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The Occupant Perception and Investigation of Indoor Air Quality at Home in Seoul

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국문요약

최근 산업장 뿐만아니라 주택에서의 실내환경오염은 대단히 중요한 관심사이다. 특히 미국 EPA에서는 성인이 하루에 약 80 % 이상을 실내 공간에서 생활하고 있는 것으로 보고하고 있으며, 이러한 생활 방식의 변화에 인한 최근 도시화 지역에서의 실내 공기질(indoor air quality)의 문제가 새로운 환경 이슈로 부각되고 있고, 일본을 비롯한 구미 각 국에서도 21세기 환경문제 중 실내환경(indoor environment) 문제를 최우선으로 다루고 있다.

그러므로 본 연구에서는 주택에서의 실내공기질을 평가하기 위하여 설문지를 통하여 인식도를 조사하고 그를 토대로 6개의 다른 주거환경을 가진 주택을 대상으로 실내공기오염도를 측정하였다.

본 연구에서 평가한 측정항목은 온도, 습도, CO, CO_2, 호흡성분진, 포름알데히드, 총부유세균(TBC)이었으며, 주택의 지역 및 계절별로 나누어 측정하였는데, 측정결과 호흡성분진은 주택 5,6에서 국내의 기준을 초과하였으며, 총부유세균은 홍콩과 싱가폴의 실내기준 권고치인 500 CFU/m^3을 초과였고, HCHO는 모든 대상 주택에서 초과하였다.

또한 통계적으로 분석한 결과 주택의 건축년도와 CO, TBC가 0.01 수준에서 유의성 관계를 나타냈으며, 습도는0.05 수준에서 유의성을 나타냈다.또한 주택의 거주자 500인을 대상으로 조사한 설문지 결과에서는 대부분 응답자가 실내공기오염에 대하여 인식하고있으며, 실내오염으로 인해 피로>두통>눈 아픔>기침 등을 호소하고 있으며, 실내공기정화장치가 필요하다고 응답하였다.

결론적으로 본 연구의 목적은 주택에서의 실내공기질을 평가하여 실내공기질의 중요성을 인식시키고, 그에 대한 구체적인 대책방안을 제시하여 관련 기준을 준비하는데 기초적인 자료를 마련하고 주민들이 쾌적한 삶을 유지하는데 기여하고자 한다.

Abstract

Indoor air quality(IAQ) in workplace and residential environments has been concern of people. Recently, Ministry of Environment in Korea has recognized the the potential risk on the healthy effect related to indoor air pollution at home.

Therefore, the purpose of this study was performed to measure the indoor air pollutants of IAQ at different homes and investigate to compare the perception of IAQ recognition at home from questionnaire survey in Seoul.

We estimated the IAQ of selected 6 homes based on site region and housing type. The indoor air pollutants and parameters such as temperature, relative humidity, respirable suspended particulate matter(PM_{10}), formaldehyde(HCHO), total bacteria counts, carbon monooxide(CO) and carbon dioxide(CO_2) were monitored for summer and winter. In monitoring results, The respirable suspended particulate matter(PM_{10}) and indoor airborne bacteria level of home 5 and 6 were higher than the standard of the public 150 $\mu g/m3$ and 500 CFU/㎥, the level formaldehyde(HCHO) was exceed 0.1 ppm of the standard of Korea at all monitored homes. In statistics analysis, we could find a correlation between the building age and the concentration of CO, TBC were significant at 0.01 level and Relative Humidity was significant at 0.05 level for summer. Finally, the important air pollutants of IAQ in home were HCHO and total bacteria counts(TBC) .

And we performed a questionnaire survey of 500 people about their awareness for the importance of IAQ in our home during same period. In results, all most response of occupant has recognized the importance of IAQ at home.

Therefore, it can be concluded that the IAQ of selected 6 home studied was perceived as acceptable, it is recommended that the government related IAQ was suggested the guideline and control of IAQ problems, and the occupants need to be effort to reduce the exposure of sources to undesirable pollutants.

