Environmental pollution means lowering of environmental quality at local scale caused exclusively by human activities whereas environmental degradation means lowering of environmental quality at local, regional and global levels by both natural processes and human activities.

Environmental pollution is very much close to the inside household environment. Urban health in developing countries has distinctive characteristic. There are communicable diseases on one hand and proliferation of non-communicable diseases, triggered by urbanization and industrialization on the other. This dual characteristic complicates the problem of health. Besides ill effects of the environment it generates promoting factors for the growth of many more diseases. Human health is also affected by the quality of the environment in the place of air, water noise and waste its improper disposal affects the environment adversely. Environmental degradation including the degradation of land and water is the most serious impact of pollution. The discussion revealed that residents of the Aligarh City are most affected by ill drainage system, disposal of solid or liquid waste in and around the houses, over population, lack of accommodation, smoky and improper ventilated houses. Many of the environmental problems described in the previous chapters pose health risks. In the individual chapters, some these healths were discussed and empirical associations between particular environmental hazards and ill health were presented. The environmental concern for air pollution has largely been focused on the question of pollution outdoors. However the attention of scientists has shifted to the quality of air indoors. The indoor air pollutants are nearly the same as that of the outdoor ones. However in some instances the concentration of household pollutants exceeds the standard set for the outdoors. These pollutants reach such a high level despite they are emitted in small volumes but they cannot escape easily from the buildings due to lack of proper ventilation. Indoor air pollution is more harmful and poses greater health hazards because on average a person spends nearly 16 to 18 hours indoors. Keeping these points in mind, it was thought worth studying the
indoor air pollution and its impact on the health of the people in a medium size city of India, i.e. Aligarh with a population of nearly 0.6 million by the end of 2001 in Aligarh city. An attempt was made to see the income-wise household environmental pollution and its health impact on the sampled residents of Aligarh city. The study addresses the use of various fuels for cooking, place of cooking, indoor smoking, outside smoke coming inside the house, ventilation in the house and also the floor space per person in the sleeping rooms, the poor household environmental condition responsible for the occurrence of diseases.

This chapter has been divided into 4 parts, deals separately different set of indoor and outdoor environmental pollution related diseases, the detailed study causes of environmental pollution (air, water and waste) in the previous chapter.

- Indoor Air Pollution Intensity and Associated Diseases.
- Household Water Supply, Sanitation and pollution-Its Intensity and Resultant Water Born Diseases.
- Indoor Noise Pollution and Its Intensity and Resultant Diseases.
- Analysis of Solid Waste and Its Impact on Health of the Inhabitants

7.1 Indoor Air Pollution Intensity and Associated Diseases

Though physical housing conditions are documented across much of the world, little information is available on the quality of the built environment except for a broad classification of house type, the provision of environmental infrastructure and occasionally the levels of crowding.

An attempt has been made to establish the relationship between indoor air pollution with associated diseases. The following variables of indoor air pollution and diseases as related with indoor air pollution.

- Per head living space (room density) ($X_1$)
- Proper ventilation not exit ($X_2$)
- Multipurpose room ($X_3$)
Smoking in house (X₄)
Bio-fuel used for cooking (X₅)
kerosene used for cooking (X₆)
Smoke remain inside the house (X₇)
Smoke coming from outside (X₈)

Whereas, eight types of diseases related with household air pollution.

- Conjunctivitis (Y₁)
- Rhinitis (Y₂)
- Sore throat (Y₃)
- Bronchitis (Y₄)
- Asthma (Y₅)
- Allergies (Y₆)
- Tuberculosis (Y₇)
- Pneumonia (Y₈)

Table 7.1 depicts that all the selected disease namely, Conjunctivitis, Rhinitis, Sore Throat, Bronchitis, Asthma, Allergies, Tuberculosis and Pneumonia are positively correlated with the causes of indoor – outdoor air pollution. Their positive correlation generalized the fact that all the diseases are associated with the causes which have been taken for the present study.

**Conjunctivitis**¹: Spatial analysis of the Conjunctivitis is exhibited in table 7.1 under very high and high income group household’s percentage of Conjunctivitis affected households are 3.54 per cent and 8.81 per cent from selected wards of the city. The medium income group of Conjunctivitis affected household’s is 17.28 per cent of the city. 37.41 per cent of the low income households Conjunctivitis affected households. The analysis reveals

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¹ Conjunctivitis is the inflammation of the conjunctiva (the membrane that lies the eyelids and covers the exposed surface of the eyeball). It can be caused by allergies, bacteria, viruses, chemicals, or underlying health conditions.
that very high occurrence of conjunctivitis disease is found in low income group of households who live in peripheral and central part of the city.

**Rhinitis**\(^2\): Table 7.1 exhibits that 32.35 per cent households belong to low income group most affect by rhinitis. These areas are more prone to risk factor of the rhinitis like ill ventilation, per head living space characterized with high pollution density and also very congested inhabitation in the houses. It is observed that 22.47 per cent of households affected by rhinitis come under medium category, very high 9.34 per cent and high 12.65 per cent households are affected by rhinitis respectively.

**Sore Throat**\(^3\): Table 7.1 reveals that very high and high income group households affected by sore throat are 9.06 per cent and 14.38 per cent respectively, 27.03 per cent affected belong to medium category and the highest affected category household belong to low income group household i.e. 38.94 per cent. It is observed that sore throat infection is very closely associated with ill ventilation, use of bio-fuel, high pollution density, traffic congestion, high frequency of automobiles, and emission of harmful gases such as \(\text{NO}_2\), \(\text{SO}_2\) and also SPM from automobiles. The affected people are the inhabitant of the peripheral of the city and industrial area where the risk factors are significant.

---

**Note:**

- **Rhinitis**\(^2\): Rhinitis is the medical term describing irritation and inflammation of some internal areas of the nose. The primary symptom of Rhinitis is a running nose. It is caused by chronic or acute inflammation of the mucous membrane of the nose due to viruses, bacteria or irritants. Risk factors of the Rhinitis are pollen in the air, indoor allergens, dust and animal dander, smoke, strong smells, and fumes, changes in temperature or humidity.

- **Sore Throat**\(^3\): Sore Throat the dry scratchiness and painful swallowing that are the hallmarks of a sore throat can be miserable, yet a sore throat is not a disease. Most often, it is a symptom of another illness, such as, the common cold or the flu. The most common factors associated with a sore throat are bacteria, smoking or exposure to second hand smoke, dust, molds or pet dander, chemical irritants, particulate matter in the air from burning of fossil fuels, as well as common household chemicals, poor hygiene, viral bacterial etc.
**Bronchitis**: Of the total sample, about 38.01 respondents reported of suffering from bronchitis infection belong to the low income households of the sampled household of the city. Under very high to high category of households affected by bronchitis are 9.35 per cent and 16.27 per cent respectively, under the medium category household affected by bronchitis disease 27.22 per cent of the sampled households of the city. The spatial analysis reveals that high percentage of occurrence of bronchitis is found mostly in the low income category household of the city. It is attributed to the high use of bio-fuel, ill ventilated house, low living space availability and high density of population, congested houses and high traffic flow. Besides, affected people are also reported from industrial area located in outer margin and central part of the city.

**Asthma**: Of the total sample, about 23.48 per cent of the respondents reported of suffering from asthma (37.21 per cent of low, 29.73 per cent of the medium 15.89 per cent of the high and 11.09 per cent of the very high income household). The analysis reveals that high percentage of asthma affected households are found mostly in low income households located in the central part and some in-peripheral area of the city. Central part of the city attributed to mainly very high density room (very low per head living space availability), ill ventilated and congested house, and some time some comes from outside peripheral area of the city closely associated with high use of bio fuel and emitting smoke industries.

