Research Journal of Environmental and Earth Sciences 4(11): 982-989, 2012
ISSN: 2041-0492

Submitted: August 17, 2012 Accepted: September 13, 2012 Published: November 20, 2012

Assessing Vulnerability of Women to Indoor Air Pollution

Abha Lakshmi Singh and Saleha Jamal
Department of Geography, Aligarh Muslim University, Aligarh 202002,
Uttar Pradesh, India

Abstract: In this study an attempt has been made to identify the factors that have contributed to vulnerability of women to indoor air pollution and suggests suitable measures for its intervention. The study is based on primary sources of data collected with the help of questionnaire interviews from a sample of 2,101 women respondents belonging from different income groups, from Aligarh city. Information regarding their cooking conditions (4 factors), cooking related exposures (4 factors), housing (3 factors) and health conditions (3 factors) were collected. Total 14 factors linked with women vulnerability to indoor air pollution were identified. Indoor air pollutants were monitored in the cooking area and with different fuel usages to assess the indoor air quality. The results show that women are vulnerable to indoor air pollution but there was difference in the levels of vulnerability among the women belonging to different income groups. It was the lower income women who were most vulnerable because they were using biomass fuels/*chulhas*, cooking in a multipurpose room, spending long hours in kitchen, they were more exposed to smoke, heat, pollutants and the conditions were exacerbated because they were living in sub-standard housing, in one room leading to congestion/crowding and with no ventilation. They were suffering most from various problems and specific diseases like respiratory infections (ALRI, AURI, COPD, asthma, pulmonary tuberculosis), perinatal mortality, low birth weight, cataract and eye irritation associated with indoor air pollution.

Keywords: Cooking, exposure, health, housing, vulnerability, women

INTRODUCTION

Vulnerability is the degree to which a system or unit is likely to experience harm due to exposure to perturbations or stresses (Steffen *et al*., 2002). It is typically identified in terms of three elements: system exposure to crises, stresses and shocks; inadequate system capacity to cope; and consequences and attendant risks of slow or poor system recovery. This perspective suggests that the most vulnerable individuals, groups, classes and regions or places are those that experience the most exposure to perturbations or stresses i.e., most likely to suffer from exposure and have the weakest capacity to respond and ability to recover (Sherbinen *et al*., 2007).

Vulnerability of people continues to increase in many developing countries, despite interests and initiatives on vulnerability reduction. Among the factors that have contributed to the rise of vulnerability is the rapid spread of urban settlements or development of slums in high risk or hazardous areas, lack of drinking water and sanitation facilities, use of traditional fuels for the purpose of cooking, poverty etc. Cooking on solid fuels including biomass fuels (e.g., fuel wood, agricultural residues, dung etc.) is an important source of indoor air pollution which has contributed to vulnerability. Approximately half of the world's population and 95% in developing countries and more than 90% in India still rely on unprocessed biomass fuels (Smith, 1990). The type of stove used depends upon the type of fuel for e.g., LPG users use gas stoves, kerosene users use kerosene stoves while the biomass fuels are burnt in *chulhas* (made of three stones which are plastered with mud) or in open fires. Of these, the *chulhas* or open fires are most inefficient in which the fuels are not completely burnt. Nearly three fourth of the Indian households (3 out of 10 urban households and 8 out 10 rural households) use *chulhas* or open fires without chimney and appropriate ventilation (National Family Health Survey, 2007). The unprocessed solid fuels typically releases 50 times more noxious pollutants like particulate matter, carbon dioxide, carbon monoxide, nitrogen dioxide, sulphur dioxide, formaldehyde and carcinogens such as benzo (a) pyrene and benzene which is harmful to health (Ezzati *et al*., 2000).

