Research Article

# Risk Factors associated with Leprosy and its Disability in Araria, A High Endemic District of India

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**DOI:** https://doi.org/10.24321/0019.5138.202274

## I N F O

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**How to cite this article:**
Karotia D, Kishore J, Kumar A. Risk Factors associated with Leprosy and its Disability in Araria, A High Endemic District of India. J Commun Dis. 2022;54(2):72-82.

Date of Submission: 2022-04-25
Date of Acceptance: 2022-06-24

## A B S T R A C T

*Background:* Despite the achievement of elimination of leprosy in 2005 at the national level, India still has more than a dozen states reporting a Grade II Disability (G2D) rate of > 2 per million populations, and over two-fifth of districts are high or moderate endemic. It is necessary to understand the factors leading to continued endemicity and disability in these districts to plan strategies and achieve the envisaged targets of NLEP.

*Method:* To identify individual, environmental, socio-demographic, and health system-related factors responsible for leprosy and disability occurrence in a high endemic district of Bihar, case-control design was adopted. A total of 896 individuals (448 cases and 448 controls - excluding family members; matched with age and gender) were interviewed with pre-designed, pre-tested schedules. Blocks were stratified based on the proportion of G2D among new cases detected (NCD) in the year 2019 to draw samples in proportion to NCD. Descriptive, stratified, bivariate and multinomial logistic regression was done to find the association among factors.

*Results:* Factors found significant for leprosy occurrence were Scheduled Caste (SC) category, education less than 8th class, unemployment, living in the household without windows/ light/ safe water supply, kutcha type, family income less than INR 8000, and history of leprosy patients in family/ friends. Further age more than 14 years, ST category, reporting delay of 6-12 months, remoteness of health facility, financial constraints etc. were found significant for disability occurrence.

*Conclusion:* Further exploration in this area and designing strategies considering these factors may help in controlling this chronic disease in endemic areas and preventing related disability.

**Keywords:** Leprosy, Bihar, NLEP, Determinants, Risk Factors, Socio-demographic, Behavioural, Environmental

**73**

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*
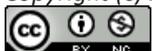
## Introduction

In India, with incessant active case detection under the National Leprosy Eradication Programme (NLEP), leprosy elimination at the national level was achieved in the year 2005. At present, it is being implemented as a centrally sponsored scheme by the Ministry of Health & Family Welfare (MoHFW), Government of India to control leprosy. Strategies being followed are: 1) Integration of anti-leprosy services under the General Healthcare System, 2) Early detection, and complete treatment of leprosy cases, 3) Conduction of household contact survey for early case detection, 4) Involvement of Accredited Social Health Activist (ASHA) in detection and treatment completion, 5) Strengthening of Disability Prevention and Medical Rehabilitation (DPMR) services, 6) Information, Education and Communication (IEC) activities to improve self-reporting to Primary Health Centre (PHC) and reduction of stigma in the community, and 7) Intensive monitoring and supervision at Health & Wellness Centres (HWCs) and Block Primary Health Centre (BPHC)/ Community Health Centre (CHC).[1,2]

Under the programme, it is targeted to achieve Grade II Disability (G2D) percentage among new cases as less than 1% and G2D rate per million population less than 1 permillion population. Further, as per the latest available data, the G2D percentage among new cases decreased from 3.05% (2018-19) to 2.39% (2019-20) and the G2D rate per million population decreased from 2.65/million population (2018-2019) to 1.94/million population (2019-2020) at the national level. However, state-level data indicate that there are 14 states/ UTs reporting a G2D rate per million population more than the national level, namely, Maharashtra (2.01), Andhra Pradesh (2.38), Assam (2.56), Daman & Diu (2.68), Jharkhand (2.86), Meghalaya (2.97), Madhya Pradesh (3.38), Bihar (3.61), Odisha (4.24), Puducherry (4.51), Chandigarh (4.94), Tripura (7.7), Chhattisgarh (10.29), and Delhi (12.88) as on 31st March 2020.[3]

Another study stated that endemic pockets are still limited to those states/ UTs where leprosy was endemic for a long time, i.e., Chhattisgarh, Bihar, West Bengal, Madhya Pradesh, Uttar Pradesh, Odisha, and Dadra & Nagar Haveli (DNH).[4] In addition, it is noted that out of 708 districts, 324, i.e., 46% are high or moderate endemic districts, and 118, i.e., 17% are high endemic districts.[3] An understanding of the factors which are responsible for chronic leprosy endemicity and high disability rate in certain districts/ areas is of prime importance to chalk out local strategies which will help in the achievement of targets envisaged under NLEP.

