Assessment of Indoor Pollution in Rural and Urban Houses

Kaur D.[1], Sidhu M.[2], Bal S.[3] and Chuneja N.K.[4]

1, 2 & 3, Department of Family Resource Management, College of Home Science, 4. Department of Farm Machinery & Power Engineering, College of Agricultural Engineering and Technology, PAU, Ludhiana

Corresponding author e-mail: muninderkaur@pau.edu

Paper Received on July 08, 2015, Accepted on October 13, 2015 and Published Online on October24, 2015

ABSTRACT

Environmental pollution is any undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil) which can cause harmful effects on various forms of life and property. The pollution can be both indoor and outdoor but generally people think that pollution is only outdoor or affecting the indoor environment due to the different outdoor sources. The inside environment of houses often has a higher level of pollutants than the outdoor surroundings. Unfortunately, indoor pollution has not been given much importance. Keeping the concern and significance of indoor pollution in mind a study was planned to know the pollution causing features of the respondent's houses and to assess different indoor pollutions objectively. It was observed that the majority (69.16 %) roads near to the respondent's houses were pucca and that too in good condition. Nearest pollution causing features reported were to their houses included flour mill, religious place, school and main road. Mean noise level in kitchens and drawing rooms was observed to be 53.85 and 55.67 dB respectively and concentration of CO2 in kitchens and drawing rooms was found to be 838.38 ppm and 650.60 ppm respectively. Mean concentration of CO in kitchens and drawing rooms were: 1.15 ppm and 0.68 ppm respectively. Humidity level in selected houses was 58.77% .

Key words: *Carbon-di-oxide, Carbon-mono-oxide, Humidity, Noise, Pollution causing features;*

Health status of an individual, a community or a nation is determined by the inter play and integration of indoor environment of man and the external environment which surrounds him (*Banik, 2010*). It is an established fact that environment has direct impact on physical, mental, social and economic well being of those living in it. Health is one of the fundamental requirements of man along with food, clothing and shelter and to lead a healthy life.

Right to live in a healthy environment is a fundamental human right. It is the basic requirement of all the living beings; including humans, livestock, plant, micro-organisms and the wildlife. In the society man constantly interacts with his environment which affects him both physiologically and psychologically. It has been observed that our environment is getting degraded and polluted day by day.

Environmental pollution can, therefore, be defined as any undesirable change in the physical, chemical or biological characteristics of any component of the environment (air, water, soil) which can cause harmful effects on various forms of life and property (*Maharajan and Samual, 2010*). Human beings are very fortunate that mother earth is the only planet in the universe gifted with elements like water, air, land, flora and fauna etc. which are of vital importance for only living things. The possibility of life and its development depend entirely on maintaining the balance of the environment and wise utilization of the natural resources. Human dependence on environmental resources is so great that man cannot continue to live on earth without protecting the earth's environmental resources. Unlimited exploitation of nature by human is disturbing the ecological balance between living and non living components of biosphere (*Songsore and McGranahan, 1993*). The adverse condition created by man himself is threatening the survival not only of man himself but also of other living organisms. Due to the progress of industries, technology, chemicals, atomic energy etc., there are a number of industrial effluents and emission of poisonous gases in the atmosphere which are lowering the quality of environment. Environmental pollution is one of the most formidable dangers that confronts mankind today, because where we are living, is almost fully polluted, whatever we drink, we breath, we eat contain pollutants. The pollution of the environment is wholly man created.

The pollution can be both indoor and outdoor but generally people think that pollution is only outdoor or affecting the indoor environment due to the different outdoor sources. Although we spend about 80 to 90 per cent time indoors yet we consider very little about the indoor pollution and causes of the same. As we walk through our homes, the air turbulence created by the movement of human beings stirs up a combination of dust and debris that can be very irritating to the lungs (*Godish, 2010*).