It is generally women (or girls) who take the responsibility for tending the fire and cooking and who inhale larger concentration of pollutants over longer periods (Singh and Parveen, 2010). In India indoor air pollution is an important cause of morbidity and mortality especially among the poorest and more

Corresponding Author: Abha Lakshmi Singh, Department of Geography, Aligarh Muslim University, Aligarh 202002, Uttar Pradesh, India, Tel.: 0571-2400789, 09997392325

vulnerable populations. It has been estimated that about half a million women and children die every year from indoor air pollution (World Health Organization, 2005). India has the largest burden of diseases associated with indoor air pollution like acute respiratory infections, chronic lung diseases, adverse pregnancy outcomes (still birth, low birth weight), tuberculosis, asthma, otitis media, nasopharyngeal cancer, cataract, blindness and cardiovascular diseases. While the precise mechanism of how exposure causes diseases is still unclear but it is known that the small particles and several of other pollutants contained in indoor smoke cause inflammation of airways and lungs and impairs the immune response. Women are exposed more than men because of their role and responsibility for household/kitchen management, thus they are more vulnerable. Keeping all these aspects in mind an attempt has been made to assess vulnerability of women to indoor air pollution. Vulnerability assessment is systematic examination to identify persons/households that may be at risk and determine the appropriate procedure that can help in reducing risk. This analysis will help to identify the factors leading to vulnerability of women to indoor air pollution, assess the causes and suggest suitable measures for its intervention.

DATABASE AND METHODOLOGY

The study is mainly based on primary sources of data collected through household surveys with the help of questionnaire interviews. Field work was conducted during the years 2009-10 (Jamal, 2012).

In this study, 2,101 women respondents belonging to different income groups (300 from the high income group (>Rs. 25,000 per month), 620 from medium income group (Rs. 15,001-25,000 per month), 647 from low income group (Rs. 5,001-15,000 per month) and 533 from very low income group (<Rs. 5000 per month) were interviewed with the help of well structured questionnaire. The questionnaire which was

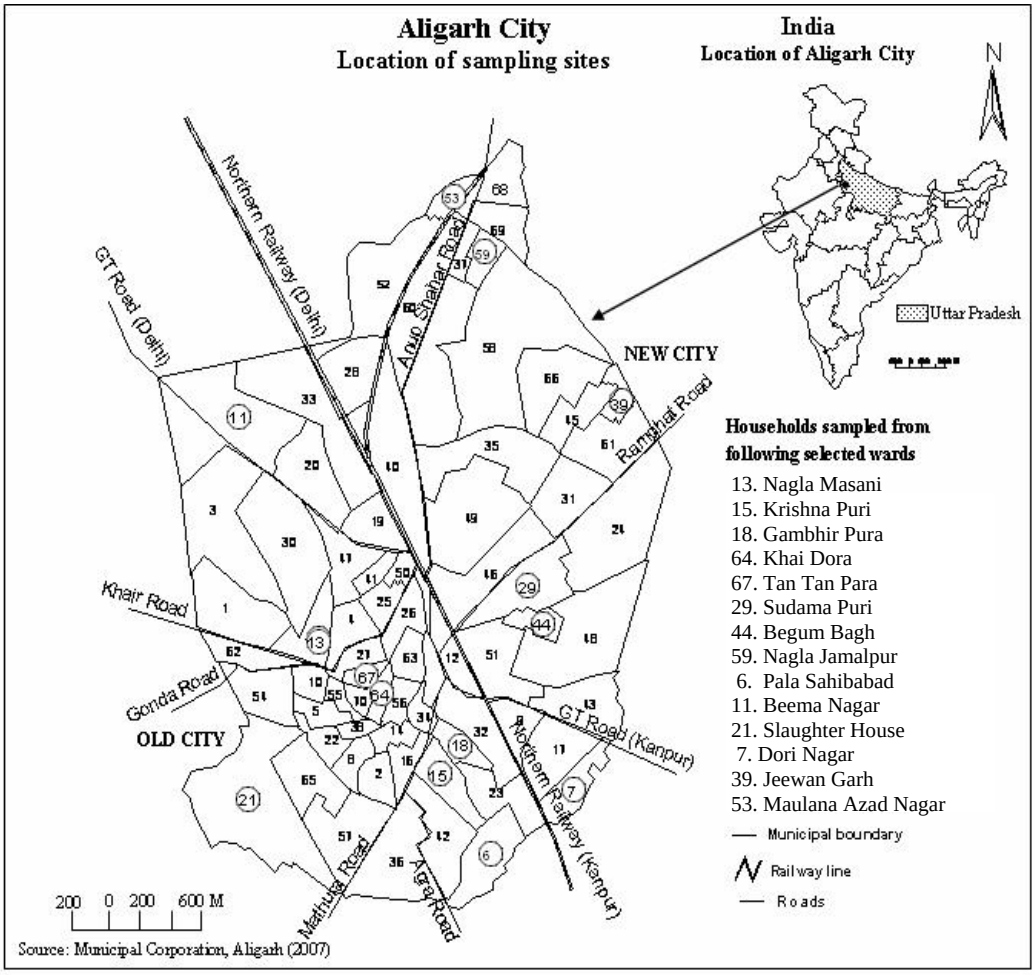

Fig. 1: Location map of Aligarh city

used required information regarding cooking conditions, cooking related exposures and housing and health conditions.

