Five years after the Fukushima Daiichi Nuclear power plant accident

Health consequences after the accident

Koichi Tanigawa
Fukushima Medical University
Today’s Topics

1. Health consequences in the acute phase after the accident
2. Fukushima Health Management Survey and mid-term health consequences of the accident
3. Lessons learned in the Fukushima accident and the future roles of Fukushima Medical University
1. Health consequences in the acute phase after the accident
1. Fukushima Nuclear Disaster Management Center
2. Futaba Kosei Hospital*
3. Fukushima Prefectural Ohno Hospital*
4. Imamura Hospital*
5. Minami Soma city General Hospital*
6. Soso Health Care Office
7. Fukushima Rosai Hospital*
8. Iwaki Kyoritu Hospital*
10. **Fukushima Prefectural Medical University**
* Primary radiation emergency hospital
** Secondary radiation emergency hospital

The radiation emergency hospitals in Fukushima before March 11th, 2011
Fukushima Pref. Gov.

Fukushima Medical University (FMU)

8 Hospitals, 1240 patients
17 nursing facilities, 983 patients

Off site center (Command center)

Hospital evacuation from 20 km zone
Most of the patients hospitalized within 20 km zone were transported by SDF helicopters or charted buses to shelters in Fukushima Prefecture by March 15th. However, no medical personnel attended during or after evacuation (no care, medicine, even water/food). Significant difficulties were encountered to find facilities to accept those patients. In addition, appropriate medical care was not available at shelters.
In the Fukushima Daiichi Nuclear Power Plant accident, what we have seen,

• Difficulties in reallocating patients forced them to stay in the confined space of the transporting vehicles for long hours without any care, even water and food.
• At least 50 patients died during or soon after evacuation. Suspected causes of deaths include deterioration of underlying medical problems, hypothermia and dehydration*.
• No significant contamination was found in the evacuated patients despite the fact that 48 hours had already passed since the first explosion. Ill-prepared evacuation increased the health risk of hospitalized patients or the elderly**.

Failure of Radiation Emergency Medical System

Fukushima Nuclear Disaster Management Center

1. (C-spine injury, susp)
   (Fukushima Medical U.)
   (Fx of the clavicle, scaple)

2. (Dislocation of shoulder J)

3. (Contusion of the thigh)
   (Laceration of the thigh)
   (National Institute of Radiological Sciences)

4. (Plant clinics at Fukushima Daini NPP)

5. (Contusion of the ankle)

6. (Contusion of the chest and abdomen)

7. (Contusion of the back)

8. (Contusion of the back and abdomen)

