

# Epidemiological determinants of leptospirosis in rural and urban districts of Maharashtra, India

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## ABSTRACT

**Background:** Leptospirosis is emerging as one of the growing public health problems in many parts of India. It can occur in both rural and urban areas with varied risk factors. This study was taken up in three districts of Maharashtra namely—Mumbai, Ratnagiri, and Sindhudurg to understand the determinants of leptospirosis in both the urban and rural areas and look for differences if any. **Materials and Methods:** This cross-sectional study was carried out during the year 2017. A pretested validated questionnaire was used to collect data. Field observations were made. Eighty-seven cases from Sindhudurg and 14 from Ratnagiri and 307 cases from Mumbai were included in the study. **Results:** A total of 408 cases were included in the study. A total of 63 (62.4%) were males and 38 (37.6%) were females. Most cases belonged to the 20–35 year age group (37%). In rural areas, 32.7% of them visited government facilities first, whereas, in the urban areas, it was 73.9% ( $P = 0.006$ ). Headache, myalgia, and prostration were more common in cases from rural areas ( $P < 0.05$ ). Skin rash was found to be associated with urban cases of leptospirosis. The presence of rodents, cattle sheds, pets, and working in paddy fields were common environmental risks in rural areas, and using water for recreational activities were common in urban areas ( $P < 0.001$ ). **Conclusions:** Context-specific risk factors were found significantly associated with the cases. No important difference was found in the epidemiology of leptospirosis in the urban and rural areas except the source of infection.

**Keywords:** Epidemiology, leptospirosis, rural, urban slums

## Introduction

Leptospirosis, a zoonotic disease, often more neglected than the neglected tropical diseases, is emerging as one of the growing public health problems in many parts of India. Kerala, Gujarat, Tamil Nadu, the Andaman and Nicobar Islands, and Maharashtra bear the highest burden.<sup>[1–4]</sup> In Maharashtra, the coastal districts namely Thane, Mumbai, Raigad, Ratnagiri, and Sindhudurg are mainly affected. Sporadic cases have been reported from other districts also. Leptospirosis can occur in both rural and urban areas. In rural areas, the known risk factors are working in the agricultural

sector (paddy fields and other crops requiring a lot of water), animal husbandry, and barefoot walking. In the urban areas, overcrowding, the emergence of slums, waterlogging, increased rodents and stray animals, unhygienic slaughterhouses are some of the known risk factors.<sup>[1,3,5]</sup> Leptospirosis presents with varying clinical symptoms and can be challenging for primary care physicians who are usually the first point of contact.<sup>[6]</sup> Correct knowledge of its wide spectrum of symptoms and risk factors will aid the physicians in overcoming diagnostic difficulties. This study was taken up in three districts of Maharashtra namely—Mumbai, Ratnagiri, and Sindhudurg to understand the determinants of leptospirosis in both the urban and rural areas and to look for differences if any.

## Materials and Methods

This cross-sectional study was carried out during the year 2017. Mumbai was chosen as the urban setting and Ratnagiri

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and Sindhudurg districts served as the rural setting. Both probable and confirmed cases of leptospirosis during the year 2017 were included in the study.<sup>[1]</sup> The line list of these cases was obtained from the respective District Surveillance Units. A pretested validated questionnaire was used to collect data. Field observations were made. Post-graduate students in Community Medicine were trained for data collection. Ethical approval was obtained from the Institutional Ethical Committee (EC-GOVT-05-17). A total of 89 and 21 cases were reported from Districts Sindhudurg and Ratnagiri, respectively, in the year 2017. Out of these, 87 cases from Sindhudurg and 14 from Ratnagiri could be traced in the community and were included in the study. In the same year, 1,429 (both probable and confirmed) cases were reported in Mumbai out of which 307 cases were included in the study. The reasons for non-traceability in Mumbai were incomplete/wrong address, migration, and permanently locked house [Figure. 1] Data entry and analysis were done in SPSS version 21.0 IBM.

