

Assessment of Indoor Environment Risk Factors and Occurrence of Respiratory Diseases in Srinagar City, J&K

Shanawaz Ahmad Baba¹, Irshad Ahmad Bhat²

^{1,2} Department of Geography and Regional Development, University of Kashmir, Srinagar

Abstract

The paper seeks to explore the risk factors associated with poor indoor environment and to examine the relationship between the poor indoor environment and the occurrence of related respiratory diseases using Karl Pearson's Correlation Coefficient. The study is based on primary sources of data collected with the help of well structured questionnaire from a sample of 1500 households belonging to different income groups. The main finding which has been drawn from this study is that 'poverty is the greatest polluter. The results substantiate that poor indoor environment contributes to respiratory diseases. The problems were more severe in the low and lower middle income households.

Key Words: Income Groups, Indoor Environment, Poverty, Respiratory Diseases, Risk Factors

I INTRODUCTION

In terms of environmental risks, indoor environmental pollution is the second most important risk factor, after unsafe water. It accounts for twice the number of deaths reported from urban outdoor air pollution (Down to Earth, July 15, 2007). According to recent findings, indoor environmental pollution is five times more hazardous than outdoor air pollution and the major source, the solid fuels is the second most environmental cause of disease after water-borne disease and fourth most important of overall excess mortality and burden of diseases (WHO, 2002). Yet many millions of people, predominantly women and children in the developing countries, are obliged to breathe air that is heavily polluted with biomass emission products. Recently, however, attention has begun to shift on the quality of indoor environment i.e. within the buildings because on an average people spend nearly 16 to 18 hours inside house in India. The pollution found in the indoor air are similar to those found outdoors and in some instances they exceed the standards set for out-door concentration.

Indoor environment is affected by a variety of factors for example the type of house and mould can provoke health problems, crowding can increase the concentration of air borne pathogens, cramped living conditions will increase the transmission of air borne pathogens, excessive humidity can facilitate the spread of infectious diseases. Indoor environment is a function of physical layout of a house, place and fuel used for cooking, indoor smoking, dampness and mould, crowding, improper ventilation, carpets and rugs etc. Poor indoor environment can lead to a number of physical symptoms and complaints. The most include – headache, fatigue, shortness of breath, sinus congestion, coughs, dizziness, nausea or in short terms various types of respiratory infections. Poor indoor environment generally affects some people more seriously including, people with allergies or asthma, people with respiratory diseases, people whose immune system is weak and people who wear contact lens.

One of the most important environmental related health problems occurring very frequently in the households of Srinagar city are respiratory diseases. The level of morbidity and mortality caused by respiratory infections rivals that from water and sanitation related diseases. Keeping all this in mind, an attempt has been made to study the indoor environment and related respiratory infections in Srinagar city. The paper has been divided into two parts. In the first part an assessment of risk factors related to poor indoor environment and occurrence of respiratory has been made. In the second part an attempt has been made to examine the relationship between poor indoor environment and respiratory infections using Karl Pearson's correlation coefficient.

II. STUDY AREA

Srinagar city has been selected for this study because such type of study has not been carried out so far in the city where about 53 per cent urban population of Kashmir Valley resides. The city of lakes, Srinagar sprawls between 33°53'49" and 34°17'14" N latitudes and 74°36'16" and 75°01'26" E longitudes (fig. 1). It is the summer capital of Jammu and Kashmir and spreads over in the heart of the oval shaped valley of Kashmir and is situated at an average elevation of about 1,585 metres above mean sea level. The city is flanked by the sub-mountain branches of Pir Panjal range (Zabarwan mountains) extending from Nagabal to Gagribal on the east, north and north-east; on the south and south-east, there lies the *karewas* of Damodar (Humhama, Budgam) and Pampore (Pulwama); on the south-west of the city, there are small *karewas* of Khushupura and Zainakote, beyond which lies flood absorption basin of Hokarsar and on the west, the city is bounded by Anchar and Khushalsar lakes (Chadda, 1991).