The inside environment of houses often has a higher level of pollutants than the outdoor surroundings. Unfortunately, indoor pollution has not been given much importance. It was found that indoor pollutants form a substantial portion of the total exposure to various pollutants. The sources of such pollutants can be occupants, their activity, various appliances, building materials and infiltration of pollutants from outdoors. Indoor air contaminant materials are particulates, gases and vapors. These materials include bio-aerosols, particles, Volatile Organic Compounds (VOCs), organic and inorganic gases (*Khare and Gupta, 2000*). Studies of human exposure to air pollution indicate that the levels of many indoor pollutants can be 2-5 times higher than the levels of outdoor pollutants. *Samet et al (2000)* reported that sometimes the level of indoor air pollutants is 100 times higher than the outdoor level. The high levels of allergens and irritants are of a great concern because we spend maximum time indoors and such indoor living conditions poses serious health threats to all the occupants of the building. Therefore, combating indoor pollution can be considered as a primary and the most important concern to the mankind.

METHODOLOGY

The data for the present study was collected from 120 homemakers comprising of 60 rural and 60 urban respondents. The respondents were selected randomly. For selection of rural sample, Ludhiana 1 block was randomly selected out of 11 blocks of Ludhiana district. From this block, two villages namely; Majara and Phullanwal were randomly selected out of the total list of 65 villages. Further thirty randomly selected households were taken from each of the two selected villages, Majara and Phullanwal, thus selecting the rural sample of 60 households. For the selection of the urban respondents, out of four zones of Ludhiana city, Ludhiana - D zone was randomly selected. From the Ludhiana-D zone two localities namely; Jawahar Camp and Canal Avenue were randomly selected. From each of these localities 30 households were randomly selected; thus the urban sample comprised of 60 households.

For objective assessment of indoor pollution instruments used were ‘Noise level meter’, ‘Air quality monitor’ and ‘Hygrormeter’ to measure sound level, CO2 & CO and humidity level in the selected households. The data collected were coded and tabulated. For analyzing the data, simple averages, percentages, mean scores, t-test were used.

RESULTS AND DISCUSSION:

Distance of pollution causing features from home : Impact of outdoor pollution inside the home depends solely on distance from source of pollution to the destination. This is the main reason-For constructing houses away from pollutants is that they are considered ideal for healthy living. Features causing air and noise pollution invariably are present in the surrounding which can find their way in home interiors e.g. airport, railway station, bus stand, industries, commercial hub, filthy water body, garbage dumps, marriage palaces, flour mills, religious places, school or college and highways. In the context of present study features included were: flour mill, religious place, school or college, main road, market, railway line, marriage palace, bus stand, highway and industry etc. It can be seen in Table 1 that flour mill (*atta chakki*) was nearest to the houses of the respondents from both the areas which caused air pollution as it was just 23 meters (averaged distance) away followed by religious place, school or college and

Table 1: Distance (Kilometers) of pollution causing sources from the selected house

Near Environment	Rural (n=60)			Urban (n=60)			Total (n=120)		
	Maximum Distance	Minimum Distance	Average Distance	Maximum Distance	Minimum Distance	Average Distance	Maximum Distance	Minimum Distance	Average Distance
Flour Mill	1.00	0.10	0.33	0.15	0.10	0.13	1.00	0.10	0.23
Religious Place	1.50	0.10	0.50	1.00	0.15	0.59	1.50	0.10	0.54
School/college	1.50	0.20	0.55	2.00	0.10	0.68	2.00	0.10	0.61
Park	2.00	0.30	0.68	0.20	5.00	0.16	2.00	5.00	0.41
Marriage Place	2.50	0.60	1.68	3.00	2.00	2.50	3.00	0.60	2.09
Hospital	3.00	0.50	2.00	1.00	0.15	0.32	3.00	0.15	1.16
Market	3.00	0.50	1.54	1.00	0.10	0.61	3.00	0.10	1.08
Main Road	3.00	0.10	1.76	0.25	0.01	0.89	3.00	0.01	0.92
Railway Line	4.00	2.00	2.73	1.00	0.10	0.63	4.00	0.10	1.80
Cinema	5.00	2.50	3.38	3.00	3.00	3.00	5.00	2.50	3.19
Canal	5.00	3.00	3.68	4.00	0.02	1.91	5.00	0.02	2.80
Highway	5.00	2.00	3.33	3.50	0.50	2.03	5.00	0.50	2.66
Bus stand	2.50	1.00	2.03	5.00	0.30	3.06	5.00	0.30	2.55
Industry	9.00	2.00	4.28	5.50	5.00	5.25	9.00	2.00	4.77

