Epidemiological Determinants of Leprosy in a High Endemic District of India: A Community Based Case Control Study

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The leprosy elimination at national level was achieved in India in December 2005, however, Chhattisgarh is the only State yet to achieve same at State level and reported highest ANCDR/100000 population, i.e., 29.7 as on 31st March 2020. The efforts of the National Leprosy Eradication Programme (NLEP) are admirable wherein several initiatives introduced in phased manner since 2015, but there is need to understand the local scenario for effective control of this chronic disease in Chhattisgarh. This study conducted to identify various socio-demographic, behavioural, environmental factors associated with leprosy occurrence in high endemic district named Raipur. A community-based case control study design was adopted with inclusion criteria for cases as diagnosed, confirmed, and classified leprosy patients as per the WHO recommendation and NLEP Guidelines and controls as matched with cases' sex, age, (excluding the family members) and inhabiting same local area. Total 448 cases and 439 controls were interviewed from the district, after stratification of blocks based on G2D percentage among new cases detected & distribution of the sample (meant to be drawn from district) in proportion to the new cases reported by each stratum during year 2019. Data regarding socio-demographic profile, personal practices, disease profile & case history was collected through 2 different predesigned schedules. Descriptive, stratified analysis was performed along with chi square test score calculation for each variable. Further, bivariate & multinomial logistic regression was done to calculate adjusted odds ratio (for religion, age, caste, gender, education, occupation, residential area, family income) as measure of association. Low education level, absence of windows and safe water supply in household, use of same towel by multiple family members and history of contact with leprosy patients in family/ friends were found to be significantly associated with leprosy occurrence. The interventions targeted against these factors, i.e., emancipation of education level, IEC for hygiene, ventilation etc. may help in curbing the leprosy transmission in this high endemic district and other districts facing the same menace.

Keywords : Leprosy, India, NLEP, Determinants, Risk factors, Socio-demographic, Behavioural, Environmental

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Introduction

Leprosy is one of the oldest diseases known to mankind affecting skin and peripheral nerves with varied range of manifestation. This chronic disease is caused by an acid-fast bacillus, *Mycobacterium leprae* (*M. leprae*), a slow-growing obligatory parasite (Sardesai 2015, Sarkar & Pradhan 2016, WHO 2018, Uikey et al 2019, Galhotra et al 2019). At present leprosy is largely restricted to tropical and subtropical regions with presumed way of transmission via droplets inhalation although, skin contact or other means of transmission are not ruled out. The incubation period for this infectious disease varies from 2 to 20 years with average incubation period of 5 to 7 years (WHO 2018, Galhotra et al 2019). As per the WHO guidelines for the diagnosis, treatment and prevention of Leprosy, the operational classification of the disease includes paucibacillary (PB) case with 1 - 5 skin lesions and without bacilli in slit skin smear test and Multibacillary (MB) case with >5 skin lesions or with nerve involvement or indicating bacilli in slit-skin smear test (WHO 2018). If remain untreated this disease may lead to permanent impairments to the feet, hands, nerves, face, skin and causes disabilities which further lead to stigma and discrimination (Chakraborty et al 2015, Franco-Paredes & Rodriguez-Morales 2016, WHO 2018, WHO 2021).

In 1982 a standard treatment for leprosy as Multi Drug Therapy (MDT) consisting of dapsone, clofazimine and rifampicin was recommended by the World Health Organization (WHO). Further, after 10 years during forty-fourth World Health Assembly, it was resolved to eliminate leprosy as a public health problem defined as Prevalence Rate (PR) <1 case per 10,000 population by the year 2000 (Kumar & Karotia 2020a). Owing to the public health importance given to this disease, global level leprosy elimination was achieved in 2000 and by 2015 almost all countries have achieved the national level elimination (WHO 2018). Still, more than 200,000 new cases of this disease are being reported from >120 countries every year with physical deformities more than other infectious diseases (WHO 2020, WHO 2021). As per the latest global leprosy update 2019, out of 202,185 new cases reported worldwide 143,787 i.e., 71.12% were reported from South-East Asia Region (SEAR). This skewed burden of the leprosy in SEAR is due to the contribution made by India in terms of new cases detected, which is 57% & 80% of total new cases of leprosy reported globally & in SEAR respectively during 2019 (WHO 2020).

