



A Study on Hazard Assessment of Employees in New Buildings

Dalwoong Choi

College of Health Sciences, Korea University, Seoul 136-703, Korea

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In order to evaluate the physical and psychological health effects of air pollutants from new building materials, 100 employees who worked in new buildings were given a general health questionnaire, and the prevalence of their subjective complaints was measured. The collected data were classified according to age, gender, smoking status, profession, working time, sleep time, life style, and length of employment. The results obtained were summarized as follows: The THI lie scale scores were significantly higher among the older respondents. Compared to males, females showed a significantly higher level in the depression items as well as a tendency toward high ratios of physical and psychological complaints. The smoking group showed higher scores regarding health complaints related to most physical and psychological items. Smokers showed significantly increased respiratory organ complaints compared to nonsmokers. Those with a profession showed significantly higher level of nervousness. The group of those working 7 to 10 hours group showed higher rates of complaints in the multiple subjective symptoms and mouth/anus items than the group working less than 2 hours. Those living an irregular life showed a tendency toward higher rates of complaints for most physical and psychological subjective factors. Those who were satisfied with their environments showed significantly lower scores in the mouth/anus, impulsiveness, mental irritability, depression, and nervousness items. In summary, this study shows that the health complaint scores regarding physical and psychological symptoms tended to be higher among the unsatisfied group, the irregular life group, the group who worked long hours, the elderly, smokers, and females. These results can be used to improve the psychosomatic health status and working environments of employees working in new buildings.

Key words: Hazard assessment, Employee, Building

INTRODUCTION

As people spend more and more time in hermetically sealed and insulated houses or buildings, they increasingly complain about new symptoms related to indoor environment pollution. In particular, sick house syndrome or sick building syndrome has emerged, which encompasses diseases related to indoor environments such as allergic rhinitis, atopic dermatitis, and asthma. According to previous theses and reports, this syndrome results from harmful substances in new furniture, construction materials and interior air pollutants (Norbäck, 2009). Sick house syndrome refers to irritation responses such as allergic diseases, including allergic rhinitis, atopic dermatitis, asthma, and chronic hives and irritation to the eyes, nose, and neck, headache, and systemic fatigue occurring after exposure to chemical organic

matter or floating bacteria, especially after moving to a new or repaired house (Kanazawa *et al.*, 2010). New house syndrome emerged in the 1990s, and together with this, chemical hypersensitive syndrome appeared. There are many objects containing chemical substances, including furniture, shampoos, detergents, and pesticides; the diseases of those who sensitively respond to these chemical materials are categorized as chemical hypersensitive syndrome (Hutter *et al.*, 2006). In new buildings, sufficient oxygen supply should be made available in order to avoid chemical hypersensitive syndrome, which anybody may experience due to severe indoor contamination; furthermore, attention should be paid to construction materials and how to remove indoor building pollution sources, as well as health problems involving new interior, which people may easily come into contact with.

Hazardous substances that are the cause of these diseases are classified as particulate materials, heavy metals, fume, mist, gaseous materials, volatile organic compounds (VOCs) and formaldehyde (HCHO). Recently, VOCs and HCHO

Correspondence to: Dalwoong Choi, College of Health Sciences, Korea University, Seoul 136-703, Korea
E-mail: dwlove@korea.ac.kr

have been identified as carcinogens when the body is exposed to them in work sites or indoor spaces; this has drawn a great deal of research attention. The toxicity of HCHO was demonstrated by a Chemical Industry Institute of Toxicology report; this report used a wide range of research results to show that HCHO was harmful to the human body. In terms of exposure to HCHO, *urea* resin, and melamine resin are used often as adhesives for plywood and new furniture, as well as for insulators and antiseptic substances (Sakai *et al.*, 2004). All kinds of wooden and iron furniture and decorations installed indoors are known to emit noxious substances such as VOCs and HCHO and trigger diseases such as headache and asthma.