1. Introduction

Recently, indoor air quality in workplace and residential environments was interested in attention of people, scientists and related the public. Many studies have performed on indoor air quality(IAQ) related workplace, shopping center, school and hospitals etc. It found that IAQ is very important to us because we are spending more than 80% of their time in indoors. The cause of indoor air pollution is a combinatory effect of physical, chemical and biological factors in the environment. The sources of indoor pollutants are known from outdoor environment such as industrial activities and traffic conditions, building materials and equipments, furnishings and human activities.

And indoor air pollutants from sources was variously affected IAQ and our health. Especially, IAQ of residential house has become an issue of public concern in Seoul because indoor air pollution of home can be caused the impacts on health and well-being in the lifetime. Therefore, the purpose of this study was performed to measure the indoor air pollutants of IAQ at different homes and investigate to compare the perception of IAQ recognition at home from questionnaire survey in Seoul

And so we could be suggested an alternative idea to reduce the air pollutants exposure of residential home.

2. Methods

2.1 Site description

Residential home in Seoul are mainly consisted of two types such as private house and apartments. So we are selected homes on the basis of housing type, location and building age as specified characteristic to evaluate the potential indoor air quality. The general description of sampling site are shown in Table 1.

Table 1. Description of sampling site for measuring indoor air quality

Sampling site	Site	Type of Home	Building age	Floor area(m2)
Home1	Residential area, high population, high traffic flow	Private House	1-5	90
Home2	Residential area, high population, high traffic flow	Private House	6-10	90
Home3	Residential area, high population, high traffic flow	Private House	11-20	90
Home4	Residential area, high population, high traffic flow	Apartment	1-5	85
Home5	Residential area, high population, high traffic flow	Apartment	6-10	85
Home6	Residential area, high population, high traffic flow	Apartment	11-20	85

2-2 Sampling and Analysis

In this study, indoor air pollutants of selected homes were measured such as room temperature, relative humidity, carbon monooxide(CO), carbon dioxide(CO_2), formaldehyde(HCHO), respirable suspended particulate matter(PM_{10}), total bacteria count(TBC), Sampling equipments were placed at 1.5m above floor level at indoor location. A combined IAQ monitor (BACCUA ,Italy) was used for measuring such as indoor air temperature, relative humidity, carbon monooxide(CO), Carbon dioxide(CO_2). A SKC formaldehyde monitoring kit was used for formaldehyde measurements. The respirable particulate matters(PM_{10}) were measuring using PM_{10} Mini-vol air sampler(Airmetrics, PAS-201, USA). And Biotest Centrifugal Air Sampler(Biotest, RCS sampler, UK) for Agar strips was used for sampling bacteria at 4ml/min. Agar strips were incubated at 35℃ for 48hr. Temperature, relative humidity, CO, CO_2, HCHO and PM10 were continuously monitored for 24 hours.

3. Results

3-1 Measuring results

Table 2 shows the measuring results of indoor air pollutants and parameters at selected six homes. Fig 1,2 show the 24-h average concentration of PM10, HCHO, CO_2 and bacteria(TBC) at six selected home. As shown Fig.1,2, PM_{10} concentrations of Home 1,2 3(private house) during summer were below the Korean IAQ standard of 0.15 mg/m^3, but those at apartment during winter were above the standard. The PM_{10} concentration of home were due to sources from outdoors such as heavy traffic flow, construction activity and from indoors such as tobacco smoking, gas cooking appliances and household cleaning. And all of the level of HCHO concentration were much above the Korean IAQ standard of 0.1 ppm. The high HCHO concentrations were due to decora-

Table 2. The data of measuring results of indoor air pollutant and parameters at selected six home