In order to control leprosy in India, National Leprosy Control Programme (NLCP) was initiated in 1955 by the Govt. of India (GoI), with vertical units established for provision of domiciliary dapsone treatment and implement activities of survey, education and treatment (SET). Further, with introduction of MDT the NLCP was renamed to National Leprosy Eradication Programme (NLEP) in 1983. From 1993 to 2004 the process of elimination was strengthened with the implementation of World Bank supported projects. Due to these continuous efforts the elimination of leprosy at national level was achieved by India in 2005 and was subsumed under aegis of National Rural Health Mission (NRHM) (Kumar & Karotia 2020a, NLEP 2021). Although, national level elimination was achieved in 2005, except two State/Union Territory (UT), i.e., Chhattisgarh and Dadra & Nagar Haveli (Uikey et al 2019). As the reporting of new cases continued with PR>1/10,000 population in several districts & blocks and National Sample Survey (NSS), 2010, indicated the possibility of 287,445 to 380,851 hidden leprosy cases in community (Katoch et al 2017, Kumar & Karotia 2020a), several activities introduced in phased manner from 2015 onward

under NLEP, i.e., Leprosy Case Detection Campaign (LCDC), Sparsh Leprosy Awareness Campaign (SLAC), ASHA based Surveillance for Leprosy Suspects (ABSULS) (Gitte et al 2016, Thangaraju et al 2018, Kumar et al 2019, Patil et al 2019, Kumar & Karotia 2020a, Kumar & Karotia 2020b). At present the programme is being implemented with objective to reduce the PR <1/10,000 population at sub national and district level with national level objectives for reduction of i) Grade 2 Disability (G2D) % amongst new cases to <1, ii) G2D per million population to <1, iii) Zero disabilities in children and iv) Zero stigma and discrimination against persons affected by leprosy (NLEP 2021). However, in the annual report published by NLEP from April 2019 to March 2020, four States/UT, i.e., Chhattisgarh, Odisha, Dadra & Nagar Haveli and Chandigarh still reported PR >1/10,000 population, as on 31st March 2020. Out of these, Chhattisgarh reported highest Annual New Case Detection rate (ANCDR) per 100000 population amongst all States, i.e., 29.7 with PR 2.1/10000 population (NLEP 2019-20). As it is the only State which has never achieved leprosy elimination, there is an urgent need to investigate the factors responsible for leprosy occurrence and trans-mission in the State.

Present article gives the findings of case control study conducted in Raipur one of the high endemic districts of Chhattisgarh. This study will present the distribution of various epidemiological determinants of leprosy, i.e., socio-demographic, behavioral, hygienic practices etc. and other characteristics amongst leprosy cases and matched controls. The understanding of these characteristics will help in getting insight of this chronic persistent problem of Chhattisgarh and to design suitable interventions.

Method and Materials

Study design: a community-based case control study design was adopted with inclusion & exclusion criteria as given below:

Inclusion criteria

- **Cases:** diagnosed, confirmed, and classified leprosy patients as per the WHO recommendation and NLEP Guidelines, as below:
    1. Paucibacillary (PB) case: Skin lesions – 1 to 5 and slit skin smear test - without bacilli
    2. Multibacillary (MB) case: Skin lesions – >5 /nerve involvement/slit skin smear test – bacilli present.
- **Controls:** persons matched with cases' sex, age, (excluding the family members) and inhabiting same local area.

Exclusion criteria - Cases/controls unwilling to participate or unable to interact or understand the local Hindi language.

Study was conducted after the ethical approval of Institute Ethics Committee, VMMC & Safdarjung Hospital, New Delhi (S.No. IEC/VMMC/SJH/ Project/ 2020-12/CC-93).

Sample size: At alpha = 95% and d = 20, sample size (after inclusion of 10% attrition) for district Raipur was 442. In view of the feasibility 1:1 model, i.e., one control against one case model was espoused.

Microplanning: Under National Leprosy Eradication Programme (NLEP), the line list of total patients is maintained at block level. Hence, stratification of the blocks was done based on G2D percentage amongst new cases detected. Two strata were defined as per the criteria given below:

Stratum I: Block with G2D % amongst new cases detected <4%.

Stratum II: Block with G2D % amongst new cases detected >4%.

The line list of blocks belonging to strata was combined to make a sample frame and from that

whole sample meant to be drawn from district, i.e., 442 cases was randomly selected in proportion to the total new cases detected in each stratum of blocks. Equal number of controls matched with sex, age, (excluding the family members) were interviewed from each stratum of blocks. However, total 448 cases and 439 controls were interviewed from the district in the study.