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**Note**: Bronchitis: is a term that means inflammation of the lining of the trachea and bronchi which are the tubes leading from the throat to lungs. Smoking is the major cause of this disease also occur inhale irritating or dusts. Chemical solvents and smoke, including tobacco smoke, have been linked to acute bronchitis.

Asthma is a disease that affects the breathing passages of the lungs. Asthma affects all ages but it is the most common of children. Asthma has many costs to society as well as to the individual affected cause of asthma exposure to tobacco or wood smoke, breathing polluted air, inhaling other respiratory irritants such as perfumes of cleaning products etc.
Table 7.1 Diseases Associated with Indoor Air Pollution

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Conjunctivitis (Y₁)</th>
<th>Rhinitis (Y₂)</th>
<th>Sore throat (Y₃)</th>
<th>Bronchitis (Y₄)</th>
<th>Asthma (Y₅)</th>
<th>Allergies (Y₆)</th>
<th>Tuberculosis (Y₇)</th>
<th>Pneumonia (Y₈)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High</td>
<td>3.54</td>
<td>9.34</td>
<td>9.06</td>
<td>9.35</td>
<td>11.09</td>
<td>18.54</td>
<td>1.04</td>
<td>5.47</td>
</tr>
<tr>
<td>High</td>
<td>8.81</td>
<td>12.65</td>
<td>14.38</td>
<td>16.27</td>
<td>15.89</td>
<td>23.17</td>
<td>1.69</td>
<td>10.22</td>
</tr>
<tr>
<td>Medium</td>
<td>17.28</td>
<td>22.47</td>
<td>27.03</td>
<td>37.22</td>
<td>29.73</td>
<td>27.19</td>
<td>11.04</td>
<td>23.54</td>
</tr>
<tr>
<td>Low</td>
<td>37.41</td>
<td>32.35</td>
<td>38.94</td>
<td>38.01</td>
<td>37.21</td>
<td>37.11</td>
<td>21.38</td>
<td>42.18</td>
</tr>
</tbody>
</table>

Source: Based on field survey, 2007.
Diseases Associated with Indoor Air Pollution

- **Conjunctivitis**
- **Rhinitis**
- **Sore Throat**
- **Bronchitis**
- **Asthma**
- **Allergies**
- **Tuberculosis**
- **Pneumonia**

Fig.7.1
**Allergies**: Of the total sample, about 26.5 per cent respondents reported of suffering from allergies (18.54 per cent very high, 23.17 per cent high, 27.19 per cent of medium and 37.11 per cent of low income households). Analysis reveals that high percentage of occurrence of allergies diseases is found the households are located in the central and southern peripheral area and industrial area also.

These areas are closely associated with very high to high use of bio-fuel, ill ventilation, per head low living space besides these area are also associated with more smoking, smoke come from outside and smoke remains inside the house.

**Pneumonia**: Of the total sample, about 20 per cent respondents reported of suffering from Pneumonia (5.47 per cent of very high, 10.22 per cent of high, 23.54 per cent of medium and 42.18 per cent of low income households). The low category income households are more Pneumonia affected household. The analysis reveals that high percentage occurrences of Pneumonia are found mostly in central and southern peripheral area of the city. The central part of the city characterized by high traffic congestion, ill ventilation, low living space availability and high population density. Old central parts of the city are having congested residential area associated with narrow lanes and streets.

**Tuberculosis**: Of the total sample, about 9 per cent respondent reported of suffering from tuberculosis (1.04 per cent very high, 1.69 per cent high, 11.04 per cent medium and 21.38 per cent of low income households). The analysis

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**Note**:  
6. Allergy refers to an exaggerated reaction by immune system in response to bodily contact with certain foreign substances. Allergies are caused by a reaction in immune system by the unhealthy environment.

7. Pneumonia is an infection of the lungs it directly interferes with body’s ability to exchange carbon dioxide and oxygen. People with pneumonia usually complain of coughing, fever, shortness of breath, and chest pain. Most pneumonia is caused by bacteria or a virus also be caused by inhaling vomit or other foreign substances.

8. Tuberculosis (TB) describes an infectious disease that has plagued humans. Two organisms cause tuberculosis—Mycobacterium tuberculosis and Mycobacterium bovi Factors include TB are crowded living conditions, homelessness, low socioeconomic status, and alcoholism etc.
of the tuberculosis through its percent is not very high. It is attributed to the ill
ventilation, congested inhabitation, high population density and low living space.

**Impact of Indoor Air Pollution on Health**

To analysis the impact of indoor air pollution on the health of habitant of
Aligarh City, some significant diseases have been taken into consideration Karl
Pearson’s technique of coefficient of correlation has been adopted the
significance of their correlation has been tested with student’s’ test technique at
108 degree of freedom. Table 7.2 exhibits that all the variables of household air
pollution are positively correlated to the probable disease. The data analysis
given in table 7.2 depicts that all the selected disease namely, conjunctivitis,
Sore throat, Bronchitis, Tuberculosis, Allergies, Asthma and Pneumonia are
labeled as X₁, X₂ … … X₈ and causing factor namely, per head living space
availability, non ventilated houses, multipurpose room, bio-fuel use for
cooking, kerosene use as fuel for cooking, smoking in house, smoke coming from
outside, smoke remains inside are labeled as Y₁, Y₂, ... ... Y₈. Their correlation is
significant at 1 per cent level with exception of association between the independent
variable X₁,.. X₈ and dependent variable Y₁,.. Y₃, these are significant at 2 per
cent level. It is clear from the above analysis that household air pollutions are the
major causing factors for the respiratory diseases.

**Table 7.2 Correlation Coefficient (R) Between Dependent (Disease) and
Independent Variables (Causes of Household Air Pollution)**

<table>
<thead>
<tr>
<th></th>
<th>X₁</th>
<th>X₂</th>
<th>X₃</th>
<th>X₄</th>
<th>X₅</th>
<th>X₆</th>
<th>X₇</th>
<th>X₈</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y₁</td>
<td>0.98</td>
<td>0.94</td>
<td>0.98</td>
<td>0.88</td>
<td>0.97</td>
<td>0.95</td>
<td>0.96</td>
<td>0.94</td>
</tr>
<tr>
<td>Y₂</td>
<td>0.99</td>
<td>0.96</td>
<td>0.97</td>
<td>0.88</td>
<td>0.93</td>
<td>0.98</td>
<td>0.91</td>
<td>0.91</td>
</tr>
<tr>
<td>Y₃</td>
<td>0.97</td>
<td>0.89</td>
<td>0.90</td>
<td>0.95</td>
<td>0.80</td>
<td>0.92</td>
<td>0.89</td>
<td>0.92</td>
</tr>
<tr>
<td>Y₄</td>
<td>0.99</td>
<td>0.93</td>
<td>0.95</td>
<td>0.92</td>
<td>0.70</td>
<td>0.96</td>
<td>0.84</td>
<td>0.98</td>
</tr>
<tr>
<td>Y₅</td>
<td>0.90</td>
<td>0.78</td>
<td>0.96</td>
<td>0.74</td>
<td>0.98</td>
<td>0.95</td>
<td>0.98</td>
<td>0.84</td>
</tr>
<tr>
<td>Y₆</td>
<td>0.98</td>
<td>0.90</td>
<td>0.93</td>
<td>0.88</td>
<td>0.86</td>
<td>0.94</td>
<td>0.97</td>
<td>0.96</td>
</tr>
<tr>
<td>Y₇</td>
<td>0.98</td>
<td>0.97</td>
<td>0.97</td>
<td>0.92</td>
<td>0.95</td>
<td>0.97</td>
<td>0.84</td>
<td>0.99</td>
</tr>
<tr>
<td>Y₈</td>
<td>0.98</td>
<td>0.77</td>
<td>0.98</td>
<td>0.87</td>
<td>0.95</td>
<td>0.99</td>
<td>0.92</td>
<td>0.92</td>
</tr>
</tbody>
</table>