Sampling Point			Room Temp. (℃)	Relative Humid. (%)	CO (ppm)	CO_2 (ppm)	HCHO (ppm)	PM_{10} (ug/m^3)	Bacteria (CFU/m^3)
Standard			17-28	40-70	10.0	1,000	0.10	150	*500
Private Houses	Home 1	Summer	25.0	67	3.7	532	0.46	119	362
		Winter	24.6	43	4.4	842	0.68	143	520
	Home 2	Summer	25.0	75	4.7	559	0.34	128	584
		Winter	22.0	45	5.1	855	0.51	147	822
	Home 3	Summer	26.0	80	5.2	628	0.26	147	898
		Winter	24.0	46	5.6	955	0.44	169	960
Apartments	Home 4	Summer	23.0	60	3.6	558	1.80	149	240
		Winter	24.0	33	4.0	852	2.20	172	368
	Home 5	Summer	25.0	68	4.9	579	0.67	166	608
		Winter	25.4	38	6.4	898	1.20	192	728
	Home 6	Summer	26.0	74	5.6	595	0.51	177	984
		Winter	25.0	34	7.2	938	0.78	192	1150

* The guideline of Singapore(Korea was not the standard)

tive wall and painting of old home and new style decoration and furniture of wall at the new home. In this results, we could confirm the HCHO of indoor was concerning important pollutant any other than pollutants at home . The level of TBC at home 3,6 were above 500 CFU/m3 of the guideline of Hong Kong and Singapore. That was due to inadequate ventilation , home age and hygienic quality of home.

Table 3 shows the correlation coefficient between pollutant factors at home during summer. In Table 3, we could to be find a correlation between the building age and the concentration of CO and TBC were significant showing at the 0.01 level for summer. That was due to outdoor

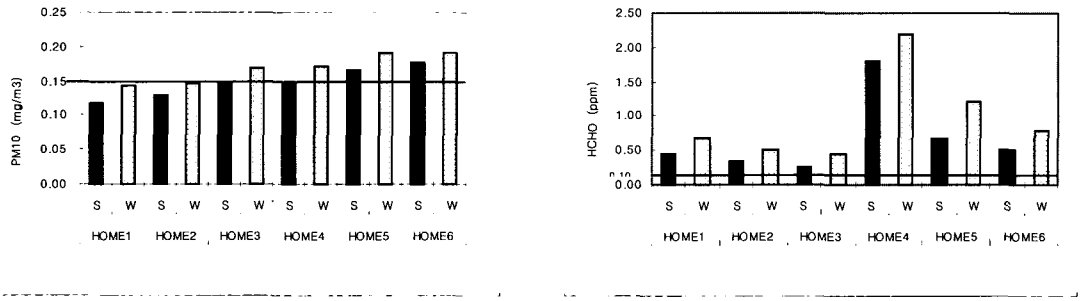

Fig. 1. The Measuring data of Indoor Air Pollutants(PM_{10}, HCHO) for Summer and Winter at Six Different Home in Seoul

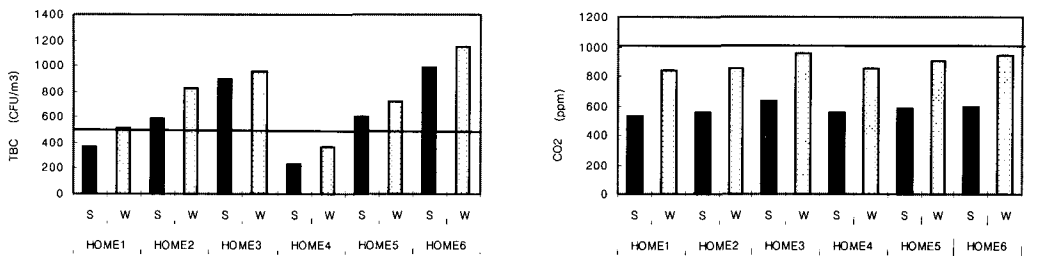

Fig. 2. The Measuring data of Indoor Air Pollutants(TBC,CO2) for Summer and Winter at Six Different Home in Seoul

infiltration caused by poor ventilation since all of the windows were opened. The correlation between HCHO and RT, RH are significant at the 0.05level. It can be found that the production rate of HCHO at home was related to room temperature and humidity.

