Health problems after the accident of Fukushima Daiichi Nuclear Power Plant
Outbreak of childhood thyroid cancer in Fukushima

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Osaka, Japan
Purpose

- Study: Are 74 thyroid cancer cases in Fukushima Prefecture the outbreak of thyroid cancer or not?
- Background:
  
In Fukushima, so far, the number of thyroid cancer has admittedly risen to as many as 74 cases. Still, the Japanese government and Fukushima Prefectural authority adamantly deny the fact of its out-break. Besides, they squarely refuse to admit the existence and occurrence of any other health hazards.

What is worse, radioactive contamination is not limited within Fukushima prefecture, and cancer is not the only radiation induced health hazard. We should see this situation as a symbolic phenomenon of various health hazards that are waiting to appear from now on.
Professor SUZUKI Shinichi said
Department of Thyroid and Endocrinology
at Fukushima Medical University

- Concerning the discovered thyroid cancer, that it is more likely that the discovered cases of thyroid cancer are those that used to be found in later years, but that, due to the development of high accuracy medical checkups by ultrasonic devices, have been found prematurely, so to speak, and they have been formed irrespective of exposure to radiation.

- He added that the data that have been obtained by the thyroid medical checkups will form the frequency baseline for the thyroid cancer of Fukushima children.

On the occasion of the 56th annual conference of Japan Thyroid Association held on November 15th, 2013,
Patients and Study Methods

- 1. Analysis of Incidence Rate Ratio
  comparative subjects: Thyroid cancer incidence rate: National Research Institute of Cancer

- 2. Analysis of Prevalence Odds Ratio and 95% confident interval (Comparison of Prevalence rate in areas and zones in Fukushima Prefecture)

- 3. Comparison of Prevalence rate in Fukushima Prefecture and in Chernobyl Accident
  - 1, 2 studies: cited studied data by Prof. Toshihide Tsuda (Okayama University)
Examinatin of Thyroid Cancer in Fukushima Prefecture (<18 years of age)

- 1st screening: all persons < 18 years of age, 2011 year
  - Thyroid echo examination
    - Positive
    - Nodule >5.0mm or Cyst>20.0mm
    → 2nd screening
- 2nd screening: 1st screening positive
  - Thyroid echo observation、
  - Risk factor(+) → Fine needle aspiration
- Fine needle aspiration positive:
  - Observation、some case Operation
  - Operated case and Cancer detected =Confirmed Case
# Thyroid cancer examination: 74 cases

<table>
<thead>
<tr>
<th>Year</th>
<th>Population &lt;18 years of age</th>
<th>1st screening Examined No.</th>
<th>1st screening (+)=2nd screening No.</th>
<th>2nd screening Determined No.</th>
<th>Cancer case (operation case)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>47,766</td>
<td>41,561 (87.0%)</td>
<td>218 (0.52%)</td>
<td>187 (85.8%)</td>
<td>14 (10)</td>
</tr>
<tr>
<td>2012</td>
<td>163,264</td>
<td>139,239 (85.3%)</td>
<td>986 (0.70%)</td>
<td>826 (83.8%)</td>
<td>50 (22)</td>
</tr>
<tr>
<td>2013</td>
<td>122,373</td>
<td>88,554 (72.4%)</td>
<td>591 (0.64%)</td>
<td>329 (55.7%)</td>
<td>10 (1)</td>
</tr>
<tr>
<td>合計</td>
<td>333,403</td>
<td>269,354 (80.8%)</td>
<td>1,795 (0.67%)</td>
<td>1,342 (74.8%)</td>
<td>74 (33)</td>
</tr>
</tbody>
</table>

2014/2/7 published (collected to 2013/12/31)
Thyroid cancer examination in Fukushima

(As of Dec.31 2013)

Thyroid cancer prevalence 14/41561 (33.7/100000)

Thyroid cancer prevalence 50/139239 (35.9/100000)

Third year (Apr. 2013 to Mar. 2014)
Thyroid cancer cases 10

Numerator = Number of thyroid patients
Denominator = Number of Echo examined patients
<1> Analysis of Incidence Rate Ratio

Methods: Comparative subjects

- Thyroid cancer incidence rate: National Reserch Institute of Cancer (1975-2008)
  - Average Thyroid cancer incidence rate in Japan: 0.5/100,000 years of age (15-19), year (1975-2008)
  - Average Thyroid cancer incidence rate in Japan: 1.1/100,000 years of age (15-24), year (1975-2008)
- to make a generous estimate,
  Average Thyroid cancer incidence rate in Japan: 0.2-0.3/100,000 years of age (0-19), year (2003-2007)
- It doesn’t matter much which value to give when the amount of data increases.

