6th LANGENDORFF–Congress
Friday , October 9th, 2015
Freiburg, Germany

# Medical consequences of Fukushima NPP accident
## -Nuclear Disaster and Health-

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THE LANCET

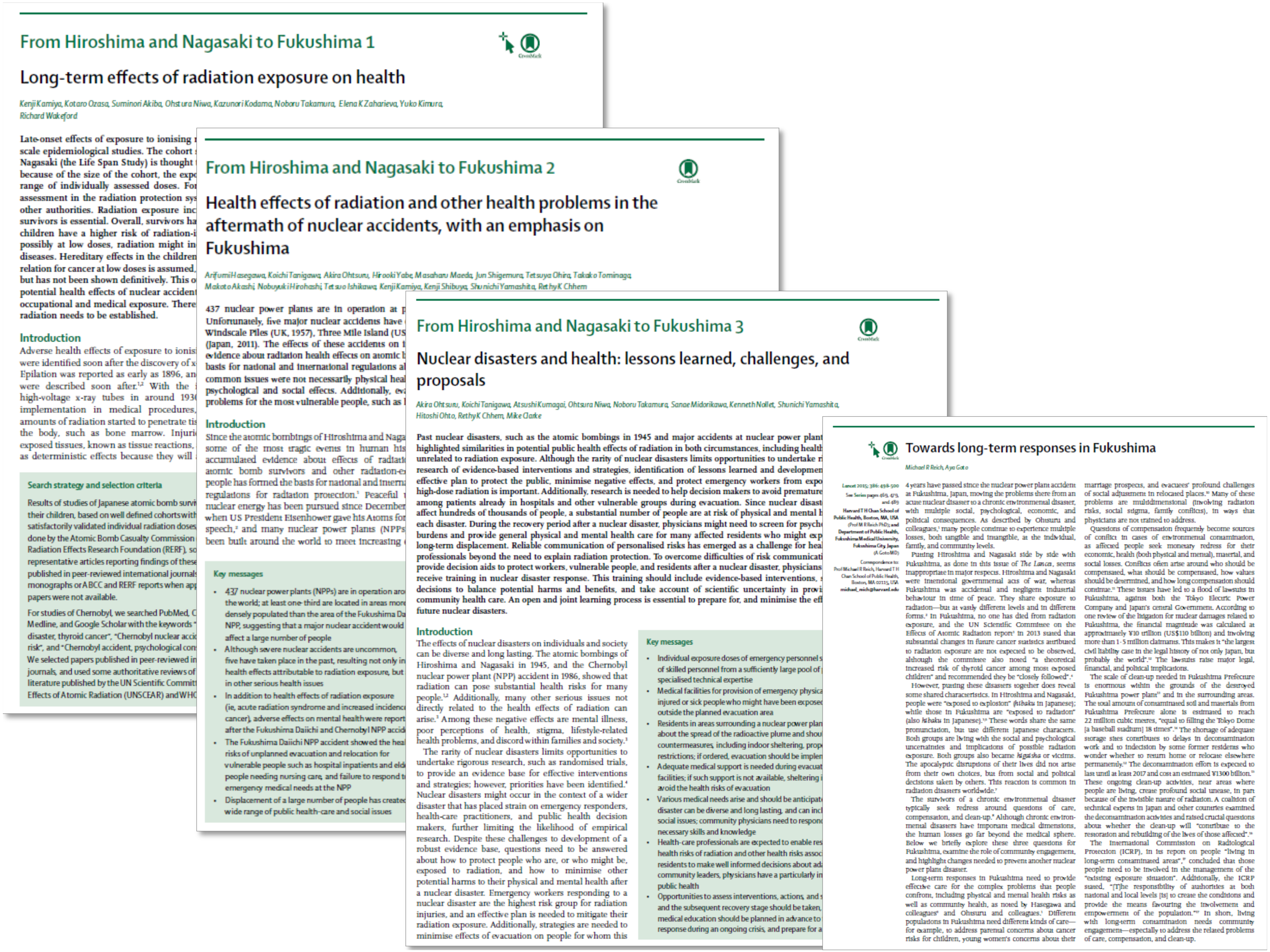
Volume 386 · Number 9992 · Pages 403–502 · August 1–7, 2015 www.thelancet.com

# From Hiroshima and Nagasaki to Fukushima through Chernobyl and Semey

"Two lessons from Fukushima are that seemingly fail-safe mechanisms can fail, and that when they do, health professionals will be expected to provide timely, accurate, and unambiguous advice, despite scarce evidence."

See Editorial page 403

August 1, 2015


From Hiroshima and Nagasaki to Fukushima 1
Long-term effects of radiation exposure on health
Kenji Kamiya, Kotaro Ozasa, Suminori Akiba, Ohstura Niwa, Kazunori Kodama, Noboru Takamura, Elena K Zaharieva, Yuko Kimura, Richard Wakeford
Introduction
Search strategy and selection criteria
From Hiroshima and Nagasaki to Fukushima 2
Health effects of radiation and other health problems in the aftermath of nuclear accidents, with an emphasis on Fukushima
Arifumi Hasegawa, Koichi Tanigawa, Akira Ohtsuru, Hirooki Yabe, Masaharu Maeda, Jun Shigemura, Tetsuya Ohira, Takako Tominaga, Makoto Akashi, Nobuyuki Hirohashi, Tetsuo Ishikawa, Kenji Kamiya, Kenji Shibuya, Shunichi Yamashita, Rethy K Chhem
Introduction
Key messages
From Hiroshima and Nagasaki to Fukushima 3
Nuclear disasters and health: lessons learned, challenges, and proposals
Akira Ohtsuru, Koichi Tanigawa, Atsushi Kumagai, Ohtsura Niwa, Noboru Takamura, Sanae Midorikawa, Kenneth Nollet, Shunichi Yamashita, Hitoshi Ohto, Rethy K Chhem, Mike Clarke
Introduction
Key messages
Towards long-term responses in Fukushima
Michael R Reich, Aya Goto

# Radiation epidemiology

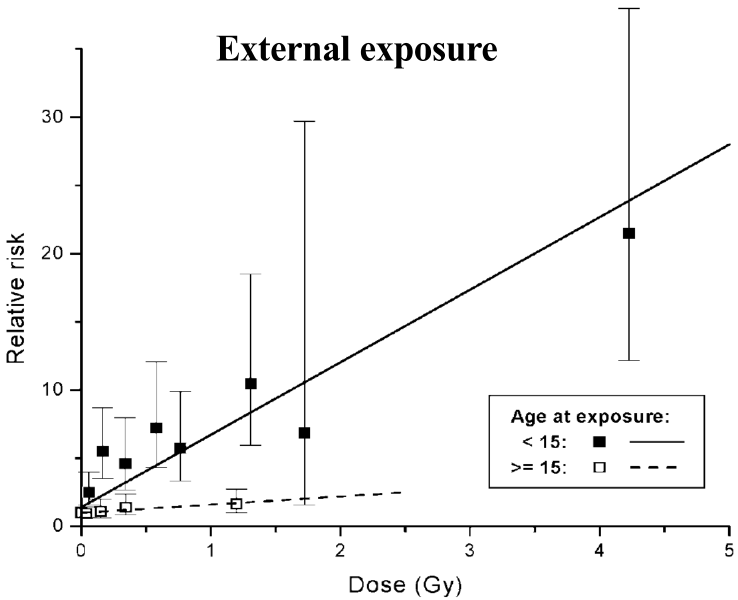
**Radiation exposure of the thyroid at young age is the most clearly defined environmental factor associated with thyroid cancer**

