Modernization and progress has had its share of disadvantages and one of the main aspects of concern is the pollution it is causing to the earth. With the increase in population, urbanization, improving living standards and the rising demand for food and other essentials there has been a rise in the amount of waste being generated daily by each household. The waste is ultimately thrown out of the house either in the municipal waste bins or in the unauthorized waste dumps from where it is collected by the city municipal workers to be further thrown into the dumps and landfills. However, either due to resource crunch or inefficient infrastructure, not all the waste gets collected or transported to the final dump sites. If at this stage the management and disposal is improperly done it can cause problems to the households, to the surrounding environment, it can cause obnoxious conditions and serious health problems.

There is just too much of waste and all of us contribute liberally every day. But what if the waste collecting municipal worker does not come? The lanes of residential colonies are seen overflowing with garbage, the stench of rotting wastes and stray dogs and other animals are seen rummaging through them. Most of us cover our noses and look the other way. Indian cities have striking similarity when it comes to heaps of garbage and overflowing bins and drains a sign of municipalities inefficiency in managing waste. The problem of waste is not just limited to large cities but it has also spread into smaller cities like Aligarh. The once beautiful small city now has open waste bins, overloaded dump yards, open overflowing drains in plenty. People in larger cities are aware and have some knowledge regarding environmental problems, especially problems associated with waste management but this is missing in smaller cities. Waste management services especially in small cities and to poor communities is deplorable, they are left to themselves.

Waste that is not properly managed especially excreta and other type of solid waste and waste water from households is serious health hazard and leads to spread of infectious diseases. Uncollected waste lying around attracts flies, cockroaches, rats and other creatures that in turn spread diseases. Normally it is the organic wet waste that decomposes and releases a bad odour. This leads to unhygienic conditions and their by to a rise in health problems. The plague outbreak in Surat (1994) is good example of a city which suffered due to callous attitude of the municipal body in maintaining cleanliness in the city. The open overflowing drains become an ideal breeding ground for mosquitoes and other pests. Plastic waste is another cause for ill health.
In the previous chapters an attempt was made to examine the general characteristics of the sampled households belonging to different income groups (chapter II), income-wise household level waste (both solid waste and waste water) generation, collection and disposal was examined (chapter III), and an analysis of physical and chemical characteristics of waste (chapter IV) was done. This chapter is in continuation with the previous chapters. This chapter addresses waste associated problems. This chapter has been divided into three parts. In the first part an attempt has been made to examine waste associated problems within the house. The second part examines problems in the neighbourhoods. In the third part an attempt has been made to identify waste associated risk factors, examine the occurrence of waste associated diseases and to examine the dimensions of relationship between solid waste/waste water related risk factors and occurrence of associated diseases. This chapter is based on primary sources of data collected through questionnaire (Appendix I) interviews from the sampled households. The survey was conducted during 2006-07.

5.1- Waste associated problems within the house

Residential domestic waste forms the bulk of all sources of waste. The first point at which waste (both solid waste and waste water) creates problems is within the house. In this part of the chapter we will be discussing the waste associated problems which occur inside the house.

5.1.1- Solid waste associated problems within the house

Household solid waste comprises of waste generated from household activities. It includes vegetable and fruit waste, food leftover, paper, rubber, ash, milk sachets, plastic, food packs, canned cold drinks, carry bags, gardening waste etc. The output of daily waste depends upon the income status, educational status, dietary habits, life style etc. The household waste is known to have high densities with high moisture content. The organic component of solid waste which is putrescible probably accounts for between 60-70 per cent of the total waste produced by the higher income households, 37 per cent by medium and 10-20 per cent by the lower income households. The data regarding generation of organic waste shows that it is the higher income households who are generating more kitchen and other waste while the lower income households generate more of animal waste (table 3.1 (1) and (2). Solid waste associated problems created within the house are due to,
- storage practices,
- disposal practices and
- accumulation of waste

Regarding the solid waste storage practices inside the house (table 3.3) it was observed that all the higher income households stored their solid waste inside the house in close containers (85-90 per cent) while rest store in open containers (10-15 per cent). Of the medium income households, 90 per cent stored waste (62 per cent in close containers, 38 per cent in open containers or polythene bags) rests did not store it. Of the lower income households, 55-78 per cent stored waste (40-45 per cent in close containers, 55-60 per cent in open containers or polythene bags) rests did not store it. This uncollected waste was either found to be pilfered all over the house or was dumped at a particular place. Thus, it was observed that the wealthy households used close containers while there was high incidence of non-storage and storage in open containers in poorer households increasing the risk of attracting disease causing pests such as flies, cockroaches and rats.

Regarding the place of storage bins, out door storage (courtyard, side gallery and in open spaces) of solid waste was more popular then indoor storage (in kitchen and in all rooms) which was relatively rare. The wealthy households used close waste bins in all rooms including kitchen. Wealth was again found to be related to this factor.

Safe disposal of household solid waste is very important from the point of view of keeping the household environment clean. A perusal of table 3.4 (1) and (2) shows that the wealthier households were found disposing most of their waste every day mostly in municipal waste bins. Nearly three fourth of the medium income households were found disposing large quantities of waste by themselves daily. Half of them disposed in municipal waste bins while rest in unauthorized sites like waste dumps or in fields or along the roads. Nearly half of the lower income households reported of disposing almost all waste by themselves everyday in waste dumps or in open fields or along the roads or in drains. This again shows that it was the wealthy households who disposed off almost all waste daily in the authorized places. Whereas, in the lower income households part of waste remained uncollected and the frequency of disposal was also poor this resulted in accumulation of waste inside the house. Non-storage and storage in open containers and less frequency of disposal of solid
waste from the house results in garbage heaps or accumulation of decaying waste inside the house. Since the garbage has more of organic components, have high densities with high moisture content it increases the risk of attracting diseases causing pests such as flies, cockroaches and rats.

5.1.2- Waste water associated problems within the house

Household waste water comes from kitchen (washing of vegetables, cereals, utensils, floor etc.), bathroom (bathing, washing clothes etc.), toilets (flush toilets, urinals) and from miscellaneous uses (washing house, cars, bathing pets etc). Generally households generate two types of waste water- grey and black. Grey water goes to the drains while black water goes to the sewer lines but all gets mixed up outside the house. Waste water associated problems are also created within the house due to improper disposal practices. Proper disposal of household waste water is necessary to keep the household environment clean. There is need of proper drains both inside and outside the house. Improper disposal of sullage or grey water results in waterlogging and stagnant pools in and around the house which provides ideal breeding grounds for mosquitoes and other pests. The drainage conditions in and around the houses are not satisfactory in the city.

Open separate drains were the principal means of waste water disposal in almost all the higher income households, 60 per cent of the medium income and few of low income households. The better methods of disposal, including closed, pucca separate drains and sewerage or septic tanks were only available in the higher income households. The least satisfactory method of street and yard dumping of waste water together accounts for over 37 per cent of household sullage disposal methods. A perusal of table 3.7(2) shows the relationship between household wealth status and the means of waste water disposal. Yard and street (in and around the house) dumping were more commonly practiced among the lower and medium income households. To make matters worse some of the kutchha drains mentioned are nothing more than mere natural channels along which waste water flows from holes made through walls of houses. This water often ends either in low-lying areas or in roadside ditches. Consequently stagnant pools of water are common in their neighbourhoods. As a result waterlogging is a permanent feature in some areas and this provides ideal breeding ground for mosquitoes and other pests.
5.1.3- Problem of pests inside the house

An important problem associated with uncollection and improper /inadequate storage and disposal practices of household solid waste is its accumulation inside the house which results in occurrence of pests inside the house. Heaps of wet garbage inside the house increases the risk of attracting disease causing pests such as flies, cockroaches, rats and mice etc.