Todai Health Index (THI) is a health questionnaire on physical, mental, psychological, and life behaviors and can be used to examine respondents' life background, ordinary life, behaviors, and habit traits (Kunugita *et al.*, 1989). It is a revised and complementary version of the Cornell Medical Index (CMI) and asks about Asian people's common physical, mental, psychological, and life behaviors; it may also look at respondents' self-learning symptoms and life background, ordinary life behaviors, and habit traits (Brodman *et al.*, 1949; Suzuki and Roberts, 1991). Since its introduction to Korea in 1979, the THI has been applied to diverse groups such as urban people, rural people, nurses, nuns, women workers, and street cleaners by various researchers (Choi and Kim, 1992; Lee, 1996; Sohn *et al.*, 2003a; Sohn *et al.*, 2003b; Tsuchiya *et al.*, 1986; Kunugita *et al.*, 1993).

Among the hazardous substances from new interiors, the noxious effects of chemical organic compounds and HCHO are most severe. Workers in buildings or cafes whose interiors have been newly decorated are highly exposed to these indoor air pollutants and may suffer from health disorders. Accordingly, using the THI, this study examined the effects of building employees' working environment on their health conditions and their perceived degree of socio-psychological health, thereby looking at the relationship between environmental factors and health hazards. The purpose of the present study is to examine the health conditions of individual workers and the entire respondent group using THI by looking at health traits; furthermore, it aims to provide basic materials that may become guidelines for smoothly performing health management of employees working within an environment with air pollutants from new building materials.

MATERIALS AND METHODS

Study subjects and method. In the present study, the researcher visited new buildings located in Seoul and Gyeonggi-Do to distribute THI questionnaire sheets to those who were part-time employees in new buildings (cafes, offices, etc.). Among a total of 110 copies distributed, 100 responses—

Table 1. Classification of 12 Items according to Todai Health Index

Items	Abbreviation (Marks)	Number of Question
Multiple Subjective Symptoms	SUSY(I)	20
Respiratory	RESP(A)	10
Eye and Skin	EYSK(B)	10
Mouth and Anus	MOUT(D)	10
Digestive	DIGE(C)	9
Impulsiveness	IMPU(H)	9
Lie Scale	LISC(L)	10
Mental Irritability	MENT(J)	14
Depression	DEPR(K)	10
Aggressiveness	AGGR(F)	7
Nervousness	NERV(E)	8
Irregular Life	LIFE(G)	11
Total		128

excluding 10 with inadequate answers or data that could not be processed such as incomplete responses—were used as data for analysis in the present study.

Study tool and assessment method. The THI health questionnaire consists of a total of 12 items: multiple subjective symptoms (I), respiratory organs (A), eyes/skin (B), mouth/anus (D), digestive organs (C), impulsiveness (H), lie scale (L), mental irritability (J), depression (K), aggressiveness (F), nervousness (E), and irregular life (G) (Table 1). In statistical processing of the data, 3 points were given for each "yes" answer and 1 point for each "no" answer; mean complaint scores and standard deviations were calculated according to each item to analyze and organize the data, and the significance of the data was tested using analysis of variance (ANOVA).

Method of analysis. All collected data were transferred into computer code and statistically processed on the computer using the SPSS package. The statistical processing was conducted using t-tests and one-way ANOVA; when significant differences between levels were recognized, Duncan's multiple range tests were used to conduct a posteriori tests.

RESULTS

General characteristics. In terms of the general characteristics of the survey subjects, there were 68 males (68.0%), and 59 were aged 20~29 years, accounting for 59.0% of the subjects. Thirty-eight employees works less than two hours a day in the building (38.0%), while the rest worked for 3~10 hours in the building (52%). Of the subjects, 43 (43.0%) had no regular occupation. Forty-four of them (44.0%) were smokers. Finally, 65 (65.0%) of them were identified as being satisfied with their working envi-

Table 2. Physical and Psychological symptom complaints according to smoking status (mean ± SD)

Item	Smoker or Non-Smoker	
	S (n = 44)	N.S (n = 56)
Multiple Subjective Symptoms	I 38.09 ± 3.88	36.82 ± 7.19
Respiratory	A 18.55 ± 4.13	16.43 ± 4.56*
Eye and Skin	B 18.16 ± 4.53	16.77 ± 4.22
Mouth and Anus	D 15.07 ± 3.74	13.84 ± 3.55
Digestive	C 16.09 ± 3.38	15.02 ± 3.75
Impulsiveness	H 18.07 ± 3.50	17.09 ± 3.55
Lie Scale	L 19.14 ± 3.03	19.02 ± 3.58
Mental Irritability	J 25.91 ± 6.67	25.30 ± 6.85
Depression	K 17.98 ± 4.71	17.13 ± 4.87
Aggressiveness	F 14.30 ± 3.05	14.96 ± 3.56
Nervousness	E 15.57 ± 3.31	16.05 ± 3.93
Irregular Life	G 23.05 ± 4.59	21.50 ± 4.02

* (P < 0.05 Student's t-test).