- Fukushima prefecture is published the data by every 3 month.
  - This analyses are based on the data made public on Feb.7 2014
<1> Analysis of Incidence Rate Ratio
Methods: Adjustment and Estimation

• Prevalence ≈ Incidence rate × Average Duration of the Disease
  – In this study, Average Duration of the Disease:
  – Period from the day when thyroid cancer becomes detectable by medical checkups and FNA to the day when the thyroid cancer becomes detectable by conventional clinical environment without detailed medical checkups.

• Sensitivity analysis: plural prevalence periods (year).
• Estimation of 95% confident interval:
  Poison distribution
The year 2011 ①
The year 2012 =
  4 areas in Central Zone in Fukushima Prefecture
    ② ③ ④ ⑤
The year 2013
  = South East and North East area
    ⑥
    ⑦ 4 cities and town other than Iwaki,
    2nd scleening examined rate > 80%

<table>
<thead>
<tr>
<th>area</th>
<th>Population</th>
<th>1st scleening Examinede No.</th>
<th>2nd scleening Subject No.</th>
<th>2nd scleening Determined No.</th>
<th>Cancer cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Near NPP (first year)</td>
<td>47,766</td>
<td>41,561</td>
<td>218</td>
<td>187</td>
<td>14(10)</td>
</tr>
<tr>
<td>② North: Fukushima (second year)</td>
<td>57,467</td>
<td>50,246</td>
<td>302</td>
<td>269</td>
<td>12</td>
</tr>
<tr>
<td>③ Central: Nihonmatsu (second year)</td>
<td>20,889</td>
<td>17,776</td>
<td>105</td>
<td>91</td>
<td>11</td>
</tr>
<tr>
<td>④ Koriyama (second year)</td>
<td>65,586</td>
<td>54,120</td>
<td>472</td>
<td>374</td>
<td>21</td>
</tr>
<tr>
<td>⑤ South: Shirakawa (second year)</td>
<td>18,980</td>
<td>16,756</td>
<td>105</td>
<td>90</td>
<td>6</td>
</tr>
<tr>
<td>⑥ Iwaki (third year)</td>
<td>62,176</td>
<td>46,201</td>
<td>381</td>
<td>221</td>
<td>8</td>
</tr>
<tr>
<td>⑦ East (other than Iwaki) (third year)</td>
<td>26,775</td>
<td>18,471</td>
<td>136</td>
<td>108</td>
<td>2</td>
</tr>
</tbody>
</table>
Analysis of Incidence Rate Ratio
(Average Duration of the Disease: 2 years)

*IRR (Incidence Rate Ratio)
(95% confident interval)

<table>
<thead>
<tr>
<th>Comparative subjects: Average Thyroid cancer incidence rate in Japan</th>
<th>0.5/100,000</th>
<th>1.1/100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>area</td>
<td>IRR*</td>
<td>(95% C.I.) *</td>
</tr>
<tr>
<td>① Near NPP (first year)</td>
<td>33.69</td>
<td>(19.49-56.19)</td>
</tr>
<tr>
<td>② North: Fukushima (second year)</td>
<td>23.88</td>
<td>(13.31-41.49)</td>
</tr>
<tr>
<td>③ Central: Nihonmatsu (second year)</td>
<td>61.88</td>
<td>(32.38-111.46)</td>
</tr>
<tr>
<td>④ Koriyama (second year)</td>
<td>38.80</td>
<td>(24.55-59.71)</td>
</tr>
<tr>
<td>⑤ South: Shirakawa (second year)</td>
<td>35.81</td>
<td>(15.59-79.29)</td>
</tr>
<tr>
<td>⑥ Iwaki (third year)</td>
<td>17.32</td>
<td>(8.15-34.24)</td>
</tr>
<tr>
<td>⑦ East (other than Iwaki) (third year)**</td>
<td>10.83</td>
<td>(1.92-39.49)</td>
</tr>
</tbody>
</table>