Table: 5.1- Income-wise distribution of sampled households (in percentages) from Aligarh City according to Prevalence of pests inside the house

(1) Prevalence of pests inside the house (2) Prevalence of pests in food preparation area and in toilets

<table>
<thead>
<tr>
<th>Income group</th>
<th>Prevalence of pests inside the house</th>
<th>In food preparation area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Very high</td>
<td>19.49</td>
<td>80.51</td>
</tr>
<tr>
<td>High</td>
<td>26.68</td>
<td>73.32</td>
</tr>
<tr>
<td>Medium</td>
<td>85.68</td>
<td>14.32</td>
</tr>
<tr>
<td>Low</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Very low</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>89.04</td>
<td>10.96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income group</th>
<th>In toilets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Almost never</td>
</tr>
<tr>
<td>Very high</td>
<td>92.1</td>
</tr>
<tr>
<td>High</td>
<td>82.4</td>
</tr>
<tr>
<td>Medium</td>
<td>54.2</td>
</tr>
<tr>
<td>Low</td>
<td>14.3</td>
</tr>
<tr>
<td>Very low</td>
<td>3.9</td>
</tr>
<tr>
<td>Total</td>
<td>49.38</td>
</tr>
</tbody>
</table>

(3) Prevalence of cockroaches and rats/ mice inside the house

<table>
<thead>
<tr>
<th>Income group</th>
<th>Prevalence of cockroaches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
</tr>
<tr>
<td>Very high</td>
<td>42.4</td>
</tr>
<tr>
<td>High</td>
<td>39.6</td>
</tr>
<tr>
<td>Medium</td>
<td>19.6</td>
</tr>
<tr>
<td>Low</td>
<td>7.7</td>
</tr>
<tr>
<td>Very low</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>22.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income group</th>
<th>Prevalence of rats/ mice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never</td>
</tr>
<tr>
<td>Very high</td>
<td>72.4</td>
</tr>
<tr>
<td>High</td>
<td>62.8</td>
</tr>
<tr>
<td>Medium</td>
<td>32.1</td>
</tr>
<tr>
<td>Low</td>
<td>18.8</td>
</tr>
<tr>
<td>Very low</td>
<td>11.6</td>
</tr>
<tr>
<td>Total</td>
<td>39.54</td>
</tr>
</tbody>
</table>

Source: Based on field survey (2006-07)
Another problem associated with improper disposal of household waste water in yards or on streets (in and around the house) results in accumulation of waste water in ditches or in low-lying areas. This provides an ideal breeding ground for mosquitoes. The risk of increasing pest infection through accumulation of decaying solid waste and waste water disposed in yards are generally confirmed by survey results (table 3.1 (1) and (2), table 3.3 and table 3.7 (2) ).

The survey results presented in table 5.1 is showing the presence of flies (1) in kitchen and toilets (2), presence of cockroaches and rats/ mice (3) inside the house as reported by sampled households belonging to different income groups. Again we observed the relationship between wealth and prevalence of pests inside the house. Mostly the lower income households reported of presence of flies in food preparation areas (70-82 per cent), presence of cockroaches often in small and large numbers (77-88 per cent), prevalence of mice/ rats often/ every night (57-68 per cent). As the income increases the incidence of pests inside the house decreased. The higher income households reported of presence of flies in cooking place (6-18 per cent) and in toilets (2-6 per cent), cockroaches (20-25 per cent) and mice/ rats (13-20 per cent).

Household waste is not a direct threat to health but waste accumulation can quickly become unpleasant, a nuisance - the smells, the disease vectors and pests are attracted. The diseases they cause or carry include some of the major causes of ill health. The house fly is both a filth feeder and breeder. Flies are mechanical carriers and can contaminate human food or drink through direct contact or by defecating or regurgitating stomach contents. Unsanitary conditions lead to more flies and a higher risk that the flies will spread disease. Flies are common in both kitchen and toilets. The difference between poor and wealthy households was more striking with respect to flies in the toilets than with respect to flies in kitchen. The lower income households have access of flies in both the places while the higher income households reported of never having flies in their toilets.

Under some conditions, cockroaches like flies, can be mechanical carriers of disease. While not inherently attracted to human faeces, they sometimes live in houses where contact is likely. Pathogenic bacteria may then be deposited on food as the cockroaches forage in a kitchen or food area. Cockroaches could be playing a role in the transmission bacterial diarrhoea. In addition to the potential health risk, cockroaches are generally considered as a nuisance, and can produce an unpleasant odour. Again this indicates the complex combination of sanitary and insect-related
conditions which are faced by many households. Not surprisingly, cockroaches like flies are more prevalent in lower income households.

Rodents consume stored food, damage property and can contaminate human food with their faeces and urine, sometimes transmitting disease in the process. Historically, rats are infamous for their role in spreading the plague. Rodents tend to be common in certain neighbourhoods as a result of the quality of housing and the environment as a whole. Houses in low income areas are not only closely built, but are typically in a very poor state of repair, both favourable conditions for these pests. The lack of adequate facilities to handle domestic waste in most of the low income households has compounded the problem.

5.2- Domestic waste associated problems in neighbourhoods

Residential domestic waste forms the bulk of all type of waste produced in Aligarh city. The changing life styles, consumption patterns, change in living standards and steep decline in the organic nature of waste have added up to the problem significantly threatening health and hygiene of people.

5.2.1- Solid waste associated problems in neighbourhoods

Aligarh Municipal Corporation is responsible for the collection, transportation and disposal of solid waste from the secondary collection points in the neighbourhoods to the final disposal points. With the increase in city population, city residential area the magnitude of solid waste management has also increased. If the waste is not managed properly it creates problems in neighbourhoods. Municipal domestic solid waste management displays an array of problems including low collection coverage, irregular collection services, open dumping and burning without air and water pollution control and the handling and control of informal waste picking and scavenging activities. This is the second point at which domestic solid waste can create problems in neighbourhoods especially in poor neighbourhood due to:

- low and irregular collection services
- inadequate disposal services
- accumulation of waste

Regarding the collection of domestic solid waste by the municipality, it was observed that the household solid waste was dumped either by the households or by the private workers in either authorized (municipal waste bins) or in unauthorized sites (waste dumps, along road or in fields/ open plots) (table 3.4 (1) and (2). In areas
where people use manual latrines human excreta is also dumped in these sites. The efficiency of waste collection by the municipality from these secondary sited (municipal waste bins, waste dumps along roads, field/ open plots etc) is very poor. Table 3.5 (1) and (2) shows the frequency of solid waste disposal by the municipality from the neighbourhoods. More than 80 per cent of lower income households reported of huge quantities of solid waste in their neighbourhoods. This was mainly due to low (monthly) collection of solid waste from their neighbourhoods. The condition in higher income households was better, where only small quantities of solid waste was observed in their neighbourhoods. Here the frequency of collection and disposal was either daily or twice a week.

It was observed that only a small quantity of solid waste reaches the final disposal site. Remaining waste accumulates in waste dumps or piles up along roadside or in low lying areas or in open plots. This was due to less number of employees, lack of willingness to work, inadequate fleet, outdated vehicles and also less in number, no monitoring of vehicle movement and lack of co-ordination between the primary collection and transportation department. Good part of domestic solid waste remains uncollected or gets collected after due period leaving the neighbouring population vulnerable to,

- pungent smells,
- germs and bacteria,
- harmful gasses,
- and pests. Rats were reported to come from waste dump sites along with flies and cockroaches.

Uncollected waste is eaten by stray animals especially cattle, pig and dogs and it usually finds its way into the open drains, thus, the drain gets choked and water overflows. Aligarh city is more known for its foul smelling heaps of unattended solid waste than by the promise of better quality of life.