III. DATABASE AND METHODOLOGY

The study is mainly based on primary sources of data which were collected through city and household surveys with the help of questionnaire interviews. The survey was conducted during the years 2012 and 2013. The following methods were adopted for the study.

(1). For the purpose of selecting the sample multistage stratified random sampling technique was adopted. The first stage consisted of grouping the 34 administrative municipal wards of Srinagar city into 9 neighbourhoods on the basis of (i) income-wise dominance in the wards (low income (< Rs 5000 p.m), lower middle (Rs 5,001 – 15,000), upper middle (Rs 15,001- 25,000) and high income (>25,000); (ii) population density (very low(<2,000 persons/sq km), low (2,001-5,000), medium (5,001 – 10,000) and high(> 10,000), (iii) household density (very low(<500 household/sq km), low (501-1,000), medium(1,001-1,500), and high (>1,500) and (iv) physiographic conditions (eastern and north-eastern lake and mountainous areas, central highly congested residential/commercial areas, west, south and south-western low lying plain areas of Jhelum and marshy wetlands, north and north- western agricultural field areas and south- eastern hilly and plateau areas). In the second stage 50 percent of the wards from each neighbourhoods were randomly selected and from each of the selected wards, 2.2 percent of the total households were randomly selected for sampling and collecting information. The total sample size consisted of 1500 households from the 9 neighbourhoods (Table 1, Fig.1).

(2). Information regarding the indoor environment was drawn with the help of well structured questionnaire from 1,500 households from the 9 different neighbourhoods. The following factors were taken into consideration:

- (i) Dilapidated housing condition
- (ii) House type (*Kutcha/semi-pucca*)
- (iii) Crowding (< 50 sq. ft. per person)
- (iv) Dampness and mould
- (v) Improper ventilation
- (vi) Indoor smoking
- (vii) Cooking in multipurpose room and
- (viii) Fuel used for cooking (kerosene/wood)

(3) Data regarding the frequently occurring respiratory diseases during the last two years were not only reported by the respondents but also confirmed from various government and private hospitals and clinics.

(4) Karl Pearson's Correlation Coefficient (r) method was applied to calculate the existing relationship between the indoor air quality and the frequently occurring respiratory diseases.

$$r = \frac{\sum xy - \frac{\sum x \sum y}{N}}{\sqrt{\sum x^2 - \frac{(\sum x)^2}{N}} \sqrt{\sum y^2 - \frac{(\sum y)^2}{N}}}$$

Where, r = coefficient of correlation
 x, y = the two given variables
 n = number of observation

IV. DISCUSSION AND RESULTS

In recent years, there have been an increasing number of complaints about the poor quality of indoor environment from residents. The pollutants found in indoor environment are responsible for many harmful health effects. The effects may show up immediately after a single exposure, and include irritation of eyes, nose and throat, headache, dizziness and fatigue. Such immediate effects are usually of short duration and treatable. Sometimes the treatment is simply eliminating the person's exposure to the source of pollution. Symptoms of some diseases such as asthma, hypersensitivity, pneumonitis and humidifier fever may appear soon after exposure to certain indoor environment pollutants. Though most of these diseases can be treated, nevertheless, some pose serious risks. Hence an epidemiological study on the association between indoor air quality and respiratory diseases should cover both the residential environment factors like dilapidated housing condition, house type (*Kutcha/semi-pucca*), crowding (< 50 sq. ft. per person), dampness and mould, improper ventilation, indoor smoking, cooking in multipurpose room and fuel used for cooking (kerosene/wood). This study is not designed explicitly to provide a basis for epidemiological analysis. Nonetheless, most of the relevant risk factors are available and the results are indeed revealing.