Consequently, we can be found that the problems of IAQ pollutants at the selected home was HCHO and TBC in comparison with other researcher (Baek et al.1997 and Lee et al. 2001). It was likely to be caused by the variety of using materials and poor ventilation system of home.

Therefore, we would like to recommend the inspection of construction material of indoor and the installation of room-sized air cleaner for improving IAQ of home.

3-1 Results of Questionnaire survey

We performed a questionnaire survey of 500 people about their awareness for the importance of IAQ in our home.

In the survey of questionnaire of occupants perception on IAQ(Fig.3,4), almost respondents of questionnaire was recognized the indoor air pollution and appealed the discomfort of healthy condition such as fatigue, headache ,eyeache so on.

Table 3. Correlation coefficient between pollutant factors at home for summer

	BA	RT	RH	CO	CO_2	HCHO	PM_{10}	TBC
BA	1	0.811	0.835*	0.941**	0.898*	-0.555	0.570	0.984**
RT		1	0.876*	0.813	0.583	-0.907*	0.216	0.881*
RH			1	0.786	0.690	-0.845*	0.062	0.843
CO				1	0.790	-0.599	0.642	0.968*
CO_2					1	-0.312	0.584	0.824*
HCHO						1	0.154	-0.647
PM10							1	0.561
TBC								1

-BA : Building Age, RT : Room Temperature, RH : Room Humidity
**. Correlation is significant at the 0.01 level
*. Correlation is significant at the 0.05 level

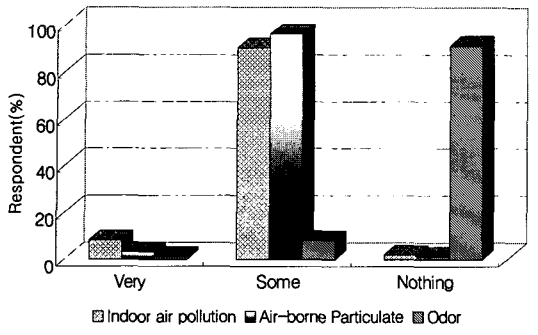

Fig. 3. The Questionnaire Survey of Occupant Perception on the Indoor Air Quality at Six Different Home in Seoul

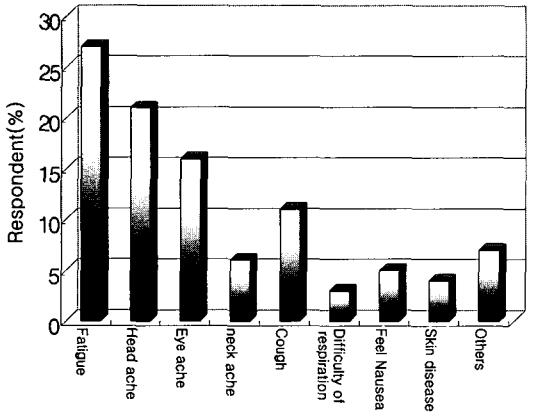

Fig. 4. The Questionnaire survey about the Healthy Condition of Occupant at Home in Seoul.

Therefore, it appeared that IAQ of home may to have the potential risk and problems of health in living occupant.

4. Conclusions

We performed a questionnaire survey of 500 people about their awareness for the importance of IAQ in our home. And we measured IAQ of housing of 6 homes as site region and housing type. We were obtained the results as follows.

The average PM10 concentrations and total bacteria counts in Apartment of Home 5, 6 was exceeded those measured in private house compared with Korea standard.

All average concentration of HCHO selected 6 Home was high in comparison with EPA and Korean standard. In statistics analysis of SPSS, the building age and RH, CO_2 were very significant at the 0.05 level. And also there were correlation coefficients significant at the 0.01 level between TBC and CO.

So it appeared that IAQ of home may to have the potential risk and problems of health in living occupant. Therefore, it can be concluded that the indoor air quality of selected 6 home studied was perceived as acceptable, it is recommended that the government related IAQ was suggested the guideline and control of IAQ problems, and the occupants need to be effort to reduce the exposure of sources to undesirable pollutants.

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