9. (Contusion of the back, ankle)
<table>
<thead>
<tr>
<th>Date</th>
<th>Injury</th>
<th>Severity</th>
<th>Triage</th>
<th>Contamination</th>
<th>Cause</th>
<th>Methods of transportation</th>
<th>Received hospitals</th>
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<tr>
<td>March 11th</td>
<td>fracture of lower extremities</td>
<td>severe</td>
<td>not done</td>
<td>no</td>
<td>earthquake</td>
<td>ambulance</td>
<td>hospital in Koriyama</td>
</tr>
<tr>
<td></td>
<td>laceration on head</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>earthquake</td>
<td>facility vehicle</td>
<td>Ono Hospital (designated hospital)</td>
</tr>
<tr>
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<td>subarachnoid hemorrhage</td>
<td>severe</td>
<td>not done</td>
<td>no</td>
<td>no</td>
<td>facility vehicle</td>
<td>hospital in Koriyama</td>
</tr>
<tr>
<td></td>
<td>open fracture of the femur</td>
<td>moderate</td>
<td>not done</td>
<td>no</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>initially treated at a clinic (non-designated facility)</td>
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<tr>
<td></td>
<td>contusion of lower extremity</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>treated at a clinic (non-designated facility)</td>
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<tr>
<td></td>
<td>contusion of upper extremity</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>treated at a clinic (non-designated facility)</td>
</tr>
<tr>
<td></td>
<td>contusion</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>treated at a clinic (non-designated facility)</td>
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<tr>
<td></td>
<td>severe tinnitus</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>treated at a clinic (non-designated facility)</td>
</tr>
<tr>
<td></td>
<td>headache, nausea</td>
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<td>not done</td>
<td>no</td>
<td>no</td>
<td>facility vehicle</td>
<td>treated at OFC</td>
</tr>
<tr>
<td>March 14th</td>
<td>fracture of clavicle, scapula</td>
<td>moderate</td>
<td>done at OFC</td>
<td>yes</td>
<td>explosion</td>
<td>ambulance</td>
<td>FMU treated at OFC</td>
</tr>
<tr>
<td></td>
<td>dislocation of shoulder joint</td>
<td>moderate</td>
<td>done at OFC</td>
<td>no</td>
<td>explosion</td>
<td>SDF vehicle</td>
<td>initially treated at Fukushima No2 NPP, transferred to</td>
</tr>
<tr>
<td></td>
<td>laceration of thigh</td>
<td>moderate</td>
<td>done at OFC</td>
<td>no</td>
<td>explosion</td>
<td>SDF helicopter</td>
<td>OFC</td>
</tr>
<tr>
<td></td>
<td>contusion on thigh</td>
<td>minor</td>
<td>done at OFC</td>
<td>no</td>
<td>no</td>
<td>SDF vehicle</td>
<td>initially treated at Fukushima No2 NPP, transferred to</td>
</tr>
<tr>
<td></td>
<td>laceration of foot</td>
<td>moderate</td>
<td>not done</td>
<td>yes</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>FMU on March 15th</td>
</tr>
<tr>
<td></td>
<td>laceration of foot</td>
<td>moderate</td>
<td>not done</td>
<td>yes</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>initially treated at Fukushima No2 NPP, transferred to</td>
</tr>
<tr>
<td></td>
<td>contusion on foot</td>
<td>moderate</td>
<td>not done</td>
<td>yes</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>FMU on March 16th</td>
</tr>
<tr>
<td></td>
<td>contusion on chest</td>
<td>minor</td>
<td>not done</td>
<td>yes</td>
<td>explosion</td>
<td>facility vehicle/ SDF helicopter</td>
<td>initially treated at Fukushima No2 NPP, transferred to</td>
</tr>
<tr>
<td></td>
<td>contusion on chest, upper extremity</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>explosion</td>
<td>facility vehicle</td>
<td>FMU on March 15th</td>
</tr>
<tr>
<td></td>
<td>contusion on foot</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>no</td>
<td>facility vehicle</td>
<td>treated at Fukushima No2 NPP</td>
</tr>
<tr>
<td></td>
<td>contusion on elbow</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>no</td>
<td>facility vehicle</td>
<td>treated at Fukushima No2 NPP</td>
</tr>
<tr>
<td></td>
<td>contusion on upper extremity</td>
<td>minor</td>
<td>not done</td>
<td>no</td>
<td>no</td>
<td>facility vehicle</td>
<td>treated at Fukushima No2 NPP</td>
</tr>
</tbody>
</table>

SDF, Self Defense Force; FMU, Fukushima Medical University; OFC, off-site center; NIRS, National Institute for Radiological Sciences; NPP, nuclear power plant

**Injuries caused by the earthquake and explosions (March 11-14, 2011)**

As for emergency medical response to the explosion,

• Marked difficulties were observed in finding hospitals to provide care for injured workers with or without contamination.

• Fortunately, none of them suffered life-threatening injuries. However, collapse of the Radiation Emergency Medical System may have resulted in preventable death for those with severe trauma.

Psychological consequences for disaster workers

• Following the Fukushima accident, TEPCO workers came under public criticism. Those workers were stigmatized and discriminated against.

• In a study conducted 2–3 months after the disaster, TEPCO workers who had suffered discrimination or slurs were two to three times more likely to have adverse psychological consequences than those without such exposure.

• A follow-up study showed both immediate and long-lasting psychological effects of discrimination.

Disaster-related Death

• According to the report on disaster related death (DRD*) in the Great East Japan Earthquake issued by the Reconstruction Agency of Japan (2012), 2,688 people died at shelters or temporary houses by 31 March 2013; these were DRDs. About 90% of DRDs were over 66 years old, and more than one third died within 1 month after the earthquake.

• The number of deaths among three Tohoku prefectures was the highest in Fukushima (1914 deaths).