## Results

**Cases' profile:** A total of 408 cases were included in the study. Out of these, 307 (75.2%) belonged to the urban area and 101 (24.8%) belonged to the rural area. Among the cases from rural areas, 63 (62.4%) were males and 38 (37.6%) were females. In the urban areas, 224 (73%) were males and 83 (27%) were females. The pattern of affliction is similar in the urban and rural areas with more males being affected than females. This difference was found to be statistically significant ( $P = 0.043$ ) with more males affected in both the urban and rural areas.

Most of the cases belonged to the age group 20–35 years (37%), closely followed by 30–60 years (35.3%), followed by 10–19 years (14.5%) [Table 1] The pattern observed in both the settings varied from each other. In the age group of 0–9 years and 36–60 years, the urban-rural difference was found to be statistically significant ( $P = 0.006$  and  $P = 0.003$ , respectively)

Of the 408 cases, 93 (22.79%) were farmers, 61 (14.95%) were college/school-going students, 49 (12.01%) were agents/repair guys/vendors or did jobs which involved frequent travel, 39 were housewives (9.55%), 28 (6.86%) were daily wage workers, 21 (5.14%) did office jobs, 17 (4.16%) were drivers, 14 (3.43%)

worked at construction sites, 11 (2.69%) were shop keepers, another 12 (2.94%) were self-employed as carpenters/weavers/tailor/barber, 7 (1.71%) worked as food handlers in food establishments and another 7 (1.17%) worked as fishermen. Others were housekeepers (5), nurses (4), security guards (3), garage workers (2), retired (2), and scrap dealers (1); 34 (8.33%) of them were unemployed.

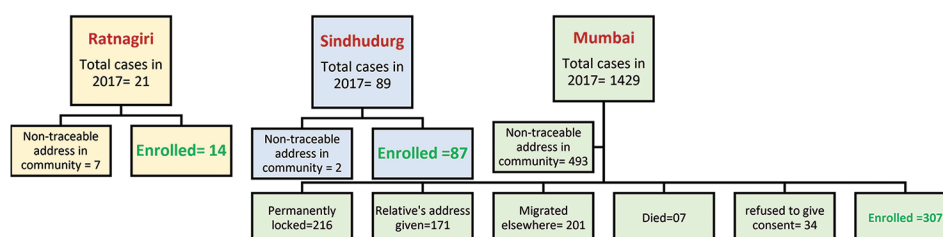
Most of the cases (263 out of 408, 64.46%) in both the urban and rural areas belonged to the lower and upper-lower socioeconomic status, another 113 (27.69%) belonged to the upper and lower-middle classes, and 32 (7.8%) belonged to the upper class according to the modified BG Prasad Socioeconomic Status Scale. There was no significant difference in the socioeconomic status among the urban and rural cases.

**Health-seeking behavior:** Two hundred and sixty (63.7%) of the 408 cases sought first care at the public or government healthcare setting, followed by 84 (20.6%) who first visited a general practitioner, 60 (14.7%) visited a private hospital, and the rest 4 (1.2%) had visited traditional healers/quacks, details of which could not be obtained. The pattern was slightly different in the rural and urban areas. In the rural area, 40.6% visited general practitioners first compared to 14% in the urban areas. However, this difference is not statistically significant. In the rural areas, 32.7% of them visited the government facilities first, whereas, in the urban areas, it was 73.9%. This difference is statistically significant ( $P = 0.006$ ).

**Clinical outcome:** The distribution of clinical signs and symptoms is given in Table 2. Fever was seen in 370 cases (90.7%). It was intermittent and associated with chills and rigor in most of the patients. Other common clinical signs and symptoms were headache (63.2%), myalgia (59.1%),

**Table 1: Age distribution of the study population**

Age group	Rural		Urban		Total
	n	Percent	n	Percent	
0-9 years	1	1.0	24	7.8	25
10-19 years	10	9.9	49	16.0	59
20-35 years	34	33.7	112	36.5	146
36-60 years	48	47.5	96	31.3	144
61-80 years	5	5.0	22	7.2	27
>80 years	1	1.0	1	0.3	2
Total	101	100	307	100	408