**External radiation exposure**
- A-bomb survivors
- Marshall Islanders (fall-out)
- Children exposed to EBT

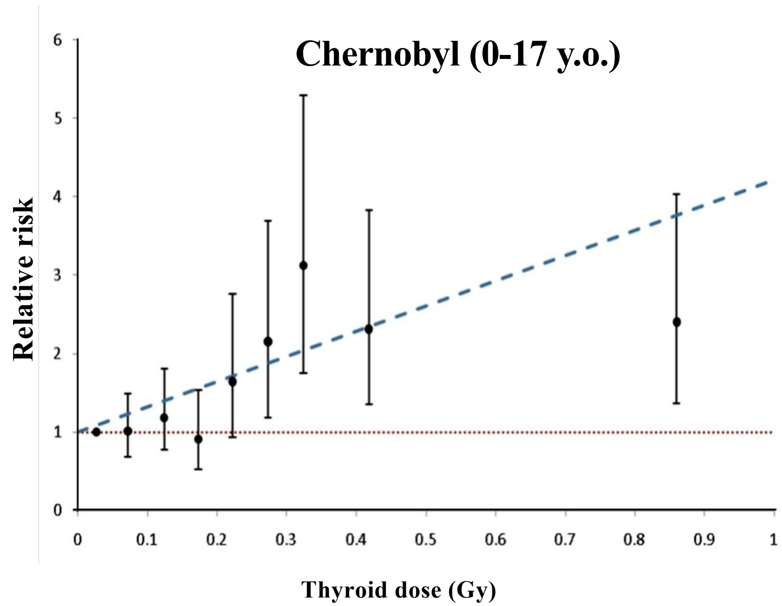
**ERR/Gy~7.7 [1.1 – 32]**

**Internal radiation exposure**
- Therapeutic radioiodine
- Hanford (fall-out)
- Chernobyl

**OR at 1 Gy~5.5 – 8.4 [ERR/Gy 1.9 – 19]**




*E.Ron 2002*




*V.Ivanov 2010*

# ISSUES to be newly discussed and changed after FUKUSHIMA

**Issue 1: Emergency Planning Zones and Protective Action and Guidelines**

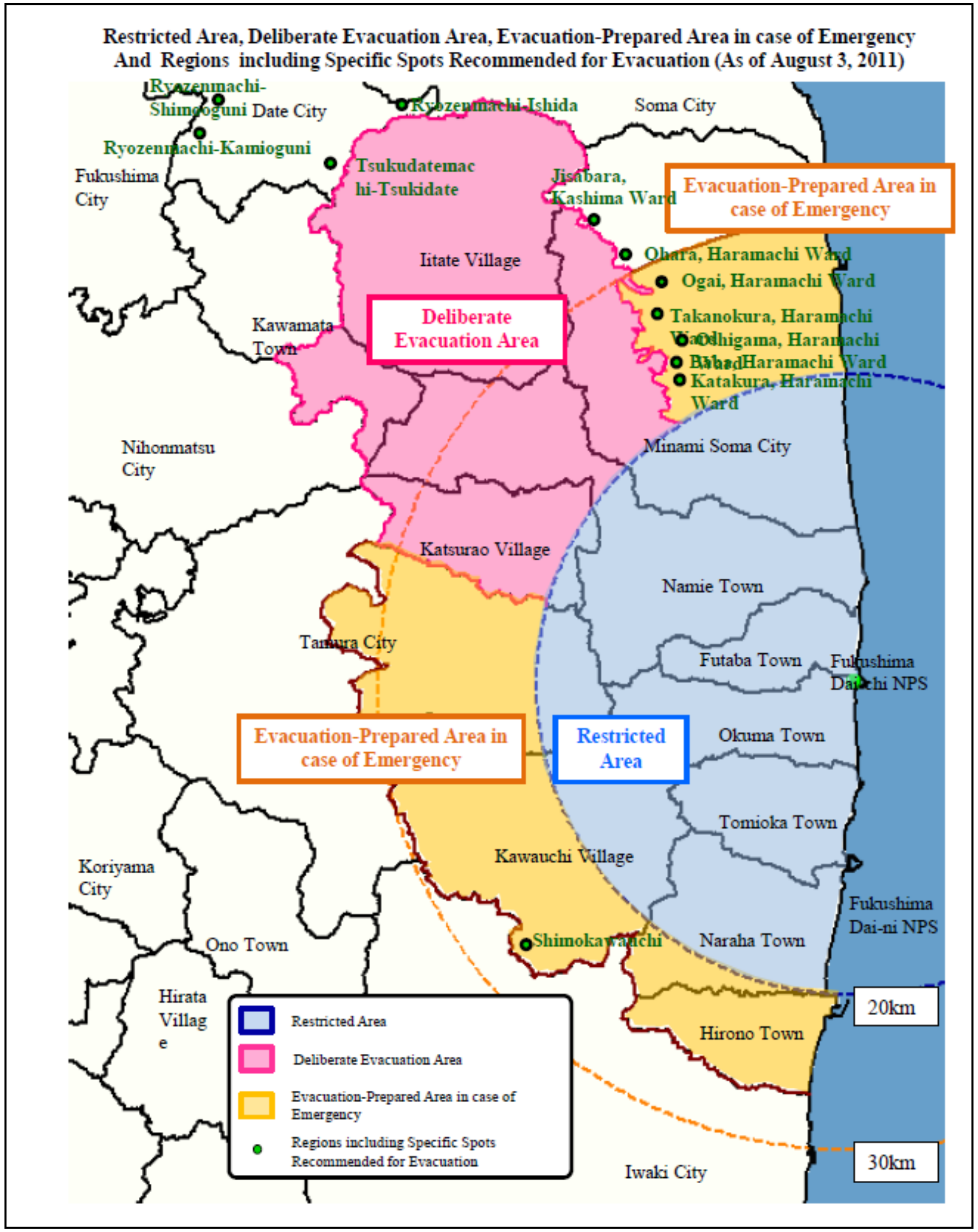
**Issue 2: Potassium Iodine (KI) Policy**

**Issue 3: Communications and Public Health Education (Countermeasures against *radiophobia*)**

**Issue 4: Reentry and Recovery Policy**

***In order to improve Global Radiation Protection Culture, Fukushima is now responsible as a focal point and world-leader to work together with international related organizations and research/education university/institutes; radiation risk analysis, risk communication, risk management, health care, risk education/training…………FMU is now the core research center for nuclear disaster.***

# Evacuation Status of Residents in Fukushima




**Number of evacuees from designated evacuation areas:**

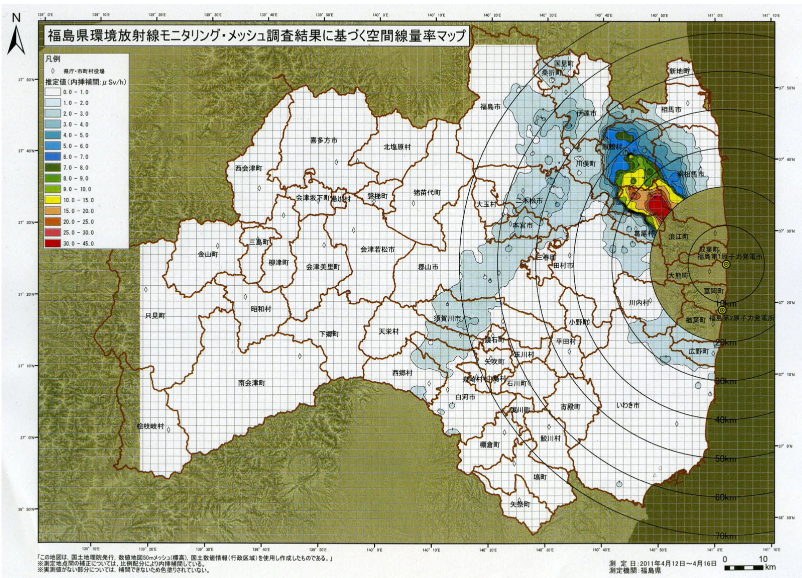
- **Restricted Area:**
  **about 77,000**
- **Deliberate Evacuation Area:**
  **about 10,000**
- **Evacuation-Prepared Area:**
  **about 26,000**

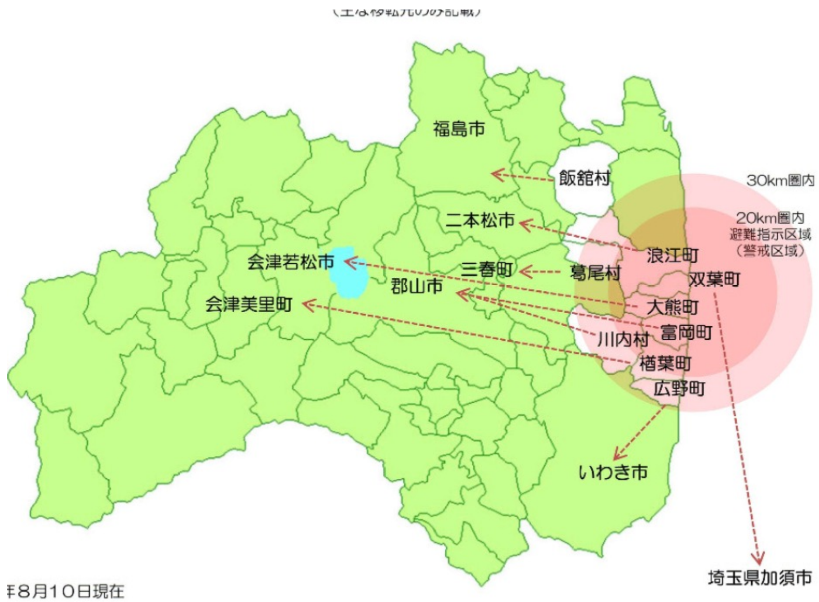
**Total: about 113,000**

**(Source: Cabinet Office, Feb 2012)**

# Fukushima Health Management Survey

- The design of the health management was planned in May, 2011, which was divided into two categories: a basic survey of dose estimates for all the residents and further examination of target populations.
- The objectives are to watch over a long-term health condition of residents in Fukushima and to promote their health and welfare.
- If exists, it is also aimed to investigate whether a long-term low-dose rate radiation exposure has an effect on their health or not.



# 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 survey**
   - **Thyroid examination by ultrasonography (370,000; 0-18 y/o)**
   - **Comprehensive medical checkups (210,000 ; Evacuees)**
   - **Mental health and lifestyle survey (210,000 ; Evacuees)**
   - **Survey on pregnant women and nursing mothers (16,000)**

# Fukushima's Big Concern from Chernobyl and Thyroid Cancer

- **The most important point learned from Chernobyl NPP accident is how to protect the public from unnecessary exposure of internal as well as external radiation, especially from the fear/anxiety of increased risk of *radiation-induced thyroid cancer*.**
- **How to overcome the difficulty of LNT model understanding depends on logical thinking way at the individual level but emotional reaction cannot be avoided.**