Study Tools: In order to collect the data various schedules were designed and translated in Hindi as per the requirement given below:

- S**chedule A -** designed to get information regarding Socio-demographic profile and personal practices followed by the participants. This schedule was filled for all the participants, i.e., cases and controls of the study.

- **Schedule B -** designed to get information on Disease profile & Case History of the persons affected by Leprosy. This was filled for cases only.

For validity, all the schedules were distributed to 14 experts from various organization working in the field of leprosy i.e., Central Leprosy Division (CLD), World Health Organisation (WHO), International Federation of Anti-Leprosy Associations (ILEP) in India, Regional Leprosy Training & Research Institute (RLTRI), Raipur, Central Leprosy Teaching & Research Institute (CLTRI), Chengalpattu and Indian Council of Medical Research (ICMR). The content of the schedules was validated and revised based on their opinion and suggestions.

Further all the schedules were pre-tested on cases and controls. Visits to two tertiary care hospitals 1) The Leprosy Mission Trust India, Shahdara Hospital and 2) Safdarjung Hospital were done to take interview of patients. Keeping in view of the understanding and interpretation of words by the participants the questions were further revised. Further, internal consistency/ reliability of the scales was checked using Cronbach alpha, which was excellent (i.e., 8.6).

Data collection: The importance of study was explained to the patient or the guardian in case of patients less than 18 years and written informed consent or assent (in case of minor) were obtained for participation in the study. Afterward the data was collected on the pretested and predesigned schedules.

Analysis of Data: Data was checked for errors and missed values, and then the corrected data was entered in Microsoft Excel and master files were created. Statistical analyses were performed using SAS (Statistical Analysis Software) 9.4 version. Descriptive analysis was carried out to determine the distribution of socio-demographic, hygienic practices, prophylaxis, and history of previous exposure to leprosy patients related characteristics in the study population. Further, all characteristics were stratified with respect to cases and controls. Odds Ratios (OR) as measures of association between variables were calculated through bivariate (where dependent variables had 2 categories) and multinomial (where dependent variables had >2 categories) logistic regression and adjusted for religion, age, caste, gender, education, occupation, residential area, family income.

Results

Most of the participants were aged ≥30 years (69.9%) followed by 15-29 years (26.7%). Proportion of males was marginally high (51.8%) than females (48.1%). More than three fourth were married (76.7%), almost all were Hindus (99.5%) and more than half were from Other Backward Classes (58.7%). Only one fourth were educated above 8th class (25.8%), however less than one third were not educated (30.8%). Around three fourth participants were not working (71.0%) and one fourth were labourer (25.4%). Most of participants were from rural

Table 1 : Overall Socio-demographic characteristics, hygiene, prophylaxis, and history of previous exposure to leprosy patients amongst all participants (N-887)

Description	Categories	Frequency	Percentage (95% CI)
Age	≤14	30	3.38 (2.19 - 4.57)
	15-29	237	26.72 (23.80 - 29.64)
	≥30	620	69.90 (66.87 - 72.92)
Gender	Male	460	51.86(48.57 - 55.15)
	Female	427	48.14(44.85 - 51.43)
Marital status	Unmarried	187	21.08(18.39 - 23.77)
	Married	681	76.78(73.99 - 79.56)
	Widowed/ Divorced/Separated	19	2.14(1.19 - 3.10)
Religion	Hindu	883	99.55(99.11 - 99.99)
	Non-Hindu	4	0.45(0.01 - 0.89)
Caste	General	139	15.67 (13.27 - 18.07)
	SC	145	16.35 (13.91 - 18.79)
	ST	82	9.24 (7.33 - 11.15)
	Other Backward Classes (OBC)	521	58.74 (55.49 - 61.98)
Education	No Formal Education	274	30.89(27.84 - 33.94)
	Up to 8th	384	43.29(40.03 - 46.56)
	Above 8th	42	4.74(3.33 - 6.14)
House type	Kutcha	229	25.82(22.93 - 28.7)
Occupation	Not working	630	71.03 (68.03 - 74.02)
	Labourer	224	25.25 (22.39 - 28.12)
	Pvt. Govt. salaried	33	3.72 (2.47 - 4.97)
Location	Rural	845	95.26(93.86 - 96.67)
	Urban	393	44.31(41.03 - 47.58)
	Pucca	367	41.38(38.13 - 44.62)
	Semi Pucca	127	14.32(12.01 - 16.63)
Window present in house	Yes	792	89.29(87.25 - 91.33)
	No	95	10.71(8.67 - 12.75)
Light reaching in house	Yes	789	88.95(86.88 - 91.02)
	No	98	11.05(8.98 - 13.12)
No. of rooms in house	≤3	187	21.08(18.39 - 23.77)
	>3	700	78.92 (76.23 - 81.61)
No. of Family members	≤3	84	9.47 (7.54 - 11.40)
	>3	803	90.53 (88.60 - 92.46)
Income (per month)	≤8000	734	82.75(80.26 - 85.24)
	>8000	153	17.25(14.76 - 19.74)
Animal present	Yes	291	32.81(29.71 - 35.9)
	No	596	67.19(64.1 - 70.29)