**Source:** Computed by researcher.
The study reveals that very high occurrences of conjunctivitis disease are found in peripheral and central part of the city. Having high correlation with per head living space availability \( (r=0.98) \) followed by smoking in house \( (r=0.96) \) and non ventilated Houses \( (r=0.94) \) respectively. Rest of the available are also moderately correlated with most severe disease conjunctivitis. The positive association is observed between Kerosene use as cooking fuel \( (r=0.97) \), smoke remain inside \( (r=0.94) \) with diseases conjunctivitis. The dependent variable \( (Y_2) \) Rhinitis closely associated with few independent variables. Table 7.2 exhibits that very high correlation occurs between Rhinitis and \( Y_1, Y_3 \) (multipurpose Room) and \( Y_8 \) (smoke remains inside). It is important to note that though their relationship in significant at 1 percent level but they are correlated with varying degree of r value. Although all the dependent variable \( (Y_1 \ldots Y_8) \) positively correlated with independent variable \( X_3 \). Table 7.2 exhibits that the variable per head living space availability to the disease sore throat, allergy, Asthma, Bronchitis and Tuberculosis Rhinitis with varying r value are correlated. Again it is observed that note a single disease is either very highly correlated or very poorly with r value more than 60 per cent and less than 20 per cent. As far as the variable non ventilated houses and multiple purpose room is concerned, it has close association with Tuberculosis \( (r=0.96) \), per head living space availability have positive correlation with Tuberculosis.

The data presented in the table 7.2 shows that all the cooking related factors or independent variables \( (Y_4, Y_5 \text{ and } Y_6) \) are not highly correlated with all the associated diseases or dependent variable \( (X_1, X_2 \ldots X_8) \) except for two cause factor that is multipurpose room is highly correlated \( (r=0.96) \), Allergies \( (r=0.93) \), Rhinitis \( (r=0.98) \), Asthma \( (r=0.97) \) except for conjunctivitis \( (r=0.82) \). Another variable use of kerosene oil as fuel are poorly correlated \( (r=0.80) \) sore throat, Bronchitis \( (r=0.72) \). Table 7.2 reveals some association between bio-fuel and associate disease Tuberculosis. Tuberculosis is positively correlated to \( (r=0.98) \) to bio-fuel used cooking. Improper ventilated houses and smoking in house is correlated with Tuberculosis with \( (r=0.78) \) and Pneumonia \( (r=0.77) \).
while correlated to rest of disease with high degree of correlation. The highest degree of correlation is found with Rhinitis ($r=0.97$), it is also observed that not a single diseases is poorly correlated with the factors smoking in house.

Dependent variable ($Y_7$) smoke coming from outside is significantly correlated to the diseases i.e. conjunctivitis, Rhinitis, some throat, Asthma and Pneumonia with $r$ values $r=0.96$, $r=0.93$, $r=0.89$, $r=0.84$ and $r=0.94$ respectively. It is highly associated with the diseases Tuberculosis ($r=0.98$). Bronchitis and Allergies, although they are significant at 1 percent level except $r$ value 0.84 at 2 percent level

From the above discussion and Table 7.2 it may be generalized that the causing factors should be controlled and checked for the partial control over the spread of associate diseases up to some extent in the study area.

**Intensity of Air Pollution and its Resultant Diseases**

To examine the relationship between household air pollution and related diseases, all the parameters are computed with the help of composite z-score.

**Intensity of Air Pollution**

The analysis of intensity of household air pollution is calculated based on composite mean z-score (CS) which clearly reveals that under high category of intensity household air pollution lies in between above 0.5 CS values i.e. 36.36 per cent sampled wards of the city (Table 7.3) consisting of 4 wards such as Sarai Bala, Kala Mahal, Rasalaganj, and Bhujpura. Moderate intensity of household air pollution ranging in between ±0.5 value of CS values are found in 54.54 per cent of the total sampled wards of the city, occupying six wards such as Tantanpara, Kishore Nagar, Begpur, Nagla Mehtab, Dori Nagar and Hamdard Nagar. Low intensity of household air pollution ranges below -0.5 value of CS, consisting of only 9.09 per cent of the sampled ward of the city i.e. Dodhpur. It has been clear from the spatial analysis of intensity of household air pollution are mainly found in the central part of the city and
peripheral area of the city as well as industrial areas, the core area of the city characterized by very high population density, unplanned residential areas, narrow lane, street, and improper ventilated houses. Some areas are as congested as there is no space for fresh air to replace the room air.

**Table 7.3 Intensity of Indoor Air Pollution**

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Percent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.5 Above</td>
<td>4</td>
<td>36.36</td>
</tr>
<tr>
<td>Medium</td>
<td>± 0.5</td>
<td>6</td>
<td>54.54</td>
</tr>
<tr>
<td>Low</td>
<td>Below -0.5</td>
<td>1</td>
<td>9.09</td>
</tr>
</tbody>
</table>

**Source:** Computed by Researcher

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**Aligarh City**

*Intensity of air pollution (Based on Composite mean score) 2007*

![Map of Aligarh City](image)

*Source: Based on sampled household survey*

**Fig. 7.2**
Intensity of Diseases Associated With Indoor Air Pollution

Intensity of diseases is calculated based on composite mean z-score (CS) Table 7.4 reveals that high intensity of diseases are reported from Bhujpura, Sarai Bala, Rasalganj having the CS values 0.5 above occupying 27.27 per cent wards of the total sampled wards of the city. The medium intensity of diseases associated with household air pollution of the city having ±0.5 CS value, are found in 54.54 per cent of the total sampled wards of the city occupying six wards such as Kala Mahal, Tantanpara, Baigpur, Nagla Mehtab, Hamdard Nagar and Dori Nagar. Under low intensity of diseases prone areas households range from below – 0.5 CS values. The low intensity of incidence of diseases associated with household air pollution is found in 18.18 per cent of sampled wards of the city i.e. Kishore Nagar and Dodhpur. The study reveals that highest intensity of diseases is mainly confined in the central and peripheral areas of the city. It is attributed that in additions to all the indoor air pollution factors, these areas are also facing the problem of high content of SPM, this is even beyond the prescribed limit due to number of household small industries located in these areas.

Table 7.4 Intensity of Incidence of Diseases Associated with Indoor Air Pollution

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Percent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.5 Above</td>
<td>3</td>
<td>27.27</td>
</tr>
<tr>
<td>Medium</td>
<td>± 0.5</td>
<td>6</td>
<td>54.54</td>
</tr>
<tr>
<td>Low</td>
<td>Below -0.5</td>
<td>2</td>
<td>18.18</td>
</tr>
</tbody>
</table>

Source: Computed by Researcher
7.2 Household Water Supply, Sanitation and Pollution-Its Intensity and Resultant Water Born Diseases

Adequate and clean water supplies as well as better sanitary condition are the prime necessity of good health of community. But if it found poor maintained drainage and failure of water supply system causes the outbreak of many health risks. The detailed study household water supply, sanitation and pollution in the previous chapter.

For the present analysis some water born and water related diseases are taken into consideration, these are Malaria, Fileriasis, Jaundice, hepatitis ‘A’, Diarrhoea, Dysentery, Cholera, Roundworm infection, Typhoid, Dengue Fever, Ameobiasis and Gastroenteritis.
Malaria: Main factor responsible for incidence of malaria are poor sanitation, water, logging around the houses or in the mohallah, ill ventilation and ill lighted house which provide ideal indoor resting places for mosquitoes. Appraisal of table 7.5 observed that 25 per cent of malaria affected households in the sampled wards of the city (8.59 per cent of very high, 17.41 per cent of high, 34.98 per cent of medium and 39.02 per cent of low income households). These households are found mostly in the southern western and Northern peripheral area of the city. It is attributed to poor sanitation, water logging and ill drainage system.