main road which cause noise pollution as these were also nearly 0.54 kilometers, 0.61 kilometers, 0.92 kilometers away from their houses respectively. The far away pollution causing place was the industry which was 4.77 kilometers (mean distance) away from houses, followed by highway, bus stand, marriage place which caused the noise pollution as it was 2.66 kilometers, 2.55 kilometers, 2.09 kilometers (away from the homes), respectively.

It was also noted from the table that nearest pollution causing features (to rural houses) was flour mill (*atta chakki*), followed by religious place and main road and the far away was industry (9.00 kilometers), followed by highway and railway line (4.00-5.00 kilometers). In urban areas, nearest pollution causing features were again flour mill, followed by school or college, market, railway line and religious place and far away was industry and bus stand which were on an average 5.25 and 3.06 kilometers away respectively. There was more number of pollution causing features in urban areas as compared to rural areas.

Assessment of indoor pollution : Indoor pollution is the presence of substances either in gases or particulates from within a home's atmosphere that could negatively affect human health. These pollutants may be natural materials, for example pollens or may be derived from man-made substances (emissions from synthetic materials). As per the Italian Ministry for the Environment 'Indoor pollution is the presence of physical, chemical or biological contaminants in the air of confined environments, which are not naturally present in high quantities in the external air of the ecological systems'.

An objective assessment of indoor pollution was done with the help of some selected instruments. Parameters included for objective assessment of indoor pollution were annoying noise, air quality (presence of CO_2 and CO beyond permissible limits) and humidity beyond tolerance level.

Assessing the environment objectively requires a well planned scientific approach and use of accurate instruments. The parameters generally considered important for objectively assessing the physical environment are light intensity, noise level, humidity, temperature, vibration and bad elements in air (SPM, percentage of CO, nitrogen and sulphur). In the context of present study however, the elements which are applicable to indoor pollution were taken which included noise level, air quality and humidity.

Assessment of indoor noise pollution : It can be seen in Table 2 that noise level, indoor, was just within permissible limits in the kitchens of selected respondents (mean value 53.85 dB ± 12.12). Noise in any residential area should not be beyond 55 dB according to recommendations of NBO of India 2010.

Data presented in the Table 2 showed that the

Table 2: Assessment of indoor noise pollution in the selected houses

Objectives parameters	Rural (n=60)		Urban (n=60)		Total (n=120)	
	Kitchen	Drawing room	Kitchen	Drawing room	Kitchen	Drawing room
Noise	*Permissible limit 45-55 dB*					
Below 45 dB	10 (16.67)	10 (16.67)	28 (46.67)	16(26.67)	38 (31.67)	26(21.67)
46 – 55 dB	4(6.67)	7(11.67)	16 (26.67)	25(41.67)	20 (16.67)	32(26.67)
Above 55 dB	46 (76.67)	43(71.67)	16 (26.67)	19(31.67)	62 (51.67)	62(51.67)
Mean	57.90	58.32	48.26	52.02	53.85	55.67
SD	11.83	11.54	10.31	8.18	12.12	10.67

t value- Kitchen 4.76**, Drawing room 3.45** Figures in parentheses indicate percentages.
* Significant at 5% level, ** Significant at 1% level

