The Occurrences of Allergic Diseases and Accidents within Housing and Residents' Consciousness

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Abstract Allergic diseases as the major symptoms of Sick Building Syndrome have significantly increased because of the indoor pollutants resulted from the enhanced energy conservation performances of residential buildings. Following traffic accidents, domestic accidents are known as the second most frequent accident type. This study analyzes the occurrences of allergic diseases and home accidents caused by housing conditions, together with the residents' consciousness of the diseases and accidents. The findings of this study are expected to help develop the design guidelines and new housing types conducive to the healthy housing environment. For this study, a questionnaire survey was conducted in two rounds which include face-to-face questionnaire survey and online survey, collecting 200 responses and 1000 responses respectively. The data based on the valid 1011 responses were analyzed by Frequency Analysis and T-test.

Keywords: Allergic Diseases, Safety Accidents, Residents' Consciousness, Healthy Housing

1. INTRODUCTION

(1) Background & Aim of the Study

The concerns on the healthy housing environment have been intensified amid the improved standard of living and enhanced quality of life. In response to the new life styles, new housing types have been introduced to the nation with the consideration on environment-friendliness, well-being, Ubiquitous and community development.

A number of studies have been conducted with regard to the assessment of functional and technical performances of buildings, residential satisfaction and demand measurement. The concept of healthy housing environment has developed along with the development of new housing types and performances evaluation systems. However, the efforts to investigate allergic diseases and domestic accidents from which residents suffer with regard to residential environment seem insufficient. Since diseases and accidents directly affect residents' physical health, they should be discussed with a great care by researchers and practitioners (Shon & Lee, 2012).

The healthy housing environment can be defined in various aspects, namely, physical, mental, social, environmental and managerial health (Cho et al., 2011; Park, 2003). Among them,

physical health seems the basic element which immediately affects other aspects of health and closely related to our daily lives.

Physical health is a key aspect in designing for healthy housing environment and is closely associated with housing features, such as indoor environmental quality, housing type, housing size and building age, and household characteristics, like length of residency. Allergies as the symptom of sick building syndrome (SBS), or multiple chemical sensitivity(MCS), and physical injuries from domestic accidents appear to be the relevant indicators of residents' physical health affected by housing conditions. Some literature also argues that indoor air pollution and home accidents caused by the physical conditions of houses are the major factors hindering the healthy housing environment (see, for example, Shon & Lee, 2012).

Allergic diseases as the major symptoms of Sick Building Syndrome have significantly increased because of the indoor pollutants resulted from enhanced energy conservation performances of residential buildings (Kim et al., 2012). Following traffic accidents, domestic accidents are known as the second most frequent accident type (Jang et al., 2012). This study analyzes the occurrences of allergic diseases and accidents affected by housing conditions, together with the residents' consciousness of the diseases and accidents. The findings of this study are intended to contribute to developing the design guidelines of healthy housing environment and strategies which can be applied in the future housing development.

(2) Research Methods

In order to investigate the occurrences of allergic diseases and domestic accidents, a structured questionnaire survey was carried out in January and February 2012. The survey was undertaken in two rounds. In the first round, a hundred self-administered questionnaires were collected in Seoul metropolitan region and another hundred in Daegu. The second round

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questionnaire survey was conducted online, in which a thousand respondents participated from the whole country. In result, 1101 questionnaires, among 1200, were found to be valid for statistical analyses. In analyzing the responses, frequency analysis and t-test were used.

The respondents' experiences of allergic diseases and home accidents were limited to those occurring in the past ten years. The residents 9 years old or younger were excluded in the survey.

The questionnaire consists of three parts. The first asks about the respondents' socio-demographic and household characteristics (e.g. gender, age, income, length of residency) and housing features (e.g. building age, bathroom window type).

The second part concerns the respondents' allergic diseases, their choice of treatment and intention of housing improvement. Allergic diseases described in the questionnaire include conjunctivitis, allergic rhinitis, dermatitis, asthma and headache. They were selected among the disease codes listed in the 'Korean Standard Classification of Diseases' according to the opinions of preventive and industrial medicine professionals that these diseases were seemingly associated with housing conditions to certain extent. Hereditary Asthma and headaches from general cold or fever were excluded since they seemed to have little relationship with housing environment.