The sample was selected from the 14 wards of Aligarh (27°53'N latitudes and 78°4'E longitudes) a medium sized city located in the western part of the state of Uttar Pradesh, in the fertile Gangetic tract of North India. About 10% households belonging to different income groups were sampled from each selected ward of the city (Fig. 1). The total sample size consisted of 2,101 women respondents.

With the help of household information, 14 factors (under 4 subheads; cooking conditions (4 factors), cooking related exposures (3 factors), housing conditions (4 factors) and health conditions (3 factors) linked with women's vulnerability to indoor air pollution were identified. On this basis, women belonging to different income groups were categorized under 3 vulnerability levels-most vulnerable, moderately vulnerable and least vulnerable.

To diagnose the indoor air quality, indoor air pollutants were monitored in the cooking area and with different cooking fuel (biomass, LPG) usages. For the purpose of monitoring of SPM (PM_{10}, $PM_{2.5}$), a handy sampler "Portable GRIMM Dust Monitor Series 1.109" and for monitoring gaseous pollutants (CO_2, CO, SO_2, NO, NO_2) "YES-206" and "YES-205" handy samplers were used.

RESULTS AND DISCUSSION

Field surveys have revealed that household environmental conditions are of special importance to women because of the great amount of time they spend inside the house. They are responsible for all the domestic work including cooking. When the housing conditions are poor (having thatched leaking roofs, without appropriate ventilation), rooms and kitchen are smoky, food is cooked in unhygienic conditions using biofuels and *chulhas*, the effects on health of women are likely to be more severe. The place of cooking food, the type of fuel/*chulha* used and the long hours spent for kitchen work carries the biggest risk to the health of women. Women are more vulnerable than men to many environmental hazards because of their sex (i.e., as a result of biological differences), some because of gender (i.e., as a result of particular social and economic roles that women have, determined by social, economic and political structures), long hours of indoor work (cooking alone takes 5 to 7 h/day) and exposure to indoor smoke, heat and pollutants.

It was observed during household surveys that pregnant women are particularly vulnerable to adverse environmental condition. Every stage of multi-step process of reproduction can be disrupted by external environmental agents and this may lead to risk abortions, birth defects, fetal growth, retardation and perinatal death (World Health Organization, 1992). This particular vulnerability during pregnancy, child birth and the period after child birth is biologically determined. An estimated 136,000 women die in India every year due to pregnancy related problems (UNICEF, 2009).

Since women take the sole responsibility for household care and management (i.e., cooking, cleaning/dusting, washing, child care etc.) they are exposed more too indoor pollutants than men. It is generally women or girls who take the responsibility of cooking from an early age of 10 or 13 which meant a much longer period of exposure to pollutants. Household surveys helped in identifying the factors linked with women's vulnerability to indoor air pollution. The most important being the cooking conditions i.e., use of biomass fuels/*chulhas*, cooking in a multipurpose room, cooking in a small sized kitchen (<30 sq. ft.) and spending long hours for kitchen work (>5 h/day); cooking related exposures of women to smoke (>2 h/day), heat (>2 h/day) and prevalence of smoke in cooking place/house (>1 h/day). Other factors which exacerbates indoor air pollution is the housing condition i.e., *kutcha*/semi *pucca* houses, crowding in the house (i.e., living in only one room, average sleeping floor space (<20 sq. feet) and inappropriate ventilation. Women are obliged to breathe the air that is heavily polluted with biomass emission products which is hazardous to her health. Indoor air pollution is the most direct physical health risk. So the health conditions of the women (instant problems, short term problems and specific diseases associated with indoor air pollution) were also taken into consideration while discussing the vulnerability of women.