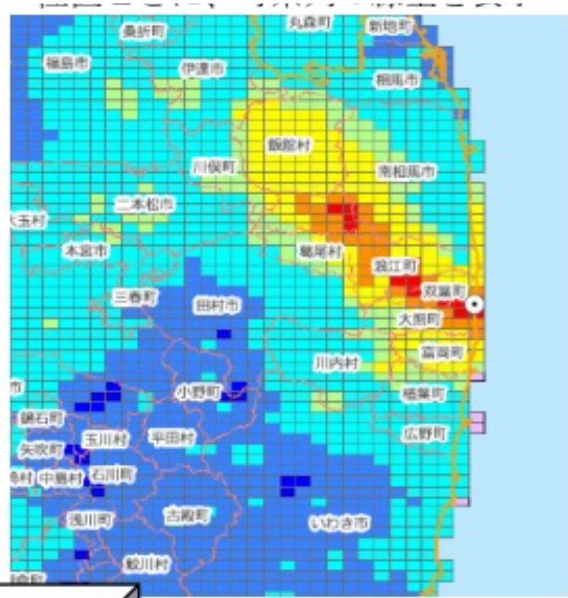
# How to analyze radiation dose

**Questionnaire**

**Movement & behavior**


**+**

**Time-course of air dose map**



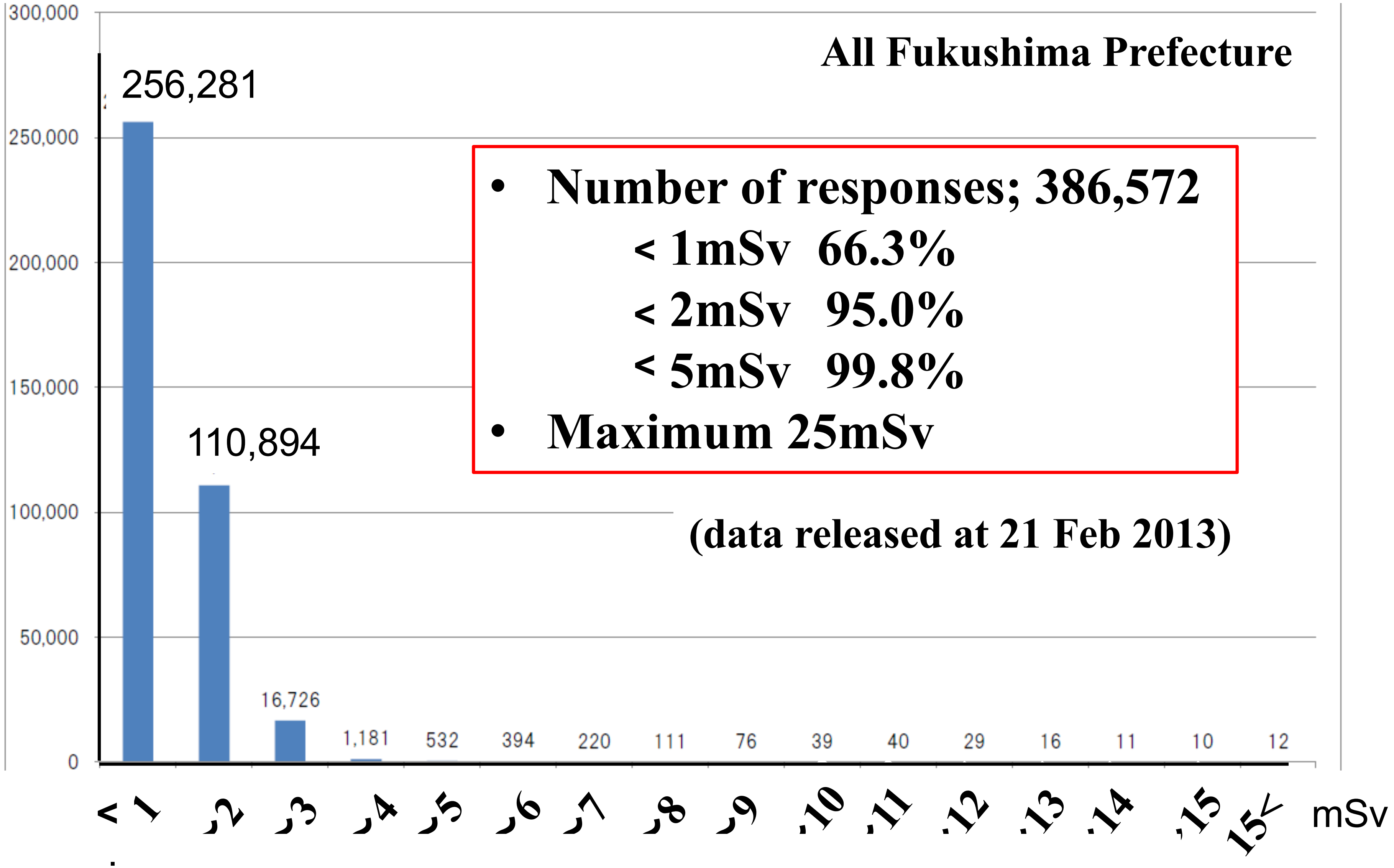

**Estimation dose calculating combined above two information by NIRS**

**To help understanding of individual first 4M dose**

**To help understanding of radiation-related health risk**

**To establish database for long-term health management**

# Distribution of External Exposure Dose (mSv)
## (Estimated Cumulative effective dose from March 11 to July 11)




- Number of responses; 386,572
  - < 1mSv 66.3%
  - < 2mSv 95.0%
  - < 5mSv 99.8%
- Maximum 25mSv

(data released at 21 Feb 2013)

**Estimated from location and time course on questionnaire**

# Fukushima's Data

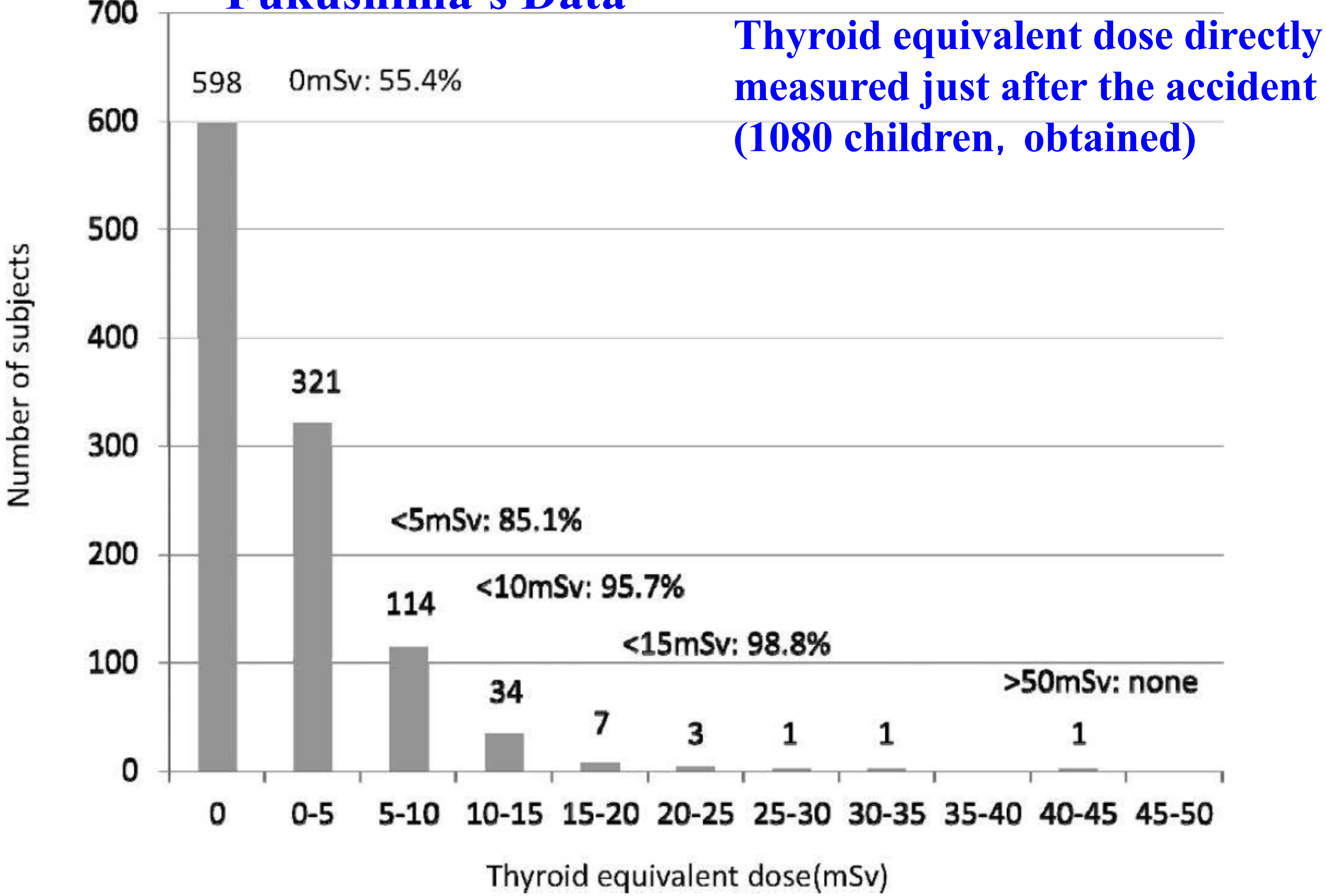



Fig.5 Distribution of thyroid equivalent doses estimated by the results of the screening survey and the intake scenario from March 12, 2011 to the day before measurements.