The last part deals with the types of home accidents which the respondents have experienced and the respondents' consciousness of the accidents. The types of accidents were extracted from various studies on housing and accidents (See, for example, Lee et al., 1993; Shin et al., 1996) and the official statistical data of Korea Consumer Protection Board (2011). They include 'slip', 'bump', 'stumble', 'electric shock', 'burn' and 'fall'.

(3) Related Studies

In its technical report, WHO (1974) emphasized the importance of housing conditions with regard to the occurrence of chronic respiratory diseases, lung cancer and mental hygiene. Eastern European countries set up the detailed environmental standards to maintain the quality of housing in diverse aspects related to health. These standards were developed based on the comprehensive data on potential hazardousness of new chemicals used in residential buildings and furnishing, efficiency of heating and ventilation systems and insulation system and housing design affecting indoor microclimate. Many studies have also been conducted in line with the globally rising demand for healthy and safe indoor housing environment which ensures amenity and functionality.

Kim (2005) argues that, apart from dust mites, mold, cockroaches and indoor air pollution, housing conditions, such as housing type, size, structure and building age, can cause atopic dermatitis. Kang (2005) also claims that the indoor environment of high rise housing affects residents' health. Son(2002) contends that residents' health with regard to housing may be associated with spatial arrangement, density, sanitary plumbing system, indoor air quality, building materials, indoor climate conditions, safety, lighting, noise and privacy.

Many studies on residents' health have been carried out in a form of case studies investigating the design elements and performance indicators of the indoor air quality and physical characteristics of houses. In addition, much literature on allergic diseases and domestic accidents has mainly focused on children and aged

people. This study, however, widens the research scope by including the extents and methods of the residents' intentions to improve their housing conditions for healthier living environment in the survey questions.

In the questionnaire design, the questions about the methods of medical treatment and efforts to alleviate allergic symptoms were drawn on the related literature (Table 1). The questions about the methods of housing condition improvement according to different diseases were based on the literature on environment-friendly remodeling and the improvement of deteriorated housing (See, for example, Kim, 2008; Koo and Je, 2006 and Lee et al., 2006).

Table 1. Things to do to improve allergic diseases (literature review)

Literature	Extracted items
Author (year) Survey of Health Functional Foods Usage and Oriental Herbal Medicine Dosage for Children Suffering from Skin Dermatitis	Clinic/Medicine Home remedy
An Empirical Study on the Relationship between the Quality of Life, Disease Management Patterns, Patient's Satisfaction and Behavioral Intension in Allergic Rhinitis	Clinic/Medicine, Device Home remedy Cleaning/Washing
Comparison of Eating Habits and Dietary Intake Patterns between People with and without Allergy	Dietary
Recommendations for the prevention of allergic diseases in Korea	Frequent Ventilation
The Status of the Exposure Levels of Children Suffering from Respiratory Allergies to Environmental Factors	Moving to other housing types, Moving, Device Replacing furniture
Impact of Environmental Tobacco Smoke Exposure and Home Environment on Astham and Wheeze in School Children	Replacing furniture
Relation of Residential Environment of Apartments with Children Health	Frequent Ventilation,
My Polluted Home	Frequent Ventilation Replacing furniture Air filtering plants Device
Prevention and Treatment of Sick Building Syndrome	Renovation of house Replacing furniture Frequent Ventilation Device
The Influence of Urban Residential Type on Medical Pathology Phenomenon	Moving to other housing types

2. SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS AND HOUSING FEATURES

As shown in Table 2, 52.2% of the respondents were male, while 47.8% were female. The number of respondents was similar among the age group of '20s', '30s' and '40s', each of which accounted for 21% to 23% of the total respondents. However, each of the '10s' and '60s and above' groups accounted for less than 10%. 32.4% of the respondents had the average monthly household income of KRW 3million to KRW 4.5million, while

23.1% with KRW 1.5million to KRW 3million, and 20.3% with KRW 4.5 million to KRW 6 million.

