INDOOR AIR QUALITY AND SICK HOUSE SYNDROME IN FUKUSHIMA, JAPAN

Masatoshi TANAKA¹²†, Kazuko TANAKA¹², and Tetsuhito FUKUSHIMA²

¹Fukushima College, Fukushima, Japan
²Fukushima Medical University, Fukushima, Japan

ABSTRACT
Outbreaks of Sick Building Syndrome (SBS) first gained attention in the 1970s in the USA, with the development of more energy-efficient buildings that depend on mechanical ventilation systems to circulate fresh air, as well as to control air temperature and sometimes humidity. SBS at office building and so on is not such a severe problem, but, a similar syndrome has been recently reported with increasing frequency in airtight new houses in Japan, that is, Sick House Syndrome (SHS). We have conducted the survey concerning SHS in Fukushima city, northeast area of Japan since 2003. At first we sent the questionnaire to about 1000 new houses, built from 1996 to 2002 which were independently owned houses. And then in 2004, we measured the indoor air quality (volatile organic compounds (VOC), fungus, mite and so on) in about 70 houses of those surveyed in 2003, and did also the questionnaire survey about health conditions etc of people of the families.

KEYWORDS
Sick House Syndrome, VOC, Fungus, Mite, Ventilation

INTRODUCTION
A popular explanation of cause of Sick Building Syndrome (SBS) was that several volatile organic compounds (VOC) present at very low levels, together exerted a toxic effect (Carrie et al. 1997, Menzies et al. 1997. Seppanen and Fisk 2002). At present, no single environmental factor or group of factors has been established as the single cause of SBS. Recently a similar syndrome has been reported with increasing frequency in airtight new houses in Japan, that is, Sick House Syndrome (SHS). We have conducted the survey concerning SHS in Fukushima city since 2003 with other areas; Sapporo, Nagoya, Osaka, Okayama and Kitakyushu cities. We sent the questionnaire to new houses in each area in 2003. And then in 2004, we measured the indoor air quality (VOC, fungus, mite and so on) in houses of those surveyed in 2003, and did the questionnaire survey about health conditions etc of people of the families.

† Corresponding Author: Tel / Fax:+81 24 545 6585
E-mail address: mtanaka@fmu.ac.jp
METHODS OF RESEARCH
We conducted the survey concerning SHS in Fukushima city, northeast area of Japan in 2003. We sent the questionnaire to about 1000 new houses, built from 1996 to 2002 which were independently owned houses. The response rate was 47% (428 houses). The items of the questionnaire were the conditions of the house, the indoor environment conditions, health conditions of the family, and symptoms related to the indoor air.

And then in 2004, we measured the indoor air quality (VOC, fungus, mite, CO2, house dust and so on) in living rooms of 68 houses of those surveyed in 2003, and did also the questionnaire survey about health conditions etc of 246 people of the families. To collect fungal specimens, we used pbi BIO-SAS sampling system and Petri dishes for identification of colony-forming unite (CFU). House dust-mite samples were collected from carpets etc of living room floors by one of the authors. The dust was collected by vacuuming for 2 min / m² using a vacuum cleaner (National HC-V15). Collected dust samples were stored at -20°C. We collected formaldehyde etc on passive sampler during a 24-h period. To measure CO2 we used a direct-reading, nondispersed infrared detector. We did the surveys at autumn season.

RESULTS AND DISCUSSION
On the questionnaire in 2003, popular indoor ventilation methods were to open the window, and to use ventilation system in each room. Ventilation systems were located mainly in the kitchen and bathroom. On the contrary there are few in bedroom and study room (Figure1).

Frequent symptoms of the families were nasal obstruction, eye strain, breathlessness, skin eczema, skin itching, weariness, languidness, abdominal symptoms, allergic reaction, asthma.

The dew developed in many houses, frequency near 70%. The dew at window was over 90%. The mould developed in the bath room in many houses, frequency over 65%.