Access to safe water	Yes	687	77.45(74.7 - 80.21)
	No	200	22.55(19.79 - 25.3)
Bath frequency	Once/week	22	2.48(1.45 - 3.51)
	Twice or thrice/week	63	7.10(5.41 - 8.80)
	Daily	802	90.42(88.48 - 92.36)
Towel washing frequency	Once/week	424	47.8(44.51 - 51.1)
	Twice or thrice /week	331	37.32(34.13-40.51)
	Daily	132	14.88(12.53 - 17.23)
Pillow bedsheet	Once/week	466	52.54(49.24 - 55.83)
washing frequency	Twice or thrice /week	419	47.24(43.95-50.53)
	Daily	2	0.23(0 - 0.54)
Towel usage by multiple	Yes	323	36.41(33.24 - 39.59)
	No	466	52.54(49.24 - 55.83)
	Don't know	98	11.05(8.98 - 13.12)
BCG vaccination done	Yes	374	42.16(38.91 - 45.42)
	No	166	18.71(16.14 - 21.29)
	Don't know	347	39.12(35.90 - 42.34)
History of Leprosy	Yes	20	2.25(1.28 - 3.23)
patients in family/ friends	No	610	68.77(65.72 - 71.83)
	Don't know	257	28.97(25.98 - 31.97)
Still on treatment*	Yes	4	20(0.79 - 39.21)
	No	9	45(21.11 - 68.89)
	Don't know	7	35(12.10 - 57.90)
Relationship with patient*	Husband/Wife	2	10(0.00 - 24.41)
	Daughter/Son	7	35(12.1 - 57.9)
	Mother/Father	4	20(0.79 - 39.21)
	Brother/Sister	2	10(0.00 - 24.41)
	Friend	2	10(0.00 - 24.41)
	Neighbour	3	15(0.00 - 32.15)

*N = 20 only for who said yes for history of contact with leprosy patient.

areas (95.2%) with Kutcha house as the most prominent form of dwelling (44.3%). In majority of houses windows were present (89.2%) and light was reaching (88.9%). More than three fourth of the houses had >3 rooms (78.9%). Most predominant family size was >3 members (92.4%) & majority of family had income ≤8000 (82.7%). Around two third said that they did not have animal (67.1%) and more than three fourth had access to safe drinking water (77.4%). In respect to hygiene practices, majority of participants were taking bath daily (90.4%). The towel & pillow cover/bedsheet washing frequency once per week was followed by around half of the participants 47.8% and 52.5% respectively. More than one third responded that single towel was used by more than one member/s of families (36.4%). Less than half had BCG vaccine (42.1%), however, 18.7% had not. Out of all only 2.2% cited that they had contact history with leprosy

Table 2 : Stratified distribution of Socio-demographic characteristics, hygiene, prophylaxis, and history of previous exposure to leprosy patients amongst cases and controls.

