Title
Immediate mental consequences of the great east Japan earthquake and Fukushima nuclear power Plant accident on mothers experiencing miscarriage, abortion, and stillbirth: the Fukushima health management survey

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INTRODUCTION

The mental health of women with fetal loss such as miscarriage, abortion, and stillbirth has not attracted healthcare providers’ attention until recently. Sudden, expected, or unexpected pregnancy loss can cause mothers and their families to suffer with profound grief and mental health issues such as depression and anxiety. In recent years, many researchers have reported that fetal loss is related to mental health issues such as depression, anxiety, and post-traumatic stress. Recently, Bellieni and Buonocore reviewed research literature on the psychological and psychiatric issues of mothers with...
pregnancies that ended in abortion and miscarriage. They concluded that fetal loss appears to predispose women to a higher risk for mental disorders than childbirth, and that abortion can be considered to involve risks comparable to that of miscarriage, although further investigation is needed. In cases of stillbirth, the death of a baby occurs at or near full-term and the etiology is not elucidated in many cases. Therefore, bereaved mothers often suffer from feelings of guilt and shame, which last over a long period\(^2\).\(^3\).

On March 11 2011, immediately after the Great East Japan Earthquake, a huge tsunami hit the Fukushima Daiichi Nuclear Power Plant (NPP) and caused serious damage. As a result, large amounts of radioactive materials were released into the environment. Frequencies of abortions and miscarriages were reported not to have increased\(^4\). However, negative mental health consequences of mothers were reported after the Chernobyl accident\(^5\), and other disasters such as terrorist attacks, environmental disasters, earthquakes, hurricanes, and other natural disasters\(^6\). These investigations demonstrated that pregnant and postpartum women are vulnerable to the effects of disaster on mental health, however, as of yet there is no research on the effects of disaster on women experiencing fetal loss. Therefore, the influence of the Great East Japan Earthquake and Fukushima NPP accident on the mental health of women with negative pregnancy consequences is of particular concern. In the present survey, we focused on evaluating the mental health status of mothers who experienced miscarriage, abortion, and stillbirth immediately after this earthquake and NPP accident.

**MATERIALS AND METHODS**

The Pregnancy and Birth Survey was included in the Fukushima Health Management Survey as described in a previous report\(^7\).\(^8\). Briefly, the subjects of this investigation were women receiving a maternity health record book from Fukushima prefecture from August 1 2010 to July 31 2011. Questionnaires were distributed to 16,001 women and 9,321 responded. Mothers with fetal loss were divided into three groups based on the type of loss: miscarriage, abortion, and stillbirth. Data from 88 mothers with fetal loss (61 miscarriages, 5 abortions, and 22 stillbirths) were analyzed. In mothers with childbirth, characteristics of 8,196 women experiencing live births of singletons were summarized. Excluded were 458 women whose pregnancies ended before the accident, 146 women with unknown dates of pregnancy outcome, 9 women who were pregnant twice during the targeted period, 9 women who delayed responding, 22 women who left Fukushima Prefecture, 232 women who had other than a live birth as a pregnancy outcome, 85 women with twin pregnancies, 62 women who did not fill out the questionnaires by themselves, and 198 women who missed responding to the depression measure, with overlaps among these exclusion criteria as described in previous research\(^9\).

Mental health was evaluated using a two-item case-finding instrument for depression. This is reported to be a useful and quick method for detecting depression in primary care, and validity of this measurement was similar to six previously validated instruments\(^10\). This questionnaire includes two questions about depressed mood and anhedonia as follows: “During the past month, have you often been bothered by feeling down, depressed, or hopeless?” and “During the past month, have you often been bothered by having little interest or pleasure in doing things?” Mothers who answered yes to one of these questions were classified as positive for depressive symptoms.

The contents of women’s opinions written in free-form text were categorized into six groups: child-related, pregnancy-related, service-related, mother’s health-related, radiation measurement-related, and other. These were categorized, double-checked, and entered into the survey database with the other quantitative data. In order to study the content of the pregnancy-related items in detail, two researchers (KH and GA) read and summarized the original texts written by respondents independently, and then, compared and combined the results.