Table 3: Assessment of Carbon-di-oxide in the selected houses

Objectives parameters	Rural (n=60)		Urban (n=60)		Total (n=120)	
	Kitchen	Drawing room	Kitchen	Drawing room	Kitchen	Drawing room
Air quality	*Permissible limit of CO2 is 1000 ppm*					
Below 500 ppm	2(3.33)	0(0.00)	3(5.00)	0(0.00)	5(4.17)	0(0.00)
501 – 999 ppm	48 (80.00)	58(96.67)	42 (70.00)	60(100)	90 (75.00)	118 (98.33)
Above 1000 ppm	10 (16.67)	2(3.33)	15 (25.00)	0(0.00)	25 (20.83)	2(1.67)
Mean	778.94	645.67	920.69	657.42	838.38	650.60
SD	289.78	127.60	425.66	92.05	356.94	113.35

t value- Kitchen 2.13*, Drawing room 0.57
Figures in parentheses indicate percentages. *Significant at 5% level, **Significant at 1% level

Table 4: Assessment of carbon-mono-oxide in the selected houses

Objectives parameters	Rural (n=60)		Urban (n=60)		Total (n=120)	
	Kitchen	Drawing room	Kitchen	Drawing room	Kitchen	Drawing room
Air quality	*Permissible limit of CO is 9 ppm*					
0-3.5 ppm	54 (90.00)	58(96.67)	44 (73.33)	51(85.00)	98 (81.67)	109 (90.83)
3.6-8 ppm	6 (10.00)	2(3.33)	14 (23.33)	9(15.00)	20 (16.67)	11(9.17)
Above 9 ppm	0(0.00)	0(0.00)	2(3.33)	(0.00)	2(1.67)	0(0.00)
Mean	0.67	0.39	1.82	1.08	1.15	0.68
SD	1.15	0.90	2.35	0.93	1.83	0.97

t value-Kitchen 3.41**, Drawing room 4.13** Figures in parentheses indicate percentages.
* ignificant at 5% level, ** Significant at 1% level,

Table 5: Assessment of humidity in the selected houses

Humidity of the house	*Permissible limit 60%*					
	Rural	%	Urban	%	Total	%
Below 40%	8	13.33	14	23.33	22	18.33
41-60%	26	43.33	16	26.67	42	35.00
Above 60%	26	43.33	30	50.00	56	46.67
Mean	58.50		59.15		58.77	
SD	14.36		18.20		15.95	
t value	0.22					

Figures in parentheses indicate percentages. *Significant at 5% level, ** Significant at 1% level average noise levels were higher in rural kitchens (mean value 57.90 dB) as compared to urban kitchens (mean value 48.26 dB). Noise levels in rural kitchens crossed the safe limits imposed by NBO of India. This may be due to the fact that most rural kitchens were open kitchens in the open front area of the house, so the usual household activities as well as street traffic and courtyard noises were the main reasons for the raised noise levels of their kitchens also. These finding are in line with the finding of Bhatt (2012) who reported that in urban kitchens the average noise level in the cooking area was between 45 to 55 dB. *Verma (2001)* also highlighted that the humidity level in the rural and urban kitchens was 55 per cent and 54 per cent.

It can further be noted from the Table 2 that noise levels in drawing rooms of the houses of the selected respondents was more than the safe limits imposed by NBO of India marginally as indicated by mean value of 55.67 dB. The noise level of the drawing rooms of rural areas was higher (mean value=58.32 dB) than that of the urban area (mean value=52.02 dB). This may be due to the reason that generally drawing rooms in rural houses are away from the house and placed at the entrance just adjoining street. So, vehicular traffic and movement of people in the streets increases noises in drawing room invariably.

It can also be seen in the Table 2 that maximum number of people (51.67% from both urban and rural areas) experienced noise level, in their kitchens and drawing rooms, more than 55 dB, which is beyond permissible limits (specified for residential buildings). Minimum number of respondents (16.67%) had noise level in kitchens in the range of 41-55 dB followed by 21.67 per cent respondents who had a very quite drawing rooms (noise level recorded below 40 dB). This difference in the objective assessment of noise level of rural and urban houses was found statistically significant for kitchens as well as for the drawing rooms at 1% level of significance.