Table 3. Physical and Psychological symptom complaints according to Gender (mean ± SD)

Item	Male and Female	
	M (n = 68)	FM (n = 32)
Multiple Subjective Symptoms	I 36.74 ± 7.87	38.75 ± 4.70
Respiratory	A 17.74 ± 4.68	16.56 ± 3.98
Eye and Skin	B 17.35 ± 4.79	17.44 ± 3.47
Mouth and Anus	D 14.38 ± 3.92	14.38 ± 3.13
Digestive	C 15.28 ± 3.84	15.94 ± 3.09
Impulsiveness	H 17.53 ± 3.75	17.50 ± 3.13
Lie Scale	L 18.75 ± 3.47	19.75 ± 2.95
Mental Irritability	J 24.90 ± 7.00	27.00 ± 6.02
Depression	K 16.60 ± 4.48	19.41 ± 4.96*
Aggressiveness	F 14.71 ± 2.99	14.59 ± 4.05
Nervousness	E 15.47 ± 3.81	16.63 ± 3.25
Irregular Life	G 21.87 ± 4.55	22.84 ± 3.79

* (P < 0.05 Student's t-test).

ronment.

Rates of physical and psychological complaints among the study subjects.

Responses involving physical and psychological subjective complaints according to smoking status: In responses involving physical and psychological subjective complaints according to smoking status, smokers showed significantly increased respiratory organ complaints compared to nonsmokers (Table 2). This is considered to be due to the harmful substances in cigarette smoke.

Responses involving physical and psychological subjective complaints according to gender: In responses involving physical and psychological subjective complaints according to gender, females showed a significantly increased level in the depression item compared to males, as well as a

tendency toward high ratios of physical and psychological complaints (Table 3). This could be because females have greater environmental sensitivity than males.

Responses involving physical and psychological complaints according to age: Responses involving physical and psychological subjective complaints showed significant differences in the symptom lie scale between those in their 10s and those aged 30 years or more; higher rates of complaints were shown among the older respondents (Table 4). Given this result, it is considered that those aged 30 years or more are more sensitive to environmental modification.

Responses involving physical and psychological subjective complaints according to profession: In responses involving physical and psychological subjective complaints, those with a profession showed significant increases in ner-

Table 4. Physical and Psychological symptom complaints according to age (mean ± SD). Different alphabet means significant difference (P < 0.05)

Item		Ages (year)		
		10~19 (n = 35)	20~29 (n = 59)	> 30 (n = 6)
Multiple Subjective Symptoms	I	36.63 ± 8.50	37.92 ± 6.03	36.50 ± 7.94
Respiratory	A	17.71 ± 5.00	17.10 ± 4.07	17.83 ± 5.78
Eye and Skin	B	17.46 ± 4.62	17.32 ± 4.25	17.50 ± 5.24
Mouth and Anus	D	13.86 ± 3.66	14.64 ± 3.56	14.83 ± 5.08
Digestive	C	14.14 ± 3.57	16.15 ± 3.34	16.83 ± 4.79
Impulsiveness	H	17.17 ± 3.86	17.78 ± 3.38	17.00 ± 3.58
Lie Scale	L	18.31 ± 3.79a	19.31 ± 2.90ab	21.17 ± 3.87b
Mental Irritability	J	25.00 ± 6.23	26.03 ± 7.16	24.33 ± 5.85
Depression	K	17.14 ± 5.21	17.88 ± 4.50	15.83 ± 5.49
Aggressiveness	F	14.54 ± 3.85	14.63 ± 3.07	15.83 ± 3.06
Nervousness	E	15.34 ± 3.84	16.17 ± 3.55	15.50 ± 3.94
Irregular Life	G	21.26 ± 4.20	22.93 ± 4.25	20.17 ± 4.92

One way-ANOVA followed by Duncan's Multiple Range Test.