Table 2. Socio-demographic characteristics of the respondents

N=1,101

Characteristics	Categories	N	%
Gender	Male	575	52.2
	Female	526	47.8
Age	10s	108	9.8
	20s	255	23.2
	30s	231	21.0
	40s	242	22.0
	50s	192	17.4
	60s and above	73	6.6
Average Monthly Household Income	< KRW 1.5 mil.	65	5.9
	KRW 1.5-3.0 mil.	254	23.1
	KRW 3.0-4.5 mil.	357	32.4
	KRW 4.5-6.0 mil.	224	20.3
	KRW 6.0 mil.<	195	17.7
	No response	6	0.6

According to Table 3, 84% of the respondents resided in multi-flex/row houses or high-rise apartments, and about 70% were found to live in houses as large as 66.1 sq.m (20 pyeong) to 132.2 sq.m (40 pyeong).

The majority of the respondents have lived in the current houses for 3 to 10 years, and 23.8% for more than 10 years. Almost half of the respondents were found to live in houses built more than ten years ago. Therefore, the strategies to improve housing performances should be developed not only for new buildings, but also for old, deteriorated buildings (Table 3).

In terms of lighting and ventilation, it is desirable to plan the windows exposed directly to the air outside. In multi-family housing, however, functions other than lighting and ventilation are usually prioritized in the floor plans. This was proved in the questionnaire result that 61.8% had their bathrooms without windows exposed to the air outside (Table 3).

Table 3. The features of the respondents' houses

N=1,101

Features	Categories	N	%
Housing type	Detached	156	14.2
	Multi-flex/Row	239	21.7
	Flat/Apartment	686	62.3
	Others	20	1.8
Housing size (floor area)	< 66.1sq.m (20 pyeong)	182	16.5
	66.1sq.m – 99.2sq.m (30 pyeong)	378	34.3
	99.2sq.m – 132.2sq.m (40 pyeong)	384	34.9
	132.2sq.m – 165.3sq.m (50 pyeong)	98	8.9
	165.3sq.m <	59	5.4
Length of residency	<1 year	125	11.4
	1 – 3 years	294	26.7
	3 – 10 years	420	38.1
	10 years <	262	23.8
Building age of the houses	<1 year	26	2.3
	1 – 3 years	81	7.3
	3 – 10 years	275	25.0
	10 years <	583	53.0
	Uncertain	136	12.4
Whether bathroom windows exposed to the air	No	680	61.8
	Yes, and openable	408	37.1
	Yes, but not openable	11	1.0
	No response	2	0.1

3. FINDINGS

1) the occurrences of allergic diseases and residents' consciousness

(1) The Occurrences of Allergic Diseases

As a result of the survey, 84.6% of the respondents (82.1% among male and 87.4% among female) were found to have suffered from allergic diseases. It seems that female is relatively more vulnerable to allergic diseases. In effect, according to the data provided by National Health Insurance Corporation (NHIC), women (4.54 million cases reported) tended to suffer from allergic conjunctivitis, atopic dermatitis or asthma more than men did (3.77 million cases reported) (Statistics Korea, 2010).

64.6% of the respondents were found to have had headaches, except for the ones caused from general cold or fever, as the most common allergic diseases. Allergic rhinitis (58.7%), conjunctivitis (47.3%), dermatitis (40.7%) and asthma (20.9%) followed.

With regard to the disease types by age group, '10s' group showed relatively higher rate of allergic rhinitis (30%), while '60s or above' tended to have asthma (12%) more than other groups. Allergic dermatitis was more common among '30s,' '40s' and '50s,' ranging from 18.1% to 19.7% (Fig 1). Despite the slight differences, the data appear to demonstrate that allergic diseases were certainly correlated with age.

Figure 1. Occurrence of Diseases by Different Age Groups

In fact, NHIC (2010) has shown in a report tracking patients' medical treatment history that patients under age 9 accounted for 25.5% of the total patients, followed by teens(15.9%), 30s(13.5%), 40s(12.2), 60s(13.5%), 20s(10%) and 50s(9.5%). This research, however, did not include children aged 10 or below because parental advice was required for the questionnaire survey. Thus, the results of the present study seem to be different from those of the NHIC's data.