Of all the wastes, the residential municipal solid waste are most non-homogeneous since they consist of nearly all materials used by people such as organic waste, paper, plastics, fabrics, leather, metals, glass and miscellaneous materials. The heterogeneous waste makes it difficult to treat it with one effective method. In such case, the various types of wastes have to be separated first before being sent to treatment plants. However, in view of the fact that only 5.8 per cent of solid waste
gets treatment before disposal, a huge chunk of the collected waste gets dumped at the landfills where it rots and emits health hazardous methane gas. This not only has serious implication for the environment, health and hygiene of the residents but may also adversely affect the quality of ground water. We have already observed that the solid waste has high content of ash and dust. This is increasing in the environment leading to many respiratory diseases.

With the expansion of city area (table 1.10) there is every possibility that the efficiency in the collection and disposal of domestic solid waste will further deteriorate. An increase in the distance of dumping site from the generation and collection places (due to expansion of cities and consequent assimilation of the hitherto outskirts used for dumping) may increase already high cost of transport considerably. With the increasing load of heterogeneous types of solid waste and limited financial means of disposal of municipalities, the end outcome could be considerable reduction in the collection and disposal of the solid waste. The poor infrastructure and financial status of the municipalities of small towns is responsible for this situation.

5.2.2- Waste water associated problems in neighbourhoods

The Aligarh Municipal Corporation is responsible for the disposal and treatment of waste water generated within the city limits. The domestic waste water is mostly collected through a system of open and few closed drains and covered sewers and dispose through big and small drains (fig.1.11 and 1.12). The grey water usually goes into the drains while the black water goes into the sewer lines but often leaving the house both the water mixes up in the city drains and ends up in the river. The open drains which carry the storm water as well as domestic waste water are partly tapped into the sewerage system which causes choking of sewer lines due to silt load. These drains are connected to main drain which flows along the periphery of the city which joins a small tributary of river Yamuna. Since there is hardly any ground slope available, the flow in the drains is sluggish and there is large scale spreading of sewage in the city area.

The drainage system of the city is defective because there is lack of natural drainage due to its saucepan shaped topography and location of the city in the low lying tract. This is responsible for the drainage and sewerage problems. Because of this not only the dirty water from the city collects here but also the water from
neighbouring areas collects here and there is no outlet, most parts of the city gets submerged not only during the rainy season but waterlogging can be seen in some areas all the year round. Since there is no slope waste water remains stagnant in the open drains. The city is engulfed with waterlogging problem.

Domestic waste water after coming out from the house can create problem in neighbourhoods due to,

- faulty natural drainage
- open blocked drains

Drainage is simply the removal of storm water, external flood water sullage and toilet wastes. Sewers may deal adequately with sullage and toilet waste but smaller cities do not posses the connection to sewer system. Excreta is also disposed in open drains. It is thus important to consider problems arising from lack of provision for drainage in neighbourhoods. Improved drainage will help control waste water related or waste water based diseases or disease vectors. The existing city drainage system is lacking proper gradient, adequate carrying capacity and proper disposal of waste water out of the city municipal area resulting in flooding of roads, streets and low lying areas. This results in accumulates of waste water and it become breeding ground for mosquitoes. Stagnant water in the drains can provide the breeding place for schistosomiasis snails and may contaminate shallow water aquifers, malarial mosquitoes and mosquitoes which serve as vectors for dengue may breed in standing water. Surface water is often contaminated with human and animal excreta.

5.2.3- Problem of waterlogging in neighbourhoods

The city suffers from the problem of waterlogging. This is due the peculiar location of the city in the low lying tract and faulty natural drainage (fig.1.10). Not only the waste water from the city collects here but water from nearby areas also accumulates here due to the slope towards the city. Another important cause for waterlogging is the open blocked drains from which water over flows. All over the city drains are open and the residents dump their waste in it. The result is that the level of water rises and overflows. Perusal of the table 5.2 (1) shows that it is the lower and medium income households who complaint about severe problem of waterlogging.

The lower income households 80-90 per cent have reported of the problem of waterlogging and 63 per cent of medium, 33 per cent of high and 27 per cent of very
Photo plate (20) Accumulation of waste water on road

Photo plate (21) Waterlogging – accumulation of waste water in low lying residential areas of Shahjamal
high income households are facing the same problem. Nearly 50 per cent of the lower income households complain about permanent waterlogging, while only 9-10 per cent higher income have the same problem. There are only few areas in the city where waterlogging does not occur, almost the whole city is engulfed with seasonal and occasional waterlogging. Seasonal and occasional waterlogging is caused by rain, overflowing drains and collection of household waste water in low lying areas are increasing in the city due to congestion, increased constructional activities, poor drainage system (both natural and man made) disposal of sullage in open drains, which are permanently blocked by garbage, polythene etc. since the city is located in a depression there is no or very sluggish flow of water in the drains.

Table: 5.2 Income-wise distribution of sampled households (in percentages) from Aligarh City according to

<table>
<thead>
<tr>
<th>Income group</th>
<th>No waterlogging</th>
<th>Waterlogging</th>
<th>Type of water logged</th>
<th>Waste water</th>
<th>Rain water</th>
<th>Both waste and rain water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>72.81</td>
<td>27.19</td>
<td>19.22</td>
<td>9.77</td>
<td></td>
<td>71.01</td>
</tr>
<tr>
<td>High</td>
<td>66.86</td>
<td>33.14</td>
<td>24.42</td>
<td>8.27</td>
<td></td>
<td>67.31</td>
</tr>
<tr>
<td>Medium</td>
<td>37.02</td>
<td>62.98</td>
<td>37.96</td>
<td>26.06</td>
<td></td>
<td>35.98</td>
</tr>
<tr>
<td>Low</td>
<td>15.27</td>
<td>84.73</td>
<td>41.06</td>
<td>46.43</td>
<td></td>
<td>12.50</td>
</tr>
<tr>
<td>Very low</td>
<td>10.62</td>
<td>89.38</td>
<td>49.94</td>
<td>38.44</td>
<td></td>
<td>11.62</td>
</tr>
<tr>
<td>Total</td>
<td>30.38</td>
<td>69.72</td>
<td>34.53</td>
<td>25.79</td>
<td></td>
<td>39.68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Income group</th>
<th>Type of waterlogging</th>
<th>Permanent</th>
<th>Seasonal</th>
<th>Occasional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td></td>
<td>10.63</td>
<td>20.81</td>
<td>68.56</td>
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<tr>
<td>High</td>
<td></td>
<td>9.28</td>
<td>27.01</td>
<td>63.71</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td>38.69</td>
<td>21.73</td>
<td>39.58</td>
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<tr>
<td>Low</td>
<td></td>
<td>46.43</td>
<td>40.43</td>
<td>13.14</td>
</tr>
<tr>
<td>Very low</td>
<td></td>
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<tr>
<td>Total</td>
<td></td>
<td>30.93</td>
<td>29.55</td>
<td>39.52</td>
</tr>
</tbody>
</table>

(2) Prevalence of mosquitoes

<table>
<thead>
<tr>
<th>Income group</th>
<th>Never</th>
<th>Occasionally</th>
<th>Often</th>
<th>Every night</th>
<th>Present</th>
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<tbody>
<tr>
<td>Very high</td>
<td>84.3</td>
<td>10.7</td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>High</td>
<td>72.5</td>
<td>12.3</td>
<td>10.2</td>
<td>5</td>
<td>15.2</td>
</tr>
<tr>
<td>Medium</td>
<td>29.5</td>
<td>28.3</td>
<td>20.1</td>
<td>22.1</td>
<td>42.2</td>
</tr>
<tr>
<td>Low</td>
<td>9.5</td>
<td>32.2</td>
<td>25.1</td>
<td>33.2</td>
<td>58.3</td>
</tr>
<tr>
<td>Very low</td>
<td>-</td>
<td>34.2</td>
<td>27.4</td>
<td>38.4</td>
<td>65.8</td>
</tr>
<tr>
<td>Total</td>
<td>39.16</td>
<td>23.54</td>
<td>17.56</td>
<td>19.74</td>
<td></td>
</tr>
</tbody>
</table>

