Effect of medical institution change on gestational duration after the Great East Japan Earthquake: The Fukushima Health Management Survey

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Kohta Suzuki[1,2], Aya Goto[2,3], Keiya Fujimori[2,4] for the Pregnancy and Birth Survey Group of the Fukushima Health Management Survey

1 Department of Health Sciences, Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi, 1110 Shimokato, Chuo, Yamanashi 409-3898, Japan

2 Radiation Medical Science Center for the Fukushima Health Management Survey, 1 Hikariga-oka, Fukushima, Fukushima 960-1295, Japan

3 Department of Obstetrics and Gynecology, School of Medicine, Fukushima Medical University, 1 Hikariga-oka, Fukushima, Fukushima 960-1295, Japan

4 Department of Public Health, School of Medicine, Fukushima Medical University, 1 Hikariga-oka, Fukushima, Fukushima 960-1295, Japan

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Address correspondence and reprint requests to:

Dr. Kohta Suzuki

Department of Health Sciences, Interdisciplinary Graduate School of Medicine and Engineering, University of Yamanashi

1110 Shimokato, Chuo, Yamanashi 409-3898, Japan

Tel.: +81-55-273-9566; Fax: +81-55-273-7882; E-mail: kohtas@yamanashi.ac.jp

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Abstract

Aim

To examine the association between medical institution change for perinatal care and gestational duration after the Great East Japan Earthquake using data from the Fukushima Health Management Survey.

Methods

The data of pregnant women who experienced the earthquake in Fukushima prefecture and participated in a pregnancy and birth survey as part of the Fukushima Health Management Survey was analyzed. The primary and secondary outcomes of this study were gestational duration and preterm birth, respectively. The main study factor was prenatal checkup institution (only one institution, changed institution for self-referral, changed institution for medical indication, and went to parents' home for childbirth). The self-referral was considered as indicative of relocation after the disaster. Multiple linear and logistic regression analyses were conducted to examine the effect of earthquake on each outcome.

Results

A total of 5,593 (60.2%) participants experienced the earthquake between the 4th and 37th weeks of their gestational period. After controlling for variables, pregnant women who changed their perinatal checkup institution for medical indication were significantly associated with shorter gestational duration ($\beta = -10.6$, $p < 0.001$) and preterm birth (Adjusted odds ratio (aOR): 8.5, 95% confidence interval (CI): 5.8–12.5) compared with women who visited only one institution. The self-referral however did not significantly associate with the outcomes.

Conclusions

It was suggested that the effect on gestational duration of the Great East Japan Earthquake and the subsequent Fukushima Daiichi nuclear disaster through prenatal checkup status was not significant.

Key words:

gestational duration, Great East Japan Earthquake, prenatal checkup, preterm birth

Introduction

It has been suggested that psychological distress during pregnancy may increase the risk of preterm birth[1]. Because a natural disaster might act as a major stressor for pregnant women, the effect of a natural disaster, such as a great earthquake, has been previously suggested. For example, in Chile, the rate of preterm births, especially in girls, was increased among women who experienced the great earthquake in 2005 during pregnancy[2]. In addition, Oyarzo et al. reported that pregnant women who experienced the earthquake in Chile in 2010 during early pregnancy were more likely to have preterm premature membrane rupture and to deliver babies before full term[3]. These articles suggested that maternal distress regarding the earthquake might be associated with gestational duration[2,3]. On the other hand, Harville et al. conducted systematic review which suggested that natural disaster might affect only fetal growth and not gestational duration[4]. In Japan, there are few articles examining the association between natural disaster and perinatal outcomes including preterm birth.

On March 11, 2011, a huge earthquake occurred in East Japan called the Great East Japan Earthquake. Subsequently, a massive tsunami struck the area, and millions of people were affected. This earthquake was determined to be the most severe natural disaster in Japan in recorded history[5]. Recently, we examined effects of the Great East Japan Earthquake on perinatal outcomes including gestational duration using vital statistics of Japan. As a result, no apparent negative effect of the earthquake on gestational duration was observed[6]. However, particularly in the coastal area of Fukushima prefecture, the Fukushima Daiichi nuclear disaster occurred just after the earthquake. Therefore, many pregnant women evacuated and were forced to change medical institutions for prenatal checkup. These situations may have exposed them to stress. Although the previous study examined the effect of the earthquake itself, the effect of the subsequent situation in Fukushima prefecture on perinatal outcomes was not examined. Thus, Fukushima prefecture and Fukushima Medical University carried out the pregnancy and birth survey as part of the Fukushima Health Management Survey[7]. This survey was questionnaire-based to describe the health conditions and support health management for pregnant women in Fukushima prefecture[8].