Fileriasis: The analysis reveals that fileriasis affected households are found in the old part and the peripheral area of the city, because of poor sanitation, open drainage and absence of drainage around the house. The overall picture of the total sampled households shows that nearly 25 per cent households reported that Fileriasis affected households of the city (13.32 per cent of high, 38.11 per cent of medium and 42.79 per cent of low income households).

Dengue Fever: Some of the factors responsible for Dengue Fever are artificial container for storage of water as well as residual water in air cooler and poor drainage system. Table 7.5 shows that of the total sample, about 7 per cent respondents reported Dengue Fever affected households (1.01 per cent of high, 9.38 per cent of medium and 17.23 per cent of low income households). The analysis reveals that Dengue Fever affected households are found in the

Note: Malaria is a protozoal disease caused by infection with parasites of the genus plasmodium’s and transmitted to man by certain species of infected female Anophelies mosquito Main factor responsible for incidence of malaria are poor sanitation, water, logging around the houses, ill ventilation and ill lighted house which provide ideal indoor resting places for mosquitoes.

Fileriasis is infection with fileriasis worms, wuchereria bancrofti, Burgia, Malayi or Bitimori. These parasites are transmitted to human through the bite of an infected mosquito and develop into adult worms in the lymphatic vessels, causing sever damage and swelling. Poor drainage, water logging, illiteracy poor sanitation and overcrowding are major risk factor for Fileriasis.

Dengue Fever is the most common arthropod borne self limiting viral disease with clinical spectrum ranging from asymptomatic infection to life threatening shock, so called Dengueshock syndrome. Dengue Fever is transmitted by mosquito vector. Some of the factors responsible for Dengue Fever are as, artificial container for storage of water as well as residual water in air cooler and poor drainage system.
southern and northern peripheral part of the city and interior part of the mohallah. The analysis reveals that households too much affected by the Dengue Fever, is found in the area of poor sanitation, kuchcha drainage, water logging around the houses and the mohallah and lack of awareness.

Diseases Related with Household Water Pollution

Fig.7.4 (a)

**Typhoid Fever**: Polluted drinking water supplies open defecation, lack of personal hygiene and poor sanitation are responsible for typhoid. Analysis

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Note: Typhoid fever is the result of systematic infection mainly by S. typhi. It is known as enteric. Polluted drinking water supplies open defecation, lack of personal hygiene and poor sanitation are responsible for typhoid.
reveals that 42 per cent respondents reported that of the total sampled households of the city suffering from typhoid fever. Lack of personal hygiene and poor sanitation are responsible for Typhoid. It has been observed that 14.07 per cent, 29.84 per cent of very high income.

Typhoid Fever affected households of the city 38.01 per cent under medium income group typhoid affected households. The highest percentage of typhoid affected household is low income category. It has been observed that typhoid affected areas are closely related with over crowding, poor sanitation, open drainage, use of faecal contaminated drinking water, storage of water in open container, inadequate water availability for personal and domestic hygiene, use of manual latrine, flush out dry latrine in open drainage, use of open lavatory for defecation.

**Cholera**\(^{13}\): Those factors, which play an important role in occurrence of cholera, are living standard, poor hygienic condition. Poor sanitation, contaminated water and food, lack of education, and poor quality of life faecal contaminated water uncontrolled water sources such as wells, lakes, ponds stream and rivers.

Appraisal of table 7.5 Shows that 3.19 per cent of very high and 6.03 per cent of high income category cholera affected households comprise of the total sampled wards of the city. The high intensity of cholera affected people reported belong to low income group households.

**Diarrhoea**\(^{14}\): The highly affected area by the diarrhoea lies in the peripheral zone, central and old part of the city. Analysis reveals that the highly affected

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**Note:**\(^ {13}\) Cholera is an acute Diarrhoeal disease it is characterized by sudden onset of profuse effortless, watery stool. Diarrhoea is followed by vomiting, rapid dehydration, muscular cramps and suppression of urine; it frequently strikes adult as well as children. Those factor plays an important role to occurrence of cholera is as living standard, poor hygienic condition.

\(^ {14}\) Diarrhoea is defined as the passage of loose, liquid or watery stool. The liquid stools are usually passed more than three times. The important factor responsible for occurrence of Diarrhoea is lack of personal hygiene and domestic hygiene, contaminated food and dirty water
area by the diarrhoea lies in the peripheral area, central and old part of the city. Of the total samples 46 per cent respondents are suffering from diarrhoea, (2.09 per cent of very high, 12.05 per cent of high, 78.39 per cent of medium and 91.73 per cent of low income category households). The highly affected households are very much exposed to insanitation, lack of proper hygiene, and flush out the dry latrine in open drainage from manual latrine, and subsequently contaminate the drinking water.

**Dysentery**\(^1\): The factor responsible for Dysentery is unhygienic condition to live in, lack of personal hygiene and domestic hygiene contaminated food and water. Of the total samples, about 11 per cent respondents are suffering from Dysentery (13.45 per cent of medium and 29.12 per cent of low income households). Very high and high income category household are not reported dysentery affected households.

**Amoebiasis**\(^2\): Of the total samples, 10 per cent respondents are suffering from Ameobiasis (2.03 per cent of high, 14.16 per cent of medium and 25.46 per cent of low income households). Very high income households are not reported Ameobiasis disease of the selected wards of the city. It has been observed that high amoebiasis affected areas are associated with the overcrowding, poor sanitation, open drainage, contaminated drinking water due to the leakage of pipeline, storage of water in open containers, inadequate water availability for personal and domestic hygiene, use of manual latrine, flush out dry latrine into open drainage and field.

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\(^1\) Dysentery is an infection of the digestive system caused by a bacterium shigella. It is formerly known as flux or the body flux in frequent small volume, severe diarrhoea that shows blood in the faces along with intestinal ramping. The factor responsible for Dysentery is unhygienic condition to live, lack of personal hygiene and domestic hygiene contaminated food and water.

\(^2\) Amoebiasis: The term amoebiasis defined as, intestinal parasitic illness which is caused by a single parasite called Entamoeba histolica. Gastroenteritis (Diarrhoea or Dysentery with abdominal pain and exhaustion) is the main symptoms of Amoebiasis. It includes involvements of liver, lungs, brain, spleen, skin etc. it carries morbidity and mortality.
Table 7.5 Diseases Related With Household Water Pollution

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Malaria $Y_1$</th>
<th>Filariasis $Y_2$</th>
<th>Dengue Fever $Y_3$</th>
<th>Typhoid $Y_4$</th>
<th>Cholera $Y_5$</th>
<th>Diarrhoea $Y_6$</th>
<th>Dysentery $Y_7$</th>
<th>Ameobiasis $Y_8$</th>
<th>Hepatitis ‘A’ $Y_9$</th>
<th>Jaundice $Y_{10}$</th>
<th>Gastro-enteritis $Y_{11}$</th>
<th>Roundworm infestation $Y_{12}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. High</td>
<td>8.59</td>
<td>5.78</td>
<td>0</td>
<td>14.07</td>
<td>3.19</td>
<td>2.09</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.69</td>
<td>1.06</td>
<td>1.79</td>
</tr>
<tr>
<td>High</td>
<td>17.41</td>
<td>13.32</td>
<td>1.01</td>
<td>29.84</td>
<td>6.03</td>
<td>12.05</td>
<td>0</td>
<td>2.03</td>
<td>1.06</td>
<td>9.45</td>
<td>3.38</td>
<td>8.6</td>
</tr>
<tr>
<td>Medium</td>
<td>34.98</td>
<td>38.11</td>
<td>9.38</td>
<td>38.01</td>
<td>11.34</td>
<td>78.39</td>
<td>13.45</td>
<td>14.16</td>
<td>6.17</td>
<td>21.35</td>
<td>16.67</td>
<td>22.42</td>
</tr>
<tr>
<td>Low</td>
<td>39.02</td>
<td>42.79</td>
<td>17.23</td>
<td>88.48</td>
<td>33.48</td>
<td>91.73</td>
<td>29.12</td>
<td>25.46</td>
<td>13.24</td>
<td>55.68</td>
<td>33.49</td>
<td>41.27</td>
</tr>
</tbody>
</table>

Source: Based on field survey, 2007.
**Hepatitis ‘A’**\(^{17}\): Poor sanitation, overcrowding, lack of personal and domestic hygiene, contaminated food, faecal contaminated drinking water supply, use of contaminated syringe are some of the important factor which are responsible for Hepatitis ‘A’. Of the total samples, 5 per cent respondents reported are suffering from Hepatitis ‘A’ households (1.06 per cent of high, 6.17 per cent of medium and 13.24 per cent of low income households). It is observed that the hepatitis ‘A’ prone areas are exposed to overcrowding, poor sanitation, lack of personal hygiene, use of contaminated water without any precaution, and lack of awareness.