Source: Based on field survey (2006-07)

The water seems to either standing in the drains or overflowing. These pools of stagnant water in different parts of the city provide ideal breeding ground for mosquitoes and other insects causing many diseases. Mosquitoes are in abundance in this city table 5.2 (2) is showing the prevalence of mosquitoes in the house. Again we have observed that mostly the lower income households reported of occurrence of
mosquitoes often every night (58–66 per cent). As the income increase the prevalence of mosquitoes in house decreases, in the higher income households only 5–15 per cent reported of mosquitoes. Poor sullage disposal, blocked drains and the generally poor drainage system facilitate mosquitoes breeding. An anopheles mosquito, the vectors of malaria, generally prefers unplanned, natural breeding sites. Moreover, continual urban water use combined with poor drainage has creates a situation where mosquitoes are common throughout the year. Excluding households with full screening, the responses were quite similar in different areas of the city and among poor and wealthy households.

5.3- Waste associated health problems

Waste, including both solid waste and waste water is not a direct threat to health. Solid waste, if allowed to accumulate whether inside the house or in the neighbourhoods is a health hazard,

- it decomposes and favours fly breeding
- it attracts rodents and vermins,
- the pathogens which may be present in the solid waste may be conveyed back to man’s food through flies and dust,
- possibility of water and air pollution
- Heaps of refuse present an unsightly appearance and nuisance from bad odour.

There is a correlation between improper disposal which leads to accumulation of solid waste and incidence of vector-borne diseases. So there should be an efficient system for its periodic collection, removal and final disposal without risk to health. The domestic refuse consists of ash, rubbish and garbage. Garbage consists of leftover food, vegetable peelings and other organic matter which needs quick removal and disposal because it ferments on storage. We have observed that from the house waste is dumped along the roads, in low lying areas or in municipal waste bins. Mostly open dumping is practiced and the drawbacks of open dumpling are,

- the waste is exposed to flies and rodents
- it is a source of nuisance from smell and unsightly appearance
- the loose refuse is dispersed by the wind
- drainage from dumps contributes to the pollution of surface and ground water.
‘Open dumping of wastes is a most unsanitary method that creates public health hazards, a nuisance and a severe pollution of environment’ (WHO, 1967). Human excreta disposal with waste is a source of infection. The health hazards of improper excreta disposal are soil and water pollution, contamination of foods and propagation of flies. The resulting diseases are typhoid and paratyphoid fever, dysentery and diarrhoea, cholera, hookworm disease, ascariasis, viral hepatitis and similar other intestinal infections and parasitic infections.

Sewage is waste water derived from houses, streets, yards, factories, and industries contain both grey and black water. It resembles dirty water with an unpleasant smell. If not disposed properly it creates problems. Aligarh city, which lacks in natural drainage, the problem of waterlogging is especially serious. Unless prompt measures are taken to provide proper means of sewage disposal, the following environmental problems may be created,

- creation of nuisance, unsightliness and unpleasant odours,
- breeding of flies and mosquitoes,
- pollution of soil and water supplies,
- contamination of food,
- increase in the incidence of diseases especially enteric and helminthic diseases (viral, diarrhoeal, cholera, typhoid, amoebiasis, ascariasis, hookworm etc.) and anthropod borne infections (malaria, dengue etc.).

Certain human diseases are transmitted from one host to another through the agency of an insect intermediary or vector. The previous part of this chapter has shown that the households and neighbourhoods provide favourable conditions for some of the more severe vector-borne diseases. Many insect vectors exist in Aligarh city but this study focuses primarily on mosquitoes, flies and cockroaches. The incidence of rodents-mice and rats is also summarized briefly.

Mosquitoes constitute the most important single family of insect from the standpoint of human health. The four important groups of mosquitoes prevalent in India which are related to disease transmission are the Anopheles, Culex, Aedes, and Mansona. In the city though the mosquito population increases during the rainy season but due to poor sullage disposal, blocked drains and generally poor drainage system facilitates mosquito breeding. So the mosquito population is high throughout the year. Anopheles mosquitoes, the vector of malaria is very common in Aligarh city.
Accumulation of solid waste and waste water in and around residential areas, creating ideal breeding ground for insects and pests
They generally prefer unpolluted natural breeding sites. But they can easily adapt to urban breeding sites. The survey results have shown that in almost all residential areas mosquito biting was prevalent during both dry and wet seasons especially indoors at night. Mosquitoes act as vectors of many diseases in India - Anopheles are carriers of malaria, Aedes are carriers of dengue and chikanguniya fever and mosonpides are carriers of chikangunia fever. Cases of dengue have been reported in Aligarh city hospitals.

Houseflies are the commonest and the most familiar of all insects, they occur in abundance all the year round. Houseflies are also known to be a health risk, especially given unsanitary conditions. The house fly is both a filth feeder and breeder. Flies are mechanical carriers and can contaminate human food or drink through direct contact or by defecating or regurgitating stomach contents. Unsanitary conditions leads to more flies and a higher risk that the flies will spread disease. Flies are common in all neighbourhoods (in both food preparation areas and in toilets). Flies are potential vectors of many diseases, typhoid and paratyphoid fevers, diarrhoea and dysenteries, cholera and gastroenteritis, amoebiasis, helminthic infections, conjunctivitis, trachoma etc. infact most diseases which can be spread by mechanical transmission.

Under some conditions, cockroaches like flies can be mechanical carriers of disease, while not inherently attracted to human faeces, they sometimes live in habitats where contact is likely. Pathogenic bacteria may then be deposited on food as the cockroaches forage in a kitchen or food preparation area. Cockroaches could be playing a role in the transmission of bacterial diarrhoea. In addition to the potential health risk, cockroaches are generally considered a nuisance, and can produce an unpleasant odour, several species of rats and mice consume stored food, damage property, and can contaminate human food with their faeces and urine, sometimes transmitting diseases in the process. Rats are infamous for their role in spreading plague.

During household survey, questions were asked regarding the occurrence of diseases occurring in the last two years. Certain human diseases are transmitted from one host to another through the agency of an insect intermediately or vectors. In Aligarh city, inadequate disposal of solid waste and faulty natural drainage system creates the general environmental conditions for some of the vector borne diseases. Many insect vectors exist in Aligarh city. A large range of disease vectors live, breed
or feed within or in the neighbourhoods. The diseases and premature deaths they cause are malaria (anopheles mosquitoes) and diarrhoeal diseases (houseflies, cockroaches and blowflies) but there are many other diseases caused or carried by insects, mites (especially occurring in India includes dengue fever (aedes mosquitoes), hepatitis A (houseflies, cockroaches), plague (certain fleas), scabies (scabies mites). Although some of these diseases remain predominantly rural but now have become urban problems for instance malaria, infectious hepatitis, viral fever and dengue fever. Aedes aegypti (mosquito vector for dengue fever) is often found to breed in polluted water sources such as soak pits and septic tanks. Although anopheline (mosquito vector for malaria) generally avoids polluted water but certain species have adopted to urban environment and now breed in swamps and ditches in or close to urban areas.

5.3.1- Identification of waste related risk factors and occurrence of associated diseases in sampled households

We have already observed inadequacies in disposal of solid waste and waste water which are widespread throughout the city. Differences in waste collection and disposal system also exist between the various income households.