**2nd screening examined rate > 80%
partial reversion of data analysed by Dr. Tsuda
Analysis of Incidence Rate Ratio
(Average Duration of the Disease: 4 years)

*IRR (Incidence Rate Ratio)
(95% confident interval)

<table>
<thead>
<tr>
<th>Area</th>
<th>0.5/100,000</th>
<th>1.1/100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IRR*</td>
<td>(95% C.I.)*</td>
</tr>
<tr>
<td>Near NPP (first year)</td>
<td>16.84</td>
<td>(9.75-28.09)</td>
</tr>
<tr>
<td>North: Fukushima (second year)</td>
<td>11.94</td>
<td>(6.65-20.75)</td>
</tr>
<tr>
<td>Central: Nihonmatsu (second year)</td>
<td>30.94</td>
<td>(16.19-55.73)</td>
</tr>
<tr>
<td>Koriyama (second year)</td>
<td>19.40</td>
<td>(12.27-29.85)</td>
</tr>
<tr>
<td>South: Shirakawa (second year)</td>
<td>17.90</td>
<td>(7.80-39.65)</td>
</tr>
<tr>
<td>Iwaki (third year)</td>
<td>8.66</td>
<td>(4.07-17.12)</td>
</tr>
<tr>
<td>East (other than Iwaki)</td>
<td>5.41</td>
<td>(0.96-19.75)</td>
</tr>
</tbody>
</table>

**2nd screening examined rate > 80%**

(*2nd screening examined rate > 80% partial reversion of data analysed by Dr. Tsuda*)
Analysis of Incidence Rate Ratio
(Average Duration of the Disease: 6 years)
*IRR (Incidence Rate Ratio) (95% confident interval)

<table>
<thead>
<tr>
<th>Area</th>
<th>IRR*</th>
<th>(95% C.I.) *</th>
<th>IRR*</th>
<th>(95% C.I.) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Near NPP (first year)</td>
<td>11.23</td>
<td>(6.50-18.73)</td>
<td>5.10</td>
<td>(2.95-8.51)</td>
</tr>
<tr>
<td>② North: Fukushima (second year)</td>
<td>7.96</td>
<td>(4.44-13.83)</td>
<td>3.62</td>
<td>(2.02-6.29)</td>
</tr>
<tr>
<td>③ Central: Nihonmatsu (second year)</td>
<td>20.63</td>
<td>(10.79-37.15)</td>
<td>9.38</td>
<td>(4.91-16.89)</td>
</tr>
<tr>
<td>④ Koriyama (second year)</td>
<td>12.93</td>
<td>(8.18-19.90)</td>
<td>5.88</td>
<td>(3.72-9.05)</td>
</tr>
<tr>
<td>⑤ South: Shirakawa (second year)</td>
<td>11.94</td>
<td>(5.20-26.43)</td>
<td>5.43</td>
<td>(2.36-12.01)</td>
</tr>
<tr>
<td>⑥ Iwaki (third year)</td>
<td>5.77</td>
<td>(2.72-11.41)</td>
<td>2.62</td>
<td>(1.23-5.19)</td>
</tr>
<tr>
<td>⑦ East (other than Iwaki) (third year)**</td>
<td>3.61</td>
<td>(0.64-13.16)</td>
<td>1.64</td>
<td>(0.29-5.98)</td>
</tr>
</tbody>
</table>

**2nd scleening examined rate > 80%

Partial reversion of data analysed by Dr. Tsuda
Analysis of Incidence Rate

Result

- Incidence rate is clearly high!
- In 2012, Nihonmatsu City, Motomiya city –Central area in Central Zone(Nakadoori) >>
  - In 2011, City and Town, Village near NPP
- Koriyama City, South area of Central Zone >>
  - In 2011, City and Town, Village near NPP
- Continued,
  - 2011 year area > Central Zone North area、Iwai City、
  - 2013 year area other than Iwaki City
  - 2nd screening determined Subject > 80%
<2> Analysis of Prevalence Odds Ratio
（Comparison of Prevalence rate in areas and zones in Fukushima Prefecture）