Assessment of Carbon-di-oxide : As far as the air quality is concerned, both the presence of CO2, CO and also humidity level were assessed. It is clear from Table 3 that mean concentration of CO2 in kitchens of the selected respondents was 838.38 ppm which is very much within safe limits as permissible limit of CO2 in atmosphere is 1000 ppm according to Occupational Safety & Health Administration (OSHA) as well as American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

However, the concentration of CO2 in the urban kitchens was higher (920.69 ppm) as compared to rural kitchens (778.94 ppm). This may be due to the reason that urban kitchens, being closed type, the exchange of air were less. The gases (mainly CO2), released due to combustion process, did not escape effectively to the outer environment. In drawing rooms, CO2 concentration was also observed to less than the permissible limits. In urban drawing rooms CO2 concentration was observed to be 657.42 ppm (mean value) and it was found little less in the drawing rooms of rural areas which was 645.67 ppm (mean value). It may be due to the fact that in urban areas, houses are of closed and compact types where as in rural areas, houses are of open types with court yard of good size.

It can further be seen from the Table that maximum residences (98.33%) were found to have CO2 limit 501-999 ppm in their drawing rooms. CO2 limit of all the urban drawing rooms ranged between 501-999 ppm whereas 96.67 per cent of rural drawing rooms were found to be having CO2 concentration in this range.

It was thus found that overall 20.83 per cent kitchens had CO2 concentration beyond permissible limits (more than 1000 ppm). One forth (25.00%) urban kitchens and 16.67 per cent of rural kitchens had CO2 concentration beyond safe limits of 1000 ppm. This difference in the objective assessment of carbon-di-oxide level of rural and urban houses was found statistically significant for kitchens at 5% level of significance. However for drawing rooms the difference was found to be statistically non-significant.

Assessment of carbon-mono-oxide : Carbon monoxide is almost a fatal gas and maximum number of sleep deaths are due to CO released from *angeethi*, fire place etc. in the closed room. Permissible limit of this gas is only 9 ppm in the enclosed environment according to OSHA and ASHRAE. When combustion of carbon remains incomplete, due to the limited supply of fresh air, CO is formed. Carbon monoxide is also formed as a pollutant when hydrocarbon fuels (natural gas, petrol, diesel etc.) are burned.

Breathing in just a small concentration of carbon monoxide can cause haemoglobin to convert to a synthetic form called carboxy-haemoglobin. This synthetic form of haemoglobin takes the place of normal haemoglobin, which binds with and delivers oxygen through the body. This substitute prevents delivery of oxygen throughout the body, and causes the body's myoglobin, which transports oxygen through the muscle and helps with cell respiration, to be compromised.

Table 4 highlights that only two urban kitchens were found to be having CO concentration above 9 ppm. In majority of the selected households (81.67 % kitchens and 90.83% drawing rooms) had CO concentration less than 3.5 ppm. In rural areas more kitchens (90.00%) were having CO concentration less than 3.5 ppm as compared to 73.33 per cent of urban kitchens. Main reason attributed to this phenomenon seems to be the 'design of the kitchen'; as explained earlier open and extended rural kitchens did not entrap harmful residual gases like carbon monoxide.

Concentration of CO, in majority of the rural drawing rooms (96.67%) were found to be within safe limit as compared to urban ones (85.00 %) as CO concentration recorded in these areas was less than 3.5 ppm. Hardly 23.33 per cent urban kitchens were detected with CO concentration in the range of 3.6-8.0 ppm. This difference in the objective assessment of carbon-monoxide level of rural and urban houses was found to be statistically significant for kitchens as well as for drawing rooms at 1% level of significance.

Assessment of humidity : Permissible limit of humidity which ensures healthy indoor air quality is 45 per cent (Grandjean, 1973). It is shown in Table 5 that rural homes had 58.50 per cent and urban homes had 59.15 per cent humidity indoors at the time when the assessment was made. High level of humidity hampers evaporation causes great discomfort, reduces work efficiency and gives rise to various types of fungus, algae and bacteria and virus that are harmful to the health of inmates. Mean humidity level in the houses of sampled population was observed to be 58.77 per cent.