Of note, the Fukushima Health Management Survey provided telephone counseling by trained midwives or public health nurses to those who were screened positive for depression or wrote concerns in the free-space provided in the questionnaire.

We compared the characteristics regarding pregnancy history, psychiatric history before pregnancy and mode of pregnancy; and frequency of depressive symptoms, of the miscarriage, abortion, and stillbirth groups with a live birth group using chi-square or Fisher’s exact test. Open Epi Version 3.01 was used for the statistical analyses. The level of statistical significance was set at \(p < 0.05\).

This study was approved by the Ethics Committee of Fukushima Medical University. It was conducted in accordance with the guidelines ex-
pressed in the Declaration of Helsinki. Responders’ anonymity has been preserved to protect the privacy and confidentiality of their personal information.

RESULTS

Characteristics of mothers experiencing fetal loss and childbirth are shown in Table 1. In terms of history of previous pregnancies, women with current miscarriages in the survey had significantly higher proportions of previous miscarriage and stillbirth than those in the childbirth group. In addition, women with previous stillbirth had experienced more previous stillbirths as compared to the childbirth group. None of the women in the three fetal loss groups had experienced psychiatric disease prior to the survey, and 2% of women in the childbirth group had a history of psychiatric disease.

In the analysis of depression status using the two-item case-finding instrument for depression, the percentage answering “yes” to the first or second question was 41%, 60%, 55%, and 28% for the miscarriage, abortion, stillbirth, and childbirth groups (Table 2). The proportion of those screening positive for depression was significantly higher in the miscarriage and stillbirth group than in the childbirth group. The odds ratios of depressive symptoms in women with miscarriage and stillbirth to those with childbirth were 1.82 (95% CI 1.09-3.04) and 3.14 (95% CI 1.36-7.30), respectively.

As shown in Table 3, the frequency of pregnancy-related items reported in the free-form text (9 and 7 respectively) were higher than that of the other items for the miscarriage and stillbirth groups.

Original texts of women’s opinions written in a free space on the questionnaire indicated concern on the part of women experiencing fetal loss. Women in both the miscarriage and stillbirth groups questioned the influence of the nuclear accident on their negative pregnancy outcomes and were concerned about future pregnancies. Moreover, mothers who experienced stillbirth criticized the lack of accurate information and support immediately after the disaster.

Table 1. Characteristics of respondents experiencing miscarriage, abortion, stillbirth, and childbirth

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Miscarriage (N = 61)</th>
<th>Abortion (N = 5)</th>
<th>Stillbirth (N = 22)</th>
<th>Childbirth (N = 8196)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s age at the time of pregnancy (years ± s.d.)</td>
<td>30.1 ± 5.0</td>
<td>29.2 ± 9.1</td>
<td>30.0 ± 5.0</td>
<td>30.1 ± 5.0</td>
</tr>
</tbody>
</table>

Pregnancy history n (%)

<table>
<thead>
<tr>
<th>Birth</th>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not reported</td>
<td>14 (23)</td>
<td>3 (60)</td>
<td>6 (27)</td>
<td>2,634 (32)</td>
</tr>
<tr>
<td>≥1</td>
<td>47 (77)</td>
<td>2 (40)</td>
<td>16 (73)</td>
<td>5,562 (68)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not reported</td>
<td>36 (59)**</td>
<td>3 (60)</td>
<td>20 (91)</td>
</tr>
<tr>
<td>≥1</td>
<td>25 (41)</td>
<td>2 (40)</td>
<td>2 (9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abortion</th>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not reported</td>
<td>50 (82)</td>
<td>3 (60)</td>
<td>19 (86)</td>
<td>7,164 (87)</td>
</tr>
<tr>
<td>≥1</td>
<td>11 (18)</td>
<td>2 (40)</td>
<td>3 (14)</td>
<td>1,032 (13)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stillbirth</th>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not reported</td>
<td>57 (93)**</td>
<td>4 (80)</td>
<td>13 (59)**</td>
<td>8,110 (99)</td>
</tr>
<tr>
<td>≥1</td>
<td>4 (7)</td>
<td>1 (20)</td>
<td>9 (41)</td>
<td>86 (1)</td>
</tr>
</tbody>
</table>