**Jaundice**\(^{18}\): Responsible factors of jaundice are drinking too much alcohol, use of illegal drugs, faecal contamination of drinking water, poor sanitation, overcrowding and unhygienic condition of living, lack of personal and domestic hygiene. It has been observed that highly affected areas found in old built up areas, core zone of the city and peripheral areas dotted with slum dwellers. These areas are exposed to all causative factor of Jaundice. Of the total samples 22 per cent respondents reported that they are suffering from Jaundice (2.69 per cent of very high, 9.45 per cent of high, 21.35 per cent medium and 55.68 per cent of low income households).

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\(^{17}\) Hepatitis ‘A’ may be defined as infection of the liver caused by any of half dozen viruses. Besides Hepatitis ‘A’ and ‘B’ Viruses, C, D, F and G have also been identified today Poor sanitation, overcrowding, lack of personal and domestic hygiene, contaminated food, faecal contaminated drinking water supply, use of contaminated syringe are some of the important factor which are responsible for Hepatitis ‘A’.

\(^{18}\) Jaundice also known as icterus is yellowish discoloration of the skin, conjunctiva and mucus membrane caused by hyperbilirubinemia, the concentration of bitirubin in the blood must exceed 2-3 mg/dl for the coloration to be easily visible. Responsible factors of jaundice are drinking too much alcohol, use of illegal drugs, faecal contamination of drinking water, poor sanitation, overcrowding and unhygienic condition of living, lack of personal and domestic hygiene.
Diseases Related With Household Water Pollution

Fig. 7.4 (b)
Gastroenteritis: The factors responsible for the Gastroenteritis are contaminated food, faecal contaminated drinking water, poor sanitation, lack of personal and domestic hygiene, alcohol or tobacco use. It has been observed that under very high income category households are not too much affected gastroenteritis i.e. only 1.06 per cent, household 3.38 per cent of high, 16.67 per cent of medium and 33.49 per cent of low income category are affected by Gastroenteritis households.

Roundworm Infestation: Factors responsible for Roundworm infestation are poor sanitation, faecal contaminated drinking water, contaminated food faecal oral route, through infected fingers and nails, lack of proper hygiene, and inadequate water for personal hygiene. Analysis reveals that roundworm infestation affected respondents have reported from low income group of households of the sampled wards of the city. Of the total samples, about 19 per cent respondents reported that they are suffering from Roundworm Infestation (1.79 per cent of very high, 8.6 per cent of high, 22.42 per cent of medium and 41.27 per cent of low income households.

Impact of Household Water Pollution (Water Supply and Sanitation Condition) on Health

To examine the impact of household water pollution on the health of Aligarh city dwellers, some important diseases have been taken into consideration. Here an attempt has been made to establish a simple association of caused relationship between the different risk factors, the independent variables are

Note: Gastroenteritis is the irritation and inflammation of the digestive tract. This condition may cause abdominal pain, vomiting and Diarrhoea, it is caused by viral infection or bacteria in cavity passed one person to another. The factor responsible for the Gastroenteritis are contaminated food, faecal contaminated drinking water, poor sanitation, lack of personal and domestic hygiene, alcohol or tobacco use.

Roundworm also known as ascaris lumbricoides or the large intestinal huan .Roundworm. Severe infections can result in vomiting, restlessness, blockage of intestine resulting extreme abdominal pain. Factors responsible for Roundworm infestation are poor sanitation, faecal contaminated drinking water, contaminated food faecal oral route, through infected fingers and nails, lack of proper hygiene, and inadequate water for personal hygiene.
irregular water supply ($X_1$), contaminated water supply ($X_2$), Common source of drinking water ($X_3$), mode of storage of water in open contains ($X_4$), bathroom facility not present ($X_5$), open toilet ($X_6$), manual use of latrine ($X_7$) disposal of human excreta ($X_8$), open drainage ($X_9$), drainage around the house not exist ($X_{10}$), waste water around the house ($X_{11}$), water logging ($X_{12}$), the dependent variables are symbolized as Malaria ($Y_1$), Fileriasis ($Y_2$), Dengue Fever ($Y_3$), typhoid ($Y_4$) and so on as mentioned in the analysis.

To find out the extent of relationship, Karl Persons correlation coefficient ($r$) technique was applied.

Table 7.6 Coefficient Of Correlation Relationship between Occurrences of Water Related and Water Born Diseases with Water Supply and Sanitation Condition

<table>
<thead>
<tr>
<th>Variables</th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$X_4$</th>
<th>$X_5$</th>
<th>$X_6$</th>
<th>$X_7$</th>
<th>$X_8$</th>
<th>$X_9$</th>
<th>$X_{10}$</th>
<th>$X_{11}$</th>
<th>$X_{12}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_1$</td>
<td>0.91</td>
<td>0.96</td>
<td>0.98</td>
<td>0.85</td>
<td>0.80</td>
<td>0.85</td>
<td>0.74</td>
<td>0.72</td>
<td>0.90</td>
<td>0.88</td>
<td>0.97</td>
<td>0.98</td>
</tr>
<tr>
<td>$Y_2$</td>
<td>0.97</td>
<td>0.97</td>
<td>0.98</td>
<td>0.86</td>
<td>0.81</td>
<td>0.86</td>
<td>0.74</td>
<td>0.72</td>
<td>0.90</td>
<td>0.89</td>
<td>0.98</td>
<td>0.96</td>
</tr>
<tr>
<td>$Y_3$</td>
<td>0.96</td>
<td>0.92</td>
<td>0.99</td>
<td>0.98</td>
<td>0.95</td>
<td>0.98</td>
<td>0.91</td>
<td>0.90</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
<td>0.93</td>
</tr>
<tr>
<td>$Y_4$</td>
<td>0.84</td>
<td>0.94</td>
<td>0.92</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
<td>0.97</td>
<td>0.97</td>
<td>0.98</td>
<td>0.98</td>
<td>0.89</td>
<td>0.89</td>
</tr>
<tr>
<td>$Y_5$</td>
<td>0.84</td>
<td>0.94</td>
<td>0.91</td>
<td>0.99</td>
<td>0.91</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.90</td>
<td>0.86</td>
</tr>
<tr>
<td>$Y_6$</td>
<td>0.98</td>
<td>0.97</td>
<td>0.98</td>
<td>0.87</td>
<td>0.83</td>
<td>0.88</td>
<td>0.76</td>
<td>0.74</td>
<td>0.91</td>
<td>0.90</td>
<td>0.99</td>
<td>0.94</td>
</tr>
<tr>
<td>$Y_7$</td>
<td>0.94</td>
<td>0.97</td>
<td>0.98</td>
<td>0.99</td>
<td>0.97</td>
<td>0.99</td>
<td>0.94</td>
<td>0.93</td>
<td>0.99</td>
<td>0.99</td>
<td>0.98</td>
<td>0.90</td>
</tr>
<tr>
<td>$Y_8$</td>
<td>0.97</td>
<td>0.95</td>
<td>0.99</td>
<td>0.97</td>
<td>0.95</td>
<td>0.97</td>
<td>0.91</td>
<td>0.90</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
<td>0.93</td>
</tr>
<tr>
<td>$Y_9$</td>
<td>0.94</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
<td>0.98</td>
<td>0.99</td>
<td>0.94</td>
<td>0.94</td>
<td>0.93</td>
<td>0.96</td>
<td>0.97</td>
<td>0.92</td>
</tr>
<tr>
<td>$Y_{10}$</td>
<td>0.88</td>
<td>0.96</td>
<td>0.94</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.98</td>
<td>0.97</td>
<td>0.92</td>
<td>0.94</td>
<td>0.93</td>
<td>0.90</td>
</tr>
<tr>
<td>$Y_{11}$</td>
<td>0.94</td>
<td>0.99</td>
<td>0.94</td>
<td>0.99</td>
<td>0.97</td>
<td>0.99</td>
<td>0.94</td>
<td>0.93</td>
<td>0.94</td>
<td>0.95</td>
<td>0.98</td>
<td>0.92</td>
</tr>
<tr>
<td>$Y_{12}$</td>
<td>0.95</td>
<td>0.99</td>
<td>0.99</td>
<td>0.98</td>
<td>0.96</td>
<td>0.98</td>
<td>0.92</td>
<td>0.91</td>
<td>0.93</td>
<td>0.95</td>
<td>0.98</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Source: Computed by researcher

