HYGIENIC AND MANAGEMENT PLAN OF INDOOR AIR QUALITY IN ELEMENTARY SCHOOL

Kil Yong Choi¹, Seong min Han²

Abstract- Purpose: Schools are characterized by high-density spaces, grade classifications, time of use, users' physical features, and organizational operations. In order to maintain and manage the environmental sanitation of the school, it is necessary to assess the management of classroom illumination, noise, classroom air quality, water, the toilet, and the waste. References to the school environment hygiene check standards and manuals, although not reflected in the results of this study, were reflected in the students' responses. Methods: The distribution of student group questionnaire respondents is as follows. Student group surveys were conducted on all students (based on an initial survey of 25 people) in the 5th grade, junior high, and high school. A total of 2,900 students were enrolled: 1,500 elementary school students, 800 middle school students, and 600 high school students. This survey assessed the actual conditions and students' awareness of the school's environmental sanitation management. Results: The results of this study are as follows. First, students in elementary school showed high levels of awareness, and while the levels of regulation awareness and understanding were high, the clarity of regulations was relatively low. Conclusions: As a result, it is necessary to clarify the standards of facilities subject to indoor air quality measurement and make it easier for regulators to understand related terms and process test methods in order to raise the level of regulatory awareness for elementary schools.

Keywords – Elementary school, Management, Hygienic, Environmental, Indoor Air Quality

I. INTRODUCTION
In recent years, sick house and new building syndromes resulting from indoor pollution have become social concerns due to their influence on the wellbeing of the people of Korea (1-2). Children are about 40 percent more likely to be influenced by air quality during the day, especially in rural areas (60 ~ 70 ㎡) (3). This is because children are more susceptible to disease than are adults, so they are more susceptible to pollutants (4-5). Elementary students are especially health-conscious because they are in a developing state and have insufficient resistance to disease. In addition, indoor air pollution (from sources such as furniture, adhesives, plastics, dust, paint, and wallpaper, is more serious than outside air pollution (such as soot emitted from a vehicle) (6-7). Therefore, indoor air quality management is urgently needed. In January 2006, the Ministry of Education and Human Resources Development implemented the School Health Law on Indoor Air Quality, and the schools that were newly built, renovated, and expanded within 3 years were exposed to formaldehyde and total volatile organic compounds (TVOC) (School Health Law, 2006). However, nationwide surveys are lacking, and the rate of respiratory diseases due to exposure to environmental pollutants is increasing (9). There are many kinds of pollutants emitted within the indoor spaces of schools. According to the National Health and Nutrition Survey, the prevalence of allergic rhinitis in Korea has increased 13 times from 1.2% in 1998 to 15.7% in 2010, and the prevalence of asthma has increased more than three times from 1.2% in 1998 to 3.7% (10-11). The incidence of atopic diseases in Korea is higher than that of other diseases. For asthma, the prevalence rate in patients under 10 years of age is 36.4%, among those over 70 years 13.0%, and it is 10.9% among those in their 50s (12-13).

2. MATERIALS AND METHODS

2.1 The importance of school environment hygiene
School facilities are characterized by high-density spaces, grade classifications, time of use, users' physical features, and organizational operations. There is a lack of ventilation, and a large amount of harmful substances caused by building materials (flooring materials, wall materials, etc.); therefore, interest in protecting the educational environment via improving indoor air quality, including reducing fine dusts, is higher than ever. Therefore, in order to maintain and manage the environmental sanitation of the school, it is necessary to assess management of classroom illumination, school noise, classroom air quality, school water, toilet, and waste management. The purpose of this study is to carry out such assessment.

2.2 Designation and professional training of environmental hygiene manager
The head of the school shall designate an "Environmental Sanitation Manager" from among the faculty members in order to maintain and manage the environmental sanitation of the school concerned. The school superintendent, or the superintendent

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of education, shall either directly conduct the necessary education for increasing the expertise of the "Environmental Sanitation Manager" for each school, or they will entrust the education responsibilities to the professional institutions themselves.