Overall, '20s' and '50s' appear to be more vulnerable to environmental diseases than other age groups (Fig. 1). It can be assumed that '20s' group may be at the peak of their physical abilities, and '50s' may have become more health-conscious as their social life has declined. Turning to their 50s, allergic rhinitis, atopic dermatitis and asthma tended to decrease slightly, and physical health seems at more risk in their 60s due to the weakened immune systems.

With regard to the efforts to improve the diseases (Table 4), 'Clinic/Medicine' was found to be preferred the most, and 'Frequent ventilation,' 'Use of air filtering plants' and 'Cleaning/washing bed linen' followed. The results proved that the respondents did not only rely on medical treatments, but also pursued other means to prevent allergic diseases. It shows that the respondents are well aware of the seemingly association between allergic diseases and indoor air quality. In this regard, the design strategies to enhance natural ventilation (e.g. housing block design which maximizes the area of the external walls by indenting some parts of the housing units, so as to increase air flow into each flat) should be applied in housing design (Kim, 2000).

Table 4. Respondents' efforts to improve allergic diseases
(Multi-response, Number of cases (%))¹

		N=4,396				
Disease	Conjunctivitis	Allergic rhinitis	Dermatitis	Asthma	Headache	Total
Clinic/Medicine	442 (23.2)	463 (24.3)	331 (17.4)	166 (8.7)	500 (26.4)	1,902 (100)
Home remedy	30 (10.3)	83 (28.4)	54 (18.5)	32 (11.0)	93 (31.8)	292 (100)
Dietary	33 (12.8)	55 (21.3)	94 (36.4)	36 (14.0)	40 (15.5)	258 (100)
Use of equipments	51 (19.8)	93 (36.2)	49 (19.1)	38 (14.8)	26 (10.1)	257 (100)
Cleaning/Washing bed linen	73 (20.4)	120 (33.7)	104 (29.1)	41 (11.5)	19 (5.3)	357 (100)
Renovation of house	3 (5.5)	19 (34.5)	15 (27.3)	8 (14.5)	10 (18.2)	55 (100)
Moving to other housing types	2 (13.3)	4 (26.7)	5 (33.3)	3 (20.0)	1 (6.7)	15 (100)
Moving to other areas	5 (6.4)	20 (25.6)	20 (25.6)	19 (24.5)	14 (17.9)	78 (100)
Use of air filtering plants	53 (17.3)	98 (32.1)	63 (20.6)	35 (11.4)	57 (18.6)	306 (100)
Replacing furniture	1 (4.2)	9 (37.5)	7 (29.2)	6 (25.0)	1 (4.1)	24 (100)
Frequent Ventilation	105 (20.0)	169 (32.1)	66 (12.5)	54 (10.3)	132 (25.1)	526 (100)
No response	38 (12.2)	79 (25.4)	49 (15.8)	18 (5.8)	127 (40.8)	311 (100)
Others	1 (6.6)	3 (20.0)	3 (20.0)	1 (6.7)	7 (46.7)	15 (100)

The respondents with the history of allergic diseases were asked how much they felt uncomfortable after suffering from the diseases. As a result, it was found that they showed high level of discomfort, scoring 6.4 out of 10 (The responses were measured on the 10 likert scale, in which 1 indicates 'very comfortable,' and 10 'very uncomfortable.') (Table 5). Specifically, allergic rhinitis showed the strongest association with discomfort (6.8), followed by asthma (6.6), allergic dermatitis (6.5), allergic conjunctivitis (6.3) and headache (6.2). It is assumed that since headache was a common symptom of disease, people tended to be more tolerant towards

headache than other diseases. However, the scores given to each disease did not show significant differences from one another.

Table 5. Discomfort Caused by Allergic Diseases

N=2,588		
Diseases	N	Mean
Allergic conjunctivitis	521	6.3
Allergic rhinitis	647	6.8
Allergic dermatitis	448	6.5
Asthma	230	6.6
Headache	712	6.2

The respondents' efforts to improve allergic diseases with particular regard to the improvement of housing conditions were also asked. In result, the improvement of ventilation system was found to be the most preferred method, followed by the use of environment-friendly materials, improvement of lighting illumination and interior or balcony greening (Table 6).