Table 5. Physical and Psychological symptom complaints according to profession (mean \pm SD)

Item	Permanent employee	
	Y (n = 43)	N (n = 57)
Multiple Subjective Symptoms	I 37.60 \pm 7.43	37.21 \pm 6.81
Respiratory	A 17.42 \pm 4.26	17.32 \pm 4.68
Eye and Skin	B 17.65 \pm 4.54	17.18 \pm 4.31
Mouth and Anus	D 14.84 \pm 4.06	14.04 \pm 3.34
Digestive	C 15.93 \pm 3.67	15.16 \pm 3.58
Impulsiveness	H 17.44 \pm 3.81	17.58 \pm 3.37
Lie Scale	L 19.77 \pm 3.04	18.54 \pm 3.48
Mental Irritability	J 24.93 \pm 6.60	26.05 \pm 6.86
Depression	K 17.63 \pm 4.66	17.40 \pm 4.94
Aggressiveness	F 15.28 \pm 3.13	14.21 \pm 3.46
Nervousness	E 16.86 \pm 3.47	15.07 \pm 3.64*
Irregular Life	G 22.37 \pm 4.58	22.04 \pm 4.16

* (P < 0.05 Student's t-test).

vousness (Table 5). Given this result, those that had a profession are considered to have higher stress arising from the combination of a permanent job and the working environment. Employees with a regular position in their jobs are more interested in examining their working environments.

Responses involving physical and psychological subjective complaints according to average daily working time: In responses involving physical and psychological subjective complaints according to average daily working time, significant differences were shown between those who worked 7~10 hours and those who worked less than 2 hours. The 7~10 hours group showed higher rates of complaints in the multiple subjective symptoms and mouth/anus items (Table 6). Given these results, it is considered that physical health complaints increased due to working for long periods in new buildings that do not provide comfortable air environments.

Table 6. Physical and Psychological symptom complaints according to working time (mean \pm SD). Different alphabet means significant difference (P < 0.05)

Item		Working time (hours)			
		< 2 (n = 38)	3~7 (n = 35)	7~10 (n = 17)	10 < (n = 10)
Multiple Subjective Symptoms	I	35.61 \pm 6.75a	37.74 \pm 6.59ab	40.71 \pm 8.29b	37.20 \pm 6.2ab
Respiratory	A	16.26 \pm 4.11	18.00 \pm 4.78	18.06 \pm 4.71	18.10 \pm 4.18
Eye and Skin	B	16.66 \pm 4.45	18.11 \pm 4.28	17.47 \pm 4.09	17.40 \pm 5.23
Mouth and Anus	D	13.37 \pm 2.61a	14.83 \pm 4.23ab	16.06 \pm 4.41b	13.80 \pm 2.62ab
Digestive	C	14.84 \pm 3.54	15.86 \pm 3.84	16.41 \pm 3.54	15.10 \pm 3.21
Impulsiveness	H	17.16 \pm 3.76	17.29 \pm 3.36	17.88 \pm 3.59	19.10 \pm 3.32
Lie Scale	L	19.37 \pm 3.52	19.23 \pm 3.41	18.29 \pm 3.46	18.70 \pm 2.11
Mental Irritability	J	25.47 \pm 6.86	25.89 \pm 5.79	24.88 \pm 7.77	26.00 \pm 8.42
Depression	K	17.24 \pm 5.31	17.57 \pm 4.06	19.00 \pm 5.76	15.70 \pm 2.79
Aggressiveness	F	14.74 \pm 2.92	14.91 \pm 3.69	14.53 \pm 3.54	13.80 \pm 3.65
Nervousness	E	15.79 \pm 4.02	16.14 \pm 3.34	16.00 \pm 3.48	14.70 \pm 3.95
Irregular Life	G	21.53 \pm 4.19	22.91 \pm 4.03	21.53 \pm 4.46	23.20 \pm 5.59

One way-ANOVA followed by Duncan's Multiple Range Test.