In 2004 we measured VOC, fungus, mite, CO2 etc in living rooms. On the results of fungus in air at living rooms, cladosprium was high, over 300CFP/m³ (Table 1). The floor conditions in living room were wood floor (43%), carpet (34%) and tatami (Japanese matt, 18%). The number of mite was less at wood floor compared to carpet (Table 2).

On the results of VOC etc in air at living rooms, formaldehyde and acetaldehyde were detected frequently, and over the Japanese standard of formaldehyde 100ug/m³ and acetaldehyde 48ug/m³ at some living rooms. Mean concentrations of formaldehyde was about 40ug/m³, and acetaldehyde was over 30ug/m³.

On the results of allergic disease of subjects, hay fever, allergic rhinitis and so on were frequently. Frequent symptoms of the families were nasal obstruction, eye strain, skin eczema, skin itching, irritation, languidness.

These symptoms look like sick house symptom (SHS). In those cases, the symptoms were divided as SHS1 and SHS2. SHS1 is the case which occurred according to the cause of the condition in house and occurred frequently. SHS2 is the case which occurred according to the cause of the condition in
Table 1. Fungus in air at living room

<table>
<thead>
<tr>
<th>Colony number</th>
<th>Median</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>cladosprium</td>
<td>210</td>
<td>1000</td>
<td>303.2</td>
<td>266.0</td>
</tr>
<tr>
<td>penicillium</td>
<td>30</td>
<td>490</td>
<td>58.5</td>
<td>85.4</td>
</tr>
<tr>
<td>aspergillus</td>
<td>10</td>
<td>90</td>
<td>10.9</td>
<td>16.1</td>
</tr>
<tr>
<td>other</td>
<td>40</td>
<td>190</td>
<td>54.6</td>
<td>42.0</td>
</tr>
<tr>
<td>unidentified fungi</td>
<td>20</td>
<td>790</td>
<td>35.6</td>
<td>95.3</td>
</tr>
</tbody>
</table>

N = 68  (CFU/m³)

Table 2. Floor condition and mite of floor

<table>
<thead>
<tr>
<th>Floor type</th>
<th>N (%)</th>
<th>(25%-75%)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>wood floor</td>
<td>29 (42.6)</td>
<td>(0.46-11.42)</td>
<td>8.19</td>
<td>15.82</td>
</tr>
<tr>
<td>thick carpet</td>
<td>4 (5.9)</td>
<td>(3.57-16.61)</td>
<td>10.15</td>
<td>6.76</td>
</tr>
<tr>
<td>carpet</td>
<td>23 (33.8)</td>
<td>(0.9-18.85)</td>
<td>12.46</td>
<td>13.36</td>
</tr>
<tr>
<td>tatami</td>
<td>12 (17.6)</td>
<td>(2.04-17.2)</td>
<td>10.67</td>
<td>11.33</td>
</tr>
</tbody>
</table>

N = 68  (µg/g fine dust)
house and occurred frequently and sometimes. SHS1 was 7.7% and SHS2 was 17.5%. On the relationships among SHS symptoms and formaldehyde, formaldehyde levels at the house of no-symptom were slightly low, but there were no significant differences between the levels of formaldehyde at the houses with symptom and no-symptom.

CONCLUSIONS
The main features of SHS are air contamination in a house and the ventilation system to remove it. Common sources of these contaminations include renovation and remodeling material such as paints, insulation material, and VOC such as formaldehyde and so on. Frequent symptoms of the families were nasal, eye and skin symptoms.

Setting of ventilation device was increasing at new houses. Ventilation device must be set up at new house according to the hygienic law of Japanese building from 2003. Measurements of air contamination in residences need to be followed up.

ACKNOWLEDGEMENTS
The study was supported by the grant-in-aid from the Ministry of Health, Labour and Welfare, Health and Labour Sciences Research Grant, Japan

REFERENCES