**Figure 1:** Sample size included for the rural and urban part of the study.

prostration (29.7%), cough (25.7%), breathlessness (19.4%), conjunctival suffusion (16.4%), jaundice (7.8%), anuria/oliguria (6.1%), hemorrhagic manifestations (4.4%), skin rash (3.9%), hemoptysis (2.9%), and meningeal irritation (1.2%). The presentation of all the symptoms was proportionately similar in both the urban and rural areas except headache, myalgia, and prostration, which were significantly more common in cases from the rural areas ( $P < 0.05$ )

A model for signs and symptoms was predicted using multivariate conditional logistic regression by backward elimination [Table 3]. Headache and prostration are highly significant symptoms associated with cases of leptospirosis in both urban and rural areas. Jaundice is a predominant sign in rural cases of leptospirosis. Skin rash was found to be associated with urban cases of leptospirosis. However, OR was not found to be significant.

Out of the 408 cases, 349 needed hospital admission. The proportion of cases needing admission was similar in both the

urban and rural settings. Nine (8.9%) out of 101 rural cases and 43 (14%) out of 307 urban cases were managed on an out-patient basis, 79 (78.2%) out of the 101 rural cases and 251 (81.8%) out of the 307 urban cases needed admission to general wards, and 6 (5.9%) out of the 101 rural cases and 13 (4.2%) out of the 307 urban cases needed ICU care. Data for seven cases in the rural areas were not reliable, hence, were not included. Thirty-one (30.7%) out of the 101 rural cases and 54 (17.6%) out of the 307 urban cases were transferred to the higher centers.

In the rural areas, out of the 101 cases, 79 (78.2%) were confirmed by PCR/Ig M ELISA and the other 22 (21.8%) were rapid IgM positive cases (i.e. suspect cases). In the urban areas, 51 (16.6%) were confirmed cases and the rest 256 (83.4%) remained suspect cases based on only rapid test positivity. It may be noted that not all suspect cases were being subjected to PCR/Ig M ELISA for confirmation.

**Risk factors:** The distribution of the risk factors found during the study is given in Table 4. They are divided into environmental risk factors, behavioral risk factors, and other host factors. The most common environmental risk factor was the presence of rodents (180 cases, 44.11%), followed by the presence of potholes (129 cases, 31.61%), waterlogging around the house (115 cases, 28.18%), working in the paddy fields (87 cases, 21.32%), pets at home (85, 20.83%), marshy muddy land (71, 17.40%), and cattle sheds (57, 13.97%). The environmental risk factors were different in both the urban and rural areas with the presence of rodents, cattle sheds, pets, and working in the paddy fields being more common in the rural areas and other water-related sources like water for recreational activities being more common in the urban areas. These differences are statistically significant ( $P < 0.001$ ).

The most common behavioral risk factors were wading through water (143 cases, 35.04%), followed by frequent visits to marketplaces (43 cases, 10.53%), washing clothes in a well (19, 4.65%), and exhaustion for any activity (15, 3.67%). There was no difference in the distribution of the behavioral risk factors in the urban or rural area except for washing clothes in wells which were more associated with cases in the rural areas.

The most common host factors are wearing footwear which does not cover the feet fully (278 cases, 68.13%), history of water entering the shoes (274 cases, 67.15%), cracked heels (90 cases, 22.05%), skin lesion or injury before illness (60 cases, 14.70%), and not using footwear regularly (46 cases, 11.27%). Out of these two factors, footwear not covering the feet fully and cracked heels were more associated with the rural areas and the difference was statistically significant ( $P < 0.001$ ).