2.3 Types and timing of inspections

Table -1 The type and timing of the teacher's environmental hygiene check (survey period ended in November 2017)

<table>
<thead>
<tr>
<th>Types of checks</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily check</td>
<td>Every school day</td>
</tr>
<tr>
<td>Periodic inspection</td>
<td>Each grade: more than once (If a separate number of checks is specified, the regulations shall be followed)</td>
</tr>
</tbody>
</table>
| Special check  | - When there is a possibility of infectious disease  
|                | - When the environment becomes unclean or polluted due to floods, etc.  
|                | - If the school is newly constructed, rebuilt, or repaired, or if new equipment such as a desk, chair, computer, etc. is brought to the teacher and formaldehyde and total volatile organic compound exposure is introduced |

2.4 Contents of inspection

First, indoor environment: ventilation, illumination, temperature, humidity, and noise. Second, air quality: Fine dust, carbon dioxide, formaldehyde, total floating bacteria, falling bacteria, carbon monoxide, nitrogen dioxide, radon, total volatile organic compounds, asbestos, ozone, mites. Third, general environment and food hygiene: waste, canteens, drinking water, water and sewerage, toilet, other environmental hygiene.

2.5 method of inspection

References to the school environment hygiene check standards and manuals, while not reflected in the results of this study, reflect the students' responses to the questions

Table -2 Critical management standards for school hygiene in Korea.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type</th>
<th>Standard</th>
<th>Focus period</th>
<th>Number of years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor environment</td>
<td>Ventilation</td>
<td>Ventilation rate per person is more than 21.6m³</td>
<td>Winter</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Illumination (artificial lighting)</td>
<td>At least 300 lux, maximum and minimum illuminance ratio less than 3:1. Do not cause snowing.</td>
<td>Winter</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Room(indoor) temperature and humidity</td>
<td>Temperature: 18 °C ~ 28 °C (Heating 18-20 °C, Cooling 26-28 °C). Relative Humidity: 30 to 80%</td>
<td>Seasonal</td>
<td>Four times</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>Less than 55 dB (A)</td>
<td>Summer</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Fine dust</td>
<td>100 (µg / m³) or less (less than 10 micrometers)</td>
<td>Winter</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Carbon dioxide</td>
<td>1,000 (ppm) or less (machine ventilation 1,500)</td>
<td>Winter</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Formaldehyde</td>
<td>Below 100(µg/m³)</td>
<td>Summer</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Total suspended bacteria</td>
<td>Below 800(CFU/m³)</td>
<td>Summer</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Falling bacteria</td>
<td>Below 10(CFU/Room)</td>
<td>Summer</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Carbon monoxide</td>
<td>Below 10(ppm)</td>
<td>Winter</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Nitrogen dioxide</td>
<td>Below 0.05(ppm)</td>
<td>Winter</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Radon</td>
<td>Below 4.0(pCi/L)</td>
<td>-</td>
<td>More than once</td>
</tr>
<tr>
<td></td>
<td>Total volatile organic compounds</td>
<td>Below 400(µg/m³)</td>
<td>Summer</td>
<td>More than once</td>
</tr>
</tbody>
</table>
Asbestos | Below 0.01(ea/cc) | - | More than once
---|---|---|---
Ozone | Below 0.06(ppm) | Winter | More than once
Mite | Below mite 100 (mari / m 2), Below mite allergen 10 (㎍ / ㎡) | Summer | More than once

<table>
<thead>
<tr>
<th>General environmental hygiene</th>
<th>Waterworks and sewerage</th>
<th>Installation and maintenance according to the relevant regulations.</th>
<th>Summer</th>
<th>Four times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilet installation and disinfection</td>
<td>Classification of man and woman, A flushed toilet. Hand washing and disinfection facilities. - April to September: more than 3 times a week. - October to March: Disinfection more than once a week.</td>
<td>Summer</td>
<td>Four times</td>
<td></td>
</tr>
<tr>
<td>Waste</td>
<td>Weight loss and separation discharge</td>
<td>Summer</td>
<td>More than 2 times</td>
<td></td>
</tr>
</tbody>
</table>

Inspection and Support Principal: daily life, regular, after special checkup action. Superintendent of education (schools): guidance of inspection method, support of professional manpower and conducting surveys.

### 3. RESULT

#### 3.1 Respondent (Student Groups) Characteristics

The distribution of the student group questionnaire respondents is as follows. Student group surveys (based on responses from 25 people) were conducted on all students in the 5th grade, junior high, and high school. A total of 2,900 students were enrolled: 1,500 elementary, 800, and 600 high school students.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Target investigation</th>
<th>for Survey respondent</th>
<th>Response rate</th>
<th>Composition ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>1,500</td>
<td>1,118</td>
<td>74.5%</td>
<td>54.2%</td>
</tr>
<tr>
<td>Middle School</td>
<td>800</td>
<td>531</td>
<td>66.4%</td>
<td>25.8%</td>
</tr>
<tr>
<td>High school</td>
<td>600</td>
<td>413</td>
<td>68.8%</td>
<td>20.0%</td>
</tr>
<tr>
<td>Total</td>
<td>2,900</td>
<td>2,062</td>
<td>71.1%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

#### 3.2 Elementary school group

The distribution of elementary school survey respondents is as follows. The elementary school questionnaire respondents included 25 samples of 5th grade elementary school students. These were randomly extracted from the responses of 1,500 elementary school parents and 5 faculty members.