The data analysis given in table 7.6 depict that all the selected diseases like, Malaria, Fileriasis, Dengue, Cholera son on are positively correlated with the risk factors such as irregular water supply ($X_1$), contaminated water supply ($X_2$), and water logging ($X_{12}$) etc. (variables of causes). Their positive correlation generalized
the fact that all the disease are associated with the cause factor which have been taken for the present study.

The detailed study of table 7.6 depicts that Ameobiasis is the diseases which is strongly associated with public source of water supply \( (r = 0.92) \). However, the diseases like Malaria, Fileriasis, Jaundice, Cholera, Typhoid, Dengue Fever, Roundworm, infestation, Gastroenteritis with this factor are also identified with higher degree of correlation.

The most significant variable storage of drinking water in open containers is associated with majority of disease at higher degree of correlation. Diseases; jaundice, gastroenteritis, cholera, typhoid and diarrhoea are significant diseases which are caused by open storage of drinking water. These diseases are positively correlated with open storage of water. Among the above deception gastroenteritis having jaundice \( (r =0.94) \) and typhoid \( (r=0.89) \) i.e. \( (r = 0.87) \) followed by cholera \( (r = 0.84) \) and diarrhoea having \( (r=0.86) \) degree of correlation.

Rest of the disease like Dengue, Malaria, Fileriasis etc. are also associated with open storage of drinking water with however values of correlations. Variable \( (X_5) \) open bathroom is positively correlated with most of the diseases only Ameobiasis, Gastroenteritis, Roundworm infestation and typhoid are moderated but positively correlated with open bathroom factor. Malaria, Fileriasis, Jaundice, Hepatitis ‘A’, Diarrhoea, Dysentery having highest associated with open bathroom.

Table 7.6 exhibits the highest association of manual latrine with Ameobiasis, Gastroenteritis, Fileriasis, Dengue fever. However, manual latrine and water logging have correlation with Diarrhoea, cholera etc. Rest of the disease are moderately correlated with this significant causing factors having r-value of \( (r = 0.93) \), \( (r=0.89) \), \( (r=0.96) \) etc.
The diseases like malaria and fileriasis having close association with irregular water supply and contaminated water supply. These are main causing factor of spreading disease like malaria and fileriasis. It is also observed that cholera and Dengue fever with highest degree of correlation i.e. \( r = 0.78 \) percent and \( r = 0.824 \) respectively.

It is depicting in the table 7.6 that independent variable; absence of drainage around the houses is positively correlated to the diseases, i.e. Ameobiasis, Gastroenteritis and Roundworm infestation with its degree 41-60 percent. This factor also associated with rest of the disease either moderately or with low degree of correlation.

The overall study table 7.6 reveals that all the dependent variables are highly correlated with all the independent variable.

**Household Water Pollution Intensity (Water Supply and Sanitation)**

Analysis of intensity household water pollution based on composite mean Z-score, clearly reveals that high intensity of household water pollution ranges in between with CS (Composite mean Z-score) 0.5 above i.e. Bhujpura, Nagla Mehtab, Kala Mahal Rasalganj, Dori Nagar and Tantanpara, sampled wards of the city. These households are lying in old central and southern peripheral area of the city. Moderate intensity of water pollution lies in between \( \pm 0.5 \) (i.e. Sarai Bala, Begpur and Hamdard Nagar), under low intensity comes in below – 0.5 CS values.

**Table 7.7 Intensity of Household Water Pollution**

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Percent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.5 Above</td>
<td>6</td>
<td>54.54</td>
</tr>
<tr>
<td>Medium</td>
<td>( \pm 0.5 )</td>
<td>3</td>
<td>27.27</td>
</tr>
<tr>
<td>Low</td>
<td>Below -0.5</td>
<td>2</td>
<td>18.18</td>
</tr>
</tbody>
</table>

**Source:** Computed by Researcher
Intensity of Incidence of Diseases

Analysis of intensity of diseases associated with water pollution is shown in table 7.8 which reveals that high intensity of diseases ranging 0.5 above CS value. These wards are found in the central, old and northern and southern peripheral areas of the city, i.e. Sarai Bala, Kala Mahal, Rasal Ganj, Nagla Mehtab and Bhujpura, these parts of the city having high intensity of water pollution and more prone to risks of health of the people. It is attributed to the lack of awareness, poor sanitation condition, and consumption of contaminated and stagnant of water, under the moderate intensity of incidence of diseases ranging in between ±0.5 CS
values, occupying 36.36 per cent of the sampled wards of the city i.e. Tantanpara, Begpur, Hamdard Nagar and Dori Nagar. In the low intensity of incidence of water pollution related diseases ranging below -0.5 CS.

Table 7.8 Intensity of Water Born and Water Pollution Related Diseases

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Percent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.5 above</td>
<td>5</td>
<td>45.45</td>
</tr>
<tr>
<td>Medium</td>
<td>±0.5</td>
<td>4</td>
<td>36.36</td>
</tr>
<tr>
<td>Low</td>
<td>Below – 0.5</td>
<td>2</td>
<td>27.27</td>
</tr>
</tbody>
</table>

Source: Computed by Researcher

Fig.7.6
7.3 Indoor Noise Pollution and Its Intensity and Resultant Diseases

On the basis of perception of the respondents regarding the level of noise pollution, it has been categorized into four categories i.e. very high, high, medium, and low on the basis of their income.

Noise Pollution in the Mohallah

Table 7.9 clearly reveal that 49.12 per cent households belong to low income category have claimed very high to high noise pollution in the mohallah. Central part and core area of the city reported high percentage of noise in the mohoallah of the selected wards i.e. Kala Mahal, Sarai Bala, Tandan Para and Rasalganj. 41.04 per cent noise has been reported from the medium income category sampled households of the study area. 28.16 per cent noise pollution from high category and 11.05 per cent noise in the mohallah has been reported very high income category of the city.

Noise pollution in the House

Intensity of noise in the house is a serious threat to human health. The analysis reveals that table 7.9. very high to high income category of households have reported very low intensity of noise pollution in the house, (1.03 per cent, 3.72 per cent) Medium category households noise pollution has reported 23.51 per cent while, 48.15 per cent households claimed noise in the house belong to low income category of the city.
Table 7.9 Causes of Indoor Noise Pollution and Resultant Diseases

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Causes</th>
<th>Diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Noise in the Mohallah X1</td>
<td>Noise in the House X2</td>
</tr>
<tr>
<td>V. High</td>
<td>11.05</td>
<td>0</td>
</tr>
<tr>
<td>High</td>
<td>26.16</td>
<td>3.72</td>
</tr>
<tr>
<td>Medium</td>
<td>41.04</td>
<td>23.51</td>
</tr>
<tr>
<td>Low</td>
<td>49.12</td>
<td>48.15</td>
</tr>
</tbody>
</table>

Source: Based on field survey, 2007.