Table 6. Respondents efforts to improve housing conditions by different disease types (Multi-response, Number of cases (%))²

		N=5,201				
Disease	Conjunctivitis	Allergic rhinitis	Dermatitis	Asthma	Headache	Total
Well-lighting	137 (26.8)	79 (15.4)	121 (23.6)	73 (14.3)	102 (19.9)	512 (100)
Interior & balcony greening	47 (19.0)	47 (19.0)	44 (17.8)	49 (19.8)	60 (24.4)	247 (100)
Upgrade ventilation system	522 (19.5)	661 (24.8)	335 (12.5)	629 (23.5)	525 (19.7)	2,672 (100)
Upgrade thermal environment	23 (13.0)	37 (20.9)	45 (25.4)	33 (18.6)	39 (22.1)	177 (100)
Soundproofing	14 (8.1)	11 (6.4)	7 (4.0)	9 (5.2)	132 (76.3)	173 (100)
Replace pipes	29 (29.0)	11 (11.0)	31 (31.0)	17 (17.0)	12 (12.0)	100 (100)
Environment-friendly materials	238 (20.0)	197 (16.6)	408 (34.3)	191 (16.1)	156 (13.0)	1,190 (100)
Improve lighting illumination	18 (36.7)	4 (8.2)	4 (8.2)	3 (6.1)	20 (40.8)	49 (100)
Maintain water tank	11 (19.6)	2 (3.6)	26 (46.5)	12 (21.4)	5 (8.9)	56 (100)
Others	2 (8.0)	6 (24.0)	10 (40.0)	3 (12.0)	4 (16.0)	25 (100)

In fact, there are various ways to improve allergic diseases with regard to the improvement of housing conditions. However, most of these methods were related to the improvement of indoor air quality through better performing ventilation system and use of environment-friendly finishing materials. Therefore, it seems that the respondents are well aware of the influences of ventilation and finishing materials on the allergic diseases.

¹ In the questions regarding things to do to improve allergic diseases, respondents were asked to choose up to two answers.

² In the questions regarding respondents efforts to improve allergic diseases, respondents were asked to choose up to two answers.

Those suffering from headaches strived to block the noise occurring in daily life. Although headaches had relatively low association with discomfort, it should not be overlooked that residents' physical health can be affected by the noise between floors in multi-story housing and drainpipe or daily life noise in detached houses.

(2) Residents' Consciousness on Allergic Diseases

The residents' consciousness of allergic diseases was measured in three aspects: the degree of connection between diseases and housing conditions, the extent to which they feel safe from allergic diseases in housing and their willingness to improve housing conditions to improve the diseases. The results are illustrated in Table 7.

Table 7. Residents' Consciousness on Allergic Diseases (T-test)

Category	Mean		
Degree of connection between diseases and housing conditions	Mean	7.8	Statistically not significant
	Disease (Yes)	7.8	
	Disease(No)	7.9	
Extent to which they feel safe from diseases	Mean	5.6	Statistically significant
	Disease (Yes)	5.5	
	Disease (No)	6.3	
Willingness to improve housing condition	Mean	6.9	Statistically significant
	Disease (Yes)	6.9	
	Disease (No)	6.5	

The respondents scored 7.8 for the 'connection between diseases and housing conditions' (The responses were measured on the 10 likert scale, in which 1 indicates 'very weak connection,' and 10 'very strong connection'). It clearly implies that the respondents are well aware of the influence of housing conditions on diseases. The score difference between those who have had allergic diseases and those who have not was not statistically significant. That is, regardless of their experiences of diseases, the respondents considered that these diseases were related to housing environmental factors.