* DRD is defined as a death caused by the deterioration of underlying medical problems due to poor medical access or illnesses arising from poor living environments, such as temporary shelters, in a disaster.
• Population of Fukushima prefecture at the time of the accident: 2,055,325 residents
• Number of evacuees: 164,845 residents including voluntary evacuation (approx. 20,000) as of May, 2011
2. Fukushima Health Management Survey and mid-term health consequences of the accident
Fukushima Health Management Survey, May 2011

Objectives:
• To monitor long-term health condition of resident in Fukushima and to promote their health
• To investigate whether a long-term low-dose radiation exposure has an effect on their health

Contents:
1. Basic survey (subjects: 2 million all resident in Fukushima)
2. Detailed surveys
   • Thyroid Ultrasound Examination (370,000; 0-18 y/o)
   • Comprehensive Health Check (210,000; designated areas)
   • Mental Health and Lifestyle Survey (210,000; designated areas)
   • Pregnancy and Birth Survey (16,000)

Fukushima Health Management (FHM) Survey

**Basic Survey**
Subject: Residents (2 million) as of March 11, 2011
Method: Self-administered questionnaire survey
Content: Details of whereabouts and daily routine from March 11 onwards to estimate exposure.

**Detailed Surveys**

- **Thyroid Ultrasound Examination**
  Subject: Residents aged 18 years or younger
  Content: Ultrasound examination
  Survey period: Three years

- **Comprehensive Health Check**
  Subject: Residents in evacuation zones
  Content: General health checkup items with differential leukocyte count
  Promotion of municipal and workplace health checkups

- **Mental Health and Lifestyle Survey**
- **Pregnancy and Birth Survey**

**Follow-ups**
- Health Management File
  - To keep health checkup records
  - To provide information on radiation

**Database**
- To provide long-term monitoring of residents' health
- To guide treatment
- To inform and guide future generations

**External Exposure Estimation**

**Health Status Assessment**

**Consultation and support**

**Follow-up**

**Treatment**

Curtesy of Prof. Seiji Yasumura
Basic Survey

An example form for writing records of moves and activities in the Basic Survey questionnaire

http://fmu-global.jp/?wpdmdl=1032
Basic survey response rates (March 31, 2015)

- **Aizu**
  - Popul: 267,203
  - RR: 21.1%

- **Minami-Aizu**
  - Popul: 30,789
  - RR: 20.2%

- **Kempoku**
  - Popul: 504,042
  - RR: 45.7%

- **Kenchu**
  - Popul: 557,234
  - RR: 24.1%

- **Kennan**
  - Popul: 152,225
  - RR: 22.3%

- **Iwaki**
  - Popul: 348,223
  - RR: 25.1%

- **Soso**
  - Popul: 195,604
  - RR: 45.7%

Estimated effective dose in each area

Estimated effective dose in Soso area

- Kawamata Town: 
  - mSv %
  - <1: 17.5
  - 1-2: 75.3
  - 2-3: 5.0
  - 3-4: 1.5
  - 4-5: 0.5
  - >5: 0.3

- Katsurao Village:
  - mSv %
  - <1: 72.5
  - 1-2: 23.2
  - 2-3: 3.5
  - 3-4: 0.6
  - 4-5: 0.0
  - >5: 0.1

- Iitate Village:
  - mSv %
  - <1: 73.6
  - 1-2: 23.9
  - 2-3: 1.946
  - 3-4: 0.375
  - 4-5: 0.138
  - >5: 0.059

- Minami-Soma City:
  - mSv %
  - <1: 69.9
  - 1-2: 23.9
  - 2-3: 4.2
  - 3-4: 0.8
  - 4-5: 0.4
  - >5: 0.1

- Namie Town:
  - mSv %
  - <1: 82.1
  - 1-2: 14.4
  - 2-3: 2.2
  - 3-4: 0.6
  - 4-5: 0.2
  - >5: 0.6
Summary of Basic Survey

• While most of the previous dose estimation studies were based on typical scenarios of evacuation and time spent inside/outside, the Basic Survey estimated doses considering individually different personal behaviors. Thus, doses for some individuals who did not follow typical scenarios could be revealed.

• Even considering such extreme cases, the estimated external doses were generally low and no discernible increased incidence of radiation-related health effects is expected.