- Estimation of Prevalence Odds Ratio and 95% confident interval
- Control area: “2013 year area other than Iwaki City ”
  AND “2nd scleening determined Subject > 80% ”
  Prevalence（Sukagawa city, Sooma city, Kagamiishi city, Shinchi town）
- Comparative subjects: 6 areas
  The year 2011=Near the Power Plant
  The year 2012=4 areas in Central Zone in Fukushima Prefecture
  The year 2013=Iwaki city
Analysis of Prevalence Odds Ratio
(Comparison of Prevalence rate in areas and zones in Fukushima Prefecture)

<table>
<thead>
<tr>
<th>area</th>
<th>Cancer cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Near NPP (first year)</td>
<td>14(10)</td>
</tr>
<tr>
<td>② North Fukushima (second year)</td>
<td>12</td>
</tr>
<tr>
<td>③ Central Nihonmatsu (second year)</td>
<td>11</td>
</tr>
<tr>
<td>④ Koriyama (second year)</td>
<td>21</td>
</tr>
<tr>
<td>⑤ South Shirakawa (second year)</td>
<td>6</td>
</tr>
<tr>
<td>⑥ Iwaki (third year)</td>
<td>8</td>
</tr>
</tbody>
</table>
## Analysis of Prevalence Odds Ratio (control area**)

*Prevalence Odds Ratio* *(95% confident interval)*

<table>
<thead>
<tr>
<th>area</th>
<th>がん症例数</th>
<th>一次検診受診者数</th>
<th>POR*</th>
<th>(95% C.I.) *</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Near NPP (first year)</td>
<td>14</td>
<td>41,561</td>
<td>3.11</td>
<td>(0.81-20.22)</td>
</tr>
<tr>
<td>② North Fukushima (second year)</td>
<td>12</td>
<td>50,246</td>
<td>2.21</td>
<td>(0.58-14.53)</td>
</tr>
<tr>
<td>③ Central Nihonmatsu (second year)</td>
<td>11</td>
<td>17,776</td>
<td>5.72</td>
<td>(1.42-37.98)</td>
</tr>
<tr>
<td>④ Koriyama (second year)</td>
<td>21</td>
<td>54,120</td>
<td>3.58</td>
<td>(0.98-22.66)</td>
</tr>
<tr>
<td>⑤ south Shirakawa (second year)</td>
<td>6</td>
<td>16,756</td>
<td>3.31</td>
<td>(0.70-23.82)</td>
</tr>
<tr>
<td>⑥ Iwaki (third year)</td>
<td>8</td>
<td>46,201</td>
<td>1.60</td>
<td>(0.37-11.03)</td>
</tr>
<tr>
<td>⑦ Control (third year) **</td>
<td>2</td>
<td>18,471</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**2nd screening examined rate > 80%**

Partial reversion of data analysed by Dr. Tsuda
Analysis of Prevalence Odds Ratio
（Comparison of Prevalence rate in areas and zones in Fukushima Prefecture）

Result

- Prevalence Odds Ratio is obviously high.
- Clear rise in Prevalence Odds Ratio that is supposed to run in accordance with the average distance from NPP and exposed dose of radiation, in the Central Zone(NakaDoori).
- In an estimation of grade of outbreak of thyroid cancer, Screening effect can not be excluded.
<3> Comparison of Prevalence rate in Fukushima Prefecture and in Chernobyl Accident

Prevalence rate in Fukushima (/100,000)

<table>
<thead>
<tr>
<th>Year</th>
<th>2nd Screening Determined Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>33.7 (39.3) (86%) published</td>
</tr>
<tr>
<td>2012</td>
<td>35.9 (42.9) (84%) published</td>
</tr>
</tbody>
</table>

Prevalence rate in Chernobyl Accident
Echo-screening by Yamashita et.al.
(1991-1996) (/100,000)

- Belarus Gomel: 198.4
- Belarus Mogilev: 8.4
- Ukraine Kiev: 21.7
- Ukraine Zhitomir: 31.0
- Russia Bryansk: 39.7
Conclusion