The extent to which they feel safe from the diseases in housing was rather moderate, scoring 5.6 (The degree of protection was measured on the 10 likert scale, in which 1 indicates 'very low protection,' and 10 'very high protection.'). Understandably, the group with the experiences of allergies gave lower score (5.5) than the group with no experiences (6.3) in this regard ($t=-4.502$, $p=0.000$). It seems that those who have experienced allergic diseases feel more vulnerable to the harmful housing conditions than those who have not.

With regard to the willingness to improve housing conditions, the respondents showed rather a strong intention of improvement, giving 6.9 (The respondents' intention to improve housing conditions was measured on the 10 likert scale, in which 1 indicates 'very weak intention,' and 10 'very high intention.'). T-test showed that those who have had allergic diseases (6.9) had stronger intention of improvement than those who have not (6.5) ($t=1.987$, $p=0.049$).

2) the occurrences of domestic accidents and Residents' Consciousness

(1) The Occurrences of Domestic Accidents

Table 8 presents the types and frequencies of domestic accidents occurred to the respondents. The respondents were found to have 'bumping' most frequently (37.4%) and 'electric shock' least often (0.8%) at home. It was also found that minor accidents, such as 'bumping,' 'slipping' and 'stumble,' took place more often than relatively more serious ones, such as 'burn,' 'falling' and 'electric shock.' In fact, it is known that even minor accidents can turn into serious injuries (Korea Consumer Agency, 2011). Therefore, the ways to prevent home accidents should be taken into consideration in housing design processes.

The spots where the accidents occurred relatively more often were found to be bathroom, kitchen, bedroom and living room (Table 8). Specifically, 'bumping,' the most common accident, occurred in the kitchen, living room, bedroom, balcony, porch, storage and elevators. 'Slipping' mostly happens in bathrooms, exterior and interior stairs, parking lots and streets in the housing estates. This result may be related to the coefficient of friction of indoor floor and outdoor ground finishing materials. Thus, the safety standards of the coefficient of friction of floor or ground finishing materials should be regulated, taking variable conditions into consideration, such as inclination of lots and dampness of the ground.

Table 8. Locations of the accidents

		(Number of cases (%))						
Type Spot	Slip	Bump	Stumble	Electric shock	Burn	Fall	Others	Total
Bathroom	1,257 (35.4)	1,171 (33.0)	595 (16.8)	45 (1.3)	175 (4.9)	127 (3.6)	180 (5.1)	3,550 (100)
Kitchen	346 (10.9)	1,254 (39.6)	454 (14.3)	28 (0.9)	832 (26.3)	154 (4.9)	101 (3.2)	3,169 (100)
Living room	572 (23.1)	1,025 (41.4)	690 (27.9)	23 (0.9)	47 (1.9)	95 (3.8)	25 (1.0)	2,477 (100)
Bedroom	364 (14.1)	1,247 (48.4)	667 (25.9)	29 (1.1)	24 (0.9)	220 (8.5)	26 (1.0)	2,577 (100)
Balcony	291 (30.2)	426 (44.1)	204 (21.1)	4 (0.4)	3 (0.3)	29 (3.0)	8 (0.8)	965 (100)
Indoor stairs	340 (35.3)	249 (25.8)	303 (31.4)	4 (0.4)	4 (0.4)	58 (6.0)	6 (0.6)	964 (100)
Outdoor stairs	307 (40.2)	165 (21.6)	234 (30.6)	4 (0.5)	3 (0.4)	47 (6.2)	4 (0.5)	764 (100)
Porch	346 (29.8)	455 (39.2)	294 (25.3)	6 (0.5)	6 (0.5)	31 (2.7)	22 (1.9)	1,160 (100)
Storage	95 (14.1)	388 (57.4)	124 (18.3)	4 (0.6)	2 (0.3)	60 (8.9)	3 (0.4)	676 (100)
Elevator	101 (27.7)	158 (43.4)	44 (12.1)	1 (0.3)	1 (0.3)	8 (2.2)	51 (14.0)	364 (100)
Yard	86 (33.5)	68 (26.5)	89 (34.6)	1 (0.4)	1 (0.4)	2 (0.8)	10 (3.9)	257 (100)
Parking lot	321 (43.0)	227 (30.4)	180 (24.1)	1 (0.1)	1 (0.1)	4 (0.5)	13 (1.7)	747 (100)
Streets in housing estates	721 (46.8)	355 (23.1)	425 (27.6)	1 (0.1)	3 (0.2)	14 (0.9)	20 (1.3)	1,539 (100)
Total	5,147 (26.8)	7,188 (37.4)	4,303 (22.4)	151 (0.8)	1,102 (5.7)	849 (4.4)	469 (2.4)	19,209 (100)