Thyroid Ultrasound Examination

http://fmu-global.jp/?wpdmid=1032
Results of the first round Thyroid Ultrasound Examination during the first 4 years after the accident

Prevalence of thyroid cancer of suspected cancer in 3 main regions

Year of test: 2011
No of subjects: 41,810
Cancer cases: 14
Proportion: 0.033%

Year of test: 2012
No of subjects: 139,338
Cancer cases: 56
Proportion: 0.039%

Year of test: 2013
No of subjects: 119,476
Cancer cases: 42
Proportion: 0.038%
Distribution of thyroid cancer patients by age at exposure diagnosed during the period of latency (1986–1989) and after it (1990–1993) in Ukraine, and patients with verified or suspicious thyroid cancer in Fukushima diagnosed during 2011–2013. Numbers above the bars correspond to the number of patients of a given age at exposure. Note that comparison of the absolute number of cases between the two regions of radiological accidents would be inappropriate because of differences in population size and screening protocols, in particular a more systematic approach, higher population coverage, and advanced ultrasound equipment in Fukushima.

Difficulties of risk communication arose in the thyroid screening program of the Fukushima Health Management Survey, which was initially expected to reduce excessive anxiety. Contrary to expectation, screening results caused unnecessary concerns among people who were examined. In addition, the apparent increase in thyroid cancer prevalence that results from screening has caused public anxiety about the health effects of radiation.

Summary of Thyroid Ultrasound Examination

• Radiation doses in Fukushima were extremely low and most of the target population for the thyroid examination received doses below 1 mSv. In addition, the youngest age group (0-5 years) at the time of the accident has shown no occurrence of cancer to date. Further, the latency for radiation induced thyroid cancer is 4-5 years; only 4 years have passed since the accident.
• Because above mentioned reasons, the thyroid cancers identified in this survey so far are unlikely to be due to radiation exposure, and are more likely to be the result of screening using highly sophisticated ultrasound techniques.
• While attention should be given to the bias of screening effects and possibility of over-treatment, proper communication is imperative to support individual autonomous decision making on the basis of sound scientific knowledge and appropriate risk perception about thyroid cancer and radiation exposure.
Comprehensive Health Check

**≤15 years old**
- People residing within the prefecture: Children’s health exams within the prefecture
- People residing outside the prefecture: Children’s health exams outside the prefecture

**≥16 years old**
- People residing within the prefecture: Additional checkup items are included in Special Health Checkups and health exams organized by municipalities. Group physical examinations organized by FMU
- People residing outside the prefecture: Individual examinations conducted within the prefecture
- People residing outside the prefecture: Individual examinations conducted outside the prefecture
Changes in the results of Comprehensive Health Check

<table>
<thead>
<tr>
<th></th>
<th>Obesity* (BMI ≥25 kg/m²)</th>
<th>Impaired glucose tolerance** (HbA1c ≥6.5%)</th>
<th>Hepatic dysfunction*** (ALT of ≥51 U/L)</th>
<th>Hypertension (Diastolic pressure of ≥90 mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>FY 2008</td>
<td>30%</td>
<td>31%</td>
<td>4.1%</td>
<td>2.9%</td>
</tr>
<tr>
<td>FY 2009</td>
<td>30%</td>
<td>30%</td>
<td>4.5%</td>
<td>2.8%</td>
</tr>
<tr>
<td>FY 2010</td>
<td>30%</td>
<td>28%</td>
<td>4.4%</td>
<td>2.7%</td>
</tr>
<tr>
<td>FY 2011</td>
<td>42%</td>
<td>34%</td>
<td>7.0%</td>
<td>3.4%</td>
</tr>
<tr>
<td>FY 2012</td>
<td>38%</td>
<td>33%</td>
<td>5.1%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

http://fmu-global.jp/?wpdmdl=1032
Changes in the prevalence of diabetes before and after the disaster

*\( p < 0.0001 \)

Incidence of diabetes in non-diabetic group evacuees and nonevacuees after the disaster

**\( p = 0.0002 \)

Summary of Comprehensive Health Check

• After the disaster, the prevalence of diabetes increased significantly, and we observed that the incidence of diabetes was significantly greater among evacuees than among nonevacuees.
• Multivariate logistic regression analysis revealed that evacuation was significantly associated with the incidence of diabetes.
• Evacuation (relocation) is associated with the incidence of diabetes and other health risks.
Mental Health and Lifestyle Survey

Report of the Fukushima Health Management Survey
(FY 2011-2013)

revised version (June 12, 2015)

FUKUSHIMA MEDICAL UNIVERSITY

http://fmu-global.jp/?wpdmdl=1032
Features of psychological impact on the Fukushima people after the accident