This study aimed to examine the association between medical institution change and gestational duration after the Great East Japan Earthquake using pregnancy and birth survey data.

Materials and Methods

The pregnancy and birth survey

The survey population comprised women who received maternal and child health handbooks from municipal officers in Fukushima prefecture between August 1, 2010, and July 31, 2011, and women who had handbooks issued in other prefectures but received prenatal care or delivered babies in Fukushima prefecture after the disaster. The objective was to reach women who were pregnant at the time of the disaster. This survey was approved by the ethics committee of Fukushima Medical University, which is guided by local policy, national law, and the World Medical Association Declaration of Helsinki (approval #13047). Questionnaires, which can be seen on our website[9], have been mailed out since January 18, 2012. A total of 16,001 questionnaires were distributed. Details of this survey have been described in previous articles[8].

Study population

Of this survey population, pregnant women who experienced the earthquake were categorized according to their gestational period as of March 11, 2011, as follows: 4–11, 12–19, 20–27, and 28–36 weeks.

Data collection

General demographic and perinatal outcome data, including residential area, maternal age, parity, gestational age at delivery, birth weight, and delivery mode, were collected by questionnaire. Regarding the residential area, Iwaki city and Soso region were categorized as the coastal area. Maternal age was categorized as follows: <20, 20–24, 25–29, 30–34, and 35≤ years. In addition, the questionnaire asked their prenatal checkup status, including timing (on schedule or unscheduled) and perinatal checkup institution (only one institution, changed institution for self-referral, changed institution for medical indication, and went to parents' home for childbirth). The self-referral was considered as indicative of relocation after the disaster. Supporting the assumption, our previous study on maternal mental health reported that the self-referral was distinctly frequent in the coastal region where the disaster damage was most severe[10]. Moreover, in Japan, some perinatal women return to their parents' homes to obtain perinatal support from their parents, which is called a "Satogaeri" delivery.

Statistical analysis

The primary and secondary outcomes of this study were gestational duration (days) and preterm birth (gestational weeks < 37), respectively. The main study factor was prenatal checkup institution.

First, potential factors associated with institutional prenatal checkup status were compared with each category. Percentages of each gestational week category, rate of on-schedule prenatal checkups, percentages of each delivery mode, percentages of each maternal age category at delivery, rate of coastal residence, rate of male births, rate of first births, mean gestational duration (days), and mean maternal age at delivery were compared between each category of prenatal checkup institutional status. Chi-square test and analysis of variance were conducted for categorical and continuous variables, respectively.

Next, multiple linear regression analysis and logistic regression analysis were conducted to examine the effect of earthquake on gestational duration and preterm birth, respectively, after controlling for confounding factors. In addition, based on the multiple linear regression analysis, adjusted mean gestational duration was calculated by the least-squares method. These multiple regression analyses used only the data without missing. Thus, the total numbers of women entered into the multivariate analysis (Table2, Table 3 and Table 4) differs from the numbers in Table 1.

For sensitivity analysis, a multiple linear regression model which excluded cesarean section cases was used to control the effect of artificial preterm delivery.

All analyses were conducted using SAS version 9.3 (SAS Institute, Inc., Cary, NC, USA).

Results

Study population (Table 1)

The number of responses as of March 31, 2013, excluding 29 outside Fukushima, was 9,298 (58.2%). Of these, 5,593 (60.2%) participants experienced the earthquake during their gestational period between the 4th and 37th weeks. The characteristics of the study population are described in Table 1. Data of 5256 participants without missing were entered into subsequent analysis.

Multiple linear regression models for gestational duration (Table 2)

Pregnant women who changed their perinatal checkup institution for medical indication were significantly associated with shorter gestational duration ($\beta = -10.56$, $p < 0.001$) compared with women who visited only one institution. In addition, cesarean section ($\beta = -7.49$, $p < 0.001$ vs. normal vaginal delivery), male infants ($\beta = -0.99$, $p < 0.001$), and second or more infants (β = −1.59, $p < 0.001$) were significantly associated with shorter gestational duration. On the other hand, instrumental vaginal delivery was associated with significantly longer gestational duration (β = 1.75, $p < 0.001$) compared with normal vaginal delivery. Based on this regression model, the adjusted gestational duration of women who changed their perinatal checkup institution for medical indication (264.3 days) was significantly shorter than for women who visited only one institution (274.9 days, $p < 0.001$ Table 3). The self-referral however did not show significant association. After excluding cesarean section cases, adjusted gestational duration of women who changed their perinatal checkup institution for medical indication (267.6 days) was significantly shorter than for women who visited only one institution (276.4 days, $p < 0.001$).