With regard to the accident occurrences by different age groups (Table 9), the respondents in their 20s, 30s and 40s were found to have more accidents than other groups. In particular, '20s' had the highest rate of accidents (5,385 cases), and '30s' (4,483 cases) and '40s' (4,322 cases) followed. The accidents occurred to the '20s' group happened mostly in bathroom, kitchen, living room, bedroom, indoor/outdoor stairs, porch and streets in the housing estates. The '30s' group tended to have accidents in parking lot more often, while '40s' in balcony, storage and elevators, and '50s' in garden. Considering the locations of the furniture, equipments and home appliances, it is assumed that furniture and equipments may be more harmful than a house itself in terms of accident occurrences. Therefore, furniture and equipments in housing should be designed in a way which does not cause any harm to residents.

Table 9. Locations of the Accidents by Age Groups

(Number of cases (%))							
Age Spot	10s	20s	30s	40s	50s	Above 60s	Total
Bathroom	417 (11.7)	806 (22.7)	758 (21.4)	804 (22.6)	623 (17.6)	142 (4.0)	3,549 (100)
Kitchen	361 (11.4)	811 (25.6)	660 (20.8)	705 (22.2)	487 (15.4)	145 (4.6)	3,169 (100)
Living room	381 (15.4)	629 (25.4)	570 (23.0)	509 (20.6)	301 (12.2)	87 (3.5)	2,477 (100)
Bedroom	386 (15.0)	752 (29.2)	559 (21.7)	503 (19.5)	309 (12.0)	68 (2.6)	2,577 (100)
Balcony	70 (7.3)	222 (23.0)	223 (23.1)	245 (25.4)	160 (16.6)	45 (4.7)	965 (100)
Indoor stairs	135 (14.0)	370 (38.4)	153 (15.9)	157 (16.3)	130 (13.5)	19 (2.0)	964 (100)
Outdoor stairs	67 (8.8)	258 (33.8)	141 (18.5)	135 (17.7)	128 (16.8)	35 (4.6)	764 (100)
Porch	157 (13.5)	361 (31.1)	260 (22.4)	233 (20.1)	120 (10.3)	29 (2.5)	1,160 (100)
Storage	68 (10.1)	141 (20.9)	145 (21.4)	161 (23.8)	133 (19.7)	28 (4.1)	676 (100)
Elevator	34 (9.3)	89 (24.5)	92 (25.3)	98 (26.9)	44 (12.1)	7 (1.9)	364 (100)
Yard	29 (11.3)	54 (21.0)	42 (16.3)	44 (17.1)	74 (28.8)	14 (5.4)	257 (100)
Parking lot	54 (7.2)	153 (20.5)	240 (32.1)	168 (22.5)	93 (12.4)	39 (5.2)	747 (100)
Streets in housing estates	192 (12.5)	426 (27.7)	378 (24.6)	306 (19.9)	176 (11.4)	61 (4.0)	1,539 (100)
Total	2,351 (12.2)	5,072 (26.4)	4,221 (22.0)	4,068 (21.2)	2,778 (14.5)	719 (3.7)	19,209 (100)

(2) Residents' Consciousness on Domestic Accidents

The survey also investigated the respondents' awareness of domestic accidents. As shown in Table 10³, it was found that the respondents did not feel considerably uncomfortable after the accidents had occurred (4.5 out of 10). In addition, they felt safe in terms of home accidents to some extent (6.1). Accordingly, they had a moderate level of intention to improve their housing conditions for the sake of reducing home accidents (5.6). In short, since most

of the home accidents were found to be minor accidents (See Table 8), the respondents tended to be comfortable to some extent after experiencing the accidents, satisfied with the safety from the accidents in housing and, therefore, have moderate intention to improve their housing conditions.