Description	Categories	Cases n (%)	Controls n (%)	2 Chi square tests & p value
Age	≤14	17(3.79%)	13(2.96%)	2.7160
	15-29	129(28.79%)	108(24.6%)	0.2572
	≥30	302(67.41%)	318(72.44%)	
Gender	Male	224(50.00%)	236(53.76%)	1.2546
	Female	224(50.00%)	203(46.24%)	0.2627
Marital status	Unmarried	99(22.1%)	88(20.05%)	1.9437
	Married	337(75.22%)	344(78.36%)	0.3784
	Widowed/ Divorced/Separated	12(2.68%)	7(1.59%)	
Religion	Hindu	446(99.55%)	437(99.54%)	0.0004
	Non-Hindu	2(0.45%)	2(0.46%)	0.9838
Caste	General	67(14.96%)	72(16.4%)	2.7061
	SC	79(17.63%)	66(15.03%)	0.4392
	ST	36(8.04%)	46(10.48%)	
	OBC	266(59.38%)	255(58.09%)	
Education	No Formal Education	156(34.82%)	118(26.88%)	**6.7886**[#]
	Upto 8th standard	180(40.18%)	204(46.47%)	**0.0336**
	Above 8th standard	112(25.00%)	117(26.65%)	
Occupation	Not working	318(70.98%)	312(71.07%)	1.0092
	Labourer	116(25.89%)	108(24.60%)	0.6037
	Pvt. Govt. salaried	14(3.13%)	19(4.33%)	
Location	Rural	427(95.31%)	418(95.22%)	0.0045
	Urban	21(4.69%)	21(4.78%)	0.9463
House type	Kutcha	206(45.98%)	187(42.60%)	1.4679
	Pucca	183(40.85%)	184(41.91%)	0.4800
	Semi Pucca	59(13.17%)	68(15.49%)	
Window present	Yes	389(86.83%)	403(91.80%)	**5.7252**[#]
	No	59(13.17%)	36(8.20%)	**0.0167**
Light reaching	Yes	390(87.05%)	399(90.89%)	3.3178
	No	58(12.95%)	40(9.11%)	0.0685
Rooms no.	≤3	103(22.99%)	84(19.13%)	1.9822
	>3	345(77.01%)	355(80.87%)	0.1592
Family size	≤3	41(9.15%)	43(9.79%)	0.1070
	>3	407(90.85%)	396(90.21%)	0.7436
Income category (per month)	≤8000	369(82.37%)	365(83.14%)	0.0939
	>8000	79(17.63%)	74(16.86%)	0.7593
Animal present	Yes	143(31.92%)	148(33.71%)	0.3235
	No	305(68.08%)	291(66.29%)	0.5695

Safe water supply	Yes	328(73.21%)	359(81.78%)	**9.3085[#]**
	No	120(26.79%)	80(18.22%)	**0.0023**
Bath frequency	Once/week	13(2.90%)	9(2.05%)	1.5934
	Twice or thrice/week	28(6.25%)	35(7.97%)	0.4508
	daily	407(90.85%)	395(89.98%)	
Towel washing	Once/week	235(52.46%)	189(43.05%)	**8.0761[#]**
frequency	Twice or thrice/week	150(33.48%)	181(41.23%)	**0.0176**
	daily	63(14.06%)	69(15.72%)	
Pillow cover, bed-	Once/week	257(57.37%)	209(47.61%)	**8.4838[#]**
sheet washing	Twice or thrice/week	190(42.41%)	229(52.16%)	**0.0144**
frequency	daily	1(0.22%)	1(0.23%)	
Towel usage	Yes	184(41.07%)	139(31.66%)	**8.9601[#]**
by multiple	No	215(47.99%)	251(57.18%)	**0.0113**
	Don't know	49(10.94%)	49(11.16%)	
BCG vaccination	Yes	168(37.50%)	206(46.92%)	**8.0895[#]**
done	No	90(20.09%)	76(17.31%)	**0.0175**
	Don't know	190(42.41%)	157(35.76%)	
History of Leprosy	Yes	16(3.57%)	4(0.91%)	**7.1444[#]**
patients in family/	No	305(68.08%)	305(69.48%)	**0.0281**
friends	Don't know	127(28.35%)	130(29.61%)	

Bold faced figures are statistically significant (p<0.05).

patients, of which 20% were still on treatment with most close relationship as son/daughter (35%) and parents (20%). (Table 1)

The stratification of various variables amongst cases and controls suggests that around one fourth (28.0%) of cases & controls belongs to age group 15-29 years. Half of cases and controls were male & more than half (58.1%) belonged to OBCs. Around one fourth (26.9%) of controls were not formally educated whereas proportion for same was higher (34.8%) in cases. The private/govt. salaried occupation was marginally higher among controls (4.3%) than cases (3.1%). The rural urban area distribution was similar in both, however pucca house type was marginally higher in controls (41.9%) than cases (40.8%). The proportion of houses with windows & where light is reaching is higher in controls (~91%) than cases (~87%) with parity in distribution of no. of rooms & family size characteristics and income categories. The presence of animal among two groups is almost similar however proportion for safe water supply was higher in controls (81.7%). Proportion for washing towels, pillow cover and bedsheet only once per week was lower in controls than the cases. Use of one towel by several persons of household was higher in cases (41.0%) than controls (31.6%). Proportion of BCG vaccination done was higher in controls (46.9%) whereas history of leprosy patient in family/ friend was higher in cases (3.5%). (Table 2)

