Journal of Communicable Diseases
Volume 54, Issue 1 - 2022, Pg. No. 156-160
Peer Reviewed & Open Access Journal

Short Article

# Rodent Vector Surveillance and Management in Urban Areas - Current Issues and Solutions

AMK Mohan Rao[1,2], SN Sharma[3]

[1]Former Joint Director, National Institute of Plant Health Management, Ministry of Agriculture & Farmers Welfare, Rajendranagar, Hyderabad, India.
[2]Member, Vector Control Working Group for Asia Pacific, Swiss TPH, Switzerland.
[3]National Centre for Disease Control, Civil Lines, Delhi.
**DOI:** https://doi.org/10.24321/0019.5138.202262

## I N F O

**Corresponding Author:**
AMK Mohan Rao, Member, Vector Control Working Group for Asia Pacific, Swiss TPH, Switzerland
**E-mail Id:**
mohanrao.arasada@live.com
**Orcid Id:**
https://orcid.org/0000-0002-3127-3496
**How to cite this article:**
Rao AMKM, Sharma SN. Rodent Vector Surveillance and Management in Urban Areas - Current Issues and Solutions. J Commun Dis. 2022;54(1):156-160.

Date of Submission: 2022-02-24
Date of Acceptance: 2022-03-15

## I N T R O D U C T I O N

In the near future, the incidence of emerging infectious diseases in humans is likely to rise significantly due to the socio economic and demographic factors prevalent in the country. Over 30 new infectious diseases have been discovered since 1990; more than half of these originate from zoonotic sources. There emerged eight pathogens of emerging and re-emerging ailments in different areas of the country, 6 among which were from zoonotic sources.[1] Emerging infections will be more difficult to prevent and control without a combination of technologies, behavioural changes, national policies, and effective response methods to be better prepared. Various sustained efforts have been made by the Governments at both union and state levels to cover both emerging and re-emerging diseases.[2] The grey areas identified include developing an emergency response plan for pandemics and epidemics; increasing public health response capability, establishing a functioning disease surveillance system; allocating required financial resources; enhancing community and civil society participation; increasing investment in research including engagement of academic institutions; building international collaboration (both technical and financial) and greater national and global stewardship for public health. However, looking at the size and population of India, the new variants pose a real and present threat.

### Vectors and Pathogens

Most of the disease-transmitting vectors are arthropods and disease-causing pathogens including bacteria, viruses, protozoan, and metazoan microorganisms. Among various vectors, rodents are one of the most neglected, but pandemic causing vector group needing attention. However, unlike entomological vectors, rodents are not covered under entomology resulting in a lack of personnel in public health departments with sufficient knowledge. Even in higher educational institutions,they only find a mention in animal classification which resulted in a lack of research guides too. The net result is that their pestilence, not vector nature, could not reach the attention of planners and administrators. There is no institution/ department/ university in India having any specialisation covering rodent biology and management.

## Rodents

Rodents are vertebrates (under the animal classification of Mammalia) with a vertebral column similar to birds, fish, wild animals etc. They are smaller mammals with a habit of gnawing the food and nonedible items to arrest the perennially growing incisor teeth (@0.4 mm/day normally). These rodents could be identified easily by their morphology (particularly dentition of 1003/1003), burrows, and other features.

## Urban Rodent Species of Economic Importance

The most common rodents playing the role of a pest/vector in towns and cities are *Rattus rattus* (House rat), *Rattus norvegicus* (Norway rat), *Mus musculus* (House mouse), *Bandicota indica*, and *Bandicot abengalensis*.

**House rat (*Rattus rattus*):** The rats with black dorsal colour and longer tails are commonly occurring rodents in houses and are also called roof rats. They are nocturnal rodents with a short, bicoloured tail that is longer than their bodies and heads (80-120 grams) and are adapted to climbing roofs. They are nocturnal, and their activity is confined to night hours. They nest underground and are generally suited for burrowing. In urban areas, they live in holes.

Norway rat (*Rattus norvegicus*) is seen in coastal port towns and it is also called Brown rat or Sewer rat. With approximately 120 gm body weight, it possesses a blunt nose with a smaller tail. It moves at night and lives in and around drainage channels, along the foundation of buildings, under concrete, or close to trash piles.