*Radiation Research 180(5):439-447, 2013*

(a) **Different thyroid dose between Ukraine and Fukushima**

(b) **Different thyroid dose between Belarus and Fukushima**

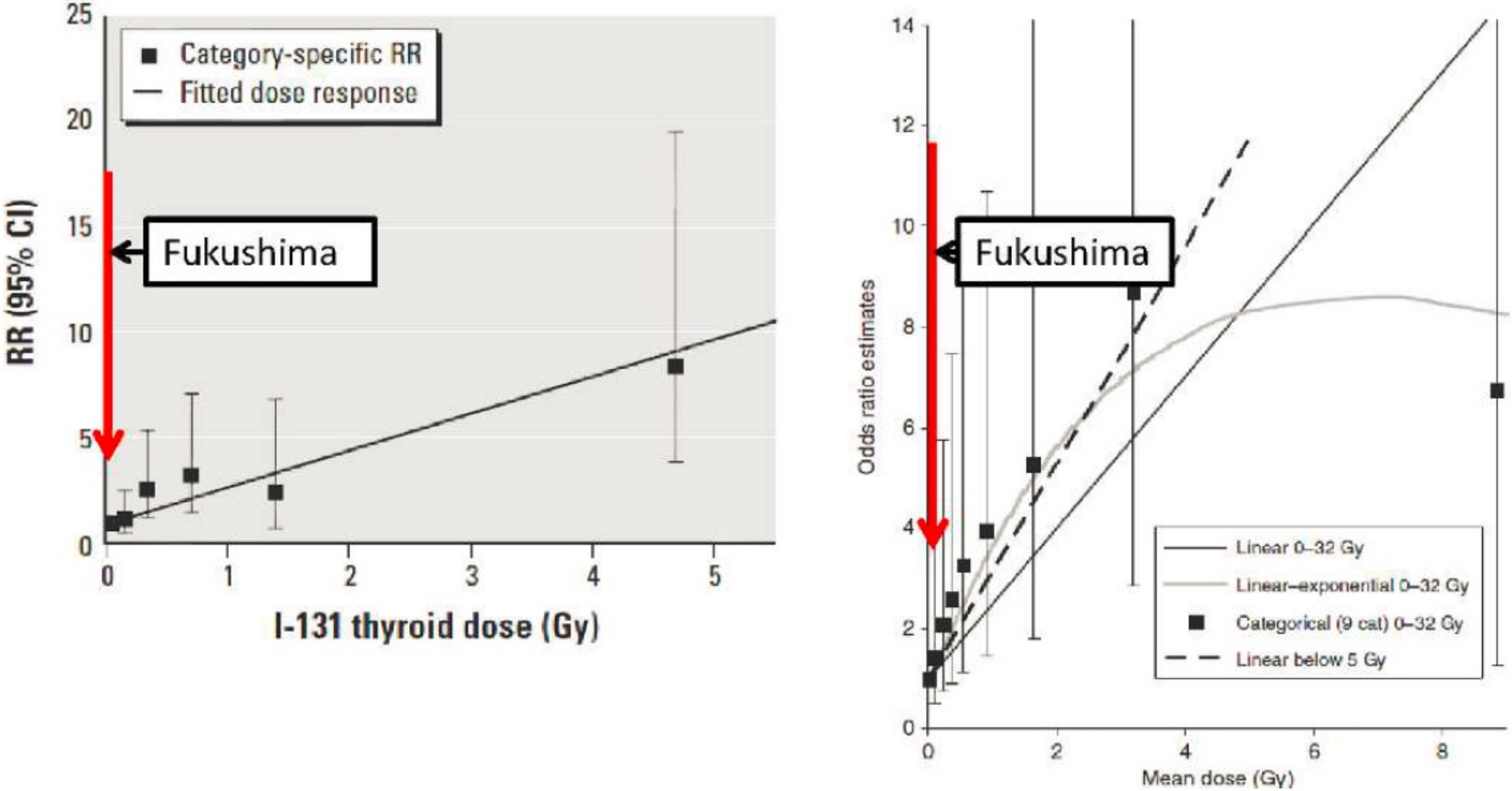


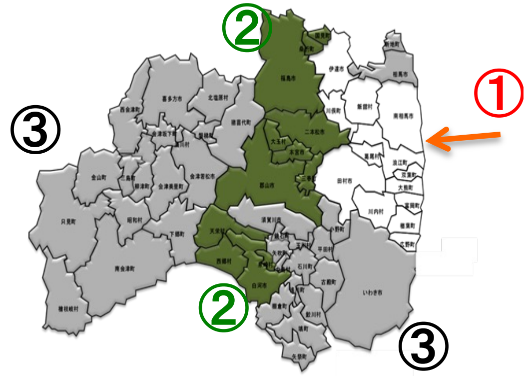

Fig.6. Panel a: Thyroid radiation doses in Fukushima, Ukraine and Belarus in dose-response relationship between thyroid cancer and $^{131}$I. Panel b: Dose-response relationship for the incidence of thyroid cancers. Both figures were modified from two articles (republished with permission, Brenner AV, et al. *Environ Health Perspect* 2011; 119: 933-9 and Zablotska LB, et al. *Br J Cancer* 2011; 104: 181-7).

*Radiation Research 180(5):439-447, 2013*

# Thyroid Ultrasound Examination (TUE) Schedule

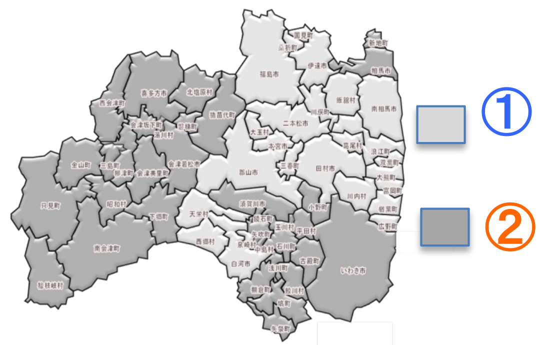
- **Preliminary Baseline Survey (PBLS)subjects: 368,000**

  ① ***1st survey: FY2011, from October 2011 to March 2012***
  ② ***2nd survey: FY2012, from April 2012 to March 2013***
  ③ ***3rd Survey: FY2013, from April 2013 to March 2014***

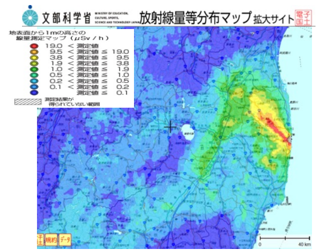


- **Full scale survey（FSS) subjects: 380,000**

  ① ***1st survey: FY2014, from April 2014 to March 2015***
  ② ***2nd survey: FY2015, from April 2015 to March 2016***



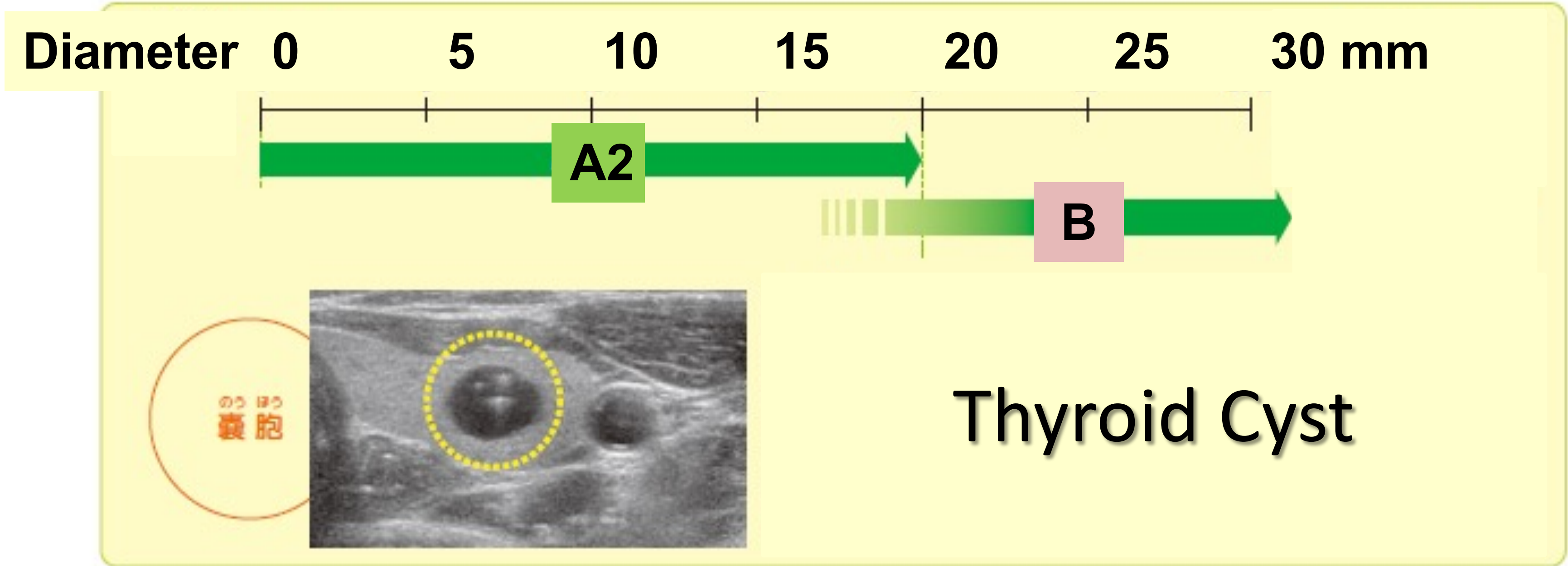
**TUE was performed firstly on those who were living in high-exposure areas at the time of the accident.**

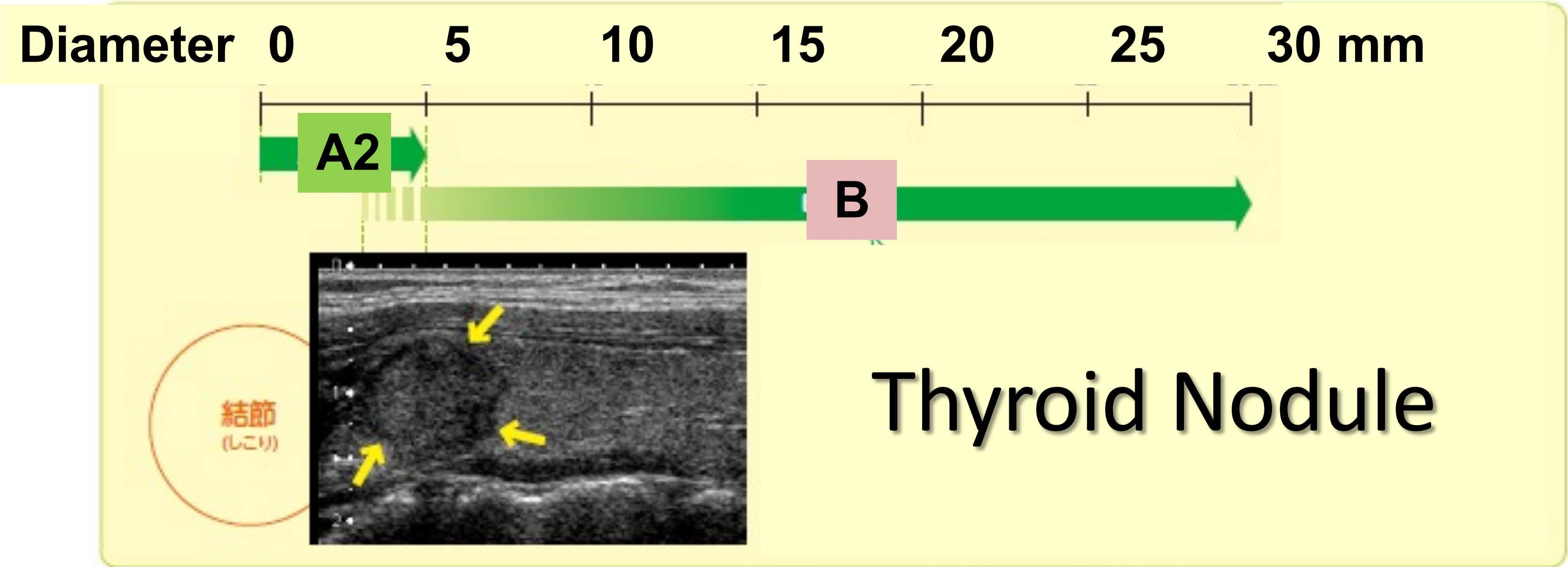


**The full-scale survey will then continue every two years until the age of 20, and every five years thereafter for the remainder of the subject's life.**