Regression analysis revealed that subjects educated upto 8th standard (AOR=0.58) & above (AOR=0.61) were significantly less likely to get leprosy disease as compared to not formally educated. Subjects residing in households without windows (AOR=1.64) & safe water supply (AOR=1.74) had significant higher odds for

Table 3 : Logistic regression analysis of determinants of leprosy

Description	Categories	Unadjusted Odds Ratio (CI)	P value	Adjusted* Odds Ratio (CI)	P value
Age	15-29	0.91(0.43-1.97)	0.8167	0.89(0.41-1.96)	0.7789
(ref : ≤14 years)	≥30	0.73(0.35-1.52)	0.3963	0.61(0.28-1.30)	0.1969
Gender (ref: Male)	Female	1.16(0.89-1.51)	0.2630	1.16(0.89-1.53)	0.2740
Religion (ref: Hindu)	Non-Hindu	0.98(0.14-6.99)	0.9838	0.77(0.11-5.59)	0.8002
Caste (ref: General)	SC	1.29(0.81-2.05)	0.2900	1.25(0.78-2.00)	0.3591
	ST	0.84(0.49-1.46)	0.5361	0.78(0.45-1.36)	0.3785
	OBC	1.12(0.77-1.63)	0.5500	1.13(0.77-1.66)	0.5194
Education (ref: No	Upto 8th standard	**0.67(0.49-0.91)**	**0.0111**	**0.58(0.41-0.80)**	**0.0011**
formal education)	Above 8th standard	0.72(0.51-1.03)	0.0727	**0.61(0.42-0.90)**	**0.0120**
Marital status	Married	0.87(0.63-1.20)	0.4028	1.09(0.68-1.75)	0.7185
(ref: Unmarried)	Widowed/ Divorced /Separated	1.52(0.58-4.04)	0.3973	1.51(0.52-4.43)	0.4509
Occupation	Labourer	1.05(0.78-1.43)	0.7363	1.33(0.95-1.88)	0.1010
(ref: Not working)	Pvt. Govt. salaried	0.72(0.36-1.47)	0.3690	0.96(0.45-2.05)	0.9249
Location (ref: Rural)	Urban	0.98(0.53-1.82)	0.9463	1.07(0.57-2.02)	0.8307
House type	Pucca	0.90(0.68-1.20)	0.4819	0.95(0.71-1.27)	0.7232
(ref: Kutcha)	Semi-pucca	0.79(0.53-1.18)	0.2438	0.86(0.57-1.30)	0.4703
Window present (ref: Yes)	No	**1.70(1.1-2.63)**	**0.0177**	**1.64(1.05-2.57)**	**0.0307**
Light reaching (ref: Yes)	No	1.48(0.97-2.27)	0.0698	1.42(0.92-2.20)	0.1182
Rooms no. (ref: ≤3)	>3	0.79(0.57-1.10)	0.1596	0.84(0.60-1.16)	0.2866
Family size (ref: ≤3)	>4	1.08(0.69-1.69)	0.7436	1.11(0.70-1.75)	0.6615
Income category (per month) (ref: >8000)	≤8000	0.95(0.67-1.34)	0.7594	0.88(0.61-1.27)	0.4879
Animal present (ref: Yes)	No	1.09(0.82-1.44)	0.5696	1.12(0.84-1.50)	0.4310
Safe water supply (ref: Yes)	No	**1.64(1.19-2.26)**	**0.0024**	**1.74(1.26-2.42)**	**0.0009**
Bath frequency	Once/week	0.78(0.46-1.30)	0.3363	0.65(0.38-1.11)	0.1167
(ref: Daily)	Twice or thrice/week	1.40(0.59-3.32)	0.4420	1.43(0.59-3.44)	0.4250
Towel washing	Once/week	**0.91(0.61-1.36)**	**0.6386**	**0.85(0.56-1.28)**	**0.4344**
frequency (ref: Daily)	Twice or thrice/week	1.36(0.92-2.02)	0.1222	1.35(0.90-2.01)	0.1421
Pillow cover,	Once/week	0.83(0.05-13.35)	0.8952	0.95(0.06-15.72)	0.9691
bedsheet washing frequency (ref: Daily)	Twice or thrice/week	1.23(0.08-19.78)	0.8840	1.47(0.09-24.45)	0.7884