The areas of low noise pollution in the house cover most of the Sir Syed Nagar, New Sir Syed Nagar, and duplex quarters of the city. This is calm and quite residential area. Despite the chaos across the city, the Aligarh Muslim University campus area remains safe from the threat posed by ever rising noise pollution. The area has the distinction of being the only one of its kind in the city where noise level is far below the permissible limit.

**Day-time Noise Pollution**

During the course of study people have been interviewed and reported that during day time they suffer too much noise in the *mohallah* of the total samples, about 25 per cent households suffer from noise pollution (9.29 per cent of very high, 13.28 per cent of high, 31.11 per cent of medium and 45.88 per cent of low income category households).
Night-time Noise Pollution: Table 7.9 reveals that under very high to high night time noise pollution claimed medium and low income category households. Of the total samples, about 12 per cent households suffer from noise at night hours (3.56 per cent of high, 19.07 per cent of medium and 27.11 per cent of low income category households). Very high and high intensity of night time noise pollution is attributed to frequent movement of vehicles, trains and loudspeakers for advancement etc.

Analysis of Diseases

Some of the diseases caused by noise pollution have been taken into consideration like auditory fatigue, deafness, speech interference, annoyance, work efficiency and physiological changes, which are discussed in sequent manner.
**Auditory Fatigue:** Of the total samples, about 32 per cent households suffer from auditory fatigue affected disease (7.36 per cent of very high, 18.33 per cent of high, 23.84 per cent of medium and 79.12 per cent of low income category households). Some of the important wards are Rasalganj, Tandanpara, Bhujpura, Kala Mahal and Sarai Bala. These wards are mostly found in central or core area and extreme southern peripheral area of the Aligarh city.

**Indoor Noise Pollution Resultant Diseases**

![Graphs showing various noise pollution resultant diseases](image)

Fig. 7.8
Deafness: Table 7.9 reveals that very high category income households have not too much deafness affected households of the total samples, about 8 per cent respondent reported of suffering from deafness (2.7 per cent of very high, 4.08 per cent of high, 7.95 per cent of medium and 18.86 per cent of low income households).

Speech Interference: Speech interference is basically a masking process, in which simultaneous interfering noise renders speech incapable of being understood. The inability to understand speech results in a large number of personal handicaps and behavioral changes. Problems with concentration, fatigue, uncertainty and lack of self confidence, irritation, misunderstandings, decreased working capacity, problems in human relations, and a number of stress reactions have all been identified. Particularly vulnerable are the hearing impaired, the elderly children in the process of language and reading acquisition, and individuals who are not familiar with spoken language. Speech intelligibility in every day living conditions is influenced by speech level; speech pronunciation; talker to listener distance; sound level and characteristics of the interfering noise; hearing acuity; and by the level of attention. Indoors, speech communication is also affected by the reverberation characteristics of the room. Reverberation time over 1 s produce loss in speech discrimination and make speech perception more difficult and straining. For full sentence intelligibility in listeners with normal hearing, signal-to-noise-ratio (i.e. the difference between the speech level and the sound level of the interfering noise) should be at least 15 dB (A). Since the sound pressure level of normal speech is about 50 dB (A), noise with sound levels of 35 dB (A) or more interferes with the intelligibility of speech in smaller rooms. Of the total sample, 19 per cent respondents reported of interference with speech. The analysis table 7.9 reveals that 4.56 per cent very high, 8.91 per cent high, 29.13 per cent medium and 33.89 per cent of low income category households from selected wards of the city suffering from deafness due to noise pollution.
analysis further reveals that almost all the households are located along with roads near commercial as well as small industries or business centres which attract frequent movement of vehicle of different nature, become major causative factors of noise pollution.

Annoyance: Noise annoyance may be defined as a feeling of displeasure evoked by noise. The annoyance inducing capacity of noise depends upon its physical characteristics, including the sound pressure level, spectral characteristics and variations of these properties with time. However, annoyance reactions are sensitive to many non-acoustic factors of a social, psychological, or economic nature and there are considerable differences in individual reactions to the same noise. During day time, few people are highly annoyed at LAeq levels below 55 dB (A), and few are moderately annoyed at LAeq levels below 50 dB (A). Sound levels during the evening and night should be 5-10 dB, lower than during the day. Table 7.9 exhibit that very high income category of households were not less annoyance affected in comparison to low income category households of the total sample, about 26 per cent respondents reported of suffering from annoyance diseases (6.87 per cent of very high, 14.72 per cent of high, 37.16 per cent of medium and 44.18 per cent of low income households).

Disturbance in work efficiency: Table 7.9 reveals that the total samples, about 34 per cent households have reported against disturbances in work efficiency caused by noise pollution. Very high and high (13.46 per cent and 22.78 per cent) category income households claimed that disturbance in work efficiency reported households. 37.84 per cent medium category of disturbance in work efficiency reported households, while, the low income category reported highest percent of disturbance in work efficiency of the sampled household in 59.93 per cent. Mostly these households are found in central or core area of the city.
Physiological Changes: In workers, exposed to noise, and people living near airports, industries and noisy streets, noise exposure may have a large temporary, as well as permanent, impact on physiological functions. After prolonged exposure, susceptible individuals in the general population may develop permanent effects, such as hypertension and ischemic heart disease associated with exposure to high sound levels. The magnitude and duration of the effects are determined in part by individual characteristics, lifestyles, behaviors and environmental conditions. Workers exposed to high levels of industrial noise for 5-30 years may show increased blood pressure and an increased risk for hypertension. Cardiovascular effects have also been demonstrated after long-term exposure to air and road traffic with $L_{Aeq, 24h}$ values of 65-70 dB(A). Table 7.9 reveals that the total samples, about 25 per cent households affected with Physiological changes caused by noise pollution (12.14 per cent of very high, 19.06 per cent of high, 27.47 per cent of medium and 39.75 per cent of low income category households) The noise level mainly in central core part of the city where day time and night time noise level are high even beyond the desirable limit, while, mostly in the outer area of the city where the noise level is very low also physiological changes reported household. Occasionally noise level increases beyond the threshold effect on the health like high blood pressure, high heart beat, high breathing rate etc.

Impact of Household Noise Pollution on Health

Analysis the impact of indoor noise pollution on health variables of indoor noise pollution as independent variables and associated diseases as dependent variables have been analyzed using Karl Pearson’s coefficient of correlation technique and t-test at 1 per cent significant level. An attempt has been made to establish the relationship between housing related risk factors and the occurrence of associated diseases. The following causing factors were considered.
Whereas, six types of environmental diseases associated with these cause factors, were considered.