The present article is the synthesis of an attempt made to understand the factors responsible for leprosy and its disability in Araria, a high endemic district of Bihar. It focuses on various social, individual, and healthcare delivery system-related determinants responsible for leprosy occurrence and transmission in the community. Further, it also sheds light on the impending question, i.e., why disability rate is so high in certain areas? The information may be utilised in taking corrective measures to curb the transmission of this age-old disease and prevent disability related to it.

## Materials and Method

**Study Design:** A case-control study design with inclusion and exclusion criteria as given below was adopted.

### Inclusion Criteria

**For Cases:** Confirmed, paucibacillary (PB) case, multibacillary (MB) case classified as per the WHO and NLEP guidelines.

**For Controls:** Participants inhabiting the same local area (excluding the family members) matching cases' gender and age.

### Exclusion Criteria

Persons who did not provide consent to participate or were unable to interact or understand the local Hindi language.

**Sample Size:** Holding degree of freedom, i.e., d = 20, at alpha = 95%, the sample size attributed to district Araria was 442 (including 10% attrition). One control against one case model was followed in view of feasibility.

**Microplanning:** In order to get the representation of good and bad performing blocks, two strata of blocks were defined on the basis of G2D% amongst new cases detected, i.e., stratum I: G2D% < 4% and stratum II: G2D% > 4%. The stratification at the block level was performed as the line list of the cases maintained at this level. The sample frame was made by combining the line list of blocks coming under each stratum. Further, the desired sample size was randomly withdrawn in proportion to new cases detected in the stratum. Against each case, one control was interviewed after matching with gender, age, and area. A total of 442 cases and 442 controls were interviewed in the district.

**Study Tools:** The data were collected on various predesigned schedules:

- Socio-demographic profile and individual practices of the participants: This schedule titled schedule A was filled for all the study participants, i.e., cases and controls
- Disease profile and case history of the leprosy cases: This schedule was titled schedule B and was filled for cases only

The content validity for all the schedules was ensured through review by 14 experts in the field belonging to various organisations i.e., Central Leprosy Division (CLD), International Federation of Anti-Leprosy Associations (ILEP) in India, World Health Organisation (WHO), Central Leprosy Teaching & Research Institute (CLTRI), Chengalpattu,

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

**74**

Regional Leprosy Training & Research Institute (RLTRI), Raipur, and Indian Council of Medical Research (ICMR). The content of the schedules was further revised based on the expert's suggestions and opinions.

Furthermore, pre-testing of all schedules was done on cases/ controls of two tertiary care hospitals 1) Safdarjung Hospital and 2) The Leprosy Mission Trust India, Shahdara Hospital. In accordance with the ability of participants to understand and interpret the questions, further revisions were made. The Cronbach alpha for internal consistency of the scales was 0.8.

**Data Collection:** Data were collected from February to June, 2021, using the schedules after explaining the objectives of the study to the participant or guardian (if the participant was a minor) and written informed consent or assent was obtained.

**Analysis of Data:** After data cleaning, analysis was carried out using SAS (Statistical Analysis Software) 9.4 version. The distribution and stratification of characteristics were performed amongst cases and controls.

Odds Ratios (OR) through bivariate logistic regression for dependent variables with 2 categories and multinomial logistic regression for dependent variables having > 2 categories were calculated and adjusted for age, gender, religion, caste, and education.

## Review Board Approval

Ethical approval for the study was taken from the Institute Ethics Committee, VMMC & Safdarjung Hospital, New Delhi (S. No. IEC/VMMC/SJH/Project/2020-12/CC-93).

## Result

The stratified distribution indicated that nearly three-fifths of both cases and controls were above 30 years of age, two-thirds were male, and about four-fifths were married. Around three-fourths were Hindus and around two-thirds belonged to backward classes. Around half of the cases were not formally educated and not working whereas only around one-third of controls were not formally educated, and were not working. More than four-fifths of both cases and controls lived in rural areas. Less than one-fifth of cases and more than one-third of controls lived in pucca households. Among cases, around one-fifth had ≤ 2 rooms, window present and light not reaching in the house. Around half of the controls had salaries less than INR 8000 per month, domestic animals, and safe water supply in their houses. Among hygiene practices, the bathing pattern was similar among cases and controls but the daily towel washing frequency was lower and towel usage by multiple persons was higher among cases (18% and 46% respectively). Around one-fifth and half of the cases had Bacille Calmette-Guerin (BCG) vaccination and exposure to leprosy patients in family or friends respectively (Table 1).