**Lesser bandicoot (*Bandicot abengalensis*):** It is a moderate rodent (around 150 to 300 gm body weight) with a short tail, rough hair, and sometimes has long black-tipped piles throughout the back. It can dwell in crop fields as well as in human colonies and is nocturnal. It makes burrows under residential complexes or vacant areas and places soil at the entrance.

**Larger bandicoot (*Bandicota indica*):** It has a weight of 500 gm or more with a tail shorter than the head and body. It harms the floors and creates deep burrows in open areas viz., roads, drain canals, poultries/ dairy sheds, and larger burrow openings. It is commonly seen in neglected public spaces and causes extensive damage in storage houses.

**House mice (*Mus musculus*):** With a size of only 25 gm, these dwell in homes and food storage/ outlet regions and breed and nibble quickly. They have bicoloured bodies and their tails are longer than their heads and bodies. They are nocturnal and make burrows that are too small to be visible.

## Economic Importance

### Structural and Commodity Losses

They cause structural losses as well as commodity losses through feeding and spoiling. The estimated loss of stored commodities due to commensal rodents in tropical and sub-tropical areas ranged from 2-15%. A WHO estimate indicated a saving of food grains enough to feed 90,000 people in a year by adequate rat control in Mumbai alone. Various reports in all India basis exhibit a wide range of post-harvest losses varying from 2.5 to 30 per cent. Besides harming agricultural crops and commodities in storage, they are the sources of multiple ailments to humans as well as domestic animals. They are vectors of pathogens and act as reservoirs of diseases. Rodents live near humans and eat and contaminate food, this increases the threat of transfer of diseases.

### Role as Disease-causing Vectors

Rodents live near humans and eat and contaminate food, which enhances the threat of transfer of diseases. A proper understanding of the public health importance will provide a stimulus for their improved control and also focus control in areas where it is particularly needed. The rodents transmit bacterial, viral, and protozoal diseases.

Leptospirosis is a bacterial disease in human beings with leptospires possessing a large number of closely wound spirals - *Leptospira interrogans*. There are 26 serogroups with about 140 serovars within the species of *L. interrogans*. This disease is transmitted to men in whom hepatocellular jaundice is one important manifestation. It is reported as highly prevalent in Andaman, Mumbai, Kerala, and Tamil Nadu since the 1960s. In recent times, it is reported from most of the states in the country. The bacteria localise in the epithelium of the renal tubules and contaminate the environment through urine. The clinical symptoms may be similar to those of short fever, influenza, typhoid fever, dengue haemorrhagic fever, Hantavirus haemorrhagic fever, viral hepatitis, bacterial meningitis, or acute renal failure. The ailment may last from a few days to 3 weeks with low human mortality. Unless human infectious diseases are aetiologically diagnosed in all hospitals, the magnitude of the morbidity of human leptospirosis will remain unrecognised. Rodents are natural hosts to pathogenic leptospires which dwell for a long time in the convoluted tubules of the kidney, multiply and come out with urine; there may be up to 100 million leptospires per 1 ml of urine. Warm soil and stagnant waters with alkaline pH make favourable habitats for them.Occasionally, they are transmitted through the ingestion of food or water contaminated with the urine of rats. Therefore, rice-field workers, because of the ecological conditions in which they work, are particularly vulnerable to this disease. The limited work in India indicated only three rodent species i.e., *Rattus norvegicus*, *Rattus rattus*, and *Bandicota bengalensis*, associated with this disease and information for other major rodent pests is not available. The disease is more common than ordinarily diagnosed

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202262

and many so-called fevers of unknown origin are due to it.