- Auditory Fatigue (Y1)
- Deafness (Y2)
- Speech interference (Y3)
- Annoyance (Y4)
- Disturbance in work efficiency (Y5)
- Physical changes (Y6)

**Table 7.10** Correlation between Indoor Noise Pollution and Incidence of Diseases in Sampled Households

<table>
<thead>
<tr>
<th>Variables</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y1</td>
<td>0.82</td>
<td>0.82</td>
<td>0.91</td>
<td>0.86</td>
</tr>
<tr>
<td>Y2</td>
<td>0.92</td>
<td>0.98</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>Y3</td>
<td>0.97</td>
<td>0.94</td>
<td>0.97</td>
<td>0.93</td>
</tr>
<tr>
<td>Y4</td>
<td>0.98</td>
<td>0.95</td>
<td>0.98</td>
<td>0.94</td>
</tr>
<tr>
<td>Y5</td>
<td>0.95</td>
<td>0.92</td>
<td>0.99</td>
<td>0.98</td>
</tr>
<tr>
<td>Y6</td>
<td>0.86</td>
<td>0.97</td>
<td>0.95</td>
<td>0.91</td>
</tr>
</tbody>
</table>

**Source:** Computed by Researcher

The relationship between housing factor and health is highly complex. The data analysis given in table 7.10 depicts that all the selected diseases namely auditory fatigue (Y1), deafness (Y2), Speech interference (Y3), Annoyance (Y4), Disturbance in work efficiency (Y5) and Physical changes (Y6) etc. are positively
correlated with their causing factor namely noise pollution in the mohallah \((X_1)\), noise pollution in the house \((X_2)\), day time noise pollution \((X_3)\), and noise pollution at night\((X_4)\) etc. Their positive correlation generalized the fact that all the disease are associated with causes which have been taken for the present study.

A detailed study of the housing related causing factors by disease group is presented in table 7.10 of the total sample nearly 45 per cent of the respondent suffering from auditory disease. The following factors were found to have independent effects on the health of human being. Noise in the mohallah \((r = 0.82)\) and noise in home \((Y_2)\) \((r = 0.80)\), increases of last two causing factors Noise in day \((Y_3)\), \((r = 0.91)\) and noise in night \((Y_4)\) \((r = 0.86)\) the correlation is very strong and positive.

Auditory Fatigue is the disease which associated with almost the entire causing factor. The correlation shows that the following causing factor have strongly affected \((Y_1)\) noise in the mohallah, \((r = 0.91)\), \(Y_2\) noise in the home \((r = 0.98)\), \(Y_3\) noise in day time.

Rest of these factors also shows a positive correlation \((r = 0.96)\), \(Y_4\) noise at night \((r = 941)\) deafness is said to be a common and found to be strongly associated with noise in the mohallah \((Y_1)\), noise in the home \((Y_2)\) and noise in the day time \((Y_3)\).

**Intensity of Indoor Noise Pollution**

Analysis of intensity of indoor noise pollution based on composite mean Z-score \((CS)\) clearly reveals that the high intensity of household noise pollution is ranging in between 0.5 above CS values are found in 63.63 per cent of the sampled wards of the city table 7.11. These sampled wards are Sarai Bala, Kala Mahal, Kishore Nagar, Tantanpara, Rasalgunj, Bhujpura, and Nagla Mehtab, most of the household in these wards having household industries. Moderate intensity of household noise pollution lies in between ±0.5 CS values are lying in the 3
sampled wards of the city, i.e. Begpur, Dodhpur and Dori Nagar, the low intensity of household noise pollution ranging in between below -0.5 CS values. Highest intensity of household noise pollution is attributed to high frequency of vehicular movement, Railways, loudspeakers and also household appliances handcart puller, street hawkers etc. contributors the noise pollution in the area.

**Table 7.11 Intensity of Indoor Noise Pollution**

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Percent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Above 0.5</td>
<td>7</td>
<td>63.63</td>
</tr>
<tr>
<td>Medium</td>
<td>±0.5</td>
<td>3</td>
<td>27.27</td>
</tr>
<tr>
<td>Low</td>
<td>Below -0.5</td>
<td>1</td>
<td>9.09</td>
</tr>
</tbody>
</table>

*Source: Computed by Researcher*

*Fig.7.9*
Intensity of Diseases Associated With Indoor Noise Pollution

Analysis of intensity of disease related with household noise pollution shows in table 7.12 reveals that very high intensity of diseases lies in between 0.5 above CS values; Occupying 5 sampled wards of the city i.e. Kala Mahal, Rasal Ganj, Tanatnpara, Nagla Mehtab and Bhujpura. The highest intensity of diseases of household noise pollution in the central part of the city i.e. heart of the city and also these areas are experiencing high intensity of household noise pollution.

Table 7.12 exhibits that Moderate intensity of incidence of household noise pollution lies in between ±0.5 CS values, having 27.27 per cent of wards of the city, i.e. Sarai Bala, Kishore Nagar and Begpur. Low intensity of incidence of diseases lies in between below – 0.5 CS values, consisting of 3 sampled wards such as Dodhpur, Hamdard Nagar and Dori Nagar.

Table 7.12 Intensity of Incidence of Diseases Associated with Indoor Noise Pollution

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Per cent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Above 0.5</td>
<td>5</td>
<td>45.45</td>
</tr>
<tr>
<td>Medium</td>
<td>±0.5</td>
<td>3</td>
<td>27.27</td>
</tr>
<tr>
<td>Low</td>
<td>Below - 0.5</td>
<td>3</td>
<td>27.27</td>
</tr>
</tbody>
</table>

Source: Computed by Researcher
7.4 Analysis of Indoor Pollution and Its Impact on Health of the Inhabitants

To examine the relationship between indoor pollution and resultant diseases, all the parameters are computed with the help of composite mean z-score (CS).

Indoor Pollution Intensity

The analysis of household pollution intensity based on composite mean z-score (CS) clearly reveals that the high intensity of indoor pollution ranging in between 0.5 CS values spread over in 6 sampled wards of the city i.e. Sarai Bala, Kala Mahal, Rasal ganj, Tanatanpara, Nagla Mehtam and Bhujpura. These wards are located in old central and
southern peripheral area of the city, which accounts 54.54 per cent wards of the city, under moderate intensity of pollution lies in between ± 0.5 CS values are lies 4 sampled wards which accounts 36.36 per cent wards of the city consisting of Kishore Nagar, Begpur, Dodhpur, and Dori nagar, low intensity of waste pollution ranging in between below – 0.5 CS values holding 9.09 per cent sampled wards of the city.

**Table 7.13 Indoor Pollution Intensity**

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Percent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0. above</td>
<td>6</td>
<td>54.54</td>
</tr>
<tr>
<td>Medium</td>
<td>±0.5</td>
<td>4</td>
<td>36.36</td>
</tr>
<tr>
<td>Low</td>
<td>Below – 0.5</td>
<td>1</td>
<td>9.09</td>
</tr>
</tbody>
</table>

*Source: Computed by Researcher*

*Fig.7.11*
Intensity of Diseases Associated with Indoor Pollution

Analysis of intensity of incidence of disease exhibited in table 7.14, which reveals that high intensity of diseases are lying in between 0.5 above CS values consisting of 4 sampled wards of the city i.e. Kala Mahal, Sarai Bala Rasalganj, and Bhujpura. These wards found in the central and southern peripheral part of the city.

Table 7.14 Intensity of Diseases Associated with Indoor Pollution

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranges (CS)</th>
<th>Total Sampled Ward</th>
<th>Percent of Wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.5 above</td>
<td>4</td>
<td>36.36</td>
</tr>
<tr>
<td>Medium</td>
<td>±0.5</td>
<td>3</td>
<td>27.27</td>
</tr>
<tr>
<td>Low</td>
<td>Below – 0.5</td>
<td>4</td>
<td>36.36</td>
</tr>
</tbody>
</table>

Source: Computed by Researcher

Fig. 7.12
It is attributed to the high intensity of indoor pollution, illiteracy lack of awareness and peripheral area dotted with slums. They are mostly located in the central old and peripheral area of the city. Under moderate intensity of diseases associated with solid waste lies in between ±0.5 CS values are lies 3 sampled wards which account 27.27 per cent wards of the city consisting of Tantanpara, Nagla Mehtab and Dori Nagar. Low intensity of incidence of diseases occurs in 4 sampled wards in between below -0.5 CS value i.e. Begpur, Kishore Nagar, Hamdard Nagar and Dodhpur. Spatial analysis of the intensity of incidence of diseases reveals that old, central and peripheral zone of the city identified as disease prone areas, attributed to high intensity of indoor pollution.