(i) Indoor Environment and the Associated Respiratory Diseases in the High Income Group

Although most of the households in this income group were having concrete houses but about 15 per cent sampled households were living in dilapidated housing conditions. Mould and dampness is estimated to affect 10 – 50 per cent of indoor environment. It was reported by about 2 per cent sampled high income respondents. Household surveys have revealed that the most important sources of poor indoor environment were the type of fuel used for cooking, the level of ventilation, indoor smoking and use of *kangri/bukhari*. About 30 per cent sampled households reported of indoor smoking. And nearly 90 per cent reported of use of *Kangri/ bukhari* (fire pot having charcoal, coal and wooden residue as fuel for heating purpose) during winter season which also contributes to indoor pollution. About 76 per cent of the high income household reported of the occurrence of acute upper respiratory infection (AURI), 38 per cent cold/cough/fever, 10 per cent chronic obstructive pulmonary diseases (COPD), 10 per cent acute lower respiratory infections (ALRI) and 0.12 per cent pulmonary tuberculosis during the last two years. The sampled households of this group were exposed to 6 risk factors. (Table 2 and 3)

(ii) Indoor Environment and the Associated Respiratory Diseases in the Upper Middle Income Group

About one-third of the sampled households were living in dilapidated houses of which 4 per cent were lacking proper ventilation. Dampness and mould were reported by 10 per cent sampled households. Nearly 4 per cent were cooking in multipurpose room using kerosene/wood as cooking fuel. More than half sampled households reported of indoor smoking. All most all reported of use of *Kangri/bukhari* during winter season which also contributes to indoor smoke. About 83 per cent of the upper middle income household reported of the occurrence of acute upper respiratory infection (AURI), 58 per cent cold/cough/fever, 18 per cent chronic obstructive pulmonary diseases (COPD), 13 per cent acute lower respiratory infections (ALRI) and 1.75 per cent pulmonary tuberculosis during the last two years. In overall, the sampled households of this group were at the exposure of 7 risk factors. (Table 2 and 3)

(iii) Indoor Environment and the Associated Respiratory Diseases in the lower middle Income Group

More than half of the sampled households were having dilapidated houses and majority of them were *kutcha/semi-pucca* type. About 20 per cent of the sampled households in the income group were found crowded. Dampness and mould was reported by about 10 per cent sampled upper middle income respondents. About 15 of the lower middle income households cook food in multipurpose room which is very dangerous for health of residents as 8 per cent were not having proper ventilated kitchens and secondly about 6 per cent were using kerosene/wood as cooking fuel. About 59 per cent reported of indoor smoking. All the households reported of use of *Kangri/ bukhari* during winter season which also contributes to indoor smoke. About 92 per cent of the lower middle household reported of the occurrence of acute upper respiratory infection (AURI), 76 per cent cold/cough/fever, 25 per cent chronic obstructive pulmonary diseases (COPD), 21 per cent acute lower respiratory infections (ALRI) and 6 per cent pulmonary tuberculosis during the last two years. (Table 2 and 3)

(iv) Indoor Environment and the Associated Respiratory Diseases in the Low Income Group

In about 96 per cent sampled households, the average floor space per person in the sleeping rooms was less 50 sq. ft. So, keeping average area per sleeping room as crowding index, they were found very much crowded. Dampness and mould was reported by about 27 per cent sampled low income households as they were mostly located along the river banks, water bodies, marshy lands and along the drains. It was observed that half of the low income households cook food in multipurpose room hence their life is at the risk of exposure to various types of pollutants. About 8 per cent were using wood/kerosene as cooking fuel. It is very important to mention here that the low income households were using illegal electricity for cooking purposes. About 29 per cent had improper ventilated kitchens. About 61 per cent reported of indoor smoking. All the households reported of use of *Kangri/ bukhari* during winter season which also contributes to indoor smoke. About 99 per cent of the high income household reported of the occurrence of acute upper respiratory infection (AURI), 87 per cent cold/cough/fever, 33 per cent chronic obstructive pulmonary diseases (COPD), 24 per cent acute lower respiratory infections (ALRI) and 8 per cent pulmonary tuberculosis during the last two years (Table 2 and 3).