Plague is another bacterial disease in India prevalent since the 16th century and has caused pandemics. Rodents are vectors and reservoirs for this bacterial ailment. Rodents are primary hosts of *Yersinia pestis*, which causes plague and fleas. The oriental flea, *Xenopsylla cheopis* is the primary vector for this bacterium. Certain varieties of rodents are susceptible to the ailment causing high mortality, while some are more resistant to the disease. The major species of wild rodents infected with *Y. pestis* in India is the Indian gerbil (*Tatera indica*) which is resistant to the disease and acts as a permanent reservoir host maintaining the wild rodent plague activity. When commensal rodents are infested from the wild rodents, epizootic murine plague occurs. As the body temperature of these carcasses reduces, fleas escape and find other warm-blooded hosts such as dogs and humans nearby. These fleas may infect the peri-domestic rodent species like the lesser bandicoot, *Bandicota bengalensis*. Once *B. bengalensis* interacts in the domestic areas, the infected flea reaches the House rat, *Rattus rattus*. Both *R. rattus* and *B. bengalensis* are susceptible to infection, disease, and rapid mortality; they act as links between wild rodent infection and human plague (Figure 1).

with human infections mainly being reported in the Aravali hill range. Transmission occurs by Haemaphysalis ticks and the disease is maintained in small mammals, such as *Suncus murinus* and Rattus species, while monkeys in forest areas serve as amplifying hosts.

There are five ailments among rickettsial diseases caused by rickettsia and all have rodent implications as reservoir hosts. Among them, Murine typhus is a very widespread, acute, febrile rickettsial disease caused by *Rickettsia typhi*. The reservoir hosts of the disease are primarily Rattus spp., *Rattus norvegicus*, and *R. rattus*. The most important flea vector is *Xenopsylla cheopis*. This disease is most common in cities with high rat populations and a relatively high incidence of the vector flea.

Metazoan disease, leishmaniasis is caused by protozoan parasites pertaining to the genus Leishmania. Cutaneous leishmaniasis is spread by *Leishmania tropica*. The cutaneous ulcers of varying degrees of severity are common in areas where sandfly vector, Phlebotomus spp. are present. Visceral leishmaniasis is caused by *Leishmania donovani* (kala-azar) with the vector, Phlebotomus sandfly bites. The reservoirs include man himself as well as dogs.

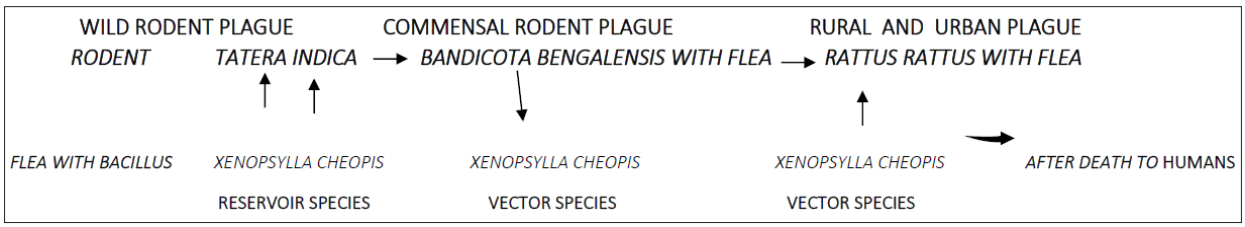


**Figure 1.Transmission Pattern of Plague Bacillus from Wild Rodents to Humans**

Salmonellosis is the third bacterial disease and one of the most important zoonoses in man. It causes acute gastroenteritis in humans. Rodents contaminate water and food stuffs and thus transmit ailments. Since the disease does usually not affect rodents clinically, their frequent sub-clinical infection gives them an important carrier role. Rats are one of the global causes of salmonellosis infection.

Scrub typhus is caused by *Streptobacillus moniliformis* form is and *Spirillum minor* transmitted by secretions from the rodent's mouth or nose or by bite. Incubation occurs many days after the ratbite and symptoms are generally visible after healing of the wound.

Rodents are also reservoirs for arboviruses causing haemorrhagic fevers in man. They are caused by a group of arena and hanta viruses. The virus is transmitted from host to host through infected saliva, urine, and faeces. The virus can survive for months even outside the host and can infect further hosts if they inhale the dust formed from dried infected faeces. The virus of Kyasanur forest disease (KFD) is known to be widely distributed in India,

## Vector/ Rodent Borne Disease Surveillance

Due to the above reasons, there is a need for a surveillance programme in place for rodent-borne diseases. Information through such surveillance activities collects, analyses, and interprets clinical, epidemiological, and epizootiological data on rodent-borne diseases. Surveillance should identify cases and epizootics as quickly as possible so that steps can be taken to control the disease spread.