<table>
<thead>
<tr>
<th>Psychological impact</th>
<th>Features</th>
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</thead>
<tbody>
<tr>
<td>Post-traumatic stress responses</td>
<td>Traumatic memories of plant explosion and evacuation</td>
</tr>
<tr>
<td></td>
<td>Hyper arousal</td>
</tr>
<tr>
<td></td>
<td>Re-experiencing symptoms</td>
</tr>
<tr>
<td>Chronic anxiety and guilt</td>
<td>Fear of radioactive exposure, especially in the case of parents with young children</td>
</tr>
<tr>
<td></td>
<td>Negative influence on children’s development</td>
</tr>
<tr>
<td></td>
<td>Guilt about abandoning friends and neighbours</td>
</tr>
<tr>
<td>Ambiguous loss experience</td>
<td>Loss of home through evacuation rather than damage</td>
</tr>
<tr>
<td></td>
<td>Uncertainty of nuclear accident evacuees about returning home</td>
</tr>
<tr>
<td></td>
<td>Depressive symptoms</td>
</tr>
<tr>
<td>Separated families/communities</td>
<td>Weakened resilience within community</td>
</tr>
<tr>
<td></td>
<td>Increased conflicts within and between families</td>
</tr>
<tr>
<td></td>
<td>Frustration of neighbouring cities that take in evacuees</td>
</tr>
<tr>
<td>Self-stigma</td>
<td>Discrimination against workers and young women</td>
</tr>
<tr>
<td></td>
<td>Concealment of history in Fukushima</td>
</tr>
<tr>
<td></td>
<td>Righteous anger</td>
</tr>
<tr>
<td></td>
<td>Loss of self-esteem</td>
</tr>
</tbody>
</table>

Kessler six-item psychological distress scale (K6) after the accident

- Scores >20 denote substantial problems, and scores of 13–19 denote mild to-moderate problems
- 3% for K6>13 in the usual state
Posttraumatic Stress Disorder Checklist (PCL) after the accident

- The proportion of adults with a PCL score of 44 or more; i.e., probable PTSD
Suicide rates in the aftermath of the 2011 earthquake in Japan

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
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<th>2013</th>
<th>2014</th>
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<td>N</td>
<td>540</td>
<td>525</td>
<td>458</td>
<td>466</td>
<td>476*</td>
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<tr>
<td>Deaths per 100 000 people</td>
<td>26.6</td>
<td>26.4</td>
<td>22.8</td>
<td>23.9</td>
<td>24.5*</td>
</tr>
<tr>
<td>Standardised suicide mortality ratio</td>
<td>108</td>
<td>107</td>
<td>94</td>
<td>96</td>
<td>126</td>
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<tr>
<td>Iwate prefecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>467</td>
<td>401</td>
<td>373</td>
<td>373</td>
<td>374*</td>
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<tr>
<td>Deaths per 100 000 people</td>
<td>35.1</td>
<td>30.1</td>
<td>28.6</td>
<td>28.8</td>
<td>28.9*</td>
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<tr>
<td>Standardised suicide mortality ratio</td>
<td>141</td>
<td>122</td>
<td>115</td>
<td>115</td>
<td>138</td>
</tr>
<tr>
<td>Miyagi prefecture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>N</td>
<td>620</td>
<td>483</td>
<td>508</td>
<td>485</td>
<td>519*</td>
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<tr>
<td>Deaths per 100 000 people</td>
<td>26.4</td>
<td>20.8</td>
<td>21.9</td>
<td>20.8</td>
<td>22.3*</td>
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<tr>
<td>Standardised suicide mortality ratio</td>
<td>108</td>
<td>84</td>
<td>88</td>
<td>88</td>
<td>110</td>
</tr>
<tr>
<td>Japan total</td>
<td></td>
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<tr>
<td>N</td>
<td>31690</td>
<td>30651</td>
<td>27858</td>
<td>27283</td>
<td>25374*</td>
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<tr>
<td>Deaths per 100 000 people</td>
<td>24.9</td>
<td>24.0</td>
<td>21.8</td>
<td>21.4</td>
<td>19.9*</td>
</tr>
</tbody>
</table>

Information of suicide deaths were from the Cabinet Office, Japan and the Reconstruction Agency, Japan. We calculated standardised suicide mortality ratios to compare mortality in each prefecture based on the age-specific rates per year. * Provisional data.