Table 10. Residents' Consciousness on Home Accidents

Category	Mean
Degree of discomfort after accidents	4.5
Extent to which they feel safe from accidents	6.1
Willingness to improve housing conditions	5.6

It was also found that in order to prevent accidents within housing, the respondents wished to improve bathroom/toilet (50.6%), kitchen (10.8%), bedroom (7.4%) and living room (6.5%) (Table 11).

Table 11. Locations where the respondents intend to improve

Spot	N	%
Toilet/Bathroom	499	50.6
Kitchen	106	10.8
Living room	64	6.5
Bedroom/other	73	7.4
Balcony	58	5.9
Stairs	27	2.7
Porch	26	2.6
Parking lot	37	3.8
Storage/Utility	24	2.4
Elevator	10	1.0
Yard/Garden	6	.6
Streets in / in front of housing estates	48	4.9
Others	8	.8
Total	986	100.0

With regard to the detailed methods of housing improvement, the use of non-slip materials was most preferred (48.8%), followed by the installation of edge and corner guards (14.1%) and installation of hand rails and window grills (9.7%) (Table 12). In fact, according to the data provided by the Korea Consumer Agency (2010), 52% of the accidents occurring in bathroom and toilet (84 cases) were 'stumbling' or 'slipping'.

Table 12. Preferred methods of housing Improvement

Item	N	%
Hand rail/Window grills	96	9.7
Removing level differences	34	3.4
Slip-resistant flooring materials	481	48.8
Electrical outlet covers	41	4.2
Edge & corner guards	139	14.1

³ The residents' consciousness of home accidents was measured on the 10 likert scale.

Gas leak detector	51	5.2
Automatic fire extinguishing appliances	49	5.0
Light fittings	72	7.3
Others	23	2.3
Total	986	100.0

4. CONCLUSIONS

This study analyzed the occurrences of allergic diseases and domestic accidents which may be caused by residential environments and residents' consciousness of the hazards resulting in the diseases and accidents.

1. It was found that 85% of the respondents have suffered from any form of allergic diseases for the past ten years. The most widely used method to alleviate the symptoms was found to be having medical treatments, followed by frequent ventilation. With regard to the improvement methods according to different diseases, the improvement of ventilation system was found to be preferred the most, while the use of eco-friendly finish materials and natural lighting followed. These results demonstrate that ventilation is important in terms of both disease treatment and improvement of housing conditions. As lighting and ventilation may affect not only residents' physical health, but also their mental health, it is crucial to employ the housing design methods which can enhance natural lighting and ventilation.

2. The respondents generally agreed that allergic diseases were highly associated with the housing environment (scoring 7.8 out of 10). However, since they were moderately satisfied with the safety of their homes (5.6), their intention of housing improvement for better safety was not significantly high (6.9).

3. In the occurrences of home accidents, it was found that the relatively light accidents, such as 'bump,' 'slip' and 'stumble,' took place more frequently than serious ones, such as 'electric shock,' 'burn' and 'fall.'

4. The spot where accidents occurred most frequently and, therefore, the respondents wished to improve was bathroom, followed by kitchen, bedroom and living room. The preferred improvement methods were the use of non-slip floor covering and installation of corner protectors and window bars (or railings). Domestic accidents are closely related to spatial planning, furniture and fixtures. Thus, home furnishings and fixtures should be designed and installed in a way that prevents any possible accidents.

5. The respondents perceived that their housing environment was designed safe from accidents more than diseases. Therefore, they had stronger intentions to improve their housing conditions for the sake of disease prevention, rather than accident prevention.

This study investigated the occurrences of allergic diseases and accidents caused by certain conditions of housing environment, residents' consciousness of the diseases and accidents and their intention to improve housing conditions. It showed that lighting and ventilation mitigated the occurrences of allergic diseases. In the follow-up studies, therefore, we will investigate the lighting and ventilation regulations of developed countries. Then, we will

also attempt to develop the design guidelines for achieving healthy housing environment based the international case studies on housing design manuals for prevention of home accidents

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