Vulnerability of women due to use of biomass fuels/*chulhas* and cooking in a small multipurpose room/small kitchen without appropriate ventilation: A perusal of Table 1 shows that vulnerability of women increases with the increase in use of biomass fuels/*chulhas*, cooking in a multipurpose room, cooking in a small sized kitchen and long hours for kitchen work. The results indicate a fuel transition as one move from poor to wealthy households. All the wealthy higher income women use LPG/gas stoves, while the main cooking fuel used by most (97% of the very low and 80% of the low) of the lower income women was biomass. Most of these poor women burn the biomass fuels in *chulhas* without a chimney and appropriate ventilation in the place of cooking and in their homes. Most of them were found cooking in multipurpose room or in a small sized kitchen. The biomass combustion in *chulhas* generates toxic/hazardous pollutants which gets concentrated in the small multipurpose room and cooking space. The problem gets exacerbated because of lack of venting facilities. Sample survey also revealed that nearly half of the

Table 1: Assessment of vulnerability of women due to cooking conditions (in percentages) in the sampled households

		Vulnerability assessment factors						
Income group	WR/HH	1	2	3	4	ERF	Average	VL
High	301	-	-	-	17.94	1	4.490	LV
Medium	620	6.450	1.450	15.34	22.74	4	11.50	MV
Low	647	79.44	18.70	82.42	29.52	4	52.52	MOV
Very low	533	96.62	30.77	100.0	36.26	4	65.90	MOV
Total	2,101	50.88	13.99	23.74	26.60	4	28.80	

WR: Women respondents; HH: Households; ERF: Exposure to number of cooking related risk factor; VL: Vulnerability levels, LV: Least vulnerable; MV: Moderately vulnerable; MOV: Most vulnerable; Factors: 1 = Use of biomassl fuels/*chulhas*, 2 = Cooking in a multipurpose room, 3 = Cooking in a small sized kitchen (<30 ft^2), 4 = Long duration of kitchen work (>5 h/per day); Based on field survey (2009-10)

Table 2: Assessment of vulnerability of women due to cooking related exposures (in percentages) in the sampled households

		Vulnerability assessment factors					
Income group	WR/HH	1	2	3	ERF	Average	VL
High	301	-	48.38	-	1	16.13	LV
Medium	620	9.840	67.42	6.450	3	27.90	MV
Low	647	82.07	98.15	49.30	3	76.50	MOV
Very low	533	97.93	100.0	58.91	3	85.61	MOV
Total	2,101	53.02	78.49	32.04	3	54.52	

Based on field survey (2009-10); WR: Women respondents; HH: Households; ERF: Exposure to number of cooking related exposures; VL: Vulnerability levels; LV: Least vulnerable; MV: Moderately vulnerable; MOV: Most vulnerable; Factors: 1 = Exposure to smoke (>2 h/per day), 2 = Exposure to heat (>2 h/per day), 3 = Prevalence of smoke in kitchen/house (>1 h/per day)

Table 3: Mean concentrations of SPM and gaseous pollutants in place of cooking food and in living area using biomass and LPG

	PM_{10}			$PM_{2.5}$					
Different exposure area	Avg.	Max.	Min.	Avg.	Max.	Min.			
Place of cooking (Bio)	322.86	604.40	198.80	188.77	358.35	117.1			
Place of cooking (LPG)	130.41	318.00	65.280	70.960	157.08	41.90			
Living area	83.840	121.10	58.700	42.410	83.300	26.80			
Different exposure area	CO_2			CO					
	Avg.	Max.	Min.	Avg.	Max.	Min.			
Place of cooking (Bio)	509.71	729.50	3050	3.34	8.27	0.31			
Place of cooking (LPG)	398.71	564.00	238.5	0.90	1.70	0.20			
Living area	311.69	399.00	228.0	0.59	0.90	0.20			
Different exposure area	SO_2			NO			NO_2		
	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
Place of cooking (Bio)	0.07	0.17	0.01	0.10	0.19	0.02	0.03	0.07	-
Place of cooking (LPG)	0.02	0.06	-	0.04	0.07	0.01	0.02	0.04	-
Living area	0.02	0.03	-	0.03	0.05	0.01	0.01	0.03	-

Based on field survey (2009-10); Min.: Minimum; Max.: Maximum; Avg.: Average

lower income women spent long hours inside the house for kitchen work. Hence, it is the lower income women (53%) who are the greatest sufferers due to unhealthy cooking practices.