Logistic regression models for preterm birth (Table 4)

After controlling for variables as well as the multiple linear regression model, women who changed their perinatal checkup institution for medical indication were likely to give birth to preterm birth infants compared with women who visited only one institution (Adjusted odds ratio (aOR): 8.5, 95% confidence interval (CI): 5.8–12.5). The likelihood of preterm birth for the self-referral was not significant. In addition, cesarean section was associated with 3.2 times higher risk of preterm birth compared with vaginal delivery (aOR: 3.2, 95% CI: 2.4–4.3). On the other hand, female infants were significantly associated with preterm birth (aOR: 0.7, 95% CI: 0.5–0.9).

Discussion

The data from the pregnancy and birth survey suggested that there was no significant association between medical institution change for self-referral and gestational duration and preterm birth after the Great East Japan Earthquake, although institution change for medical indication and cesarean section were significantly associated with gestational duration and preterm birth. Unscheduled prenatal checkup and the checkup with a different institution for self-referral were not significantly associated with gestational duration or preterm birth. These results suggested that the negative effect of the earthquake and subsequent Fukushima Daiichi nuclear disaster on gestational duration might be small.

Risk factors for preterm birth—especially idiopathic preterm birth—including severe maternal hypertension, abruptio placentae, and intrauterine growth restriction[11], have been suggested as reasons for prenatal checkup institution changes. Thus, the change of institution for medical indication, particularly to tertiary medical institutions, might be associated with shortened gestational duration and preterm birth. In addition, our results were consistent with previous reports describing the association between cesarean section and preterm birth[12–14]. Our sensitivity analysis using a multiple linear regression model excluding cesarean section cases showed similar results as found in our main analysis. Therefore, because there were no significant associations between institution change for self-referral and gestational duration or preterm birth in main and sensitivity analyses, it might be difficult to consider institution change for self-referral as a risk factor for shortened gestational duration.

Moreover, regarding the effect of great earthquakes on gestational duration, our results were consistent with the systematic review which was carried out by Harville et al. but not with the Chilean studies[2,3]. This discrepancy in the results might be caused by differences in geographical factors and medical support systems after natural disasters in each country.

This study has certain limitations. First, because the survey response rate was relatively low (58.2%), it might be difficult to generalize the results. Second, there might be inaccurate data, particularly in medical information like gestational duration, because of the questionnaire-based survey. In addition, prenatal checkup status as an explanatory variable might be biased, because this information was requested after delivery. However, because these biases might be non-differential, it was suggested that their effect could be small in our relatively large study. Moreover, medical information, such as gestational duration and birth weight, was considered to be almost accurate because these were transcribed from maternal and child handbooks, which were recorded by gynecologists and midwives. Third, although it might be important to compare the effect of this kind of change in institution on gestational duration before and after the earthquake, it was impossible to conduct this analysis because we did not have pre-earthquake data. Fourth, because there was no information about the diseases and complications including psychiatric disorders which lead to change the medical institution, it was also impossible to show the detailed reasons and to examine the effect of psychiatric stresses on gestational duration. However, because our other study group described that there was no significant effect of the earthquake on perinatal outcomes including gestational period among the women who were pregnant at the time of earthquake[6], it might be assumed that the influence of psychiatric stresses caused by the earthquake was relatively small. Moreover, in this analysis, residential area and gestational period as of March 11, 2011, might be proxy indicators of the difference in psychiatric stresses in women. For example, the effect of the disaster in coastal areas was larger than its effect in other areas. In fact, Goto et al. described the regional variation in frequency of mothers who screened positive for depressive symptoms[10]. However, the effect of psychiatric stress might be relatively small because, in our results, there was no significant effect of these variables on gestational duration. Fifth, because there was no information about maternal smoking during pregnancy in the survey, it was impossible to include maternal smoking status during pregnancy in the final models. Furthermore, adjusted R-squared was relatively low (0.143). However, because a recent Japanese study suggested that maternal smoking during pregnancy was not an independent risk factor for preterm birth[15], the effect of this limitation might be small.

Despite these limitations, this study provided some important findings indicating that the negative effect on gestational duration of the earthquake and subsequent nuclear disaster, which was mediated by prenatal checkup status, might be limited. However, our results might describe the effect of the earthquake on mothers and their children only in a short period. It is necessary to follow them up and provide adequate support.