Figure 1. Elementary school survey response rate and composition ratio of elementary school
3.3 Student Group Respondent Characteristics

This survey assessed the actual condition and awareness of the school's environmental sanitation management. The survey items analyzed aspects of the classroom such as ventilation, lighting, noise, drinking water, toilet conditions, air quality, and items needing top priority improvements. The subjects' questionnaire was divided into 5 steps. The results of the survey confirmed the degree of positivity and negativity based on the percentage of quantitative evaluation. The elementary school students responded 30% for "Lighting in the classroom," "Classroom noise," "Water at school," "School restroom," and "Air condition in the classroom." The rest tended to receive responses as high as 50%. Mean values were 2.7264, 2.6281, 2.5816, 2.7503, and 2.4497, respectively, and the standard deviation was statistically significant at 0.0874, 0.9444, 1.0492, 1.0441, and 0.9099 (<.0001, .0001, .0001, 0.0002, and .0001).

Table -4 Correlation between Elementary school and Survey response

<table>
<thead>
<tr>
<th>Lighting in the classroom</th>
<th>Woman</th>
<th>Mean</th>
<th>Std Dev</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>216(23.3)</td>
<td>2.7264</td>
<td>0.0874</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Good</td>
<td>356(38.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually</td>
<td>267(28.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not good</td>
<td>71(7.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very bad</td>
<td>15(1.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Great obstruction</td>
<td>111(12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequent obstruction</td>
<td>297(32.1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usual obstruction</td>
<td>360(38.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little obstruction</td>
<td>139(15)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No obstruction at all</td>
<td>18(1.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very safe</td>
<td>169(18.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe</td>
<td>246(26.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually safe</td>
<td>343(37)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uneasy about drinking</td>
<td>137(14.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very uneasy drinking</td>
<td>30(3.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very clean</td>
<td>106(11.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean</td>
<td>289(31.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually</td>
<td>301(32.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dirty</td>
<td>188(20.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very dirty</td>
<td>41(4.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>very good</td>
<td>141(7.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfactory</td>
<td>342(36.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually good</td>
<td>339(36.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>91(9.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not satisfactory at all</td>
<td>12(1.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finally, 50% of the respondents answered that they need help and practice, and that they were interested in the survey response (environmental hygiene management). On the other hand, in terms of what the respondents knew, positive and negative tendencies were similar, and this finding was statistically significant.

Table -5 Correlation between Elementary school and Survey response (Environmental hygiene management)

<table>
<thead>
<tr>
<th>School environment hygiene management (1)</th>
<th>Woman</th>
<th>Mean</th>
<th>Std Dev</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very well known</td>
<td>65(7.0)</td>
<td>2.893</td>
<td>0.8556</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>know</td>
<td>172(18.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually know</td>
<td>511(55.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uncertain</td>
<td>151(16.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extremely uncertain</td>
<td>26(2.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School environment hygiene management (2)</th>
<th>Woman</th>
<th>Mean</th>
<th>Std Dev</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very helpful</td>
<td>167(18.0)</td>
<td>2.3027</td>
<td>0.8265</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Helpful</td>
<td>359(38.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually helpful</td>
<td>354(38.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not helpful</td>
<td>42(4.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extremely unhelpful</td>
<td>3(0.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results of this study are as follows. First, students in elementary school showed high levels of awareness. Further, the levels of regulation awareness and understanding were high, but the clarity of regulation was relatively low. As a result, it is necessary to clarify the standards of facilities subject to indoor air quality measurement and make it easier for regulators to understand related terms and process test methods in order to raise the levels of regulatory awareness in elementary schools.

The participation of elementary schools was high due to the degree of regulation, which was good, and the degree of recognition of regulatory necessity and compliance with the regulation purpose was high. However, the degree of adherence to regulation levels was relatively low. As a result, the need for an indoor air quality measurement system and compliance with objectives are high, but the regulation level's appropriateness is not high. Therefore, we will consider ways to fill a need by improving the regulatory level (range of regulated substances, number of measurements, measurement items, and measurement conditions).

In terms of regulatory compliance, elementary school participation was high, which reflected good policy. Both regulated and enforcement officials had a high compliance rate, but regulatory enforcement was low.

### 5. REFERENCES