Vulnerability of women due to cooking related exposures to smoke, fire and pollutants: Cooking fires are almost certainly the main source of exposure to indoor air pollution. Exposure to smoke, fire, high temperatures and pollutants effects women far more than men and other household members because women spend long hours in the kitchen before the fire. The amount of smoke that is inhaled from indoor cooking fires is equivalent to smoking two packs of cigarettes per day. The pollutants from the smoke make lungs vulnerable to disorders such as acute lower respiratory infections, chronic obstructive pulmonary diseases, asthma, tuberculosis, low birth weight, infant mortality etc. Exposure to high temperatures results in health problems such as heat cramps, heat exhaustion, heat strokes etc. A perusal of Table 2 shows that higher percentage of poor lower income women reported (more than 80%) of being exposed to smoke and heat. This is because most of them used biomass fuels/*chulhas* for cooking food. Because of the inefficiency of *chulhas*, giving less heat and more smoke they had to devote long hours in the cooking place before the fire. The smoke remains inside the multipurpose room for longer duration due to inappropriate ventilation and the *kutcha* material used for the construction of their homes absorbs the smoke and heat for longer duration increasing the time of exposure to all the toxic pollutants.

The researcher has measured the indoor air pollutants (SPM, CO, CO_2, SO_2, NO, NO_2) at the place of cooking food and in living area using biomass fuels and LPG (Table 3). Results given in Table 3 suggest that the average concentration of indoor air pollutants were highest at the cooking place during cooking hours with biomass fuels. Personal exposure of mean suspended particulate matter in cooking area ranges from around 322.86 $\mu g/m^3$ for PM_{10} and 188.77 $\mu g/m^3$

Table 4: Assessment of vulnerability of women due to housing conditions (in percentages) in the sampled households

		Vulnerability assessment factors						
Income group	WR/HH	1	2	3	4	ERF	Average	VL
High	301	-	-	14.68	-	1	3.670	LV
Medium	620	9.840	11.50	55.32	17.58	4	23.56	MV
Low	647	43.89	50.80	100.0	30.14	4	56.21	MOV
Very low	533	64.73	94.10	100.0	45.22	4	76.01	MOV
Total	2,101	32.83	39.10	67.52	25.94	4	41.34	

Based on field survey (2009-10); WR: Women respondents; HH: Households; ERF: Exposure to number of housing related risk factor; VL: Vulnerability levels; LV: Least vulnerable; MV: Moderately vulnerable; MOV: Most vulnerable; Factors: 1 = *kutcha*/semi-*pucca* houses, 2 = Household occupies only one room, 3 = Average sleeping floor space (<20 ft^2), 4 = Improper ventilation in house

for $PM_{2.5}$ and concentration in the living area was also high, it ranged between 83.4 µg/m^3 for PM_{10} and 42.41 µg/m^3 for $PM_{2.5}$ in houses using biomass fuels and *chulhas*. While in houses using LPG it was around 130.41 µg/m^3 for PM_{10} and 70.96 µg/m^3 for $PM_{2.5}$. In houses using biofuels carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen oxide, nitrogen dioxide (509.71, 3.34, 0.07, 0.10 and 0.03 ppm, respectively) concentrations were also higher as compared with houses using LPG. Therefore, use of a particular fuel/stove, location of cooking areas and ventilation are very important determinants of exposure not only for women involved in cooking but also to other members of a household.

The monitoring of indoor air pollutants reveals that cooking related exposures were maximum when women cooked with biomass fuels/*chulhas*. Much higher level of pollutants is released during cooking hours and this has far reaching consequences on the health of women.

Vulnerability of women due to *kutcha*/semi-*pucca* houses, household crowding and inappropriate or lack of ventilation facilities: Other factors which exacerbate indoor air pollution and increase the vulnerability of women are the *kutcha*/semi-*pucca* houses. The walls and roof of the *kutcha* houses were made of brick, mud, bamboo, thatched, tin sheets, polythene etc. The semi-*pucca* houses were made of a combination of both *pucca* and *kutcha* material. One room was *pucca* while an extension of the house where cooking was done was *kutcha*. The kitchen was neglected part either it was built *kutcha* or semi-*pucca* having thatched roof. These built materials absorbs and retains smoke and pollutants emitted from cooking fuels for a longer period thus, increasing the duration of exposure and posing severe health risks (sore throat, dry cough, phlegm, running nose-all symptoms of respiratory diseases). These sub standard dwellings were also characterized by dampness and leaky roof. The results presented in Table 4 reveals that it was the lower income women (45 to 65%) who were living in sub standard dwellings and were affected by it.

