HYGIENIC AND MANAGEMENT PLAN OF INDOOR AIR QUALITY IN ELEMENTARY SCHOOL

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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)

Types of checks	Period
Daily check	Every school day
Periodic inspection	Each grade: more than once (If a separate number of checks is specified, the regulations shall be followed)
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.

Classification	Type	Standard	Focus period	Number of years
Indoor environment	Ventilation	Ventilation rate per person is more than 21.6㎥	Winter	More than once
	Illumination (artificial lighting)	At least 300 lux, maximum and minimum illuminance ratio less than 3: 1. Do not cause snowing.	Winter	More than once
	Room(indoor) temperature and humidity	Temperature: 18 ℃ ~ 28 ℃ (Heating 18-20 ℃, Cooling 26-28 ℃). Relative Humidity: 30 to 80%	Seasonal	Four times
	Noise	Less than 55 dB (A)	Summer	More than once
Teacher Indoor Air Quality	Fine dust	100 (μg / ㎥) or less (less than 10 micrometers)	Winter	More than once
	Carbon dioxide	1,000 (ppm) or less (machine ventilation 1,500)	Winter	More than once
	Formaldehyde	Below 100(μg/㎥)	Summer	More than once
	Total suspended bacteria	Below 800(CFU/㎥)	Summer	More than once
	Falling bacteria	Below 10(CFU/Room)	Summer	More than once
	Carbon monoxide	Below 10(ppm)	Winter	More than once
	Nitrogen dioxide	Below 0.05(ppm)	Winter	More than once
	Radon	Below 4.0(pCi/L)	-	More than once
	Total volatile organic compounds	Below 400(μg/㎥)	Summer	More than once

	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 (μg / ㎡)	Summer	More than once
General environmental hygiene	Waterworks and sewerage	Installation and maintenance according to the relevant regulations.	Summer	Four times
	Toilet installation and disinfection	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.	Summer	Four times
	Waste	Weight loss and separation discharge	Summer	More than 2 times
	Drinking water	Water supply: direct supply of water. Groundwater: water tank with diesel. Water tank: check once a month, clean twice a year. Drinking water meets quality standards.	Seasonal	Four times
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 -3 Distribution of students' survey respondents   Unit: persons (%)

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

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.
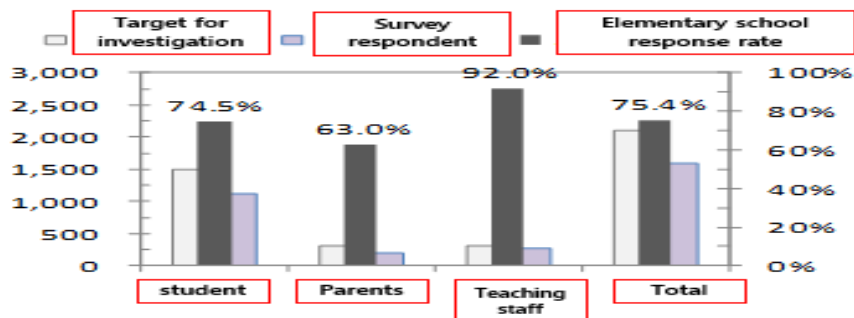
Figure 1.   Elementary school survey response rate and composition ratio of elementary school

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

		Woman	Mean	Std Dev	p-value
Lighting in the classroom	Very good	216(23.3)	2.7264	0.0874	<.0001
	Good	356(38.4)			
	Usually	267(28.8)			
	Not good	71(7.6)			
	Very bad	15(1.6)			
Classroom noise	Great obstruction	111(12)	2.6281	0.9444	<.0001
	Frequent obstruction	297(32.1)			
	Usual obstruction	360(38.9)			
	Little obstruction	139(15)			
	No obstruction at all	18(1.9)			
Water at school	Very safe	169(18.2)	2.5816	1.0492	<.0001
	Safe	246(26.5)			
	Usually safe	343(37)			
	Uneasy about drinking	137(14.8)			
	Very uneasy drinking	30(3.2)			
School restroom	Very clean	106(11.4)	2.7503	1.0441	0.0002
	Clean	289(31.2)			
	Usually	301(32.5)			
	Dirty	188(20.3)			
	Very dirty	41(4.4)			
Air condition in the classroom	very good	141(7.4)	2.4497	0.9099	<.0001
	Satisfactory	342(36.9)			
	Usually good	339(36.6)			
	Unsatisfactory	91(9.8)			
	Not satisfactory at all	12(1.3)			

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)

		Woman	Mean	Std Dev	p-value
School environment hygiene management (1)	Very well known	65(7.0)	2.893	0.8556	<.0001
	know	172(18.5)			
	Usually know	511(55.2)			
	uncertain	151(16.3)			
	Extremely uncertain	26(2.8)			
School environment hygiene management (2)	Very helpful	167(18.0)	2.3027	0.8265	<.0001
	Helpful	359(38.8)			
	Usually helpful	354(38.2)			
	Not helpful	42(4.5)			
	Extremely unhelpful	3(0.3)			

School environment hygiene management (3)	Very well practiced	109(11.7)	2.4897	0.8026	<.0001
	Practiced	319(34.4)			
	Usually practiced	440(47.5)			
	Rarely practiced	49(5.3)			
	Not practiced at all	8(0.8)			
School environment hygiene management (4)	Very interested	96(10.3)	2.6432	0.8927	0.0087
	Interested	279(30.1)			
	Usually interested	434(46.9)			
	Not interested	91(9.8)			
	Extremely disinterested	25(2.7)			

4. CONCLUSION

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.

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