Psychiatric history before pregnancy n (%)

<table>
<thead>
<tr>
<th>No</th>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 (100)</td>
<td>5 (100)</td>
<td>22 (100)</td>
<td>8,071 (98)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yes</th>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>125 (2)</td>
<td></td>
</tr>
</tbody>
</table>

Mode of pregnancy n (%)

<table>
<thead>
<tr>
<th>Natural or no answer</th>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>59 (97)</td>
<td>5 (100)</td>
<td>20 (91)</td>
<td>7,863 (96)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Induced ovulation, IUI, IVF</th>
<th>Miscarriage</th>
<th>Abortion</th>
<th>Stillbirth</th>
<th>Childbirth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (3)</td>
<td>0 (0)</td>
<td>2 (9)</td>
<td>333 (4)</td>
<td></td>
</tr>
</tbody>
</table>

IUI: Intrauterine insemination, IVF: In vitro fertilization.
Chi-square or Fisher’s exact tests for 2 × 2 contingency tables were conducted by combining “no” and “no answer.”
*p < 0.01, **p < 0.05 as compared with childbirth.
DISCUSSION

The results of this study demonstrated that the percentage of mothers in a depressive state was higher for those experiencing fetal loss (especially miscarriage and stillbirth) versus childbirth, after the Great East Japan Earthquake and Fukushima NPP accident. When asked for their opinions in a free-text form, most women experiencing miscarriage and stillbirth provided text that was categorized as pregnancy-related. It appeared that mothers experiencing miscarriage and stillbirth felt disappointed about the accident, which might have been related to the fetal loss, and anxious about future pregnancy outcomes. This paper is the first to report on the depressive symptoms of bereaved mothers experiencing fetal loss after the disaster and NPP explosion.

Recent investigations have suggested that miscarriage, abortion, and stillbirth are associated with psychological well-being. Tofof et al. reported that a miscarriage affected women’s mental health in a negative way; those with a higher number of miscarriages were worse in the current state of mood.

Table 2. Depression status of mothers experiencing miscarriage, abortion, stillbirth, and childbirth based on a two-question case-finding instrument for depression

<table>
<thead>
<tr>
<th>Questions</th>
<th>Miscarriage (N = 61)</th>
<th>Abortion (N = 5)</th>
<th>Stillbirth (N = 22)</th>
<th>Childbirth (N = 8196)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of symptoms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>36 (59)*</td>
<td>2 (40)</td>
<td>10 (45)*</td>
<td>5,934 (72)</td>
</tr>
<tr>
<td>&gt;1</td>
<td>25 (41)</td>
<td>3 (60)</td>
<td>12 (55)</td>
<td>2,262 (28)</td>
</tr>
<tr>
<td>Depressed mood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No &amp; no answer</td>
<td>39 (64)**</td>
<td>2 (40)**</td>
<td>12 (55)**</td>
<td>6,111 (75)</td>
</tr>
<tr>
<td>Yes</td>
<td>22 (36)</td>
<td>3 (60)</td>
<td>10 (45)</td>
<td>2,085 (25)</td>
</tr>
<tr>
<td>Anhedonia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No &amp; no answer</td>
<td>45 (74) *</td>
<td>2 (40) *</td>
<td>15 (68)**</td>
<td>6,944 (85)</td>
</tr>
<tr>
<td>Yes</td>
<td>16 (26)</td>
<td>3 (60)</td>
<td>7 (32)</td>
<td>1,252 (15)</td>
</tr>
</tbody>
</table>

Chi-square or Fisher’s exact tests for 2 × 2 contingency table was conducted by combining “no” and “no answer.” *p < 0.01, **p < 0.05 as compared with childbirth.