Relationship between Indoor Environment Risk Factors and the Associated Respiratory Diseases

An attempt has been made to establish the relationship between sampled respondents housing related risk factors and the occurrence of associated diseases. The correlation coefficient (r) given in table 4 depicts that all the selected diseases namely, acute upper respiratory infections (AURI), cold/cough and fever, chronic obstructive pulmonary diseases (COPD), eye infections, acute lower respiratory infections (ALRI) and pulmonary tuberculosis are positively correlated with all the risk factors namely, dilapidated housing conditions, *kutch*/semi-pucca houses, crowding, dampness and mould, improper ventilation, indoor smoking, cooking in a multipurpose room and use of kerosene/wood. Their positive correlation generalizes the fact that all diseases are associated with risk factors which have been taken for the present study. The results clearly indicate that better the indoor environment the lesser will be the occurrence of respiratory diseases and vice-versa (Table 4 and fig. 2).

V. CONCLUSIONS

The main conclusion which has been drawn from this study is that 'poverty is the greatest polluter'. The results substantiate that poor indoor environment contributes to respiratory diseases. The problems were more severe in the low and lower middle income households not only because of identified risk factors but there are also other unidentified risk factors too like duration of cooking, solid waste problem, socio-economic status of the household etc. which will help in aggravating this disease. The differences in the household indoor environmental conditions give an explanation for the variations in respiratory problems among the households belonging to different income groups. Indoor environment pollution is one of the major problems that we have to solve since we spend a large part of our life indoors. We should take all necessary precautions to eliminate or minimize the harmful effects of indoor environment pollution.

S. No	Neighbourhoods Acronyms		Ward Numbers	Total number of wards	Selection of sample		
					Selection of wards (50 percent)	Total No. of Hhs in the selected wards	Selection of Sample 2 percent of total Hh
1	Low income neighbourhood with high density	LI/HD	9,10,18,23,24,28	6	3 (9,18,23)	15,075	304
2	Low income neighbourhood with very low density	LI/VLD	1,3	2	1 (3)	5,665	128
3	Lower middle income neighbourhood with high density	LMI/HD	2,4,5,7,8	5	2 (5,7)	10,955	245
4	Lower middle income neighbourhood with low density	LMI/LD	13,34	2	1 (34)	4,656	105
5	Upper middle income neighbourhood with medium density	UMI/MD	6,11,12,20,21,22,29,31	8	4 (12,20,22,29)	16,278	363
6	Upper middle income Neighbourhood with low density	UMI/LD	19,25,26	3	1 (19)	3,548	81
7	Upper middle income neighbourhood with very low density	UMI/VLD	27	1	1 (27)	3600	82
8	High income neighbourhood with low density	HI/LD	30,32,33	3	1 (33)	2,967	68
9	High income neighbourhood with very low density	HI/VLD	14,15,16,17	4	2 (14, 15)	5,523	124
Neighbourhoods				34	16	68,267	1,500

Table 1: Design for survey adopted for the selection of the sample from the different neighbourhood environmental conditions in Srinagar city, 2015

Hh=Households

I=income

D= density

U=upper

L= low/lower

M= Medium/middle

H= high/higher

Source: (i) Srinagar Municipal Corporation, Srinagar 2011

(ii) Based on Field Survey, 2012-13

(iii) IRS-ID LISS III + PAN Imagery of Srinagar city 2008

Table 2: Income-wise distribution of sampled respondents (in per centages) in Srinagar city (2012-13) according to identified indoor risk factors