Table 7. Physical and Psychological symptom complaints according to time spent sleeping (mean \pm SD). Different alphabet means significant difference (P < 0.05)

Item		Sleep time (hours)			
		< 4 (n = 11)	4~6 (n = 33)	6~8 (n = 45)	8 < (n = 11)
Multiple Subjective Symptoms	I	37.91 \pm 6.98	38.91 \pm 8.04	36.22 \pm 6.63	37.00 \pm 5.37
Respiratory	A	17.27 \pm 4.15	18.18 \pm 4.53	16.29 \pm 4.14	19.36 \pm 5.33
Eye and Skin	B	16.27 \pm 4.67	17.88 \pm 4.74	17.07 \pm 4.30	18.27 \pm 3.52
Mouth and Anus	D	14.73 \pm 3.95	15.03 \pm 4.36	13.93 \pm 3.11	13.91 \pm 3.39
Digestive	C	15.91 \pm 3.24	15.91 \pm 4.22	15.29 \pm 3.38	14.64 \pm 3.17
Impulsiveness	H	18.64 \pm 3.26	17.82 \pm 3.84	16.93 \pm 3.33	17.91 \pm 3.83
Lie Scale	L	18.09 \pm 2.55	19.52 \pm 3.92	18.89 \pm 3.01	19.45 \pm 3.53
Mental Irritability	J	25.18 \pm 8.29	26.00 \pm 7.60	25.67 \pm 6.17	24.27 \pm 5.10
Depression	K	16.36 \pm 2.66	18.15 \pm 4.88	16.96 \pm 5.24	18.91 \pm 4.16
Aggressiveness	F	13.36 \pm 3.01	15.00 \pm 3.02	14.56 \pm 2.62	15.45 \pm 6.28
Nervousness	E	14.64 \pm 3.91	16.45 \pm 3.96	15.76 \pm 3.56	15.55 \pm 2.91
Irregular Life	G	23.36 \pm 4.74	22.48 \pm 4.34	21.71 \pm 4.42	22.00 \pm 3.72

One way-ANOVA followed by Duncan's Multiple Range Test.

Table 8. Physical and Psychological symptom complaints according to job satisfaction (mean ± SD)

Item	Satisfaction and Dissatisfaction	
	S (n = 65)	DS (n = 35)
Multiple Subjective Symptoms	I 36.55 ± 7.17	38.91 ± 6.65
Respiratory	A 17.65 ± 4.49	16.83 ± 4.48
Eye and Skin	B 17.22 ± 4.29	17.69 ± 4.63
Mouth and Anus	D 13.71 ± 3.12	15.63 ± 4.29*
Digestive	C 15.29 ± 3.33	15.86 ± 4.13
Impulsiveness	H 16.95 ± 3.11	18.57 ± 4.08*
Lie Scale	L 18.83 ± 3.32	19.51 ± 3.36
Mental Irritability	J 24.26 ± 6.04	28.00 ± 7.36*
Depression	K 16.80 ± 4.28	18.80 ± 5.47*
Aggressiveness	F 14.75 ± 2.66	14.51 ± 4.38
Nervousness	E 15.31 ± 3.45	16.83 ± 3.88*
Irregular Life	G 21.98 ± 3.83	22.54 ± 5.16

* (P < 0.05 Student's t-test)

Responses involving physical and psychological subjective complaints according to daily average sleep time: In responses about physical and psychological subjective complaints according to daily average sleep time, no significant differences were shown between respondents in the following group: less than 4 hours, 4~6 hours, 6~8 hours, and 8 hours or more (Table 7). However, the 4~6 hours group showed a tendency to have higher rates of complaints in the many items related to subjective physical and psychological wellbeing.