Systematic collection of surveillance information on rodents and vectors provides information that can be used to find regions where disease may spread in the future and rodent epizootics may be found. The information may be used to locate the most common zoonotic sources of human infection and the most significant rodent, tick, mites and flea species maintaining a given focus of a particular disease; identify the hosts and vector species that need control strategies; evaluate the effectiveness of prevention and control strategies; and find local ecological factors or human activities that may enhance plague exposure risks for humans.

**ISSN: 0019-5138**
**DOI: https://doi.org/10.24321/0019.5138.202262**

### Components of Rodent Borne Disease Surveillance

It comprises the following principal components:

**Human surveillance:** Early detection of patients, quick laboratory diagnosis and proper management is seriously needed. Passive routine surveillance and routine review of the surveillance data should be done under IDSP to identify the future risk of outbreaks of rodent-borne diseases.

**Rodents surveillance:** Regular scrutiny of rodents in non-endemic and endemic regions is required in a real-time manner involving various departments.

**Tick/ mite surveillance:** Regular tick surveillance and tick mapping for isolating main areas and tick incrimination research in rodent-borne disease-prone areas for monitoring tick positivity for KFD/ CCHF/ Scrub typhus should be taken up.

## Methods for Adoption in Rodent Surveillance

### Burrow Count

For successful control of rodents, the burrow count method in a unit area can be utilised to estimate bandicoot infestations before and after control measures. Smaller bandicoots live solitary and therefore one active burrow means one adult bandicoot.

### Tracking Index

House rats and mice do not create any burrows and live inside the rooms. Tracking tiles made of vinyl plate/ sheet of about 30 X 15 cm can be used to identify them. This plate should be placed on rodent runways adjacent to the walls.

Before keeping the tracking tile, a 2 cm patch of Rangoli or Stamp pad ink should be applied on the area as shown in Figure 2.

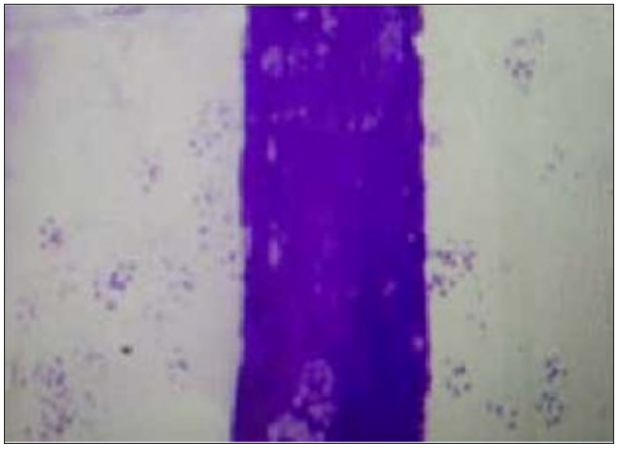

**Figure 2.Stamp Pad Ink applied on the Area**

The tiles must be inspected for rodent footprints the next morning as they run freely on their routine tracks.

Any footprints are considered positive for the presence of rodents and lack of footprints indicates their absence.

For 5 days, these steps should be repeated and data should be recorded. The tracking index can be calculated using the below-mentioned formula:

$$\text{Tracking Index (T.I.) \%} = \frac{\text{No. of tracks touched by rodents}}{\text{No. of tracks laid}} \times 100$$

Based on the tracking index values, the rodent incidence is classified as shown in Table 1:

**Table 1.Tracking index v/s Rodent Infestation**

| Tracking Index | Rodent Infestation Level |
|---|---|
| Less than 30% | Low |
| 30-60% | Medium |
| Above 60% | High |

### Planning for Urban Metropolitan Cities

1. Larger cities provide perfect habitats for rodents because of apartment complexes, piles of garbage and untreated areas in sewage/ drainage systems.
2. Most rodents dwell in drainage systems owing to unperturbed situation, stable environment, year-round breeding and absence of predators.
3. Re-infestations occur from sewage or drainage systems as rodent control methods are applied usually above the surface while rats survive under ground. Therefore, rat control both above and below the surface is needed.
4. For a long term effect of rodent control, these steps should be taken:

- A special code system should be created for macro habitats or larger complexes
- Clear micro-habitats should be found within the macro habitats which are different from each other