A model for identifying the potential risk factors was predicted using multivariate conditional logistic regression by backward elimination [Table 5]. The strongest risk factor identified in the

**Table 2: Distribution of clinical signs and symptoms among the study population**

Symptoms	Rural		Urban		Total	Percent	P
	n	Percent	n	Percent			
Fever	96	95.0	274	89.3	370	90.7	0.082
Headache	84	83.2	174	56.7	258	63.2	<0.0001
Myalgia	73	72.3	168	54.7	241	59.1	0.002
Prostration	53	52.5	68	22.1	121	29.7	<0.0001
Jaundice	12	11.9	20	6.5	32	7.8	0.082
Conjunctival suffusion	20	19.8	47	15.3	67	16.4	0.290
Meningeal irritation	0	0.0	5	1.6	5	1.2	0.339
Anuria/oliguria	9	8.9	16	5.2	25	6.1	0.179
Hemorrhage	3	3.0	15	4.9	18	4.4	0.580
Skin rash	2	2.0	14	4.6	16	3.9	0.237
Cough	21	20.8	84	27.4	105	25.7	0.190
Hemoptysis	2	2.0	10	3.3	12	2.9	0.738
Breathlessness	19	18.8	60	19.5	79	19.4	0.872

$P < 0.05$  is significant. Test applied: Chi-square for each symptom individually

**Table 3: Model for signs and symptoms in rural and urban areas**

Signs/ Symptoms	Adjusted OR	P	Unadjusted OR	95% CI for unadjusted OR
Rural area				
Headache	1.17	0.000	3.22	(1.75-5.93)
Prostration	1.21	0.000	3.36	(2.02-5.60)
Jaundice	0.93	0.028	2.54	(1.11-5.82)
Skin rash	-1.29	0.103	0.27	(0.058-1.30)
Cough	-0.54	0.073	0.58	(0.32-1.05)
Urban areas				
Headache	-1.17	0.000	0.31	(0.17-0.57)
Prostration	-1.21	0.000	0.30	(0.18-0.49)
Jaundice	-0.93	0.028	0.39	(0.17-0.90)
Skin rash	1.29	0.103	3.64	(0.76-17.18)
Cough	0.54	0.073	1.71	(1.05-3.08)

**Table 4: Distribution of risk factors among rural and urban cases**

Table 4: Distribution of risk factors among rural and urban cases						
Risk factors	Rural		Urban		Total	P
	n	Percent	n	Percent		
Environmental risk factors						
Rodents	58	57.4	122	39.7	180	0.003
Potholes in the vicinity	37	36.6	92	30.0	129	0.219
Water around the house	22	21.8	93	30.3	115	0.126
Paddy fields	79	78.2	8	2.60	87	<0.0001
Animal husbandry	11	10.9	9	2.93	20	0.003
Pets at home	63	62.4	22	7.20	85	<0.0001
Marshy muddy land	17	16.8	54	17.6	71	1.000
Cattle sheds	45	44.6	12	3.90	57	<0.001
Water-logged playground	7	6.90	33	10.7	40	0.336
Other water-related resources	0	0.00	30	9.80	30	<0.0001
Other agricultural land	1	1.00	8	2.60	9	0.462
Behavioral host risk factors						
Wading through water	34	33.7	109	35.5	143	0.810
Frequent visits to marketplaces	9	8.90	34	11.1	43	0.698
Washing clothes in the well	13	12.9	6	2.00	19	<0.0001
Exhaustion for any activity	4	4.00	11	3.60	15	0.770
Grocery godowns	2	2.00	7	2.30	9	1.000
Overnight travels	2	2.00	4	1.30	6	0.640
Other host factors						
Skin lesion/injury	16	15.8	44	14.33	60	0.777
Not using footwear always	16	15.8	30	9.77	46	0.090
Footwear not covering feet	82	81.1	196	63.84	278	0.001
Water enters shoes	69	68.3	205	66.77	274	0.774
Cracked heels	44	43.6	46	14.98	90	<0.0001