- Incidence Rate Ratio of thyroid cancer in Fukushima Prefecture is obviously high comparison with average incidence rate in Japan.
- Prevalence Odds Ratio (Comparison of Prevalence rate in areas and zones in Fukushima Prefecture) is clearly high.
- Prevalence rate in Fukushima Prefecture is comparable to prevalence rate in some areas in Chernobyl after the accident.
- Incidence Rate of thyroid cancer in Fukushima Prefecture is definitely high, there is no reason that clear and real outbreak of thyroid cancer will not occur.
- Above-mentioned studies offers that an explanation for the outbreak of thyroid cancer in Fukushima Prefecture is provided by screening effect.
Acknowledgment

• I thank Dr. Toshihide Tsuda, Department of Environmental life science at Okayama University for epidemiological and statistical analysis.

Joint Study Researchers

• Dr. N. Irie, Dr. M. Ijuuin, Dr. N. Umeda, K. Kawasaki, Dr. S. Muro, Dr. K. Mori, Dr. H. Yamamoto, Dr. K. Hayashi
Reference
群馬県、栃木県-北半分、埼玉県と東京都の一部
茨城県の南部と北部、千葉県の北部
宮城県の南部と北部、岩手県や新潟県の一部

被曝線量である40,000Bq/m²を超える汚染地帯=「放射線管理区域」
面積は、20,000平方Kmにもおよび、約1000万人の人々が該当
Childhood Thyroid cancer Prevalence in Fukushima

Thyroid cancer prevalence 14/41561 (33.7/100000)

Thyroid cancer prevalence 50/139239 (35.9/100000)

Third year (Apr. 2013 to Mar. 2014)
Thyroid cancer cases 10

分子=甲状腺がん患者数(赤字)
分母=超音波検査受診者(黒字)
航空機モニタリング-Cs134,137
甲状腺がん罹患率（対人口10万人比・人数）
（2008年、独立行政法人国立がん研究センターがん対策情報センター）

年齢階級別罹患率（男性）
[甲状腺 複数年]

年齢階級別罹患率（女性）
[甲状腺 複数年]

資料：独立行政法人国立がん研究センターがん対策情報センター
Source: Center for Cancer Control and Information Services, National Cancer Center, Japan
甲状腺がんの流行曲線・チェルノブイリ（ベラルーシ：14歳以下）

福島第一原発事故から2.7年は、ここに相当

1986年チェルノブイリ原発事故

津田敏秀氏（岡山大学大学院）作成資料
表5 チェルノブイリの非曝露集団等における集団検診データ

<table>
<thead>
<tr>
<th>研究名</th>
<th>事故時年齢</th>
<th>調査時期</th>
<th>調査時年齢</th>
<th>調査地域</th>
<th>調査人数</th>
<th>発見数</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belarus Screening Program*1</td>
<td>胎児でもない</td>
<td>2002</td>
<td>14歳以下</td>
<td>Gomel</td>
<td>25,446人 (方法不明)</td>
<td>0人</td>
</tr>
<tr>
<td>Shibata *2</td>
<td>胎児でもない</td>
<td>1998-2000</td>
<td>8-13歳</td>
<td>Gomel</td>
<td>9,472人 (超音波)</td>
<td>0人</td>
</tr>
<tr>
<td>Ito*3</td>
<td>0-10歳</td>
<td>1993-1994</td>
<td>7-18歳</td>
<td>Mogilev</td>
<td>12,285人 (超音波)</td>
<td>0人</td>
</tr>
<tr>
<td>Ito*3</td>
<td>0-10歳</td>
<td>1993-1994</td>
<td>7-18歳</td>
<td>Bryanks</td>
<td>12,147人 (超音波)</td>
<td>0人</td>
</tr>
<tr>
<td>Ito*3</td>
<td>0-10歳</td>
<td>1993-1994</td>
<td>7-18歳</td>
<td>Zhitomir</td>
<td>11,095人 (超音波)</td>
<td>1人</td>
</tr>
<tr>
<td>合計</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>70,445人</td>
<td>1人</td>
</tr>
</tbody>
</table>

*1: Demidchik YE: Childhood thyroid cancer in Belarus, Russia and Ukraine after Chernobyl and at present. Arq Bras Endocrinol Metab 2007; 51: 748-762.  