In course of household survey, questions were asked regarding the occurrence of diarrhoeal diseases, cholera, typhoid fever, amoebiasis, hookworm infections, conjunctivitis, and malaria among the households during the last 2 years. Eight frequently occurring waste associated diseases were reported by the sampled households. These were diarrhoeal diseases (51.41 per cent), malaria (50.91 per cent), typhoid fever (49.82 per cent), infectious hepatitis (43.75 per cent), hookworm infections (38.99 per cent), amoebiasis (38.77 per cent), cholera (36.62 per cent), and conjunctivitis (28.02 per cent). These diseases were not only reported by the respondents but they were the most frequently reported health problems at the Out Patient Department (OPD) of J.N. Medical college of Aligarh Muslim University, Malkhan Singh Government Hospital and at various private clinics and nursing homes of the city.

In addition to exposure, other factors also influence the incidence of diseases. City/ household survey helped in the identification of following waste related risk factors,

1. uncollected solid waste inside the house
2. collection of solid waste in open containers inside the house
3. disposal of household solid waste in unauthorized sites (open waste dumps)
4. uncollected waste in the neighbourhoods
5. disposal of excreta from flush/ manual latrines in open drains/ in waste dumps/ in municipal waste bins
6. waterlogging in neighbourhoods
7. presence of pests inside the house (houseflies, cockroaches, rats/ mice)
8. prevalence of mosquitoes inside the house

Table 5.3 throwing light on the overall exposure of the income-wise distribution of sampled households to the 8 waste related risk factors and the occurrence of 8 associated diseases (the 8th risk factor i.e. prevalence of mosquitoes inside the house – was considered only in relationship with the occurrence of malaria). The most vulnerable group is the lower income group (both low and very low). They are exposed to all the 7 risk factors and on an average nearly 88 per cent of the very low and 77 per cent of low income households reported of being exposed to waste related risk factors. This is because they are least able to afford homes that protect them against environmental hazards, neat neighbourhoods, they lack education and awareness. They are found to be living in unhealthy conditions where the basic necessary infrastructure is not available. Environmental problems created due to the waste dumps, waterlogging, pest/ mosquitoes infestations and resultant bad health and diseases are immediate and most visible in poor households and poor neighbourhoods. Thus, they share the highest burden of associated diseases. 73 per cent of very low, 57 per cent of low and 51 per cent of the medium income households reported of being exposed to 7 waste related risk factors and on an average 40.04 per cent of the households reported of suffering from associated diseases (75 per cent of the very low, 60 per cent of the low and 45 per cent of medium income households). This was due to the fact that they were also found to be living in unhealthy households and neighborhoods.

While the conditions were much better in the higher income households, nearly 13 per cent of the very high and 18 per cent of high income households reported of being exposed to only 5 waste related risk factors. About 11 per cent of the very high and 15 per cent of the high reported of suffering from associated diseases. This throws light on the fact that resources are diverted towards the higher income households. The glaring differences were observed between the various
income households. It is a universal fact that resources and wealth goes hand in hand this is why poor suffer the most.

5.3.2- Relationship between waste related risk factors and associated diseases

An attempt has been made to test the relationship between 7 identified waste related risk factors and the occurrence of associated diseases - diarrhoreal diseases, infectious hepatitis, typhoid fever, hookworm infections, amoebiasis, cholera and conjunctivitis (Park, K.K. 2007). To test the relationship Karl Pearson’s correlation co-efficient technique was applied (Table.5.3 (1), (2) and fig.5.1 (1), (2), (3), (4), (5), (6), (7).

(1) Diarrhoeal diseases

The term diarrhoeal diseases is used for a group of diseases (diarrhoea, dysentery, gastroenteritis) in which the predominant symptom is diarrhoea which is passage of loose liquid or watery stool. If blood is visible in stools, the condition is called dysentery. In Aligarh city, diarrhoeal diseases are a major health problem. Children are especially at higher risk and inspite of several efforts to improve it, diarrhoeal diseases continue to inflict a heavy toll. In 2005 about 1.07 million cases were reported in India with 2,040 deaths (Park, K.K. 2007). The actual evidences must be many folds. This disease is infectious in origin and is transmitted exclusively by faecal-oral route.

A perusal of the table 5.3 (1) shows that of the total sampled households 51.41 per cent reported of occurrence of diarrhoeal diseases. Most of the sufferers were from the lower income households (93 per cent of very low and 80 per cent of low). While 61 per cent were from medium, 13 per cent high and 10 per cent very high income households reported of its occurrence. This shows that diarrhoeal diseases are greatly influenced by the level of economic development and environmental factors like lack of sanitation, poor disposal of solid waste, poor drainage, poor neighbourhoods etc. Food contamination is one of the most important causes of diarrhoeal diseases via bacterial, viral or helminthic infections. This is directly related to factors inside the homes e.g. dirty hands, dirty cooking utensils, domestic animals, flies and pests and contamination from human/animal faeces.

Fig.5.1 (1) is showing that there is strong positive correlation between 7 waste related risk factors and occurrence of diarrhoeal diseases, $r = +0.99$. 
Table 5.3: Household Waste Related Risk Factors and Associated Diseases in Aligarh city (2006-07)

(1) Household waste related risk factors

<table>
<thead>
<tr>
<th>Income group</th>
<th>Uncollected waste inside the house</th>
<th>Collection of solid waste in open containers / polythene inside the house</th>
<th>Disposal of household solid waste in unauthorized sites</th>
<th>Uncollected waste in the neighbourhoods</th>
<th>Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins</th>
<th>Water logging</th>
<th>Presence of pests inside the house (flies, rat/mice, cockroaches)</th>
<th>Total average of 7 risk factors</th>
<th>Exposure of households to number of risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>-</td>
<td>9</td>
<td>25</td>
<td>10</td>
<td>-</td>
<td>27</td>
<td>19</td>
<td>12.86</td>
<td>5</td>
</tr>
<tr>
<td>High</td>
<td>-</td>
<td>16</td>
<td>31</td>
<td>16</td>
<td>-</td>
<td>33</td>
<td>27</td>
<td>17.57</td>
<td>5</td>
</tr>
<tr>
<td>Medium</td>
<td>10</td>
<td>48</td>
<td>50</td>
<td>42</td>
<td>61</td>
<td>63</td>
<td>86</td>
<td>51.43</td>
<td>7</td>
</tr>
<tr>
<td>Low</td>
<td>22</td>
<td>77</td>
<td>91</td>
<td>66</td>
<td>100</td>
<td>85</td>
<td>100</td>
<td>77.28</td>
<td>7</td>
</tr>
<tr>
<td>Very low</td>
<td>45</td>
<td>100</td>
<td>100</td>
<td>85</td>
<td>100</td>
<td>89</td>
<td>100</td>
<td>88.43</td>
<td>7</td>
</tr>
<tr>
<td>Total average</td>
<td>15</td>
<td>50</td>
<td>59</td>
<td>44</td>
<td>52</td>
<td>59</td>
<td>66</td>
<td>49.52</td>
<td>5</td>
</tr>
</tbody>
</table>