Income Groups	No. of sampled households	Dilapidated housing conditions	House type (kutch a/ semi-pucca)	Crowding (<50 sq. ft. per person)	Dampness and mould	Improper ventilation	Indoor smoking	Cooking in multi-purpose room	Type of fuel used (kerosene /wood)	Total average of 8 risk factors	Exposure of households to number of risk factors
High	239	15.28	11.30	-	2.09	0.15	30.13	2.51	-	7.68	6
Upper middle	168	27.95	16.07	-	9.52	4.17	50.59	4.17	4.46	14.62	7
Lower middle	624	55.1	23.64	20.03	10.26	8.48	58.81	15.22	14.42	25.75	8
Low	469	83.09	41.15	95.52	27.08	24.7	60.77	46.27	7.78	48.30	8
Total	1,500	45.35	23.04	28.89	12.24	9.38	50.08	17.04	6.67	24.24	8

Source: Based on field survey, 2012-13

Table 3: Income-wise distribution of sampled the respondents (in per centages) in Srinagar city (2012-13) according to most frequently occurring diseases during the last two years.

Income Groups	No. of sampled households	Frequently occurring diseases (in descending order)					
		AURI	Cold/cough/fever	COPD	ALRI	TB	Average
High	239	75.95	38.49	10.39	10.23	0.12	27.04
Upper middle	168	82.54	58.31	18.13	13.23	1.75	34.79
Lower middle	624	92.30	75.85	25.11	20.83	5.76	43.97
Low	469	98.67	87.14	33.47	23.87	7.89	50.21
Total Average	1,500	87.37	64.95	21.78	17.04	3.88	39.01

Source: Based on field survey, 2012-13

Table 4: Correlation coefficient between dependent variables (associated diseases) and independent variables (indoor housing related risk factors)

Associated diseases	Housing related risk factors						
	X1	X2	X3	X4	X5	X6	X7
Y1	0.965*	0.916*	0.807*	0.890*	0.959*	0.849*	0.780
Y2	0.989**	0.974**	0.902*	0.959**	0.901*	0.930*	0.650
Y3	0.988**	0.964**	0.883*	0.940*	0.917*	0.915*	0.690
Y4	0.981**	0.928*	0.839*	0.890*	0.896*	0.878*	0.780
Y5	0.990**	0.946*	0.864*	0.920*	0.887*	0.901*	0.750
*. Correlation is significant at the 0.05 level (2-tailed)							
**. Correlation is significant at the 0.01 level (2-tailed).							

Risk Factors

X1= Dilapidated housing conditions

X2= House type (*kutcha*/semi- *pucca*)

X3 = Crowding (< 50 sq. ft/person sleeping space)

X4 = dampness and mould

X5 = Improper ventilation

X6 = Indoor smoking

X7= Cooking in multipurpose room

X8= Type of fuel used (kerosene/wood)

Source: Based on field survey, 2012-13

Related diseases

Y1= Acute upper respiratory infections (AURI)

Y2 = Cold/cough and fever

Y3 = Common obstructive pulmonary diseases (COPD)

Y4= Acute lower respiratory infections (ALRI)