Responses involving physical and psychological subjective complaints according to satisfaction with working environments: In responses involving physical and psychological subjective complaints according to satisfaction of working environments, those who were satisfied

Table 10. Physical and Psychological symptom complaints according to lifestyle (mean ± SD). Different alphabet means significant difference (P < 0.05)

Item	Regular life	
	Y (n = 33)	N (n = 67)
Multiple Subjective Symptoms	I 34.09 ± 7.23	39.00 ± 6.41*
Respiratory	A 16.70 ± 4.89	17.69 ± 4.27
Eye and Skin	B 15.97 ± 4.41	18.07 ± 4.25*
Mouth and Anus	D 12.94 ± 3.19	15.09 ± 3.70*
Digestive	C 14.91 ± 3.52	15.78 ± 3.66
Impulsiveness	H 16.88 ± 3.81	17.84 ± 3.39
Lie Scale	L 19.00 ± 3.64	19.10 ± 3.20
Mental Irritability	J 24.09 ± 6.69	26.30 ± 6.70
Depression	K 16.15 ± 4.38	18.16 ± 4.88*
Aggressiveness	F 15.12 ± 2.87	14.45 ± 3.56
Nervousness	E 15.15 ± 3.68	16.18 ± 3.64
Irregular Life	G 19.64 ± 3.98	23.43 ± 3.95*

One way-ANOVA followed by Duncan's Multiple Range Test.

with the environments showed significantly lower scores in the mouth/anus, impulsiveness, mental irritability, depression, and nervousness items (Table 8). The satisfaction group showed lower rates of complaints in most physical and psychological subjective items.

Responses involving physical and psychological subjective complaints according to length of employment: In responses involving physical and psychological subjective complaints according to working career periods, significant differences were shown in the impulsiveness, mental irritability, and irregular life items; in particular, those who had worked 3~5 years showed higher rates of complaints (Table 9). Given that most of the survey subjects (94.0%) were in their 10s or 20s, the working career periods are considered to have been too long for their ages. Therefore,

Table 9. Physical and Psychological symptom complaints according to length of employment (mean ± SD). Different alphabet means significant difference (P < 0.05)

Item	Length of employment (years)			
	I < (n = 25)	1-3 < (n = 28)	3-5 < (n = 14)	5 > (n = 33)
Multiple Subjective Symptoms	I 36.36 ± 6.96	36.25 ± 6.55	39.21 ± 5.93	38.33 ± 7.91
Respiratory	A 17.52 ± 4.72	15.79 ± 3.55	18.57 ± 4.43	18.06 ± 4.84
Eye and Skin	B 16.96 ± 4.33	16.61 ± 4.30	17.93 ± 4.22	18.12 ± 4.64
Mouth and Anus	D 14.24 ± 3.41	13.71 ± 3.61	15.36 ± 3.82	14.64 ± 3.89
Digestive	C 15.60 ± 3.91	14.68 ± 3.13	15.64 ± 3.10	16.03 ± 4.00
Impulsiveness	H 18.56 ± 3.14b	16.21 ± 2.92a	18.79 ± 4.08b	17.30 ± 3.80ab
Lie Scale	L 19.52 ± 2.58	18.29 ± 3.78	19.07 ± 1.90	19.39 ± 3.88
Mental Irritability	J 24.28 ± 7.06a	25.50 ± 6.35a	30.86 ± 5.50b	24.36 ± 6.47a
Depression	K 18.68 ± 5.08	16.61 ± 5.30	18.50 ± 3.59	16.94 ± 4.51
Aggressiveness	F 15.20 ± 4.75b	14.00 ± 2.76ab	13.00 ± 2.29a	15.55 ± 2.55b
Nervousness	E 16.76 ± 3.66	14.75 ± 3.70	16.86 ± 3.78	15.64 ± 3.45
Irregular Life	G 21.04 ± 3.54a	21.43 ± 4.33a	24.64 ± 4.07b	22.64 ± 4.65ab

One way-ANOVA followed by Duncan's Multiple Range Test.

it is considered that working career periods have large mental and physical effects. Great differences were shown between 1~3 years and 3~5 years; this is considered to have resulted from the great development of impulsiveness, mental irritability, and irregular life in about the fourth year of working.

Responses involving physical and psychological subjective complaints according to regularity of subjects' life: In responses involving physical and psychological subjective complaints according to whether subjects were living a regular life, those who were living an irregular life showed a tendency toward higher rates of complaints for most physical and psychological subjective factors (Table 10). It is considered that those living a regular life were physically and mentally healthier in terms of multiple subjective symptoms, eye and skin, mouth and anus, depression, and irregular life.