Table: Suicide deaths in prefectures affected by the earthquake and tsunami of March, 2011

Ohto H, et al. Suicide rates in the aftermath of the 2011 earthquake in Japan. Lancet 2015; 385; 1727
Psychological distress and the perception of radiation risks: the Fukushima health management survey

Yuriko Suzuki, a Hirooki Yabe, b Seiji Yasumura, b Tetsuya Ohira, b Shin-Ichi Niwa, b Akira Ohtsuru, b Hirobumi Mashiko, c Masaharu Maeda b & Masafumi Abe b on behalf of the Mental Health Group of the Fukushima health management survey

Objective To assess relationships between the perception of radiation risks and psychological distress among evacuees from the Fukushima nuclear power plant disaster.

Methods We analysed cross-sectional data from a survey of evacuees conducted in 2012. Psychological distress was classified as present or absent based on the K6 scale. Respondents recorded their views about the health risks of exposure to ionizing radiation, including immediate, delayed and genetic (inherited) health effects, on a four-point Likert scale. We examined associations between psychological distress and risk perception in logistic regression models. Age, gender, educational attainment, history of mental illness and the consequences of the disaster for employment and living conditions were potential confounders.

Findings Out of the 180,604 people who received the questionnaire, we included 59,807 responses in our sample. There were 8,717 respondents reporting psychological distress. Respondents who believed that radiation exposure was very likely to cause health effects were significantly more likely to be psychologically distressed than other respondents: odds ratio (OR) 1.64 (99.9% confidence interval, CI: 1.42–1.89) for immediate effects; OR: 1.48 (99.9% CI: 1.32–1.67) for delayed effects and OR: 2.17 (99.9% CI: 1.94–2.42) for genetic (inherited) effects. Similar results were obtained after controlling for individual characteristics and disaster-related stressors.

Conclusion Among evacuees of the Fukushima nuclear disaster, concern about radiation risks was associated with psychological distress.
Perception of radiation risks and psychological distress in Fukushima evacuees, Japan, 2012

Summary of Mental Health and Lifestyle Survey

• The proportion of those with psychological distress including children was far greater in our study (14.6%) than in other areas affected by the Tohoku earthquake and subsequent tsunami (6.2%) or the Japanese population under normal circumstances (4.2–4.4%). Not surprisingly, emergency workers were more susceptible to psychological trauma than the general affected population.

• It was indicated that greater perceived radiation risks were associated with poor mental health.

• In addition to the mental problems, complicated psycho-social issues arose in or out of Fukushima, i.e., discordance in families and society, and stigma.

• The proportion of residents who require support for depressive symptoms and anxieties has been decreasing gradually, but remained at much higher levels in comparison with general population. Continued monitoring of the mental status of the residents are still required, and we need work closely with service providers and local mental health organizations to mitigate mental impacts of the disaster.
Pregnancy and Birth Survey

http://fmu-global.jp/?wpdmdl=1032
Obstetrical outcomes (%) of pregnancy (March 31, 2013)


<table>
<thead>
<tr>
<th>Location</th>
<th>Stillbirth</th>
<th>Preterm</th>
<th>Low BW</th>
<th>Anomalies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aizu, Minami-Aizu</td>
<td>0</td>
<td>5.0</td>
<td>10.1</td>
<td>2.54</td>
</tr>
<tr>
<td>Kempoku</td>
<td>0.19</td>
<td>4.1</td>
<td>7.6</td>
<td>2.57</td>
</tr>
<tr>
<td>Kenchu</td>
<td>0.3</td>
<td>4.2</td>
<td>8.5</td>
<td>2.87</td>
</tr>
<tr>
<td>Kennan</td>
<td>0.17</td>
<td>4.6</td>
<td>8.1</td>
<td>4.4</td>
</tr>
<tr>
<td>Iwaki</td>
<td>0.36</td>
<td>5.0</td>
<td>10.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Aizu, Minami-Aizu</td>
<td>0.25</td>
<td>4.4</td>
<td>8.7</td>
<td>2.72</td>
</tr>
<tr>
<td>Japan</td>
<td>0.33</td>
<td>5.7</td>
<td>9.6</td>
<td>2.31</td>
</tr>
</tbody>
</table>
Figures in the brackets are the proportion of preterm deliveries and incidence of low birth weight infants reported in the Vital Statistics conducted by Ministry of Health, Labour and Welfare for the same fiscal year.