Towel usage by multiple (ref: No)	Yes	**1.55(1.16-2.06)**	**0.0028**	**1.58(1.18-2.12)**	**0.0022**
	Don't know	1.17(0.76-1.81)	0.4863	1.15(0.74-1.80)	0.5283
BCG vaccination done (ref: No)	Yes	**0.69(0.48-0.99)**	**0.0464**	0.73(0.50-1.07)	0.1081
	Don't know	1.02(0.71-1.48)	0.9088	1.04(0.71-1.52)	0.8323
History of Leprosy patients in family/ friends (ref: No)	Yes	**4.00(1.32-12.10)**	**0.0141**	**4.19(1.37-12.81)**	**0.0121**
	Don't know	0.98(0.73-1.31)	0.8753	0.94(0.70-1.27)	0.6850

* Adjusted for religion, caste, education, age & gender.
Bold faced figures are statistically significant (p<0.05).

disease occurrence. Towel usage by more than one person (AOR=1.58) and history of leprosy patient in family/friend (AOR=4.19) were responsible for significant higher likelihood for disease occurrence (Table 3).

Discussion

In 2013, 'Leprosy: overcoming the remaining challenges, a report of an international summit,' suggested for advancement in quality of care, laboratory services, early case detection & contact management to address key challenge of new cases occurrence (WHO 2015). In India, various innovation introduced in phased manner from 2015 onward addressing the challenges of hidden cases, delayed detection, low monitoring, and community awareness (Kumar & Karotia 2020a). However, Chhattisgarh state contributes around 8% of total new cases detected, from 2% of population in the country (NLEP 2019-20). Latest district wise status available for year 2018-19 indicated ANCDR >10 in 24 out of 27 districts (Gitte et al 2021). The risk factors for continued endemicity for leprosy in the State includes poor sanitation, overcrowding in households, illiteracy, low awareness for leprosy, leprosy contact in household etc (Kerr-Pontes et al 2006, Gitte et al 2021).

Our study shows that among the various socio-economic factors, education is a significant determinant for leprosy occurrence with 51% higher risk in the persons with no formal education than educated above 8th standard. The association between low level of school education was found in various previous studies (Ponnighaus et al 1994, Kerr-Pontes et al 2006). Education may be considered as a distant determinant of leprosy as persons with low education may be exposed to several health hazards, lack of awareness, low demand and access to healthcare services.

Although not significant but the kutcha house type had higher risk for leprosy occurrence and the houses without windows shows significant 64% higher risk for same than the houses having windows. Most plausible explanation to this would be, in the absence of windows which are essential for cross ventilation (removal of stale air and replacement with fresh air), the pathogen remain in the air of household for long and probability for infecting the persons through respiratory system increases.

Another significant factor found associated in the study was safe water supply, which showed 74% higher risk for leprosy occurrence in persons residing in the households without safe water supply. It is assumed that in view of the IEC undertaken for safe drinking water's role in preventing several infectious diseases, the water may be treated before consuming. However, for bathing and other utilities the consideration to treat the water would be least. This observation is

substantiated with findings of another study conducted in Brazil wherein it was stated that water along with wet soil may act as a reservoir for *M. leprae* and regular contact with natural water bodies increases the risk for leprosy (Kerr-Pontes et al 2006).

Further significant factors found were the use of single towel by multiple persons of the household and history of leprosy patient in family/friends, with 58% and 19% higher risks of leprosy occurrence among respondents who affirms for same respectively. This finding coincides with other research which states that risk of leprosy increases from five to nine times in household contacts to that of non-household contacts (Gitte et al 2021).

These socio-economic, behavioral significant factors can be altered with targeted IEC activities to modify household construction for proper ventilation, habit of using towels by multiple persons. Further, emancipation of education level along with awareness activities specific to leprosy disease may also have a positive impact on the disease control activities. However, association of safe water supply and leprosy may be explored further.

Conclusion

Results of this case–control study indicate that several socioeconomic, environmental, behavioural risk factors favour the occurrence of leprosy in Raipur which can be targeted through proper IEC in cutting the transmission of this disease.