**Table 1.Distribution of Socio-demographic Characteristics, Hygiene, Prophylaxis, and History of Previous Exposure to Leprosy Patients amongst Cases and Controls**

| Description | Categories | Cases | | Controls | |
|---|---|---|---|---|---|
| | | n | % (95% CI) | n | % (95% CI) |
| Age (years) | < 14 | 18 | 4.07 (2.23- 5.92) | 27 | 6.11 (3.87- 8.35) |
| | 14-30 | 156 | 35.29 (30.83-39.76) | 144 | 32.58 (28.20-36.96) |
| | > 30 | 268 | 60.63 (56.07-65.20) | 271 | 61.31 (56.76-65.86) |
| Gender | Male | 292 | 66.06 (61.64-70.49) | 292 | 66.06 (61.64-70.49) |
| | Female | 150 | 33.94 (29.51-38.36) | 150 | 33.94 (29.51-38.36) |
| Marital status* | Unmarried | 76 | 17.19 (13.67-20.72) | 78 | 17.65 (14.09-21.21) |
| | Married | 361 | 81.67 (78.06-85.29) | 343 | 77.60 (73.71-81.50) |
| | Widowed | 5 | 1.13 (0.14- 2.12) | 21 | 4.75 (2.76- 6.74) |
| Religion | Hindu | 306 | 69.23 (64.92-73.54) | 326 | 73.76 (69.65-77.87) |
| | Non-Hindu | 136 | 30.77 (26.46-35.08) | 116 | 26.24 (22.13-30.35) |
| Caste* | General | 18 | 4.07 (2.23- 5.92) | 30 | 6.79 (4.44- 9.14) |
| | SC | 81 | 18.33 (14.71-21.94) | 49 | 11.09 (8.15-14.02) |
| | ST | 22 | 4.98 (2.95- 7.01) | 36 | 8.14 (5.59-10.70) |
| | OBC | 278 | 62.90 (58.38-67.41) | 292 | 66.06 (61.64-70.49) |
| | Others | 43 | 9.73 (6.96-12.50) | 35 | 7.92 (5.40-10.44) |