*Radiation Medical Science Center for the FHM survey, FMU*

# *Thyroid Ultrasonography Screening Criteria*



# Preliminary Baseline Survey (PBLS)

- **PBLS examined 298,577 persons.**
- **Participation rate was 81.2%.**
- **Among 297,046 examinees,**

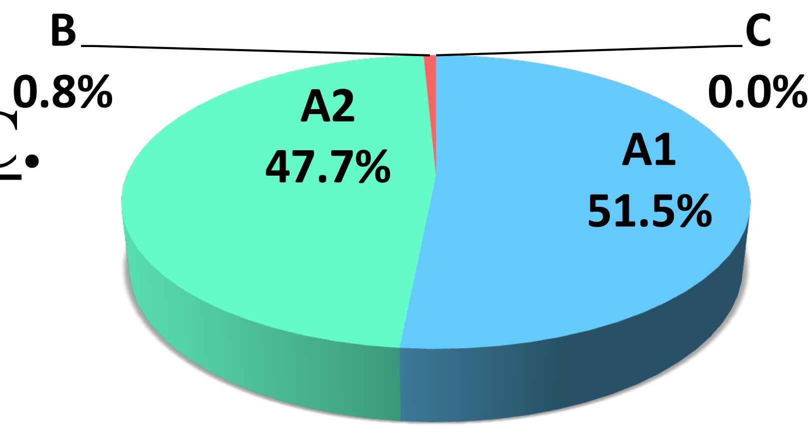
  **PBLS diagnostic results included**

  **153,017 A1 (51.5%),**

  **141,788 A2 (47.7%),**

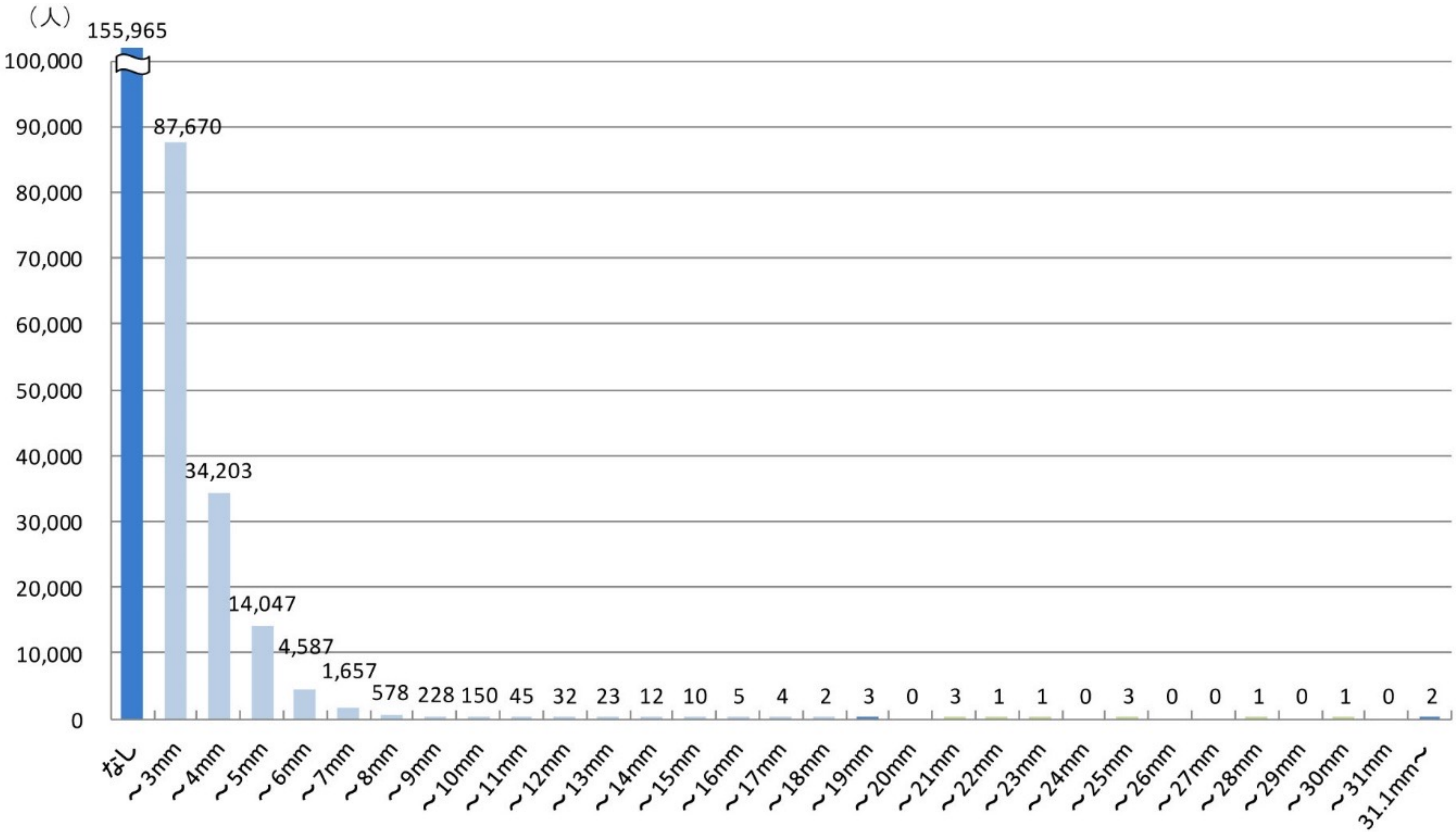
  **2,250 B (0.8%), and one C.**

→ Confirmatory examination



# Size distribution of thyroid cysts detected by US among 299,543 children

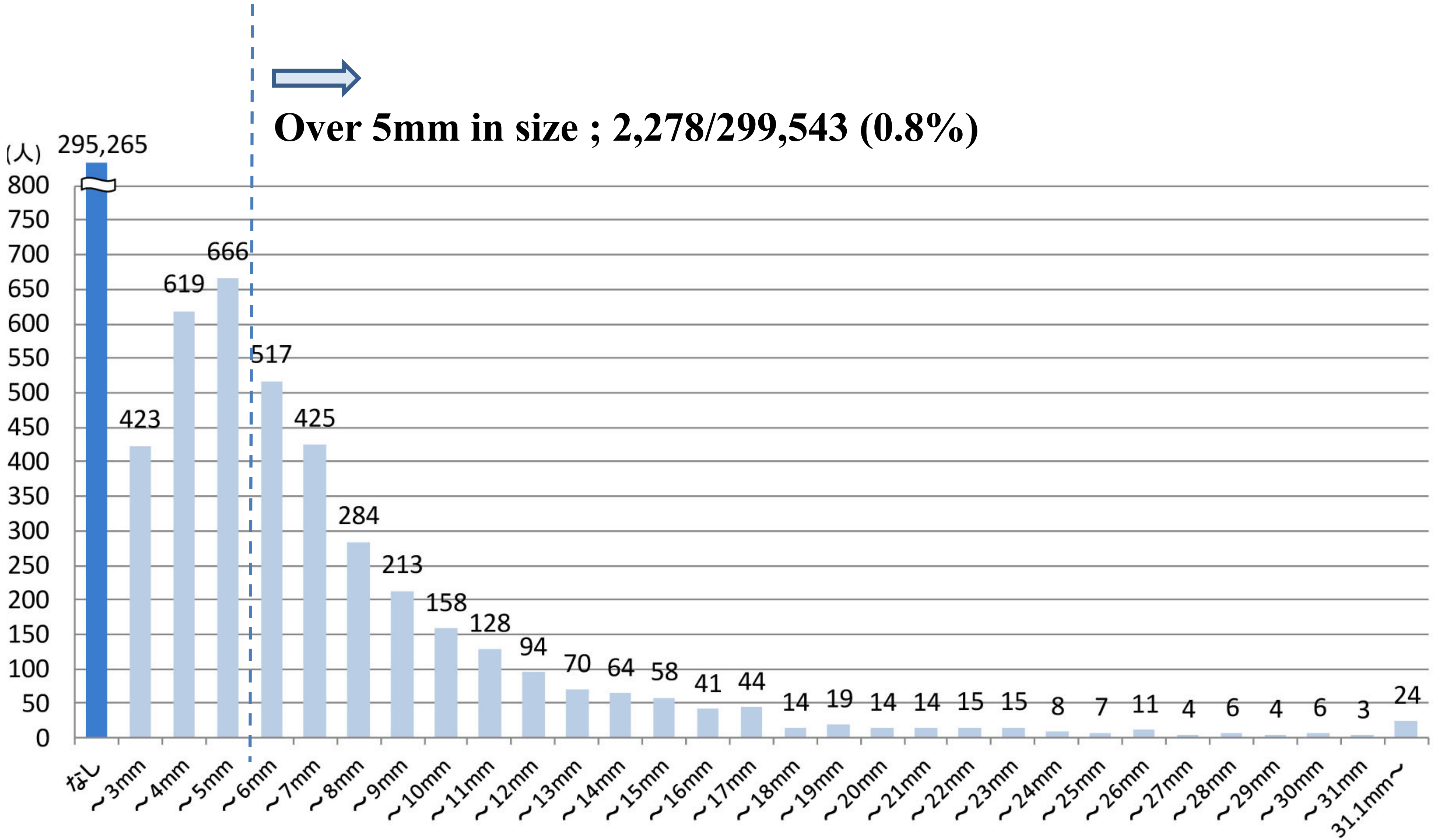
**March 31, 2015**



# Size distribution of thyroid nodules detected by US among 299,543 children

March 31, 2015

Over 5mm in size ; 2,278/299,543 (0.8%)