DISCUSSION

While conducting this investigation, the researcher focused on respondents' awareness of the degree of toxicity of a new interior materials or furniture and whether they noticed the smell of new interiors. When a simple question was asked while conducting the questionnaire, many part-time workers and business proprietors noted that they perceived the smell of new interiors and knew they were harmful. However, they did not make any effort to change the environment, nor did they attempt to use eco-friendly materials and interiors that did not emit harmful substances. The biggest reason that they were hindered in doing so was the expensive price of such materials. For the health of employees and workers in new buildings, people's perceptions should be changed, and the importance of eco-friendly interiors should be made clear. Further, interior businesses should study eco-friendly interior environments, and the health of workers in new spaces should be promoted. Fortunately, people's understanding of interior environment has improved greatly; the government held a public hearing on interior environment enhancement. Thus, a lot of relevant research will be carried out in future.

When environments where employees are working are small, air quality may deteriorate because of the number of people concentrated in a confined area. In one study, time zones and spaces with larger numbers of employees showed a tendency toward increased carbon monoxide (CO) and total suspended particles (TSP) values (Hakim *et al.*, 1995). In a different study, a tendency was shown whereby, as the time of working increased, exposure to HCHO and VOCs also increased (Sakai *et al.*, 2004). It is suspected that using rooms in badly ventilated buildings for long periods will adversely affect the respiratory system.

One of the major causes of poor air quality in enclosed building spaces is smoking. Hazardous materials generated

through smoking are inhaled even by nonsmokers through indirect smoking. In a study on indoor smoking activities, it was found that smoking increased PM₁₀ and PM_{2.5} with higher increase in PM_{2.5} rates than those of PM₁₀ (Slezakova *et al.*, 2009). Polycyclic aromatic hydrocarbons (PAH) increases were also observed. When the molecular weight of PAH was smaller, its concentration during smoking was higher; furthermore, PAH ratios in PM_{2.5} increased more than those in PM₁₀. As it has been demonstrated that indoor dust also contains PAH, some studies compared PAH concentrations in indoor dust to those brought about by smoking. In a study by Hoh, places where smoking activities were conducted showed remarkable increases in PAH, and nicotine concentrations in indoor dust were directly proportional to total PAH concentrations (Hoh *et al.*, 2012). This indicated a correlation between cigarettes and PAH. Designating indoor spaces as smoking or nonsmoking areas has been suggested as a way to reduce indoor air contamination due to smoking. This would involve separating a certain area of a space with simple barrier walls to prevent the diffusion of cigarette smoke into nonsmoking areas.

In this study, to investigate the health statuses of employees in new buildings based on their physical and psychological subjective complaints, a questionnaire survey was conducted using a THI health questionnaire; the respondents were 100 employees working in new buildings located in Seoul and Gyeonggi-Do. Based on the results, the following conclusions were made:

Responses involving physical and psychological subjective complaints showed significant differences in the symptom lie scale between subjects in their 10s and those aged 30 years or more; higher rates of complaints were found in those aged 30 years or more.

In responses involving physical and psychological subjective complaints according to genders, females showed a significantly increased level in the depression item compared to males, as well as a tendency toward high ratios of physical and psychological complaints.

In responses involving physical and psychological subjective complaints according to smoking status, smokers showed significantly increased respiratory organ complaints compared to nonsmokers.

In responses involving physical and psychological subjective complaints, those with a profession showed significant increases in nervousness complaints.

In responses involving physical and psychological subjective complaints according to average daily working time, the 7~10 hours group showed higher rates of complaints in the multiple subjective symptoms and mouth/anus items than the less than 2 hours group.

In responses involving physical and psychological subjective complaints according to whether subjects were living a regular life, those who were living an irregular life showed a tendency toward higher rates of complaints for

most physical and psychological subjective items.

In responses with physical and psychological subjective complaints according to working environments, the satisfaction group showed lower rates of complaints in most items for physical and psychological subjective complaints.

In summary, this study shows that the health complaint scores regarding physical and psychological symptoms tended to be higher among the unsatisfied group, the irregular life group, the group who worked long hours, the elderly, smokers, and females. These results can be used to improve the psychosomatic health status and working environments of employees working in new buildings.

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