Indoor crowding depends on both the numbers of members in a households and the way in which the residential space/sleeping place is managed, is equally important because it affects the well being of a household as it affects health. Table 4 reveals that crowded-cramped conditions were observed in poorer homes. Many health problems including respiratory infections (pneumonia, tuberculosis etc.) are associated with it. Even the higher income and upper middle class who have several rooms in their house, but they use only one or two rooms. Diseases are easily transmitted from one person to another due to crowding. Their spread is often aided by low resistance among the poorer women due to malnutrition and frequency of contact.

Table 2 reveals that most of the lower income women burn biomass fuels in open fire places in *chulhas*; combustion is incomplete resulting in substantial emissions which in the absence of appropriate ventilation produces very high levels of indoor air pollution. Presence of ventilation is the best recommended way to reduce indoor air pollution. All the high income women respondents were having proper ventilation facilities while it was the economically backward sections who were the main sufferers because they live in sub-standard housing having one room, no proper place for cooking food so they cook in the multipurpose room using biomass fuel and *chulhas* having no venting facilities.

Vulnerability of women due to occurrence of associated health problems: The most significant issue that concerns indoor air quality in household environment is that exposure to pollutants released during combustion of traditional fuels used for cooking in inefficient *chulhas*, in poorly ventilated cooking areas resulting in concentration of indoor air pollutants (SPM. CO_2, CO, SO_2, NO, NO_2) poses health risk to women. Particles with diameter below 10 µ particularly these less than 2.5 µ are small enough to penetrate deeply into the lungs and have the greatest potential for damaging health (USEPA, 1997). Indoor air pollution mostly affects health through inhalation, but can also affect the eyes through contact with smoke. The sampled women respondents reported of occurrence of instant problems (cough, eye irritation, skin burns, watering of eyes, low visibility, nausea, weakness, burns etc.), short term problems (like headache, backache, skin irritation, dizziness, wheezing etc.)

Table 5: Assessment of vulnerability of women due to health conditions (in percentages) in the sampled households

		Vulnerability assessment factors					
Income group	HH	1	**2**	**3**	ERF	Average	VL
High	301	-	39.87	37.21	2	25.69	LV
Medium	620	16.77	60.00	54.03	3	43.60	MOV
Low	647	78.98	84.39	77.59	3	80.32	MV
Very low	533	94.93	89.89	82.36	3	89.05	MV
Total	2,101	53.36	72.20	66.06	3	63.87	

Based on field survey (2009-10); WR: Women respondents; HH: Households: ERF: Exposure to number of health related risk factor; VL: Vulnerability; LV: Least vulnerable; MV: Moderately vulnerable; MOV: Most vulnerable; Factors: 1 = Instant problems, 2 = Short term problems, 3 = Specific diseases (associated with indoor air pollution)

Table 6: Differential vulnerability of women (in percentages) to indoor air pollution

	Averages of vulnerability assessment factors					
Income-wise women respondents/ households	Cooking conditions	Cooking related exposures	Housing conditions	Health conditions	Total average	Vulnerability
High (301)	4.490	16.13	3.670	25.69	12.50	LV
Medium (620)	11.50	27.90	23.56	43.60	26.64	MV
Low (647)	52.52	76.50	56.21	80.32	66.38	MOV
Very low (533)	65.90	85.61	76.01	89.05	79.14	MOV
Total (2,101)	28.80	54.52	41.34	63.87	47.13	

VL: Vulnerability levels; LV: Least vulnerable; MV: Moderately vulnerable; MOV: Most vulnerable