Y5 = Pulmonary Tuberculosis

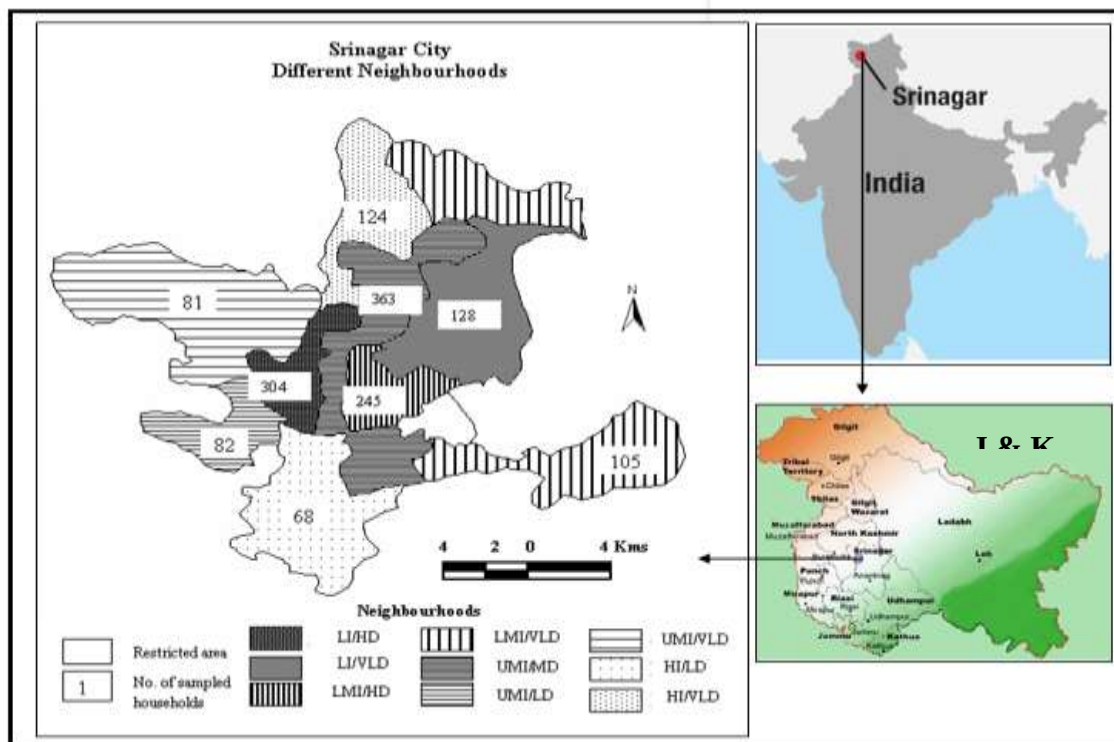


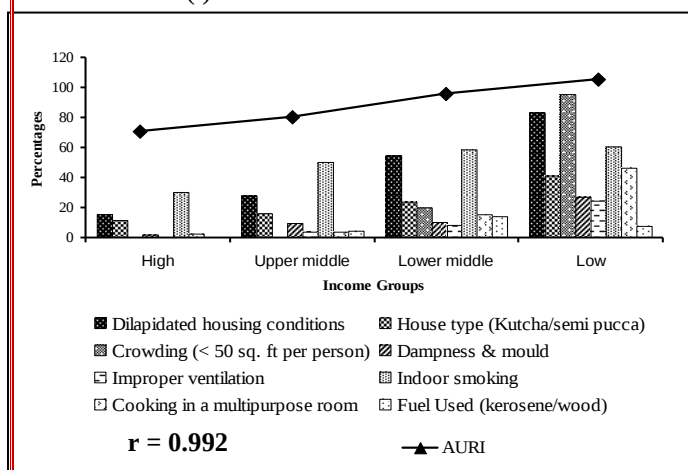
Fig. 1. Srinagar City: Location map (2011)