(2) Associated Diseases

<table>
<thead>
<tr>
<th>Income group</th>
<th>Diarrhoeal diseases</th>
<th>Infectious hepatitis</th>
<th>Typhoid fever</th>
<th>Hookworm infections</th>
<th>Amoebiasis</th>
<th>Cholera</th>
<th>Conjunctivitis</th>
<th>Total average of 7 diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>10.05</td>
<td>6.51</td>
<td>26.46</td>
<td>5.56</td>
<td>10.95</td>
<td>7.37</td>
<td>4.32</td>
<td>10.17</td>
</tr>
<tr>
<td>High</td>
<td>12.50</td>
<td>7.78</td>
<td>34.34</td>
<td>6.54</td>
<td>26.75</td>
<td>8.73</td>
<td>6.23</td>
<td>14.69</td>
</tr>
<tr>
<td>Medium</td>
<td>61.32</td>
<td>51.32</td>
<td>48.74</td>
<td>41.29</td>
<td>46.31</td>
<td>43.05</td>
<td>26.91</td>
<td>45.56</td>
</tr>
<tr>
<td>Low</td>
<td>80.45</td>
<td>70.45</td>
<td>62.77</td>
<td>60.71</td>
<td>52.56</td>
<td>45.72</td>
<td>44.83</td>
<td>59.64</td>
</tr>
<tr>
<td>Very low</td>
<td>92.69</td>
<td>82.69</td>
<td>76.79</td>
<td>80.85</td>
<td>56.84</td>
<td>78.23</td>
<td>57.83</td>
<td>75.13</td>
</tr>
<tr>
<td>Total average</td>
<td>51.41</td>
<td>43.75</td>
<td>49.82</td>
<td>38.99</td>
<td>38.77</td>
<td>36.62</td>
<td>28.02</td>
<td>40.04</td>
</tr>
</tbody>
</table>

Correlation co-efficient: 0.99, 0.99, 0.98, 0.99, 0.95, 0.95, 0.99, 0.99

Source: Based on Field Survey (2006-07)
Fig. 5.1 (1) - Relationship between waste related risk factors and occurrence of diarrhoeal diseases in Aligarh city (2006-07)

Waste related risk factors

Uncollected solid waste inside the house
Collection of solid waste in open containers / polythene inside the house
Disposal of household solid waste in unauthorized sites
Uncollected waste in the neighbourhoods
Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
Waterlogging in neighbourhoods
Presence of pests inside the house

Associated Disease

Diarrhoeal diseases

Correlation co-efficient

\[ r = 0.99 \]

Source: Based on field survey (2006-07)
(2) Infectious hepatitis

Infectious hepatitis is an acute infectious disease caused by hepatitis A virus (HAV). The symptoms of the disease are fever, chills, headaches, fatigue, aches and pains followed by anorexia, nausea, vomiting, dark urine and jaundice. The disease is benign and the fatality rate is very less, usually from acute liver failure which mainly affects adults. It is endemic in this city with frequent outburst of minor or major outbreaks. The major route of transmission is faecal–oral route. It may also occur by direct transmission.

A perusal of the table 5.3 (1) shows that of the total sampled households 43.75 per cent reported of its occurrence. The lower income households were mostly affected by this disease (83 per cent of very low, 70 per cent of low) about 61 per cent of medium income households reported of its occurrence. While only 7 to 8 per cent of the higher income households reported of suffering from this disease. Close relationship between the poor environmental conditions in the lower income households’ i.e. lack of sanitation, accumulation of waste, poor disposal of excreta etc. favours the spread of not only this infection but give rise to other water borne and food borne epidemics.

Fig.5.1 (2) is showing a strong positive correlation between the 7 risk factors and the occurrence of infectious hepatitis, $r = +0.99$.

(3) Typhoid fever

Typhoid fever is caused mainly by S. Typhi. The disease is characterized by a typical continuous fever for 3 to 4 weeks, relative bradycardia with involvement of typhoid tissues and considerable constitutional symptoms. Reported data for 2005 shows that there were 653,580 cases of typhoid with 417 deaths (Park, K.K. 2007). Typhoid fever is endemic in Aligarh city. The primary sources of infection are faeces and urine of carriers; secondary sources are contaminated water, food, fingers and flies. The peak incidence of typhoid fever is reported during July to September. This period coincides with the rainy season and an increase in fly population.

A perusal of the table 5.3 (1) shows that of the total sampled households, 49.82 per cent reported of its occurrence. The lower income households were mostly affected by this disease, 77 per cent of very low and 63 per cent of low and 49 per cent of medium income households.
Fig. 5.1 (2) - Relationship between waste related risk factors and occurrence of Infectious Hepatitis in Aligarh city (2006-07)

Waste related risk factors
- Uncollected solid waste inside the house
- Collection of solid waste in open containers inside the house
- Disposal of household solid waste in unauthorized sites (open dumps)
- Uncollected waste in the neighbourhoods
- Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
- Waterlogging in neighbourhoods
- Presence of pests inside the house (houseflies, cockroaches, rats/ mice)

Associated Disease
- Infectious Hepatitis

Correlation co-efficient
\[ r = 0.99 \]

Source: Based on field survey (2006-07)
**Fig. 5.1 (3) - Relationship between waste related risk factors and occurrence of Typhoid fever in Aligarh city (2006-07)**

**Waste related risk factors**
- Uncollected solid waste inside the house
- Collection of solid waste in open containers inside the house
- Disposal of household solid waste in unauthorized sites (open containers)
- Uncollected waste in the neighbourhoods
- Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
- Waterlogging in neighbourhoods
- Presence of pests inside the house (houseflies, cockroaches, rats/ mice)

**Associated Disease**
- Typhoid fever

**Correlation co-efficient**
\[ r = 0.98 \]

Source: Based on field survey (2006-07)
Of the higher income households about 34 per cent of the high and 26 per cent of the very high income households reported of its occurrence. Typhoid fever is regarded as an index of general sanitation conditions. Households using polluted water for drinking, open air defecation and urination, have low standards of food, personal hygiene and health ignorance suffer the most.

Fig.5.1 (3) is showing a strong positive correlation between the 7 risk factors and the occurrence of typhoid fever, \( r = +0.98 \).

(4) **Hookworm infection**

Hookworm infection is caused by *ancylostoma duodenal* or *necator americana*. They are main nematodes causing hookworm infection in man. It is widely prevalent in Aligarh city. Morbidity and mortality from hookworm infections depend upon the worm load. Hookworms enter the body, usually by feet penetrating in the skin. It may also be acquired by the oral route by direct ingestion of infective larvae via contaminated fruits and vegetables. Hookworm infection causes chronic blood loss and loss of body iron leading to iron deficiency anemia.

A perusal of table 5.3 (1) shows that of the total sampled households, about 39 per cent reported of the occurrence of hookworm infections. Highest sufferers were the lower income households, 81 per cent of very low and 61 per cent of low and 41 per cent of medium income reported of its occurrence. While only 7 per cent of the high and 6 per cent of the very high income households reported of its occurrence. This shows a close relationship between improper disposals of excreta, polluting soil and higher incidence of its occurrence in the lower income households was observed.

Fig.5.1 (4) is showing a strong positive correlation between the 7 risk factors and the occurrence of hookworm infections, \( r = +0.99 \).

(5) **Amoebiasis**

Amoebiasis is a common infection of the human gastro-intestinal tract. This intestinal disease varies from mild abdominal discomfort and diarrhoea to acute fulminating dysentery. It is a potentially lethal disease and it carries substantial morbidity and mortality. It may be transmitted through faecal-oral route and through intake of contaminated water or food. Vegetables eaten raw, from fields irrigation with sewage polluted water can readily convey infection vectors such as cockroaches and rodents are capable of carrying cysts and contaminating food and drink.
**Fig.5.1 (4) - Relationship between waste related risk factors and occurrence of Hookworm infections in Aligarh city (2006-07)**

### Waste related risk factors
- Uncollected solid waste inside the house
- Collection of solid waste in open containers inside the house
- Disposal of household solid waste in unauthorized sites (open waste dumps)
- Uncollected waste in the neighbourhoods
- Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
- Waterlogging in neighbourhoods
- Presence of pests inside the house (houseflies, cockroaches, rats/ mice)

### Associated Disease
- Hookworm infections

### Correlation co-efficient
\[ r = 0.99 \]

Source: Based on field survey (2006-07)
Fig.5.1 (5) - Relationship between waste related risk factors and occurrence of Amoebiasis in Aligarh city (2006-07)

### Waste related risk factors
- Uncollected solid waste inside the house
- Collection of solid waste in open containers inside the house
- Disposal of household solid waste in unauthorized sites (open waste dumps)
- Uncollected waste in the neighbourhoods
- Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
- Waterlogging in neighbourhoods
- Presence of pests inside the house (houseflies, cockroaches, rats/ mice)

### Associated Disease
- Amoebiasis

**Correlation co-efficient**

\[ r = 0.95 \]

Source: Based on field survey (2006-07)
A perusal of the table 5.3(1) and (2) reveals that of the total sampled households 39 per cent reported of its occurrence. Most of the sufferers were from the lower income households, nearly 57 per cent of very low and 53 per cent of low and 46 per cent of medium income households. While about 27 per cent of the high and 11 per cent of the very high income households reported of its occurrence. This shows a close relationship between the poor households having higher incidence of pests inside their homes and poor waste disposal system and occurrence of amoebiasis.