5. Rat infestation levels should be determined in public places via the following:

- Live rat movements
- Gnawing traces and faecal pellets
- Rodent burrows
- Observation of footprints and movement tracks
- Observation of consumption of non-poisoned baits
- Information from inhabitants

In addition, the following must be adopted for long term relief from urban rodents in cities/ towns:

(a) Evaluate building-related and unrelated rodent occurrence
(b) Assess the sewage system within the building
(c) Assess public sewage systems not belonging to buildings
(d) Building unrelated occurrences in other areas

6. Creation of techniques and management planning must be done on the basis of this data.

**ISSN: 0019-5138**
**DOI: https://doi.org/10.24321/0019.5138.202262**

## Suggested Action Plan for Rodent Vector Management

**Existing interventions:** Recent times encouraged the invention of a number of pest control products, delivery systems, and application methods and began novel techniques of application and latest strategies.

**Rodent-proofing:** A rodent management intervention should start with rodent-proofing preventing their entry into premises. Such a measure deprives their regular food and water spots. Rodent-proofing not only prevents rodents' entry but also increases the acceptance of baits far more readily as the area for rodent movement is reduced. It is achieved by inspection of premises.

### Inspection of Premises

- Perimeters of the building like walls and the roof and floor
- Doors and windows
- Utility pipes, drains, manholes and conduits connecting the structure to public services
- Electric conduits, wires, cables, AC ducts
- Gardens/ lawns/ compound walls for burrows, and
- Adjoining structures, trees and paths as access ways

It is generally observed that most professionals ignore these steps due to a lack of knowledge and training to carry out these evaluations. Rodents would eventually eat up wood and plastic, hence they are avoided.

### Rodent-proofing Materials

- Usually galvanised minimum 24 gauge metal sheet is recommended
- Cement patching powder is considered a good material to prevent rodents
- Epoxy and fibre-glass resins are used to fill holes
- Butyl caulking with rubber-based caulk can be used to seal any material up to 2 cm wide and 1 cm deep

### Use and Disposal of Trapped/ Dead Rats

**Non-poisonous Sticky (Glue) Boards:** Non-poisonous glue traps are being used in the form of 'ready-to-use glue boards' to remove local infestations. However, their usage is discouraged by the Ministry of Environment and Forests on humane aspects. They are not effective in public places due to dust or moisture. There is a need to check them frequently and dispose them humanely.

**Use of Live and Kill Type of Traps:** Encourage the use of snap/ kill type traps. Live traps make the technicians and residents leave the trapped rats/ mice outside.

**Bury the Dead Rats in Earth Pits:** The trapped live rats should be killed and buried in earthen pits. Even dead rodents after eating poison baits must also be buried in soil pits.

## Recommendations

The government expenditure on health in India is meagre (1.15% of GDP) and one of the lowest in the world. As the fastest-growing large economy, it is in India's interest to invest more money to build a stronger disease surveillance system as well as improve its preparedness and response, in order to control epidemic and pandemic threats.

A lack of qualified personnel with rodent management knowledge exists in the country. There is a need for the development of a curriculum at the university level on rodent biology and management. So far, entomologists are managing rodent vectors also with elementary knowledge shared with them in institutions without any rodent expertise. This subject needs to be included in Medical and Agricultural Entomology for the country's interest.

Due to the difficulty in the diagnosis of Rickettsial diseases, disease diagnosis plays a major role to avoid confusion with a number of other febrile diseases.

Activities on capacity building and capacity enhancement on urban rodent diagnosis and surveillance need to be increased for urban bodies.

ICAR may initiate joint research projects along with NCDC and relevant institutions on urban rodent management.

## References

1. Meerburg BG. Public health and rodents: a game of cat and mouse. In: Sing A, editor. Zoonoses infections affecting humans and Animals. Netherlands: Springer; 2015. p. 629-41. [Google Scholar]
2. Mohanrao AMK, editor. Extension guidelines for pest/ vector management in human habitations. National Institute of Agricultural Extension Management (MANAGE), Hyderabad; 2019. p. 1-225.

**ISSN: 0019-5138**
**DOI: https://doi.org/10.24321/0019.5138.202262**