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References

1. Chakraborty D, Sengupta J, Chakraborty T (2015). Prevention of disability in multi drug treated leprosy affected persons through Homoeopathy in two districts of Chhattisgarh, India – a pilot study. *Explor Anim Med Res.* **5(2)**: 160-168.

2. Franco-Paredes C, Rodriguez-Morales AJ (2016). Unsolved matters in leprosy: a descriptive review and call for further research. *Ann Clin Microbiol Antimicrob.* **15(1)**: 33.

3. Galhotra A, Panigrahi SK, Pal A (2019). Leprosy - A raging persistent enigma. *J Fam Med Prim Care.* **8(6)**: 1863-1866.

4. Gitte S (2016). LCDC (Leprosy Cases Detection Campaign) – Aiming at cent percent detection of leprosy cases in the community based on a line of pulse polio campaign in leprosy endemic state. *Int J Dermatol Clin Res*. **2(1)**: 012-013.

5. Gitte SRL, Santaram V, Jamil S (2021). Descriptive study of high leprosy endemic pockets and exploring occurrence factors of multicase families in the village of Salaunikhurd of Chhattisgarh State. *Int J Med Public Health*. **11(2)**: 113-117.

6. Katoch K, Aggarwal A, Yadav VS et al (2017). National sample survey to assess the new case disease burden of leprosy in India. *Indian J Med Res*. **146(5)**: 585-605.

7. Kerr-Pontes LR, Barreto ML, Evangelista CM et al (2006). Socioeconomic, environmental, and behavioural risk factors for leprosy in North-east Brazil: results of a case–control study. *Int J Epidemiol*. **35(4)**: 994-1000.

8. Kumar A, Roy R, Karotia D (2019). Leprosy case detection campaign (LCDC): An approach to accelerate progress to achieve leprosy free India. *Indian J Lepr*. **91(2)**: 125-137.

9. Kumar A, Karotia D (2020a). Accelerating towards a leprosy free India through innovative approaches in the National Leprosy Eradication Programme (NLEP), India. *Lepr Rev*. **91(2)**: 145-154.

10. Kumar A, Karotia D (2020b). ASHA based surveillance for leprosy suspects (ABSULS): An innovation for enhancing active case search of leprosy at community level. *Indian L Lepr*. **92 (3)**: 161-171.

11. National Leprosy Eradication Programme (2021). Published by Directorate General Health Services, Ministry of Health & Family Welfare [Available from: https://dghs.gov.in/content/1349_3_ NationalLeprosyEradicationProgramme.aspx.) Accessed on 12.8.2021.

12. National Leprosy Eradication Programme. Annual report 2019-20 Published by Directorate General Health Services, Ministry of Health & Family Welfare [Available from: https://dghs.gov.in/ WriteReadData/userfiles/file/Leprosy/State% 20wise%20report-2019-20.pdf.

13. Patil S, Mohanty KK, Joshi B et al (2019). Towards Elimination of Stigma & Untouchability: A Case for Leprosy. *Indian J Med Res*. **149(Suppl**): S81-87.

14. Ponnighaus JM, Fine PE, Sterne JA et al (1994). Extended schooling and good housing conditions are associated with reduced risk of leprosy in rural Malawi. *Int J Lepr Other Mycobact Dis*. **62(3**): 345-352.

15. Sardesai VR (2015). Leprosy elimination: A myth or reality. *J Neurosci Rural Pract*. **6(2**): 137-138.

16. Sarkar R, Pradhan S (2016). Leprosy and women. *Int J Wom Dermatol*. **2(4**): 117-121.

17. Thangaraju P, Venkatesan S, Showkath Ali MK (2018). Final Leprosy Push: Out of Society. *Indian J Commun Med*. **43(1**): 58-59.

18. Uikey D, Joshi R, Shah BJ et al (2019). Leprosy scenario in Ahmedabad District (Gujarat). *Indian J Dermatol*. **64(5**): 383-388.

19. WHO (2015). Leprosy: overcoming the remaining challenges. World Health Organization.

20. WHO (2018). Guidelines for the diagnosis, treatment and prevention of leprosy. World Health Organization.

21. WHO (2020). Weekly Epidemiological Record. Weekly Epidemiological Record content global leprosy World Health Organization 2020 4 SEPTEMBER 2020, 95th YEAR.

22. WHO (2021). Towards zero leprosy. Global leprosy (Hansen's Disease) strategy 2021–2030. World Health Organization; Report No. : 9290228393.