**75**

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

| | | | | | |
|---|---|---|---|---|---|
| Education* | No formal education | 211 | 47.74 (43.07-52.40) | 156 | 35.29 (30.83-39.76) |
| | Upto 8th | 164 | 37.10 (32.59-41.62) | 170 | 38.46 (33.92-43.01) |
| | Above 8th | 67 | 15.16 (11.81-18.51) | 116 | 26.24 (22.13-30.35) |
| Occupation* | Not working | 228 | 51.58 (46.92-56.25) | 160 | 36.20 (31.71-40.69) |
| | Labourer | 139 | 31.45 (27.11-35.78) | 144 | 32.58 (28.20-36.96) |
| | Pvt/ govt salaried | 75 | 16.97 (13.46-20.47) | 138 | 31.22 (26.89-35.55) |
| Location | Rural | 376 | 85.07 (81.74-88.40) | 376 | 85.07 (81.74-88.40) |
| | Urban | 66 | 14.93 (11.60-18.26) | 66 | 14.93 (11.60-18.26) |
| House type* | Kutcha | 371 | 83.94 (80.51-87.37) | 274 | 61.99 (57.46-66.52) |
| | Pucca | 71 | 16.06 (12.63-19.49) | 168 | 38.01 (33.48-42.54) |
| Window present* | Yes | 101 | 22.85 (18.93-26.77) | 380 | 85.97 (82.73-89.22) |
| | No | 341 | 77.15 (73.23-81.07) | 62 | 14.03 (10.78-17.27) |
| Sufficient light present* | Yes | 313 | 70.81 (66.57-75.06) | 365 | 82.58 (79.04-86.12) |
| | No | 129 | 29.19 (24.94-33.43) | 77 | 17.42 (13.88-20.96) |
| Rooms numbers* | ≤ 2 | 68 | 15.38 (12.01-18.75) | 31 | 7.01 (4.63- 9.40) |
| | 3-5 | 371 | 83.94 (80.51-87.37) | 367 | 83.03 (79.53-86.54) |
| | > 5 | 3 | 0.68 (0.00- 1.45) | 44 | 9.95 (7.16-12.75) |
| Family size | ≤ 2 | 6 | 1.36 (0.28- 2.44) | 4 | 0.90 (0.02- 1.79) |
| | 3-5 | 305 | 69.00 (64.68-73.32) | 323 | 73.08 (68.93-77.22) |
| | > 5 | 131 | 29.64 (25.37-33.90) | 115 | 26.02 (21.92-30.12) |
| Income category in INR (per month)* | > 16000 | 10 | 2.26 (0.87- 3.65) | 79 | 17.87 (14.29-21.45) |
| | 8000-16000 | 65 | 14.71 (11.40-18.01) | 118 | 26.70 (22.56-30.83) |
| | < 8000 | 367 | 83.03 (79.53-86.54) | 245 | 55.43 (50.79-60.07) |
| Animal present* | Yes | 284 | 64.25 (59.78-68.73) | 211 | 47.74 (43.07-52.40) |
| | No | 158 | 35.75 (31.27-40.22) | 231 | 52.26 (47.60-56.93) |
| Safe water supply* | Yes | 69 | 15.61 (12.22-19.00) | 234 | 52.94 (48.28-57.60) |
| | No | 373 | 84.39 (81.00-87.78) | 208 | 47.06 (42.40-51.72) |
| Bath frequency | Daily | 385 | 87.10 (83.97-90.23) | 371 | 83.94 (80.51-87.37) |
| | Thrice/week | 16 | 3.62 (1.88- 5.36) | 20 | 4.52 (2.58- 6.47) |
| | Twice/week | 5 | 1.13 (0.14- 2.12) | 17 | 3.85 (2.05- 5.64) |
| | Once/week | 36 | 8.14 (5.59-10.70) | 34 | 7.69 (5.20-10.18) |
| Towel washing frequency | Daily | 80 | 18.10 (14.50-21.70) | 103 | 23.30 (19.35-27.25) |
| | Thrice/week | 114 | 25.79 (21.71-29.88) | 97 | 21.95 (18.08-25.81) |
| | Twice/week | 128 | 28.96 (24.72-33.20) | 134 | 30.32 (26.02-34.61) |
| | Once/week | 120 | 27.15 (23.00-31.30) | 108 | 24.43 (20.42-28.45) |
| Pillow cover, bedsheet washing frequency* | Daily | 71 | 16.06 (12.63-19.49) | 2 | 0.45 (0.00- 1.08) |
| | Thrice/week | 206 | 46.61 (41.95-51.27) | 73 | 16.52 (13.05-19.98) |
| | Twice/week | 165 | 37.33 (32.81-41.85) | 139 | 31.45 (27.11-35.78) |
| | Once/week | - | - | 228 | 51.58 (46.92-56.25) |

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

**76**

| | | | | | |
|---|---|---|---|---|---|
| Towel usage by multiple people* | No | 208 | 47.06 (42.40-51.72) | 260 | 58.82 (54.23-63.42) |
| | Yes | 202 | 45.70 (41.05-50.35) | 97 | 21.95 (18.08-25.81) |
| | Don't know | 32 | 7.24 (4.82- 9.66) | 85 | 19.23 (15.55-22.91) |
| BCG vaccination done* | No | 115 | 26.02 (21.92-30.12) | 92 | 20.81 (17.02-24.61) |
| | Yes | 99 | 22.40 (18.50-26.29) | 194 | 43.89 (39.26-48.53) |
| | Don't know | 228 | 51.58 (46.92-56.25) | 156 | 35.29 (30.83-39.76) |
| History of leprosy patients in family/ friends* | No | 151 | 34.16 (29.73-38.59) | 269 | 60.86 (56.30-65.42) |
| | Yes | 204 | 46.15 (41.50-50.81) | 26 | 5.88 (3.68- 8.08) |
| | Don't know | 87 | 19.68 (15.97-23.40) | 147 | 33.26 (28.86-37.66) |

