysis, while the other analyses were calculated using SPSS version 21.0 (SPSS Inc., Chicago, IL).

(5) Ethical considerations

The Ethics Committee of Fukushima Medical University approved this study (No. 2462). Prior to beginning the

study, we obtained approval from the university and held preparatory meetings with the students' teachers. The teacher of each class distributed questionnaires to the participants and collected them once they had been completed. The survey aims were explained to all participants in a cover letter that was distributed with the questionnaire; in particular, the cover letter stated that students should return a blank questionnaire if they did not wish to participate. We also indicated to students that the survey was anonymous, and that they would not suffer adverse consequences as a result of their responses or by choosing not to participate. Participants were considered to provide consent by returning a completed survey.

2. Results

We received responses from all 310 participants (response proportion = 100%), with 289 proving to be valid; of these, 223 (77.2%) lived in Fukushima Prefecture at the time of the Great East Japan earthquake. To identify a suitable factor structure for the FPAM, we conducted an exploratory factor analysis (Table 5). The scree plot analysis indicated a two-factor solution, and the factor inter-correlation was 0.41; factor 1 reflected "caring for a baby" and factor 2 reflected "giving birth to a baby." In terms of the confirmatory factor analysis, the model showed unacceptable measurement properties (χ^2 = 1067.7, df = 36, CFI = 0.83, TLI = 0.77, RMSEA = 0.152, RMSEA 90% CI = 0.132–0.177, SRMR = 0.114, AIC = 5430.3, BIC = 5500.0); consequently, we chose to exclude from the factor analysis model items

with low between-item correlation coefficients and items with reduced alpha coefficients. The "caring for a baby" factor was represented by three items ("I look forward to caring for a baby," "I feel I will enjoy the baby," and "I feel that babies are not much fun to care for"), and the "giving birth to a baby" factor was also represented by three items ("I am worried that the baby might have problems," "I am confident that I will have a normal childbirth," and "I think my labor and delivery will progress normally"). This new model demonstrated acceptable measurement properties (χ^2 = 712.0, df = 15, CFI = 0.99, TLI = 0.98, RMSEA = 0.058, RMSEA 90% CI = 0.006–0.100, SRMR = 0.039, AIC = 3508.0, BIC = 3555.7).

To identify the two most important FPAM items, we calculated the alpha and correlation coefficients between the factor scores and each item score. The FPAM items, which reduced the alpha coefficients of each factor, were excluded. The "caring for a baby" score was found to have the highest correlation with "I look forward to caring for a baby" (ρ = 0.87), while the "giving birth to a baby" score was most highly correlated with "I am confident that I will have a normal childbirth" (ρ = 0.72). Therefore, these were the most important items associated with the factors of "caring for a baby" and "giving birth to a baby."

The alpha coefficients of "caring for a baby" and "giving birth to a baby" were 0.86 and 0.65, respectively. The "caring for a baby" factor showed medium correlations with the QOL (r = -0.23), self-efficacy (r = -0.24), and self-esteem (r = -0.21) scales, while the "giving birth to a

Table 5 Exploratory factor analysis of the empowerment scale

		M	SD	Factor 1	Factor 2	Communality
1	I look forward to caring for the baby. （私は、赤ちゃんの世話をすることを楽しみにしています。）	1.8	0.9	0.99	-0.14	0.88
2	I believe that I will enjoy caring for the baby. （私は、赤ちゃんとの生活を楽しむだろうと感じます。）	1.8	0.8	0.95	-0.13	0.83
3	I feel that babies are not much fun to care for. (R) （私は、赤ちゃんの世話は、そんなにおもしろい（楽しい）ものではないと感じています。）	2.1	0.9	0.63	0.06	0.48
4	I believe I can be a good mother. （私は、よい親になれると信じています。）	2.3	0.8	0.48	0.33	0.57
5	I am worried that the baby might have problems (R) （私は、赤ちゃんに何か問題があるかもしれないと気をもんでいます。）	2.1	0.8	-0.14	0.67	0.51
6	I am confident that I will have a normal childbirth. （私は、大きな問題なく出産をする自信があります。）	2.3	0.8	0.16	0.63	0.60
7	I think my labor and delivery will progress normally. （私は、陣痛と分娩（出産）が正常に進行すると思っています。）	2.3	0.7	0.22	0.50	0.52
8	I worry about problems the baby might have. (R) （私は、赤ちゃんが何らかの問題を持っているかもしれないと気になります。）	2.4	0.9	-0.20	0.60	0.44
9	I have doubts about whether I will be a good mother. (R) （私は、よい親になれるのか疑問があります。）	3.1	0.8	0.26	0.42	0.45
10	In general, I am able to live life the way I want to. （おおざっぱに言うと、私がやりたいように、自分の人生を生きることができる。）	2.3	0.8	-0.00	0.13	0.10
Contribution ratio (%)				36.89	16.63	

(R) represents reversed wording. Thus, these items were reverse scored.

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baby" factor showed medium correlations with the QOL (r = -0.17), self-efficacy (r = -0.18), self-esteem (r = -0.24), and radiation-related risk perception measures (r = 0.19). In relation to the "caring for a baby" factor, the standardized partial regression coefficients of the WHO-5, RSES, and GSES were -0.15, -0.07, and -0.17, respectively, and the adjusted R-squared value was 0.08. The standardized partial regression coefficients of the "giving birth to a baby" factor were -0.13, -0.18, and -.06, respectively, and the adjusted R-squared value was 0.07. In terms of the most important items reflecting these factors, the respective standardized partial regression coefficients were -0.14 and -0.14 for the WHO-5, -0.13 and -0.17 for the RSES, and -0.11 and -0.03 for the GSES. The adjusted R-squared values for the most important items were 0.085 and 0.069, respectively.