In conclusion, our study results suggest that the effect of the Great East Japan Earthquake and subsequent Fukushima Daiichi nuclear disaster on gestational duration through prenatal checkup status was not significant.

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Disclosure

None of the authors have financial or other conflicts of interest to disclose.

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Table 1 Participant characteristics by prenatal checkup institution categories

Variables	Number of participants	Only one institution	Changed institution for self-referral	Went to parents' home for childbirth	Changed institution for medical indication	p-value[†]
Gestational period as of March 11, 2011						<0.001
4–11 weeks	1392	1055	275	7	55	
(%)		25.8	21.9	12.5	27.4	
12–19 weeks	1400	1033	321	7	39	
(%)		25.3	25.6	12.5	19.4	
20–27 weeks	1441	1060	319	14	48	
(%)		26.0	25.5	25.0	23.9	
28–36 weeks	1360	935	338	28	59	
(%)		22.9	27.0	50.0	29.4	
Prenatal checkup schedule						<0.001
On schedule	4285	3340	780	32	133	
(%)		81.9	62.5	57.1	66.5	
Unscheduled	1295	736	468	24	67	
(%)		18.1	37.5	42.9	33.5	
Mode of delivery						<0.001
Normal vaginal delivery	3840	2796	903	37	104	
(%)		68.8	72.4	67.3	52.3	
Instrumental vaginal delivery	590	458	116	3	13	
(%)		11.3	9.3	5.5	6.5	
Cesarean section	1136	811	228	15	82	
(%)		20.0	18.3	27.3	41.2	
Maternal age at delivery						0.005
<20 years	60	42	16	0	2	
(%)		1.0	1.3	0.0	1.0	
20–24 years	705	546	115	7	37	
(%)		13.4	9.2	12.5	18.4	
25–29 years	1745	1255	413	19	58	
(%)		30.7	33.0	33.9	28.9	
30–34 years	1951	1409	464	21	57	
(%)		34.5	37.0	37.5	28.4	
35≤ years	1132	831	245	9	47	
(%)		20.4	19.6	16.1	23.4	
Residential area						<0.001
Coastal area	1516	751	694	23	48	
(%)		18.4	55.9	41.1	23.9	
Other area	4062	3329	547	33	153	
(%)		81.6	44.1	58.9	76.1	
Infant sex						0.4
Male	2861	2067	655	27	112	
(%)		50.8	52.4	48.2	55.7	
Female	2715	2003	594	29	89	
(%)		49.2	47.6	51.8	44.3	
Parity						0.3
First birth	1438	1044	336	15	43	
(%)		26.8	28.4	28.8	22.4	
Second or more	3885	2851	848	37	149	
(%)		73.2	71.6	71.2	77.6	
Mean gestational duration (day)		275.8	275.6	276.1	262.4	<0.001
(Standard deviation)		9.8	10.2	9.2	21.8	
Mean maternal age at delivery (year)		30.1	30.4	30.0	30.0	0.5
(Standard deviation)		5.0	4.8	4.5	5.5	

[†]Chi-square test and analysis of variance were conducted for categorical and continuous variables, respectively.

Table 2 Multiple linear regression model for gestational duration (day) after the Great East Japan Earthquake (n = 5,256)

	beta	Standard error	t-value	p-value†
Intercept	277.01	0.60	462.9	<0.001
Institution of prenatal checkup				<0.001
Only one institution				
Changed institution for personal reason	-0.29	0.36	-0.8	0.4
Went to parents' home for childbirth	1.34	1.39	1.0	0.3
Changed institution for medical indication	-10.56	0.74	-14.3	<0.001
Gestational period as of March 11, 2011				0.2
4–11 weeks				
12–19 weeks	0.49	0.38	1.3	0.2
20–27 weeks	-0.24	0.38	-0.6	0.5
28–36 weeks	0.26	0.39	0.7	0.5
Prenatal checkup schedule				0.5
On schedule				
Unscheduled	-0.22	0.34	-0.7	
Mode of delivery				<0.001
Normal vaginal delivery				
Instrumental vaginal delivery	1.75	0.45	3.9	<0.001
Cesarean section	-7.49	0.35	-21.6	<0.001
Maternal age at delivery				0.4
<20 years	-1.88	1.35	-1.4	0.2
20–24 years	-0.11	0.46	-0.2	0.8
25–29 years				
30–34 years	-0.34	0.33	-1.0	0.3
35≤ years	-0.59	0.39	-1.5	0.1
Residential area				0.7
Coastal area	-0.15	0.33	-0.5	
Other area				
Infant sex				<0.001
Male				
Female	0.99	0.27	3.7	
Parity				<0.001
First birth				
Second or more	-1.59	0.31	-5.1	