*Variables found significant as per Chi-square test

Further stratified distribution of various characteristics indicates that more than four-fifths of G2D and around half of the G1D cases were above the age of 30 years. Around one-fourth of G2D cases were female, three-fourths were Hindus by religion, backward castes in social status, and four-fifths of them were married and living in rural areas. Less than one-tenth of G2D cases but more than one-fourth of G1D cases were educated above 8th class and around half of both G1D and G2D cases were not working. Around four-fifths of G1D and G2D cases resided in kutcha houses, around four-fifths of them did not have windows, and light did not reach inside around one-third of them. Around four-fifths of G2D and G1D cases had 3-5 and > 5 rooms respectively. Around one-third of G1D and G2D had a family size > 5 and around four-fifths of them earned less than INR 8000 per month. Around two-thirds of G1D and G2D cases had animals in the house and only one-fifth had a safe water supply. The most frequent bathing frequency followed by G1D & G2D cases was daily. The towel washing frequency was once per week for around one-fourth of G1D cases and cases without disability. Towel usage by multiple persons in households was followed in around half of the G2D cases. Around one-fourth and one-third of G2D cases did not have BCG vaccination and exposure to leprosy patients respectively (Table 2).

**Table 2.Distribution of Socio-demographic Characteristics, Hygiene, Prophylaxis, and History of Previous Exposure to Leprosy Patients amongst Three Grades(Grade 0, Grade I, and Grade II) of Leprosy-related Impairment**

| Description | Categories | Grade 0 | | Grade I | | Grade II | |
|---|---|---|---|---|---|---|---|
| | | n | % (95% CI) | n | % (95% CI) | n | % (95% CI) |
| Age (years)* | < 14 | 15 | 8.47 (4.36-12.59) | 3 | 2.07 (0.00- 4.39) | - | - |
| | 14-30 | 64 | 36.16 (29.05-43.26) | 71 | 48.97 (40.80-57.13) | 21 | 17.50 (10.68-24.32) |
| | > 30 | 98 | 55.37 (48.02-62.72) | 71 | 48.97 (40.80-57.13) | 99 | 82.50 (75.68-89.32) |
| Gender | Male | 112 | 63.28 (56.15-70.41) | 93 | 64.14 (56.30-71.97) | 87 | 72.50 (64.48-80.52) |
| | Female | 65 | 36.72 (29.59-43.85) | 52 | 35.86 (28.03-43.70) | 33 | 27.50 (19.48-35.52) |
| Marital status | Unmarried | 33 | 18.64 (12.88-24.40) | 28 | 19.31 (12.86-25.76) | 15 | 12.50 (6.56-18.44) |
| | Married | 144 | 81.36 (75.60-87.12) | 115 | 79.31 (72.69-85.93) | 102 | 85.00 (78.59-91.41) |
| | Widowed | - | - | 2 | 1.38 (0.00- 3.29) | 3 | 2.50 (0.00- 5.30) |
| Religion | Hindu | 123 | 69.49 (62.68-76.30) | 95 | 65.52 (57.75-73.28) | 88 | 73.33 (65.39-81.28) |
| | Non-Hindu | 54 | 30.51 (23.70-37.32) | 50 | 34.48 (26.72-42.25) | 32 | 26.67 (18.72-34.61) |
| Caste* | General | 3 | 1.69 (0.00- 3.60) | 10 | 6.90 (2.76-11.04) | 5 | 4.17 (0.58- 7.76) |
| | SC | 37 | 20.90 (14.89-26.92) | 28 | 19.31 (12.86-25.76) | 16 | 13.33 (7.23-19.44) |
| | ST | 11 | 6.21 (2.64- 9.79) | 3 | 2.07 (0.00- 4.39) | 8 | 6.67 (2.19-11.15) |
| | OBC | 98 | 55.37 (48.02-62.72) | 91 | 62.76 (54.86-70.66) | 89 | 74.17 (66.30-82.03) |
| | Others | 28 | 15.82 (10.42-21.22) | 13 | 8.97 (4.30-13.63) | 2 | 1.67 (0.00- 3.97) |