Table 3. Number of types of mother’s opinions in six categories for the miscarriage, abortion, and stillbirth groups

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Miscarriage (N = 61)</th>
<th>Abortion (N = 5)</th>
<th>Stillbirth (N = 22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. and percentage of respondent with free-form text</td>
<td>15 (25)</td>
<td>3 (60)</td>
<td>13 (59)</td>
</tr>
</tbody>
</table>

Pregnancy-related items: Outcome of this pregnancy, influence on next pregnancy
Service-related items: Poor amount of information, insufficient medical service, shortage of daily necessities, difficulty in living, support for cost of goods, support for cost of living
Radiation measurement-related items: Supply of dosimeter, health examination, internal and/or external exposure, urine analysis, analysis of breast milk, ultrasonography survey of thyroid cancer
Child-related items: Water, breast or powdered milk, food, going or playing outside, influence on children
Mother’s health-related items: Psychiatric disorders of the mother in question
Other: Information transmission, decontamination from the radioactive material, complete medical service, support of refuge, complete child care service, mental care and consulting service, complaints about this survey, approval of this survey
and with a higher frequency of psychiatric diseases than those with less frequent miscarriages. As for abortion, it was demonstrated that women having abortions were at clear risk for mental health issues as compared with those who gave birth. Stillbirth is also reported to be a significant risk factor for maternal psychological disorders such as depression, anxiety, and post-traumatic stress disorder (PTSD), especially in the case when conception occurs soon after the fetal loss. A seven-year long-term follow-up revealed that mothers experiencing stillbirth continued to have PTSD. Our presented results in a hospital-based sample of 99 pregnant women. Another nuclear reactor accident at Chernobyl, Ukraine in 1986 is well known as an environmental disaster, which involved a much larger radiation leak and affected more people and environment than Fukushima. It has been reported that the Chernobyl NPP accident predisposed adults to psychological issues; in particular, depression, PTSD, and acute distress persisted in evacuee mothers even 11 to 19 years after the event. These studies suggest that disasters impact maternal mental health; however, the impact may vary depending on the type, severity and location of a disaster, as well as the socio-economic situation of the countries.

To date, the mental health of mothers who experienced fetal loss after the Great East Japan Earthquake and Fukushima NPP accident has not yet been investigated. This study suggested that the mental health of mothers experiencing fetal loss, especially miscarriage and stillbirth, was clearly impaired after the Great East Japan Earthquake and Fukushima NPP accident. Even at the time of disaster, it is recommended that healthcare providers such as clinicians, midwives, public health nurses, and clinical psychotherapists keep in mind an importance of providing grief care, so that mothers, fathers, and family members do not suffer alone with the fetal loss in a severe condition. The Inter-Agency Standing Committee guidelines recommend strengthening existing resources and capacities as one of the core principles in mental health support in a disaster setting. North and Pfefferbaum also described that the case identification, triaged care, and delivery of appropriate mental health interventions should be integrated into emergency medicine and trauma care responses. In addition to standard care needed for this vulnerable group of women, healthcare professionals should improve their communication skills regarding the effects of radiation on pregnancy, which mothers were particularly worried about. It would be important to communicate local data, such as that the Pregnancy and Birth Survey of the Fukushima Health Management reported no significant radiation impact on pregnancy outcomes after the Great East Japan Earthquake and Fukushima NPP accident.

This report has the following limitations. (1) Since the number of mothers experiencing fetal loss was small compared to those experiencing childbirth, it was not possible to carry out a detailed statistical analysis to investigate further the differences between these groups. (2) Since this study was conducted immediately after the Great East Japan Earthquake and Fukushima NPP accident, the long-term mental health of mothers experiencing miscarriage, abortion, and stillbirth was not explored. (3) Our main outcome measure was conventional depression screening with a two-question case-finding instrument for primary care evaluation. Therefore, it is possible that the true prevalence of depression is lower than that reported here.

In conclusion, all should offer effective emotional support and care for the needs of mothers with negative pregnancy outcomes to assist them in their recovery under a disaster setting.

ACKNOWLEDGMENTS

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REFERENCES