## Results of thyroid US examination; October 2011 – March 2015

(Preliminary baseline survey)

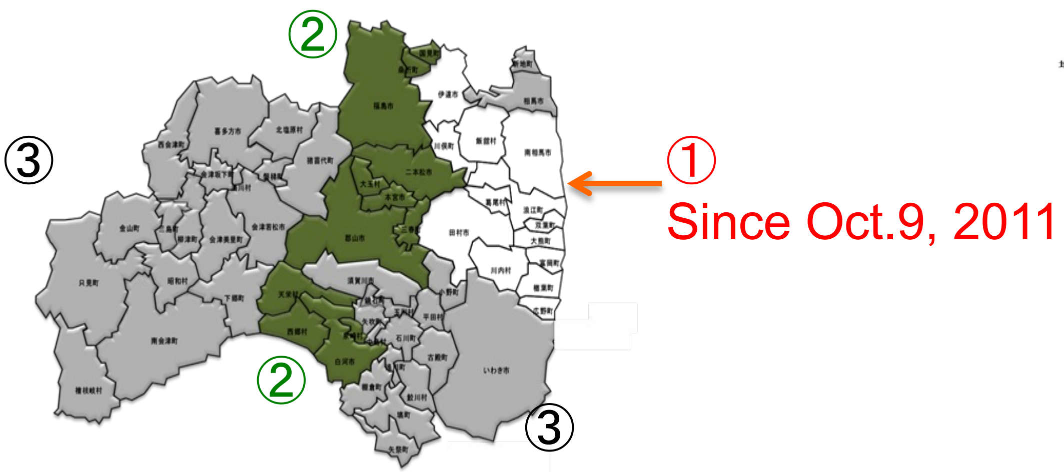
| Judgment | | Interpretation | N | (%) |
|---|---|---|---|---|
| A subtotal | | Within normal range | 296,954 | 99.2% |
| A | (A1) | No specific finding | 154,018 | 51.5% |
| | (A2) | Nodule with ≤5.0mm or/and<br>Cyst with ≤20.1mm | 142,936 | 47.8% |
| B | | Nodule with ≥5.0mm or/and<br>Cyst with ≥20.1mm<br>Recommended 2nd Screening | 2,278 | 0.8% |
| C | | Needed further examination | 1 | 0.0% |
| Total | | | 299,543 | 100% |

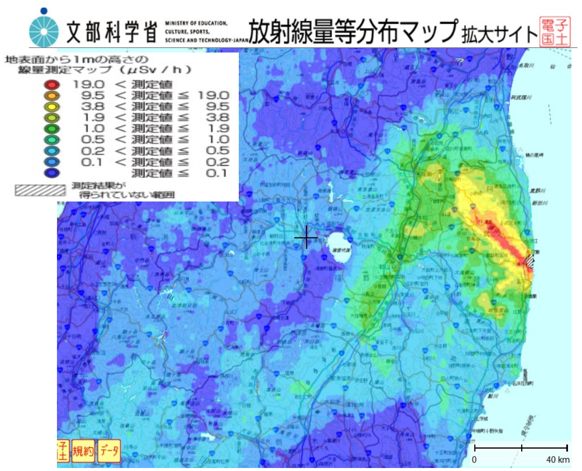
(Data are available at http://wwwcms.pref.fukushima.jp/)

# The frequency of suspicious or malignant cases diagnosed by FNAC, according to area

| | | No. of children screened | Suspiciou or malignant cases* | Proportion of suspiciou or malignant cases（%） |
|---|---|---|---|---|
| ① | FY2011 | 41,810 | 14 | 0.033 |
| ② | FY2012 | 139,339 | 56 | 0.040 |
| ③ | FY2013 | 117,428 | 39 | 0.033 |
| | Total | 298,577 | 109 | 0.037 |

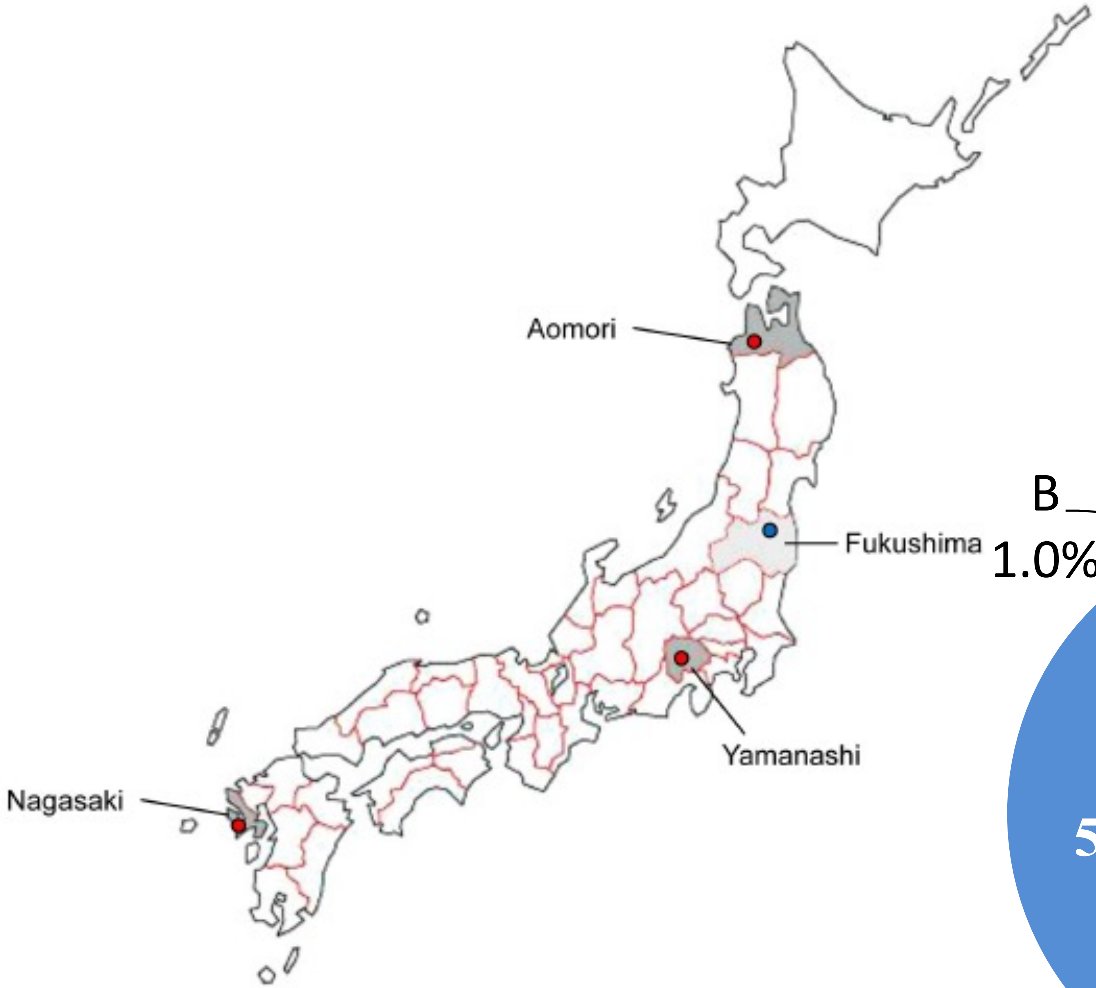
* Excluding one suspected case found benign after surgery