IV. Discussion

The aims of this study were to: (1) provide an overview of the FHMS Pregnancy and Birth Survey, (2) report on the follow-up study of the FHMS Pregnancy and Birth Survey, and (3) report on a study of college women's attitudes towards future childbirth in Fukushima Prefecture.

In regard to the review of the FHMS Pregnancy and Birth Survey, the nuclear accident in Fukushima was found to have not affected pregnancy outcomes, but to have affected maternal mental health, underlining the importance of providing mental health support to mothers from the area who have young children [18]. These results accord with the report of Adams et al. in 2002 and 2011 [40,41], who found that evacuee mothers in Kiev, Ukraine, who were directly affected by the Chernobyl nuclear accident, had lower levels of psychological well-being and more negative risk perception than control subjects, even at 11 [40] and 19 [41] years after the event. These results suggest that nuclear accidents cause mothers severe, long-lasting psychological problems. It is therefore essential to provide mental health support over long periods to mothers with infants; such measures should be prioritized after all such accidents.

In analyzing the follow-up to the 2011 FHMS survey, we found that over 40% of mothers were worried about experiencing a stigma as a consequence of their radiation exposure; this anxiety was associated with maternal age, depressive symptoms, receiving antenatal care as scheduled, and post-quake medical history. Our findings on mothers' anxieties about stigmatization are similar to those of Bromet et al.; specifically, that the Chernobyl evacuees felt that they were stigmatized when they resettled in other cities [42]. The present study shows that providing support for mothers who anxious about stigmatization continues to be a high priority in Fukushima.

For the third part of the study, we developed a new scale to assess young women's attitudes towards future childbirth and found that the scale had acceptable internal consistency reliability, content validity, construct validity, and criterion-related validity. The "caring for a baby" factor represented participants' expectations of caring for a future child, while "giving birth to a baby" reflected their confidence about delivering a baby. We also extracted a two-item version of the FPAM scale for practical purposes, and confirmed its criterion-related validity.

The "giving birth to a baby" and the two-item version of the "giving birth to a baby" tools were found to be associated with "radiation-related risk perception." This finding is consistent with Sato's [43] report that college students in Fukushima Prefecture worried that their children may experience hereditary effects as a result of their radiation exposure. Consequently, these results indicate that young women in Fukushima who have been evaluated as having a low risk of radiation exposure may have increased confidence in regard to giving birth; the students who received low scores on the full and two-item version of the FPAM scale demonstrated favorable results in terms of QOL, self-efficacy, and self-esteem. Our findings are supported by previous studies, which have found an association between self-stigma and self-efficacy and self-esteem [22,23]. It can consequently be suggested that the continuous provision of information on radiation-related health effects, particularly targeting younger generations, is imperative to empower them as future mothers.

However, this study also had one major methodological limitation: it did not evaluate the reliability of the FPAM scale. Consequently, to evaluate changes in the FPAM scale over time (e.g., reflecting changes in participants' situations), future studies must assess this tool's test-retest reliability.

V. Conclusion

The FHMS reported that radiation had no obvious effects on children's health, but had significant effects on maternal mental health, in part by generating anxieties about the stigma associated with radiation exposure. Young women's attitudes toward future pregnancy were found to be associated with their radiation risk perception. Therefore, providing mental health support to mothers with infants and adequate information on radiation health effects to younger generations over long periods is important and should be prioritized, following any similar accidents, as well as the present accident.

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福島県県民健康調査「妊産婦に関する調査」の概説
—放射線被ばくへの不安を抱える母親に焦点をあてて—

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抄録
目的：本研究の目的は（1）福島県県民健康調査「妊産婦に関する調査」をレビューすること，（2）放射線被ばくに伴うスティグマによる不安を抱える母親の割合，およびスティグマによる不安の関連要因を明らかにすること，（3）新しく“Fukushima Future Parents Attitude Measure” (FPAM尺度)を作成して，将来の妊娠出産に対する態度を明らかにすることの3点である．
方法：（1）乳児および母親の健康状態を明らかにするために，福島県県民健康調査「妊産婦に関する調査」データを使用した11論文をレビューした．（2）放射線被ばくに伴うスティグマによる不安を分析するために，2011年のベースライン調査および2015年のフォローアップ調査のデータを使用した．フォローアップ研究では，母親の主観的健康観，抑うつ症状，育児の自信，放射線被ばくに伴うスティグマによる不安等を評価した．（3）福島県の女子大学の学生310名を対象に質問紙調査を行った．
結果：（1）福島県県民健康調査「妊産婦に関する調査」データの分析によると，福島原子力発電所事故は妊娠に対して有意な影響を与えていないが，母親の精神的健康に有意な影響を与えていた．(2) 974名（41.2％）の母親がスティグマに伴う不安を感じていた．特に，母親の年齢，抑うつ症状の有無，予定通りの妊婦健診の受診，震災後の新たな病気・状態の有無が有意にスティグマに伴う不安と関連していた．（3）探索的および確認的因子分析を行った結果，“caring for a baby”（3項目）と“giving birth to a baby” (3項目)の2因子が抽出された．これらの2因子は生活の質，自己効力感，自尊感情と相関関係を示し，“giving birth to a baby”因子は放射線のリスク認知とも相関関係を示した．
結論：福島県県民健康調査「妊産婦に関する調査」の論文レビューより，小さい子供を持つ母親への精神的健康支援が重要と考えられる．2015年のフォローアップ研究より，母親の40％以上が放射線被ばくに伴うスティグマによる不安を示していることが示された．また，新しく作成したFPAM尺度によると，若い女性の将来の妊娠出産に対する態度は，放射線のリスク認知と関連していることが示唆された．

キーワード：福島県県民健康調査，スティグマ，福島原子力発電所事故，放射線，FPAM尺度