Source: (i) Srinagar Municipal Corporation, Srinagar 2011

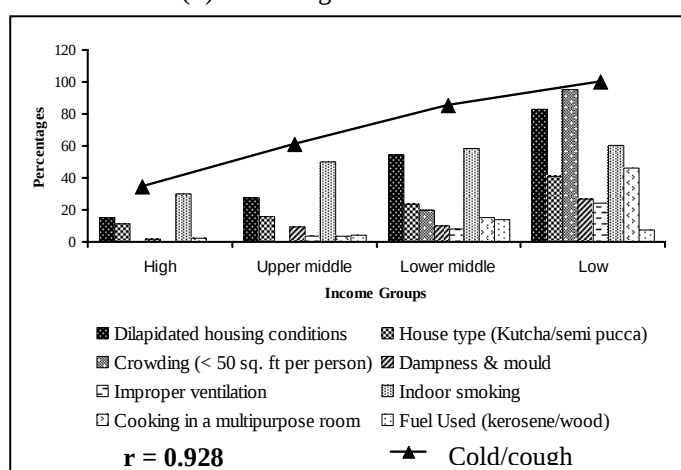
(ii) Based on Field Survey, 2012-13

(iii) IRS-ID LISS III + PAN Imagery of Srinagar city 2008

(i) AURI

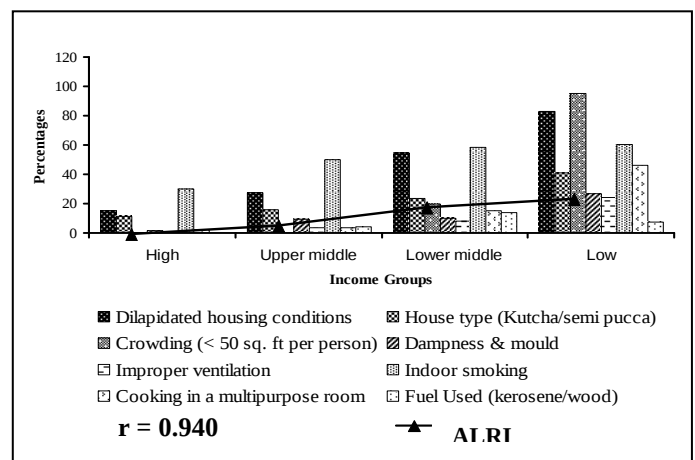
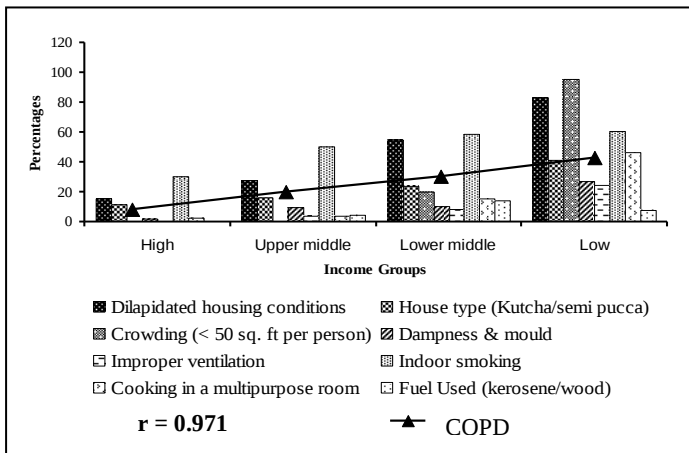


(ii) Cold/cough/fever

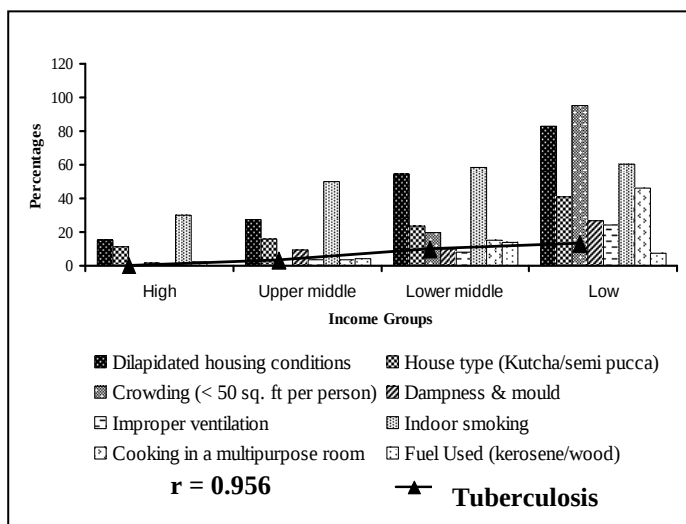


(ii) COPD

(iv) ALRI



(vi) Pulmonary Tuberculosis



Source: Based on field survey, 2012-13

Figure 2: Relationship between indoor environment related risk factors and occurrence respiratory diseases in the sampled households of Srinagar city (2012-13)

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