**77**

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

| | | n | % (95% CI) | n | % (95% CI) | n | % (95% CI) |
|---|---|---|---|---|---|---|---|
| Education* | No formal education | 75 | 42.37 (35.06-49.68) | 67 | 46.21 (38.06-54.35) | 69 | 57.50 (48.62-66.38) |
| | Upto 8th | 81 | 45.76 (38.39-53.13) | 40 | 27.59 (20.28-34.89) | 43 | 35.83 (27.22-44.45) |
| | Above 8th | 21 | 11.86 (7.08-16.65) | 38 | 26.21 (19.02-33.39) | 8 | 6.67 (2.19-11.15) |
| Occupation | Not working | 86 | 48.59 (41.20-55.98) | 76 | 52.41 (44.25-60.57) | 66 | 55.00 (46.06-63.94) |
| | Labourer | 61 | 34.46 (27.43-41.49) | 40 | 27.59 (20.28-34.89) | 38 | 31.67 (23.31-40.02) |
| | Pvt/ govt salaried | 30 | 16.95 (11.40-22.50) | 29 | 20.00 (13.46-26.54) | 16 | 13.33 (7.23-19.44) |
| Location | Rural | 157 | 88.70 (84.02-93.38) | 117 | 80.69 (74.24-87.14) | 102 | 85.00 (78.59-91.41) |
| | Urban | 20 | 11.30 (6.62-15.98) | 28 | 19.31 (12.86-25.76) | 18 | 15.00 (8.59-21.41) |
| House type | Kutcha | 153 | 86.44 (81.38-91.50) | 118 | 81.38 (75.02-87.74) | 100 | 83.33 (76.64-90.03) |
| | Pucca | 24 | 13.56 (8.50-18.62) | 27 | 18.62 (12.26-24.98) | 20 | 16.67 (9.97-23.36) |
| Window present | Yes | 49 | 27.68 (21.07-34.30) | 29 | 20.00 (13.46-26.54) | 23 | 19.17 (12.10-26.24) |
| | No | 128 | 72.32 (65.70-78.93) | 116 | 80.00 (73.46-86.54) | 97 | 80.83 (73.76-87.90) |
| Light reaching* | Yes | 145 | 81.92 (76.23-87.61) | 89 | 61.38 (53.42-69.33) | 79 | 65.83 (57.31-74.35) |
| | No | 32 | 18.08 (12.39-23.77) | 56 | 38.62 (30.67-46.58) | 41 | 34.17 (25.65-42.69) |
| Number of rooms | ≤ 2 | 25 | 14.12 (8.97-19.27) | - | - | 17 | 14.17 (7.90-20.43) |
| | 3-5 | 149 | 84.18 (78.78-89.58) | 26 | 17.93 (11.66-24.20) | 103 | 85.83 (79.57-92.10) |
| | > 5 | 3 | 1.69 (0.00- 3.60) | 119 | 82.07 (75.80-88.34) | - | - |
| Family size | ≤ 2 | - | - | 3 | 2.07 (0.00- 4.39) | 3 | 2.50 (0.00- 5.30) |
| | 3-5 | 133 | 75.14 (68.75-81.53) | 97 | 66.90 (59.21-74.59) | 75 | 62.50 (53.80-71.20) |
| | > 5 | 44 | 24.86 (18.47-31.25) | 45 | 31.03 (23.48-38.59) | 42 | 35.00 (26.43-43.57) |
| Income category (INR per month) | > 16000 | 6 | 3.39 (0.71- 6.07) | 2 | 1.38 (0.00- 3.29) | 2 | 1.67 (0.00- 3.97) |
| | 8000-16000 | 23 | 12.99 (8.02-17.97) | 25 | 17.24 (11.07-23.41) | 17 | 14.17 (7.90-20.43) |
| | < 8000 | 148 | 83.62 (78.14-89.09) | 118 | 81.38 (75.02-87.74) | 101 | 84.17 (77.61-90.72) |
| Animal present | Yes | 115 | 64.97 (57.92-72.03) | 91 | 62.76 (54.86-70.66) | 78 | 65.00 (56.43-73.57) |
| | No | 62 | 35.03 (27.97-42.08) | 54 | 37.24 (29.34-45.14) | 42 | 35.00 (26.43-43.57) |
| Safe water supply | Yes | 25 | 14.12 (8.97-19.27) | 27 | 18.62 (12.26-24.98) | 17 | 14.17 (7.90-20.43) |
| | No | 152 | 85.88 (80.73-91.03) | 118 | 81.38 (75.02-87.74) | 103 | 85.83 (79.57-92.10) |
| Bath frequency* | Daily | 155 | 87.57 (82.69-92.45) | 118 | 81.38 (75.02-87.74) | 112 | 93.33 (88.85-97.81) |
| | Thrice/week | 7 | 3.95 (1.07- 6.84) | 3 | 2.07 (0.00- 4.39) | 6 | 5.00 (1.09- 8.91) |
| | Twice/week | 2 | 1.13 (0.00- 2.69) | 3 | 2.07 (0.00- 4.39) | - | - |
| | Once/week | 13 | 7.34 (3.49-11.20) | 21 | 14.48 (8.73-20.23) | 2 | 1.67 (0.00- 3.97) |
| Towel washing frequency | Daily | 27 | 15.25 (9.94-20.57) | 30 | 20.69 (14.07-27.31) | 23 | 19.17 (12.10-26.24) |
| | Thrice/week | 57 | 32.20 (25.29-39.11) | 30 | 20.69 (14.07-27.31) | 27 | 22.50 (15.00-30.00) |
| | Twice/week | 49 | 27.68 (21.07-34.30) | 45 | 31.03 (23.48-38.59) | 34 | 28.33 (20.24-36.43) |
| | Once/week | 44 | 24.86 (18.47-31.25) | 40 | 27.59 (20.28-34.89) | 36 | 30.00 (21.77-38.23) |
| Pillow cover, bedsheet washing frequency | Thrice/week | 32 | 18.08 (12.39-23.77) | 18 | 12.41 (7.03-17.80) | 21 | 17.50 (10.68-24.32) |
| | Twice/week | 80 | 45.20 (37.84-52.56) | 74 | 51.03 (42.87-59.20) | 52 | 43.33 (34.43-52.23) |
| | Once/week | 65 | 36.72 (29.59-43.85) | 53 | 36.55 (28.68-44.42) | 47 | 39.17 (30.40-47.93) |