Fig.5.1 (5) is showing the strong positive correlation between the 7 risk factors and the occurrence of amoebiasis, $r = +0.95$ (at 1 per cent of significance level).

(6) Cholera

Cholera is an acute diarrhoeal disease caused by *V. cholerae*. Typical cases are characterized by the sudden onset of profuse effortless watery diarrhoea followed by vomiting rapid dehydration, muscular cramps and suppression of urine. Cholera is both epidemic and endemic disease. It is transmitted through faecal-oral routes - use of contaminated water, food and drinks, fruits and vegetables washed with contaminated water, cooked food contaminated through hands and flies. Direct transmission is also possible.

A perusal of the table 5.3 (1) reveals that of the total sampled households 37 per cent reported of its occurrence. Most of the sufferers were the lower income households, nearly 78 per cent of very low and 46 per cent of low and 43 per cent of medium income households. While only 9 per cent of the high and 8 per cent of the very high income households reported of its occurrence. Inadequate sanitation facilitates in the lower income households enables-feacal-oral contamination.

Fig. 5.1 (6) is showing a strong positive correlation between risk factors and occurrence of cholera $=+0.95$ (at 1 per cent of significance level).

(7) Conjunctivitis

Conjunctivitis is the most common cause of red irritated eye. High incidence of this disease is found during April-July-September. Higher temperature and rainfall favours the increase in fly population. Conjunctivitis is associated with poor quality of life. The disease thrives in poverty, ignorance, poor personal hygiene and illiteracy. It favours eye to eye transmission. It may occur by direct or indirect contact. Eye seeking flies helps in spreading the disease by mechanical transmission.
Fig. 5.1 (6) - Relationship between wastes related risk factors and occurrence of Cholera in Aligarh city (2006-07)

**Waste related risk factors**
- Uncollected solid waste inside the house
- Collection of solid waste in open containers inside the house
- Disposal of household solid waste in unauthorized sites (open waste dumps)
- Uncollected waste in the neighbourhoods
- Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
- Waterlogging in neighbourhoods
- Presence of pests inside the house (houseflies, cockroaches, rats/ mice)

**Associated Disease**
- Cholera

**Correlation co-efficient**
\[ r = 0.95 \]

Source: Based on field survey (2006-07)
Fig.5.1 (7) - Relationship between waste related risk factors and occurrence of Conjunctivitis in Aligarh city (2006-07)

Waste related risk factors

- Uncollected solid waste inside the house
- Collection of solid waste in open containers inside the house
- Disposal of household solid waste in unauthorized sites (open waste dumps)
- Uncollected waste in the neighbourhoods
- Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
- Waterlogging in neighbourhoods
- Presence of pests inside the house (houseflies, cockroaches, rats/ mice)

Associated Disease

Conjunctivitis

Correlation co-efficient

$r = 0.99$

Source: Based on field survey (2006-07)
A perusal of the table 5.3 (1) reveals that of the total sampled households, 28 per cent reported of its occurrence. Most of the sufferers were the lower income households, nearly 58 per cent of very low and 45 per cent of low. While only 27 per cent of medium, 6 per cent of the high and 4 per cent of the very high income households reported of its occurrence.

Fig. 5.1 (7) is showing a strong positive correlation between risk factors and occurrence of conjunctivitis, r =+0.99.

The analysis of the occurrence of the 7 associated diseases- diarrhoeal diseases, infectious hepatitis, typhoid fever, hookworm infections, amoebiasis, cholera and conjunctivitis reveals that,

- the diseases were greatly influenced by the level of income.
- Improper and inadequate arrangement of storage and disposal of solid waste from inside the house, it not only promotes transmission of the above mentioned diseases but also helps in promoting breeding ground for pests, houseflies, cockroaches, rodents and other vectors.
- inadequate sanitation/ drainage facilities enables faecal-oral contamination which again helps in transmission of the above mentioned diseases. This also attracts rodents and other pests which act as disease vectors.

The health risk associated with heaps of uncollected solid waste both inside the house and in neighbourhoods is the highest in the lower income households and in some part of the city, the lower income groups are at greater risk due to secondary impacts such as proliferation of disease vectors and contamination of surface and ground water caused by inadequate management of solid waste. Waste water especially faecal contaminated water (due to disposal of faecal matter in open drains) poses a high health risk both through direct ingestion and contact and indirect contamination. The most important domestic risk factor is human faeces. Bulk of this potentially biodegradable material is disposed with little or no treatment exposing residential areas to a wide range of health problems. Faeces dumped along with waste without destruction of pathogens, enter the soil and water sources and contaminate surface and ground waters. The flushing of excreta into water carriage sewerage systems causes major health hazards when it is discharged directly or indirectly into local surface waters or rivers.
Houseflies which are in abundance in Aligarh city, are linked to waste. The most obvious health risk is that they provide possible short cuts to faecal-oral routes. Some flies are likely to be in contact with human faeces and later land on human food and drink. Open uncollected piles of garbage increase the fly population. Open food preparation areas, open food storage provides opportunities for flies to land on food. Particularly where the risks are already high, flies are likely to increase the prevalence of diarrhoeal diseases, infectious hepatitis, typhoid fever, hookworm infections, amoebiasis, cholera and conjunctivitis, associated with bad water and sanitation. They are regarded as a sign of insanitation. They breed on waste dumps, human/animal excreta, fruit/vegetable dumps. They are potential vectors of many diseases like, diarrhoeal diseases, infectious hepatitis, typhoid fever, hookworm infections, amoebiasis, cholera, conjunctivitis etc. In fact most diseases are spread by mechanical transmission. Since flies are filth feeders and filth breeders, their presence in the cooking area is particularly hazardous when sanitation is generally poor and they are likely to transmit faecal material to food. They are more prevalent in poorer households.

Cockroaches like flies can also be mechanical carriers of disease pathogenic bacteria may be deposited on food by cockroaches. Cockroaches play a role in transmission of bacteria.

5.3.3- Relationship between waste related risk factors and occurrence of malaria

An attempt has been made to test the relationship between the 7 identified waste related risk factors and the occurrence of malaria. In this case 7th risk factor is prevalence of mosquitoes inside the house. The following risk factors were considered,

1. uncollected solid waste inside the house
2. collection of solid waste in open containers inside the house
3. disposal of household solid waste in unauthorized sites (open waste dumps)
4. uncollected waste in the neighbourhoods
5. disposal of excreta from flush/ manual latrines in open drains/ in waste dumps/ in municipal waste bins
6. waterlogging in neighbourhoods
7. prevalence of mosquitoes inside the house
To test the relationship Karl Pearson’s correlation co-efficient technique was applied (Table.5.3 (3), fig. 5.1 (8)).