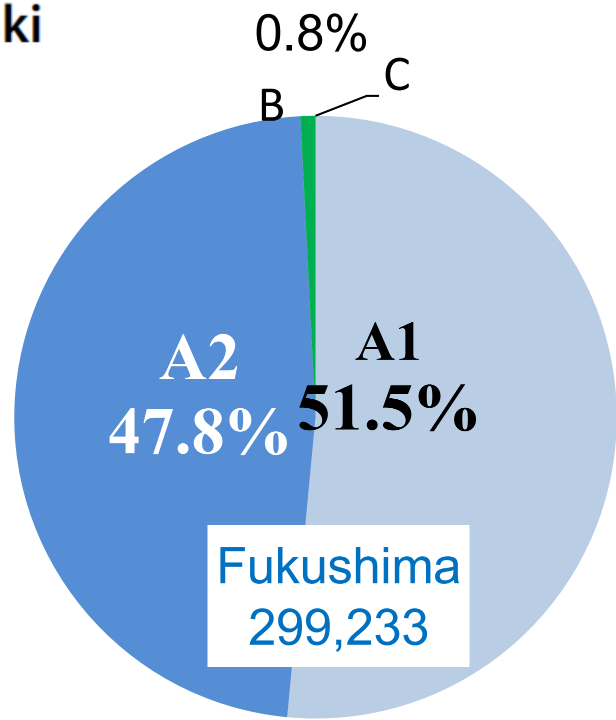


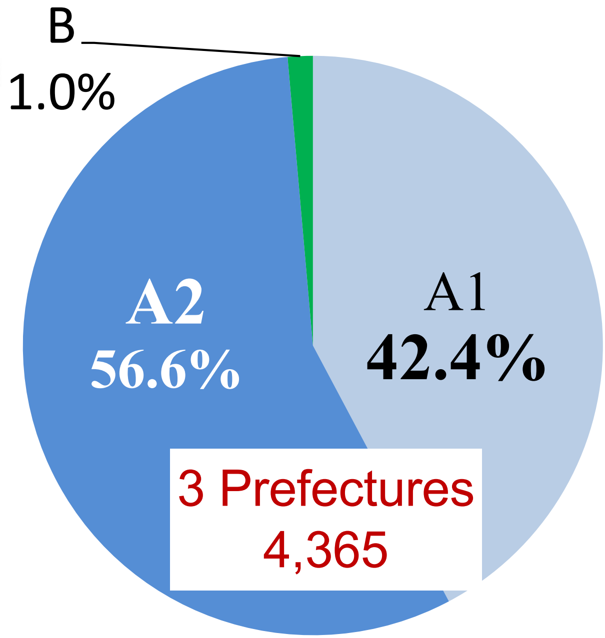



## Thyroid Ultrasound Findings in Children from Three Japanese Prefectures: Aomori, Yamanashi and Nagasaki

PLOS ONE Hayashida N de.al. December 2013 | Volume 8 | Issue 12 | e83220



# Malignant or suspicious cases detected by US-FNAB in Fukushima

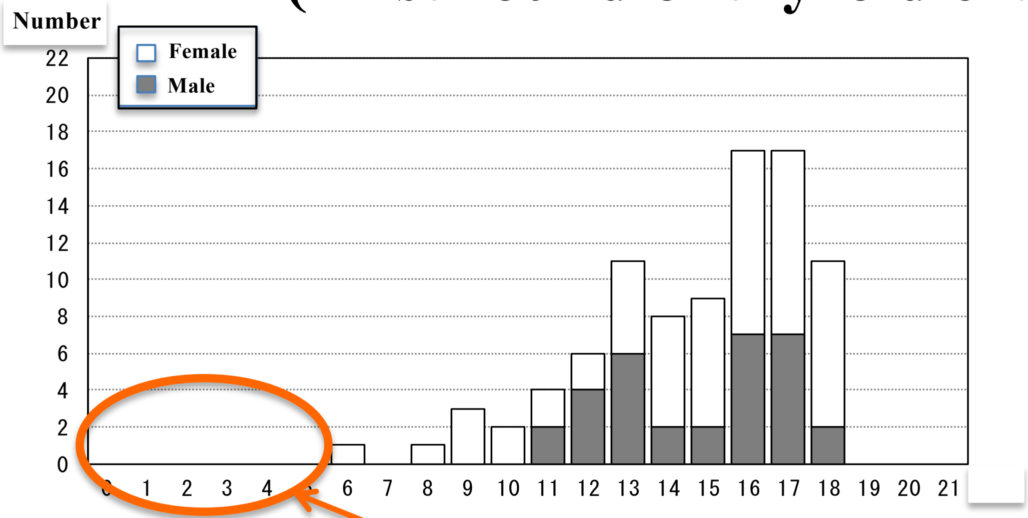
**March 31, 2015**

| | |
|---|---|
| **Number of cases (FY 2011-2013)** | **Total 112** |
| **Gender** | **Male: 38 Female: 74** |
| **Mean age (SD, min-max)** | **17.2 years (±2.7, 8-22)** ***at the time of diagnosis*** |
| | **14.8 years (±2.6, 6-18)** ***at the time of the disaster*** |
| **Mean tumor size (SD, min-max)** | **14.2 mm (±7.8, 5.1-45.0)** |

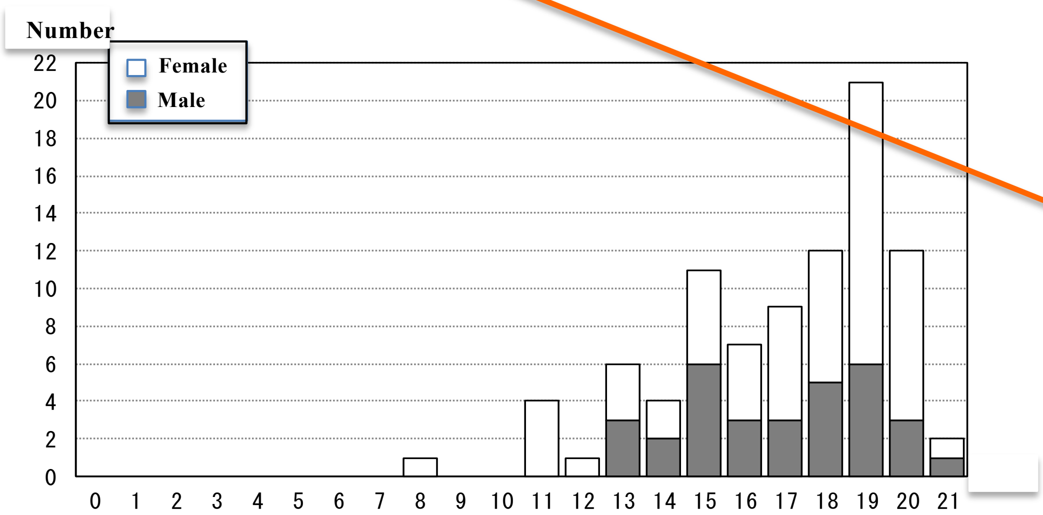
**Pathological diagnosis of 99 surgical cases**

**1 benign nodule**
**95 papillary thyroid carcinomas**
**3 poorly differentiated thyroid carcinoma**

# Age and gender distribution of 110 cases diagnosed with malignant or suspected of malignancy by FNAC (First round of thyroid examination in Fukushima)




Suspicious or malignant cases by age at the time of disaster




Suspicious or malignant cases by age as of the date of confirmatory examination

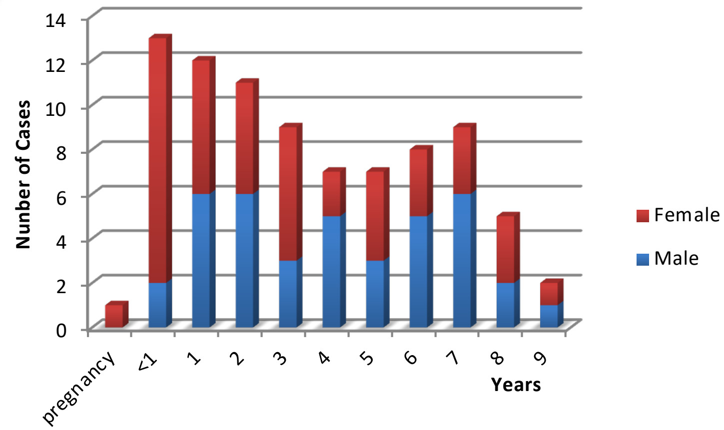



Figure 3. Age and sex distributions of patients at the time of the Chernobyl accident.

Nikiforov Y, et al. Pediatric Thyroid Cancer after the Chernobyl Disaster. Cancer 1994; 74:748-66

**Following the accident, no cases of thyroid cancer was found in children aged 0-5 years, unlike Chernobyl.**

# 68 Operated Thyroid Cancer Cases
# -clinico-pathologial and genetic findings-

- Age and sex at operation; 17.3±2.8 (M22, F 46)
- Tumor size; 14.7±9.2mm
- Histology; CP61, FV2, CMV4, PD1
- TNM classification; pT1/2 37, pT3 31; pN0 15, pN1a or 1b 52; M0 65, M1 2; pEx0 36, pEx1 32

- Genetic mutation;

  *Braf*$^{V600E}$ 43 (63.2%), *H-Ras* 0, *K-Ras* 0, *N-Ras* 0,
  *Ret/PTC1* 6 (8.8%), *Ret/PTC3* 1 (1.5%),
  *ETV6(ex4)/NTRK* 4 (5.9%), *ETV6(ex5)/NTRK* 0,
  *AKAP9/Braf* 0, *TERT C250T* 0, *TERT C228T* 0

# Thyroid Cancer in Fukushima

## -about 300,000 children screened by US for the first 3 years-

- **Due to recent advances in US technology, diagnostic image quality has dramatically improved. In addition to worldwide tendency of increased incidence of thyroid cysts/nodules and cancers, average detection rate of childhood thyroid cancer in Fukushima is *around 0.03~0.04% by US screening*, which needs to be further analyzed and both *the overdiagnosis and overtreatment* needs to be recognized, despite of low or undetectable thyroid dose.**
- **Carefully analysis of thyroid US data that takes into account not only *potential screening effect and exaggerated incidence rates of thyroid diseases*, but also *the treatment strategies for overdiagnosis and its outcomes in children* is required, especially for a long time for those who are detected thyroid abnormalities.**

# Sensational News by Media

- **Over a third of Fukushima children at risk of developing cancer (June 2012)**
- **Fukushima kids have skyrocketing number of thyroid abnormalities (February 2013)**

⇓

***Sophisticated mass screening activities in Fukushima has lead to an increase in the incidence of thyroid nodules/cysts, and cancer due to earlier detection of non-symptomatic cases. It is therefore not be possible to compare the future observed thyroid cancer incidence with the figures of any previous report, as the baseline risk changes due to the screening activities.***

# Interim Results of Health Checkup for the Evacuees in Fukushima in 2011

- **The 2011 Comprehensive Health Check clarified the general health conditions of evacuees from the government-designated evacuation zone after the Great East Japan Disaster. Obesity and hyperlipidemia exist even at young ages and increase in both male and female adults. Liver dysfunction and hyperuricemia increase at relatively young ages in male. Furthermore, hypertension, glucose dysmetabolism, and renal dysfunction increase in adulthood and are most common at older ages.**
- **We compared the comprehensive health check results after the disaster with the results of health examinations performed before the disaster in children and adults. The results suggested that the rates of obesity, glucose metabolic dysfunction, hyperlipidemia, and liver dysfunction after the disaster were high, at least in part, compared with those before the disaster. Regarding the factors that contributed to these results, changes of lifestyle, diet, exercise, and other personal habits caused by forced evacuation are suggested, although there were interfering factors such as the difference of health check period, age distribution, region distribution and participation rate.**
- **Based on the results of the health check carried out in 2011, we are continuing the comprehensive health check long term and maintaining the system to prevent various diseases, including life-style related disease of participants.**

# Interim Results of Mental Health and Life-style Survey for the Evacuees in Fukushima in 2011-2012

***In children***

- **The most remarkable issues are physical symptoms, *influences at school performance, irritation, anxiety & depression, and sensitivity to earthquakes & radiation* taken from the category of "Reactions amongst Children due to 3.11 Disaster".**

***In adults***

- **The most remarkable issues are *sleep issues, physical problems, depression, fear of future, and agitation, discount of evacuation life*, taken from the category of "Reaction to Self from the 3.11 Disaster".**