P&lt;0.05 is significant

**Table 5: Model for identifying potential risk factors in rural and urban areas**

Risk factors	Adjusted OR	P	Unadjusted OR	95% CI for unadjusted OR
Rural areas				
Paddy fields	4.58	0.000	97.87	(33.609-284.97)
Wading through water	-1.47	0.007	0.23	(0.079-0.672)
Pets at home	2.72	0.000	15.15	(5.529-41.495)
Frequent visits to marketplaces	1.22	0.071	3.39	(0.898-12.821)
Cattle sheds	1.53	0.030	4.60	(1.162-18.232)
Do not use footwear regularly	1.04	0.080	2.83	(0.883-9.08)
Footwear not covering foot	-0.96	0.398	0.38	(0.04-3.54)
Water enters shoes	0.14	0.872	1.15	(0.210-6.304)
Cracked heels	-2.42	0.000	0.09	(0.022-0.291)
Urban areas				
Paddy fields	-4.58	0.000	0.01	(0.003-0.03)
Wading through water	1.47	0.007	4.33	(1.48-12.62)
Pets at home	-2.72	0.000	0.07	(0.02-0.18)
Frequent visits to marketplaces	-1.22	0.071	0.29	(0.07-0.11)
Cattle sheds	-1.53	0.030	0.22	(0.05-0.86)
Do not use footwear regularly	-0.16	0.843	0.85	(0.18-4.06)
Footwear not covering foot	1.69	0.122	5.41	(0.64-45.99)
Water enters shoes	-0.14	0.872	0.87	(0.16-4.76)
Cracked heels	2.42	0.000	11.30	(3.47-36.75)

rural areas was working in the paddy fields (OR = 4.58). Other significant factors in the rural areas were having pets at home and the presence of cattle sheds around the house. The risk of wading through water was significantly associated with cases of leptospirosis in the urban areas (unadjusted OR = 4.33,

CI = 1.48–12.62). Cracked heels were also a significant risk factor among the urban cases (unadjusted OR = 11.30, CI = 3.47–36.75) as compared to the rural cases.

Field observations are summarized in Table 6.



## Discussion

This cross-sectional study was carried out during the year 2017 in three districts of Maharashtra, India—Mumbai, Ratnagiri, and Sindhudurg. A total of 307,14 and 87 cases were taken from each district, respectively.

In our study, we found that more males were affected than females in both the urban and rural areas. Many published studies have shown a similar gender bias with more males affected by leptospirosis.<sup>[7–12]</sup> The higher incidence in the males is often attributed to occupational exposure and other activities which put them at a greater risk.<sup>[12,13]</sup> In our study, a majority of the participants were farmers, college/school-going students, agents/repair guys/vendors, daily wage workers, drivers, construction site workers, etc., (which are male-dominated occupations). The previous studies have also shown a higher incidence of leptospirosis among certain occupations such as paddy cultivators, school-going children,<sup>[12]</sup> rubber tappers, palm oil workers, sewage workers, and cleaners<sup>[10,14]</sup>. However, further analysis was not possible due to limitations in data. No age group is immune to leptospirosis. However, young adults belonging to the age group 20–35 years were most affected closely followed by 30–60 years. This is in agreement with the previous studies which also show a higher incidence in the middle-age group due to greater mobility and exposure.<sup>[7–10]</sup> We also found that more children (0–9 years) were affected in the urban areas as compared to the rural areas. This can be attributed to the fact that during the monsoon there is dirty water stagnation inside the houses in the urban areas.

The majority of our cases sought first care in public or government healthcare settings. In rural areas, around one-third of them visited the government facilities first, whereas, in an urban area, it was around 74%. A study in Mangalore also showed that the majority of the people sought first care at government hospitals.<sup>[9]</sup> This is probably because most of the

cases belonged to the lower and upper-lower socioeconomic status. The lower socioeconomic status, especially among the urban poor residing in slums, has been reported to contribute to the risk of leptospirosis.<sup>[15–17]</sup>

Fever was the most common presentation followed by headache, myalgia, prostration, cough, breathlessness, conjunctival suffusion, jaundice, anuria/oliguria, hemorrhagic manifestations, skin rash, hemoptysis, and meningeal irritation. Jaundice was predominantly seen in rural cases of leptospirosis. Skin rash was found to be associated with urban cases of leptospirosis. Previously, fever, myalgia, and generalized weakness and vomiting have been described as the major symptoms.<sup>[7,9,18–20]</sup> Unusual symptoms like cough have also been described.<sup>[9]</sup>