†p-value was calculated using t- and F-tests

Table 3 Adjusted gestational duration (days) after the Great East Japan Earthquake based on the final multiple linear regression model

	Adjusted gestational duration (days)†	p-value‡
Prenatal checkup institution		
Only one institution	274.9	
Changed institution for personal reason	274.6	0.8
Went to parents' home for childbirth	276.2	0.7
Changed institution for medical indication	264.3	<0.001

†Adjusted for prenatal checkup institution, gestational period as of March 11, 2011, prenatal checkup schedule, mode of delivery, maternal age at delivery, residential area, infant sex, and parity and calculated with least square (LS) mean adjustment

‡p-value was calculated using the Dunnett's test with LS mean adjustment

Table 4 Adjusted odds ratio and 95% confidence interval for maternal and infant factors affecting preterm birth after the Great East Japan Earthquake (n = 5,256)

Variables	Non-preterm birth	Preterm birth	Number of participants	p-value	Crude odds ratio	95% confidence interval		Adjusted odds ratio †	95% confidence interval	
Prenatal checkup institution				<0.001						
Only one institution	3728	128	3856		Ref			Ref		
(%)	96.7	3.3								
Changed institution caused by self-referral	1119	41	1160		1.1	0.7	1.5	1.1	0.7	1.6
(%)	96.5	3.5								
Went to parents' home for childbirth	49	2	51		1.2	0.3	4.9	1.0	0.2	4.3
(%)	96.1	3.9								
Changed institution caused by medical	139	50	189		10.5	7.3	15.1	8.5	5.8	12.5
(%)	73.5	26.5								
Gestational period as of March 11, 2011				0.9						
4–11 weeks	1243	54	1297		Ref			Ref		
(%)	95.8	4.2								
12–19 weeks	1265	51	1316		0.9	0.6	1.4	1.0	0.7	1.5
(%)	96.1	3.9								
20–27 weeks	1298	60	1358		1.1	0.7	1.5	1.0	0.7	1.5
(%)	95.6	4.4								
28–36 weeks	1229	56	1285		1.0	0.7	1.5	1.0	0.7	1.5
(%)	95.6	4.4								
Prenatal checkup schedule				0.11						
On schedule	3879	160	4039		Ref			Ref		
(%)	96.0	4.0								
Unscheduled	1156	61	1217		1.3	0.9	1.7	1.2	0.8	1.6
(%)	95	5								
Mode of delivery				<0.001						
Normal vaginal delivery	3543	103	3646		Ref			Ref		
(%)	97.2	2.8								
Instrumental vaginal delivery	534	14	548		0.9	0.5	1.6	0.9	0.5	1.6
(%)	97.4	2.6								
Cesarean section	958	104	1062		3.7	2.8	4.9	3.2	2.4	4.3
(%)	90.2	9.8								
Maternal age at delivery				0.4						
<20 years	52	3	55		1.7	0.5	5.5	1.7	0.5	6.0
(%)	94.5	5.5								
20–24 years	619	29	648		1.4	0.9	2.1	1.2	0.8	2.0
(%)	95.5	4.5								
25–29 years	1585	55	1640		Ref			Ref		
(%)	96.6	3.4								
30–34 years	1750	85	1835		1.4	0.99	2.0	1.4	1.0	2.0
(%)	95.4	4.6								
35≤ years	1029	49	1078		1.4	0.9	2.0	1.1	0.7	1.6
(%)	95.5	4.5								
Residential area				0.9						
Coastal area	1373	61	1434		1.0	0.8	1.4	1.0	0.7	1.4
(%)	95.7	4.3								
Other area	3662	160	3822		Ref			Ref		
(%)	95.8	4.2								
Infant sex				0.004	Ref			Ref		
Male	2574	135	2709							
(%)	95.0	5.0								
Female	2461	86	2547		0.7	0.5	0.9	0.7	0.5	0.9
(%)	96.6	3.4								
Parity				0.9						
First birth	1364	61	1425		Ref			Ref		
(%)	95.7	4.3								
Second or more	3671	160	3831		1.0	0.7	1.3	0.9	0.7	1.3
(%)	95.8	4.2								

†Adjusted for maternal body mass index before pregnancy and maternal age at pregnancy