# Interim Results of Survey of Expectant and Pregnant Mothers in the entire Fukushima in 2011-2012

- ***There are neither any increase of miscarriage nor artificial abortion*** **owing to the extensive efforts of the Japanese Medical Association, especially Obstetricians and Gynecologists.**
- **Furthermore by the Japan Association of Obstetricians and Gynecologists (JAOG), the congenital malformations were evaluated in babies delivered in Fukushima prefecture.**
- **There is** ***no obvious increased prevalence rate of congenital malformations*** **at the present time compared with the rate of Birth Defects Monitoring of JAOG. However, it is necessary to gather more cases to draw a conclusion.**

# As a hub medical institution for recovery and revitalization of Fukushima

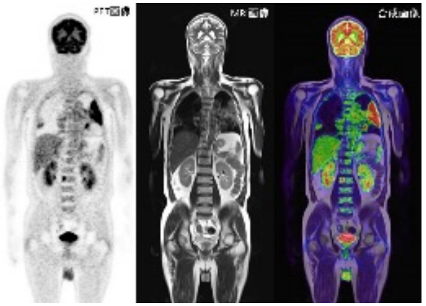
～Fukushima Global Medical Science Center～

Fukushima Medical University

# Advanced Clinical Research Center in Fukushima Medical University Hospital
# - New challenge will start 2016 with the Japanese Nuclear Medicine Experts-

## One Location and One Stretch – From medication synthetic, pre-clinical research, clinical research and trial, and treatment for the patients from the entire Japan

New Ward（ＲＩ Ward）



ＰＥＴ/ＭＲＩ

Mid-size Cyclotrons

**treatment**

・Medical Treatment for thyroid cancer
・RI Internal Treatment with the new radioactive medication

**clinical research & trial**

・Clinical Trial of the new medicine, and examine with PET/MRI
・Pre-operative BNCT examination (FBPA Examination)

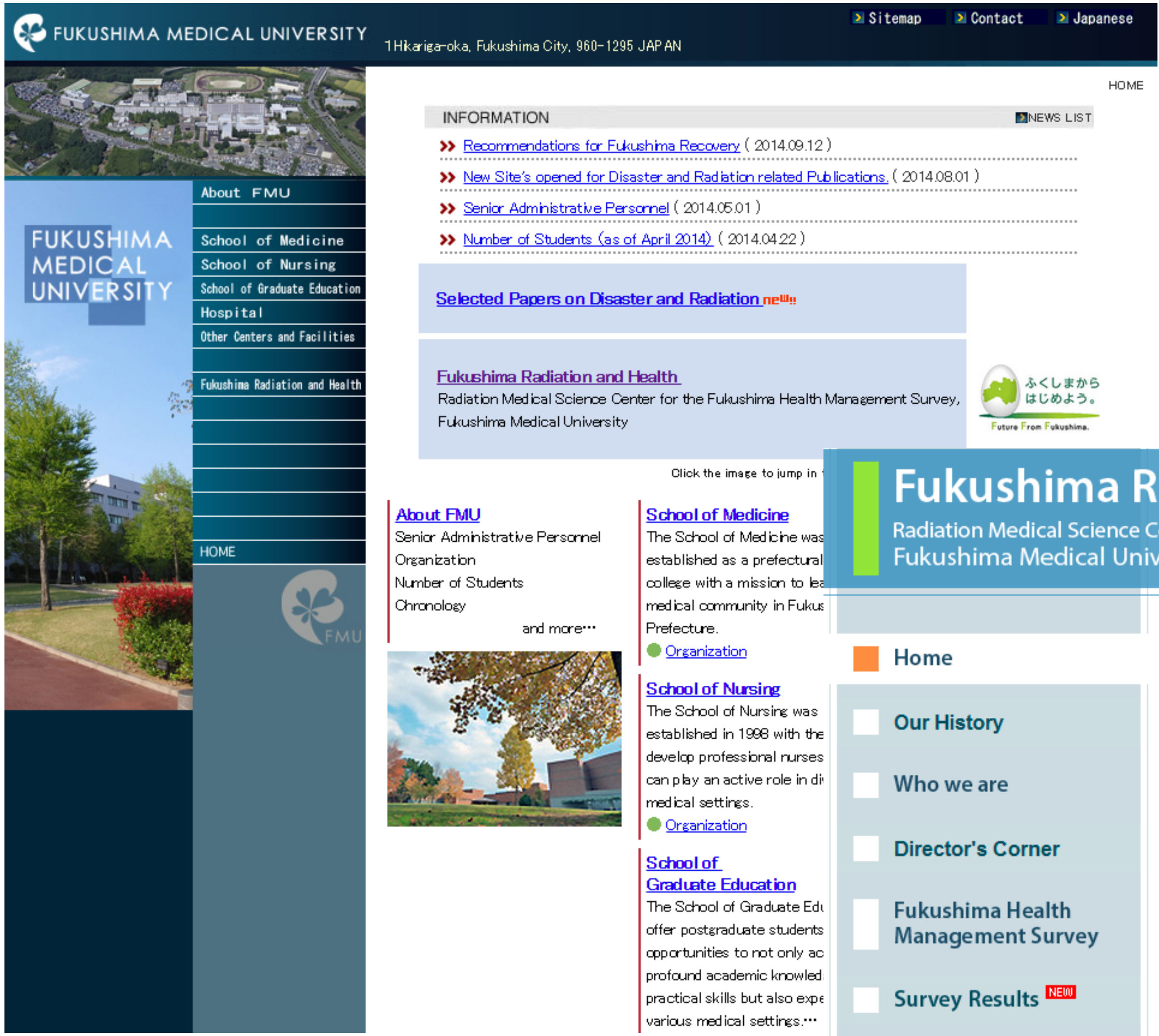
**pre-clinical research**

・Animal Testing of the new medicine, and examine with Small Animal PET/SPECT/CT to ensure safety and effectiveness

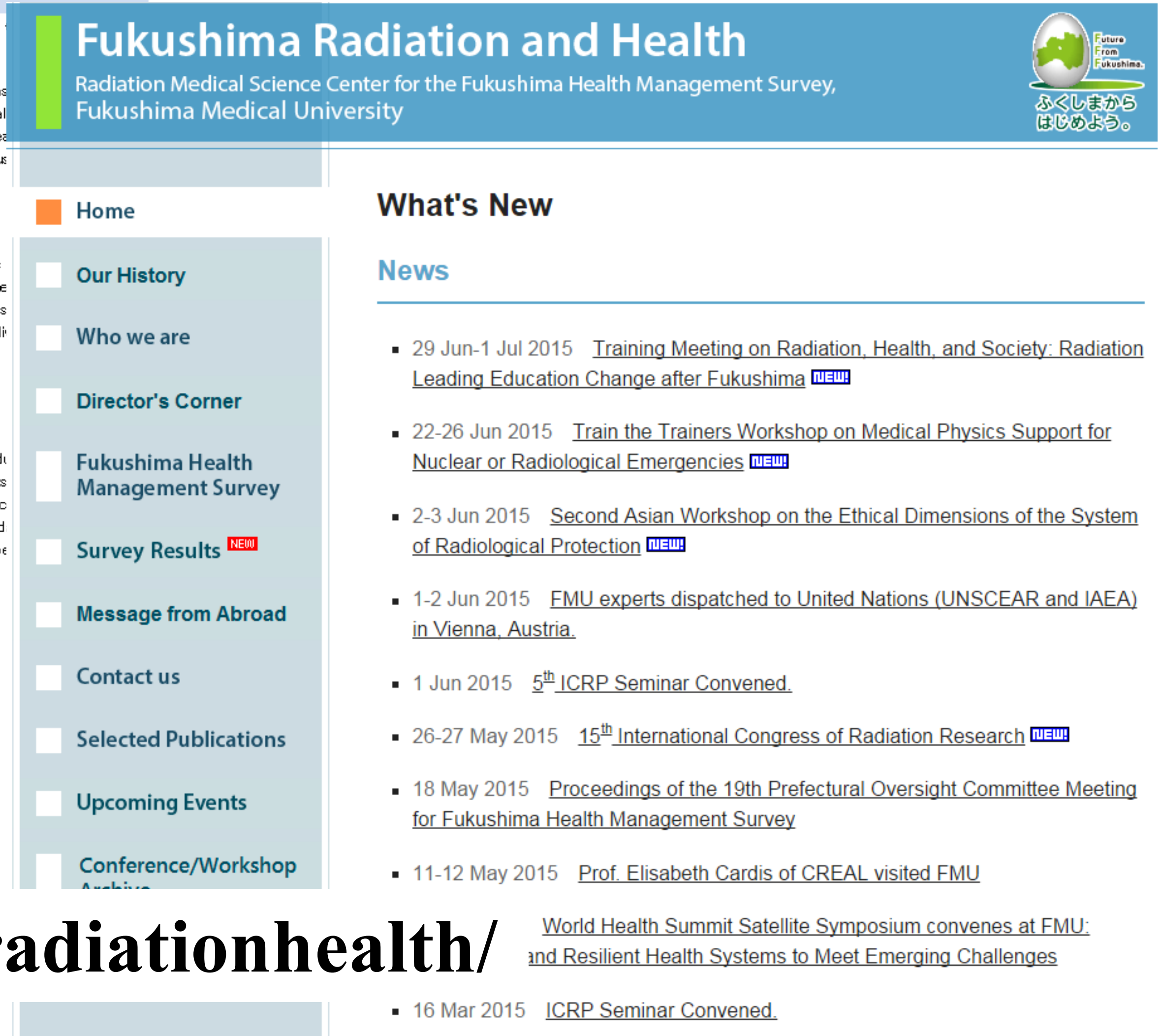
**medication synthetic**

・Production research of $^{99m}Tc$ synthetic collaborating with NIRS that is totally dependent on imports ・New radioactive medication synthetic using $^{177}Lu$ or $^{211}At$ which is still unapproved for domestic in Japan ・FBPA synthetic which is used for pre-operative examination of BNCT

**To avoid any misunderstanding and mislead of the results of Fukushima Health Management Survey, please access the Fukushima Radiation and Heath homepage.**




http://fukushima-mimamori.jp/




http://www.fmu.ac.jp/radiationhealth/