The environmental risk factors were different in both the urban and rural areas with the presence of rodents, cattle sheds, pets, and working in the paddy fields being more common in the rural areas and other water-related sources like water for recreational activities being more common in the urban areas. Other environmental risk factors like the presence of potholes, waterlogging around the house, marshy muddy land were present in both the urban and rural areas. Behavioral factors also play an important role in leptospirosis infection and are similar in both urban and rural areas. The common risk factors were wading through water followed by frequent visits to the marketplaces and exhaustion for any activity. Washing clothes around a well was also a risk factor but more common in rural areas. Wearing uncovered footwear through which water can enter shoes, cracked heels, skin lesions, or injury before illness and not using footwear regularly were some of the important host factors for leptospirosis. It was also found that farmers found it difficult to practice personal protective measures, like gumboots and hand gloves, due to inconvenience while going to the fields. The impact of rapid urbanization has led to the creation of slums with bad sanitation and poor solid waste management system which can be linked to the emergence of leptospirosis. This has

**Table 6: Field observations in urban and rural areas in the context of leptospirosis**

Context	Urban areas	Rural areas
Cases	Cases are reported throughout the year and found in all wards of the city but mainly in the slums. During the monsoon, cases occur in both the slums and non-slum areas. Clustering of cases found near the sewage lines.	Cases are reported throughout the year but, limited to specific talukas. No clustering of cases.
Rainwater stagnation	Dirty water stagnation for long periods especially in the slums. Dirty monsoon water enters the house and remains for long leading to “no option but to wade through dirty water.”	No stagnation of water for a long duration due to rains. Water collection inside the house is a rare event.
Solid waste	Garbage collection and disposal is a major concern and delays often lead to the habitation of pets and rodents.	Improper waste disposal is not a major concern.
Human-animal interaction	The likelihood of human-animal interaction is very high especially in the slum areas where there are cattle sheds and stables. These may contaminate the soil with the <i>Leptospira</i> bacilli. The density of the animals is high favoring direct and indirect contact with humans.	Cattle sheds are found near the homes. In some houses, diluted cow dung with water is spread on the floors and sprinkling of cow's urine is done for sacred purposes. The correlation of these practices has not been explored. The density of the population of animals is low.
Personal hygiene	Personal hygiene practices in the slum areas are very poor.	Overall personal hygiene practices are good.
Prophylaxis	A prophylactic dose of doxycycline was given in November 2017 to all those who gave a history of wading through the water in areas where cases of leptospirosis were reported.	Administration of prophylaxis doses of doxycycline to the people who have been exposed to the risk of acquiring the infection.

been reported by many countries.<sup>[21]</sup> It has also been reported that the proximity of residence to open sewers, open refuse dumps, rat-infested areas, and areas with a risk of flooding are more prone to leptospirosis.<sup>[15,16]</sup> Often, the growth of slums leads to poor floodwater drainage leading to contamination of water and soils by the excreta and urine.<sup>[22]</sup> Risk behaviors like contact with mud, sewage water, or garbage, and cleaning an open sewer have also been reported.<sup>[16]</sup> In a study by Galan *et al.*,<sup>[23]</sup> the findings of comparing urban and rural leptospirosis in Brazil were similar to our study with common exposures like places infected with rodents, floods in the urban areas, and agriculture and farming practices in the rural areas.

Our study had certain limitations. As no standard protocol for the investigation of acute febrile illness cases is observed uniformly, it is difficult to comment on the incidence. Practically, it is very difficult to point out the exact source of infection. However, the epidemiological link may be established. No information is generated on the animal reservoirs and soil contamination status which are closely related to the transmission of leptospirosis.

## Conclusions

The cases of leptospirosis although present throughout the year, significantly increase during the monsoon in both the urban and rural areas. Children are affected more in the urban areas compared to the rural areas. The working population and males are more affected in both areas. The majority of the patients in the urban areas seek care in government facilities, whereas, in the rural areas, they prefer to visit private general practitioners. Non-classical symptoms like cough breathlessness and hemoptysis were present in about one-third of the patients. Context-specific risk factors were found significantly associated with the cases. No important difference is found in the epidemiology of leptospirosis in the urban and rural areas except the source of infection.

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## Conflicts of interest

There are no conflicts of interest.

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