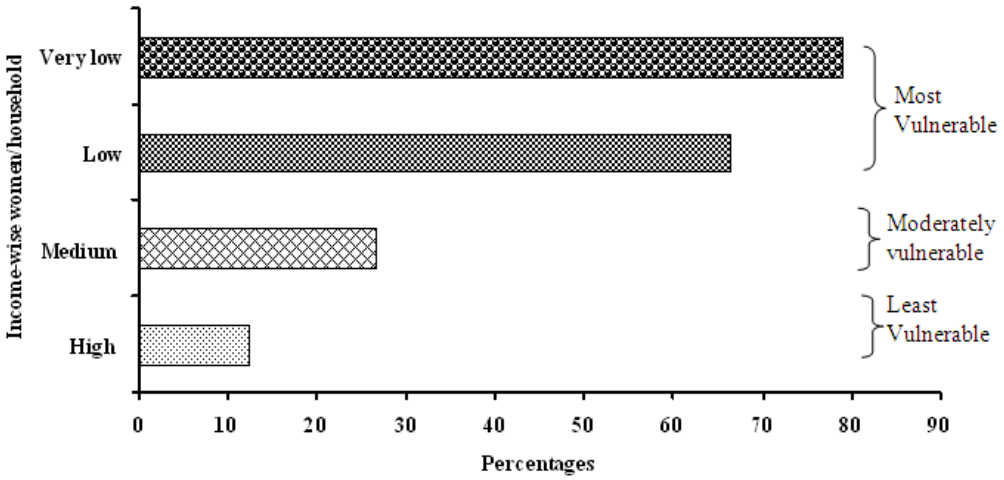

Fig. 2: Aligarh city: vulnerability status of income-wise women according to cooking conditions, cooking related exposures, housing and health conditions (2009-10)

and specific diseases associated with indoor air pollution (Acute Lower Respiratory Infection (ALRI), Acute Upper Respiratory Infection (AURI), Chronic Obstructive Pulmonary Diseases (COPD), asthma, pulmonary tuberculosis, perinatal mortality, low birth weight, eye irritation and cataract). A perusal of Table 5 shows that it was the lower income women who were living in substandard dwellings, using biomass fuels/*chulhas* were exposed to the pollutants for longer duration thus, they suffered the most from all these health problems (80 to 90%) associated to indoor air pollution.

Poor lower income women most vulnerable: The data and analysis presented in Table 1 to 5 focuses on the fact that the degree of vulnerability varies. To present an overall picture the total average of 4 subheads was worked out and a maximum (>60%), medium (20-60%) and minimum (<20%) was assigned to work out the differential vulnerability. It was observed that the very low and low income women respondents came under most vulnerable category (>60% being affected), medium income came under moderately vulnerable (20-60% being affected) and the high income group came under least vulnerable category (<20% being affected) (Table 6, Fig. 2). Thus, the poor lower income women are most vulnerable to indoor air pollution. They are more at risk because they are:

- Less able to avoid them (e.g., living in substandard dwellings *kutcha*/semi *pucca* houses which absorbs the smoke/pollutants for long hours; living in a multipurpose room with no proper ventilation food

being cooked in this room, so these women get exposed and fall prey to various diseases).

- More affected by them (cook food on biomass fuels on traditional *chulhas* which emits large amount of pollutants, they are involved in long hours of kitchen work, so they are most affected).
- Less able to cope with illness (they are more at risk with exposures, so they are engulfed with instant/short term problems and specific diseases and cannot afford to go to doctor or pay for medicines or take leave).

The characteristics that influences women's vulnerability includes income and assets which influences the households ability to afford good quality housing (*pucca*) with many rooms, separate kitchen, good ventilation, purchase of cleaner fuels etc., (which minimizes ill health) and health care including purchase of medicine and taking time off to recuperate when sick. The lower income women bear most of the burden of diseases and problems associated with indoor air pollution because of:

- Economic backwardness they are not able to afford standard good quality housing and neat neighborhoods where environmental risks are minimum i.e., cemented houses with many rooms having a separate kitchen with proper ventilation etc. As the low income have limited earnings so they are priced out of safe, well located, well serviced sites and housing.
- Again due to economic inefficiency, they are not able to afford the cleaner fuels (LPG) and mostly they use the biomass fuels, inefficient traditional stoves and *chulhas* and they cook in multipurpose room or in poorly ventilated areas which ensures the worst indoor air quality which not only inflicts the women's health but also the health of their young ones and the other family members who are simultaneously exposed to the emitted pollutants from cooking fuels during cooking. These women carry the double burden of collecting the biomass fuel which needs 2 to 4 h/day and thus, are vulnerable to shoulder ache, back ache problems from carrying heavy loads. Sometimes they become more susceptible to crimes while going too far off uninhabited areas for fuel collection.
- It is generally the traditional belief that it is the responsibility of women for tending fire and cooking food for the family. Due to which they spend long hours near stoves inhaling large concentration of noxious/toxic solid and gaseous pollutants thus damaging the respiratory system.
- Many times it was observed that these women are also the bread earners and their combined role of earning, taking care of children, household management and sometime providing biomass fuel poses them to face all the problems. Thus, they become most vulnerable.
- The most prominent cause of vulnerability of low income women is their least possibility of avoiding them or receiving treatment in order to limit their illness, injury, premature death. Due to their illiteracy and economic backwardness these women generally have access to quacks and they also have the least means to pay for medicine because of expenditure on treatment and they are least able to take leave because their salary is deducted. All this poses a challenge on their survival.
- The illiteracy among them makes them unaware of the ill effects of indoor air pollution, importance of proper ventilation, separate cooking place, use of cleaner fuels and efficient stoves etc. which makes them most vulnerable section of the society.
- The pregnant women are likely to be more sensitive to the adverse environmental conditions but due to their whole sole responsibility for household management it becomes unavoidable for them. This has a bad effect on their own self as well as on the health of foetus. Thus, leading to perinatal morbidity and mortality and low birth weight.

CONCLUSION

The foregoing analysis reveals that women are vulnerable to indoor air pollution but there are differences in the levels of vulnerability among women belonging to different income groups. It is the poor lower income women who are most vulnerable to indoor air pollution. There is need to address the problems differently. There are ways to iron out this situation and make a women's time in kitchen healthy and pleasurable. These interventions can occur on many fronts which include:

- Choice of clean and efficient cooking fuel (LPG, electricity)
- Improving cooking devices (stoves) providing more heat, less smoke and less fuel consumption
- Improving living environment (ventilation through doors and windows, separate kitchen)
- Behavioral change (spending less time in kitchen, fuel drying, using pot lids, proper maintenance of stoves, keeping children away from smoke)
- Awareness towards the ill effects of indoor air pollution

Most surveys and indoor air monitoring are needed to device programmes and strategies to reduce the health impacts of indoor air pollution. Special programmes of government focusing on health will

help in eliminating the health problems of women in long run and self awareness, choice of clean fuel/stoves, better ventilation facility will reduce the adverse effects of indoor air pollution in short run.

REFERENCES

Ezzati, M., H. Saleh and D.M. Kammen, 2000. The contribution of emission and spatial microenvironments to exposure to indoor air pollution from biomass combustion in Keny. Environmen. Health Persp., 108: 833-839.

Jamal, S., 2012. Indoor Air Pollution: Health Impacts from Household Energy. Neeraj Publishing House, New Delhi.

National Family Health Survey (NFHS-3), 2007. International Institute for Population Sciences (IIPS) and Macro International (2005-06). Mumbai, India, Vol. 1.

Sherbinen, A., A. Schiller and A. Pulsipher, 2007. The vulnerability of global cities to climate hazards. Env. Urban., 19(1): 39-64.

Singh, A.L. and U. Parveen, 2010. Fuel Choice, Indoor Air Pollution and Women's Health: A Household Level Perspective. In: Singh, A.L. (Ed.), Environment and Health. B.R. Publishers, New Delhi, pp: 1-34.

Smith, K.R., 1990. Indoor Air Quality and the Population Transition. In: Kasuga, H. (Ed.), Indoor Air Quality. Springer Verlag, Berlin, pp: 448.

Steffen, W., J. Jager, D. Carson and C. Bradshaw, 2002. Challenges of a changing earth. Proceedings of the Global Change Open Science Conference, Amsterdam NL, 10-13 July 2000, Heidelberg, Springer.

UNICEF, 2009. Maternal Mortality-A Woman Dies Every 5 Minutes from Child Birth in India. Retrieved from: http:// www. unicef. org/india/ health_1341.htm, (Accessed on: Mar 3, 2009).

USEPA, 1997. Revisions to the national ambient air quality standards for particulate matter. Fed. Register, 62: 138.

World Health Organization, 1992. Reproductive Health: A Key to a Brighter Future. WHO Special Programme of Research Development and Research Training in Human Reproduction, Geneva, pp: 21.

World Health Organization, 2005. Indoor Air Pollution and Health. Fact Sheet, No.292, June, Washington DC.