In order to have a comfortable level of atmospheric humidity inside the houses, use of air conditioners is the most effective way though dehumidifiers are also very effective to control humidity level. Correct placement of ventilators, use of fan and exhaust fans, placement of doors and windows and orientation of rooms are also very useful means to get enough air circulation, so that body evaporation can take place and other pollution causing elements like fungi, algae, breeding of mosquitoes and flies do not thrive. These different means can make variation in humidity level from one house to another in the same locality. Pertaining to this reason, it can be observed from the Table that only 13.33 per cent rural households and 23.33 per cent urban households could control indoors humidity level means they could bring humidity to less than 45 per cent. Infact there were maximum number of rural houses (86.66%) as compared to 76.67 per cent urban houses where humidity was found to be more than 45 per cent.

However, in Punjab the scenario of high humidity level can be changed only with use of AC's and affording fully air conditioned house is not possible for most middle class and lower class families. Punjab being a 'grain bowl' to India is mainly agricultural state and favouring paddy crop is more of a compulsion than a choice for most marginal farmers. This scenario has led to two major negative environmental impacts in the state: increased humidity and decreased water table. Findings of *Singh (2009)* and *Vashisht (2008)* can be substantiated with these observations which states that over use of ground water by the farmers of Punjab underground water table is getting affected and also increasing humidity during selected months.

The difference in the objective assessment of humidity level of rural and urban houses was found statistically non-significant for kitchens as well as for drawing rooms of selected houses.

CONCLUSION

It can be concluded from the preceding paras that the roads near to the respondent's houses were *pucca* and that too in good condition. Nearest pollution causing features to the respondent's houses reported were flour mill, religious place, school and main road. The other pollution causing features industries, cinema, canal, highway, bus stand and marriage palaces were found to be far away from the homes of the selected families. Mean noise level, concentration of CO_2, concentration of CO and humidity level in kitchens and drawing rooms of the selected houses was well within the permissible limit.

REFERENCES

Anonymous (2010). NBO of India

http://nbo.nic.in/Images/PDF/Urban_Indicator_Compendium_English_Version.pdf

Banik, B. K. (2010). Female perception of health hazards associated with indoor air pollution in Bangladesh. *Inter J Sociology and Anthro* 2, 206.

Bhatt, H. (2012). *Ergonomic assessment of work station for females engaged in cooking activities*. M.Sc. Thesis, Punjab Agricultural University, Ludhiana.

Godish, T. (2010). *Indoor environmental quality.* CRC Press. NY. pp 376

Grandjean, E. (1973). *Ergonomics of the home*. Pp 141 – 150. Taylor and Francis, London.

Khare M and Gupta S (2000) Indoor air pollution. *J Irrish Assoc Emergency Medicine* 27:103-10.

Maharajan, K. and Samual, K. (2010). Impact of environmental pollution on health: A sociological study in Tuticorin industrial town, TN, India. *J Eco-biotechnology* 2: 51-56.

Samet, J. M., Dominici, F., Curriero, F. C., Coursac, I. and Zeger, S. L. (2000). Fine particulate air pollution and mortality in 20 US cities. *New England J Med* 343, 1742-49.

Singh, K. (2009). Act to save groundwater in Punjab: Its impact on water table, electricity subsidy and environment. *Agril Economics Res Rev* 22, 365-86.

Songsore, J. and McGranahan, G. (1993). Environment, wealth and health: Towards an analysis of intra urban differentials within the greater Accra metropolitan area, Ghana. *Environment and urbanization* 5, 10-34.

Vashisht, A. K. (2008). Status of water resources in Punjab and its management strategies. *J Indian Water Resources Society* 28, 1-8.

Verma, S. (2001). *Ergonomic study of existing kitchen designs of rural and urban homes of Ludhiana district*. Unpublished M.Sc. Thesis, Punjab Agricultural University, Ludhiana, Punjab.

• • • • •