*Figures in the brackets are the generally reported incidence of congenital anomalies.
Changes in the numbers of mothers with depressive Symptoms

Changes of content of concerns in telephone counseling
Regional variation in frequency (%) of mothers positive for depressive symptoms

Osaka study
Depressive: 1.4 % at 4 months

Hamamatsu study
Depressive: 4 % at 2-3 months

Summary of Pregnancy and Birth Survey

• No significant adverse outcomes in the pregnancy and birth survey was observed after the disaster.
• However, 27.6% of all mothers surveyed at around 6 months postpartum showed depressive symptoms, which is remarkably high. The prevalence was found to be higher among mothers in the region in which the damaged nuclear power plant is located and lower in regions that were less affected by the nuclear accident.
• In addition, a greater prevalence was reported among mothers that experienced an interruption in their obstetrical care following the disaster.
• Our findings suggest that improving mental health support for mothers with infants should be a high priority in the acute phase of nuclear disaster response.
• We further recommend that in the strategic provisioning of parental support, close attention should be paid to regional variations in negative mental health consequences, particularly to those who experienced an interruption in their obstetrical care.

3. Lessons learned in the Fukushima accident and the future roles of Fukushima Medical University
## Health consequences of the Fukushima NPP accident

<table>
<thead>
<tr>
<th>Health effects of radiation</th>
<th>Health effects not attributable to radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• No deterministic effect cases including Acute Radiation Syndrome case to date</td>
<td>• Deaths in rapid evacuation among inpatients and elderly people at nursing care facilities</td>
</tr>
<tr>
<td>• Stochastic effect would not be expected over the baseline level</td>
<td>• Increased mortality of displaced elderly people requiring nursing care</td>
</tr>
<tr>
<td>• Although 2-3 excess cancers could be inferred over the lifetime among workers with doses greater than 100mSv, it is unlikely that such increased incidence of cancer due to radiation would be discernible</td>
<td>• Adverse health effects such as mental health and lifestyle-related issues</td>
</tr>
<tr>
<td>• No discernible radiation-related increases in rates of leukemia or breast cancer, nor in other types of solid cancer besides possible thyroid cancer among public</td>
<td></td>
</tr>
</tbody>
</table>

Continuous Support for Participants

Radiation Medical Science Center

Responses
- Evaluation of the response
- Respondents determined to require counseling

Support

Participant

Department of Psychosomatic Medicine/Children's Mental Health Treatment Center at FMU

Evaluation of the response

The Mental Health Support Team

(After the support)

- Participants who require lifestyle support
- Participants in immediate need for support
- Participants who require or wish for examination by a doctor
- Participants determined to require further professional mental health care

Municipal Government

Fukushima Center for Disaster Mental Health

Registered Physician
Addressing concerns in thyroid ultrasound examination

Although thyroid examination showed some benefits of early diagnosis with sophisticated ultrasound, the resulting increase in prevalence of thyroid cancer can cause anxiety among residents.

• We explain the results individually at the spot immediately after the examinations in order to relieve the anxieties of the examinees and their families about the results, and provide supports on health risks of radiation and self-coping methods.

• We provide classes on thyroid examinations to the students of elementary schools and junior high schools who are the subjects of the examinations.
General health consultations

- Fukushima residents were apprehensive about the consequences of the accident, but their concerns were not always related to radiation.
- Efforts have been made to address these issues, such as in “general health consultations,” to widely target the apprehensions of the evacuees and residents without specifying the effects of radiation.

General health consultations were held in Fukushima on 546 occasions by October 2015
New nuclear disaster medical system in Japan (2015 -)
Fukushima Medical University promotes education, research, and medicine based on the following principles:

• We respect human life and nurture medical professionals with high ethical standards.
• We pursue advanced medicine and nursing.
• We provide holistic and integrated medical care as the core medical institution in the prefecture.
Conclusion

- Evacuation, which intends to minimize the health risks of radiation exposure, produced other serious health risks, particularly for vulnerable populations. Establishing the evacuation zone around the nuclear power plant resulted in the collapse of the local emergency medical system; this led to difficulties in responding to mass casualty events, such as explosions at the plant, and common medical emergencies.
- In the mid-long term, dislocating hundreds of thousands of citizens created a wide range of health consequences including increase of disaster related death, socio-psychological and public care issues.
- Re-organization of the disaster medical system and planning to respond a compound disaster is a must. Strengthening of public health services is another key issue in addition to mental and psychological care, behavioral and societal support, and efforts to improve perceptions about radiation.