Malaria is a protozoal disease caused by infestation with parasites of the *genus plasmodium* and transmitted to man by certain species of infected female Anopheline mosquito. A typical attack comprises of three stages: cold stage, hot stage and sweating stage. Malaria remains a serious health problem from July to November.

### (3) Household Waste Related Risk Factors and occurrence of Malaria

<table>
<thead>
<tr>
<th>Income group</th>
<th>Uncollected waste inside the house</th>
<th>Collection of solid waste in open containers / polythene inside the house</th>
<th>Disposal of household solid waste in unauthorized sites</th>
<th>Uncollected waste in the neighbourhoods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>-</td>
<td>9</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>High</td>
<td>-</td>
<td>16</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>Medium</td>
<td>10</td>
<td>48</td>
<td>50</td>
<td>42</td>
</tr>
<tr>
<td>Low</td>
<td>22</td>
<td>77</td>
<td>91</td>
<td>66</td>
</tr>
<tr>
<td>Very low</td>
<td>45</td>
<td>100</td>
<td>100</td>
<td>85</td>
</tr>
<tr>
<td>Total average</td>
<td>15</td>
<td>50</td>
<td>59</td>
<td>44</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins</th>
<th>Water-logging</th>
<th>Prevalence of mosquitoes inside the house</th>
<th>Total average of 7 risk factors</th>
<th>Malaria</th>
<th>Correlation co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>12.43</td>
<td>15.15</td>
<td>0.96</td>
</tr>
<tr>
<td>-</td>
<td>27</td>
<td>16</td>
<td>17.57</td>
<td>18.84</td>
<td>0.96</td>
</tr>
<tr>
<td>-</td>
<td>33</td>
<td>27</td>
<td>49.14</td>
<td>65</td>
<td>0.96</td>
</tr>
<tr>
<td>61</td>
<td>63</td>
<td>70</td>
<td>75.86</td>
<td>69.16</td>
<td>0.96</td>
</tr>
<tr>
<td>100</td>
<td>85</td>
<td>90</td>
<td>88.43</td>
<td>86.37</td>
<td>0.96</td>
</tr>
<tr>
<td>100</td>
<td>89</td>
<td>100</td>
<td>50.91</td>
<td>50.91</td>
<td>0.96</td>
</tr>
<tr>
<td>52</td>
<td>59</td>
<td>60.6</td>
<td>48.68</td>
<td>65</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Source: Based on Field Survey (2006-07)

Rain provides more opportunities for the breeding of mosquitoes and may give rise to epidemics of malaria. Stagnant water in open blocked municipal drains and waterlogging provide ideal breeding ground for mosquitoes. Malaria is transmitted by the bite of infected female anopheline mosquitoes. A single infected vector, during her life time may infect several persons.

A perusal of the table 5.3 (3) reveals that of the total sampled households, 37 per cent reported of its occurrence. The lower income households were most affected, nearly 88 per cent of very low, 76 per cent of low and 65 per cent of medium income households.
Fig.5.1 (8) - Relationship between waste related risk factors and occurrence of Malaria in Aligarh city (2006-07)

Waste related risk factors
- Uncollected solid waste inside the house
- Collection of solid waste in open containers inside the house
- Disposal of household solid waste in unauthorized sites (open waste dumps)
- Uncollected waste in the neighbourhoods
- Disposal of excreta from flush / manual latrines in open drains/ in waste dumps/ in municipal waste bins
- Waterlogging in neighbourhoods
- Prevalence of mosquitoes inside the house

Associated Disease
- Malaria

Correlation co-efficient
\[ r = 0.96 \]

Source: Based on Field Survey (2006-07)
While only 17 per cent of the high and 12 per cent of the very high income households reported of its occurrence. It was observed that malaria is influenced by poor sanitary conditions and disease is more prevalent amongst the low socio-economic group living in unplanned settlements prone to periodical epidemics. Poor waste water disposal, blocked open drains, generally poor drainage system, waterlogging facilitates mosquito breeding.

The survey results shows that in almost all the sampled households mosquitoes were present inside the house (very low 100 per cent, low 90 per cent, medium 70 per cent, high 27 per cent and very high 16 per cent) and mosquito biting was prevalent during both dry and wet seasons especially indoors at night. Almost all the households surveyed reported that they were atleast or occasionally bitten by mosquitoes indoor at night. Throughout the year and were bitten regularly in both wet and dry season. Malarial mosquitoes account for a large share of illness. Thus, it was observed that mosquitoes were linked not only to waterlogging and poor drainage but increasingly to household waste management. When mosquitoes are breeding in household water containers there is relatively little an individual household can do to control breeding. Household water uses combined with poor drainage and waterlogging has caused conditions where mosquitoes are common throughout the year. The analysis shows that socio-economic status has a definite influence.

Fig.5.1 (8) shows a strong positive correlation between the 7 waste related risk factors and occurrence of malaria, \( r =+0.96 \).

According to WHO report (2002) about a half of the world’s population is at risk of insect-borne diseases. Expanding agriculture, cleaning of forests, building of dams and irrigation schemes and unplanned urban development provides mosquitoes with new breeding ground while at the same time bringing more people in contact. Changes in climate conditions are enabling mosquitoes and other disease carrying insects to survive and breed in every type of changed conditions.

**Summary**

This chapter throws light on the waste associated problems occurring both inside the house and in the neighbourhoods, problem of pests, waterlogging and waste associated health problems.

- The first point at which waste (solid waste and waste water) creates problems is within the house itself due to faulty storage and disposal practices. The
improper methods of disposal leads to the accumulation of waste, since the waste has more of organic components, high densities and moisture causes decaying of waste, increases the risk of attracting disease causing pests such as flies, cockroaches, rats etc. Again due to improper household waste water disposal practices waterlogging occurs in low lying areas and on roads which provided ideal breeding ground for breeding of mosquitoes.

- The second point at which waste creates problems is in the neighbourhoods, due to improper disposal practices by the households at unauthorized sites (near/ around the house, into the drain, waste dumps, open plots/ fields), all this leads to accumulation of solid waste in the neighbourhoods which attracts disease causing vectors and stray animals. The disposal of waste water in the open drains which lacks proper gradient, adequate carrying capacity, it is blocked with garbage and most of the time it is overflowing, this results in stagnant pools of waste water in residential areas, on streets and in low lying areas, and increases the risk of mosquitoes.

- Waste (solid waste and waste water) is not a direct threat to health, if solid waste is allowed to accumulate wether inside the house or in the neighbourhoods it becomes a health hazard because it decomposes and favours fly breeding, attracts rodents and vermin, pathogens, there is possibility of water and air pollution etc; if waste water is not properly disposed it will create the problem of waterlogging (breeding ground for mosquitoes etc.) in the neighbourhood. It is also a health hazard. A large range of disease vectors live or feed within the house or in the neighbourhood. Relationship between 8 waste associated risk factors (uncollected solid waste inside the house, collection of solid waste in unauthorized sites, uncollected waste in the neighbourhoods, disposal of excreta from flush/manual latrines in open drains/in waste dumps/in municipal waste bins, waterlogging in neighbourhoods, presence of pests/mosquitoes inside the house) and the 8 frequently reported waste associated diseases (diarrhoeal diseases, infectious hepatitis, typhoid fever, hookworm infections, amoebiasis, cholera, conjunctivitis and malaria) were examined. Strong positive correlation between the risk factors and diarrhoeal diseases ($r = +0.99$), infectious hepatitis ($r = +0.99$), typhoid fever ($r = +0.98$), hookworm infections ($r = +0.99$),
amoebiasis ($r = +0.95$), cholera ($r = +0.95$), conjunctivitis ($r = +0.99$) and malaria ($r = +0.96$) was observed.

This chapter reveals that it is the lower income households who are greatly exposed to waste related risk factors bear most of the burden of waste associated diseases.