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

**78**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Towel usage by multiple people | No | 83 | 46.89 (39.51-54.27) | 67 | 46.21 (38.06-54.35) | 58 | 48.33 (39.36-57.31) |
| | Yes | 77 | 43.50 (36.17-50.83) | 66 | 45.52 (37.38-53.65) | 59 | 49.17 (40.19-58.15) |
| | Don't know | 17 | 9.60 (5.25-13.96) | 12 | 8.28 (3.77-12.78) | 3 | 2.50 (0.00- 5.30) |
| BCG vaccination done | No | 51 | 28.81 (22.12-35.51) | 32 | 22.07 (15.29-28.85) | 32 | 26.67 (18.72-34.61) |
| | Yes | 42 | 23.73 (17.44-30.02) | 35 | 24.14 (17.15-31.13) | 22 | 18.33 (11.38-25.28) |
| | Don't know | 84 | 47.46 (40.07-54.84) | 78 | 53.79 (45.65-61.94) | 66 | 55.00 (46.06-63.94) |
| History of leprosy patients in family/ friends* | No | 86 | 48.59 (41.20-55.98) | 26 | 17.93 (11.66-24.20) | 39 | 32.50 (24.09-40.91) |
| | Yes | 65 | 36.72 (29.59-43.85) | 69 | 47.59 (39.43-55.75) | 70 | 58.33 (49.48-67.19) |
| | Don't know | 26 | 14.69 (9.45-19.92) | 50 | 34.48 (26.72-42.25) | 11 | 9.17 (3.98-14.35) |

*Variables found significant as per Chi-square test

Stratification with respect to patients' relationships indicates that around one-third of G2D cases and G1D cases had a history of exposure to the patient as husband/ wife. More than half of G2D cases had affected feet, however, in more than half of G1D cases hands were affected. Delay of 6-12 months and more than 12 months in reporting to the healthcare system was found in around two-thirds of G1D and G2D cases respectively. All G2D and G1D cases reported a lack of information as the reason for the delay in reporting. Around two-thirds of G2D cases and four-fifths of G1D cases quoted the condition of being far off as the reason for delay. Waiting in health facilities was the reason for delayed reporting in about one-tenth of G2D and G1D cases. Issue of wage loss was the reason for more than 90%, and social stigma/ fear, and financial constraints were the reason for delayed reporting in around half of the G2D cases (Table 3).

**Table 3.Distribution of Relationship with Patient, Disability Part Affected and Health System-related Factors amongst Three Grades (Grade 0, Grade I and Grade II) of Leprosy-related Impairment**

| Description | Categories | Grade 0 | | Grade I | | Grade II | |
|---|---|---|---|---|---|---|---|
| | | n | % (95% CI) | n | % (95% CI) | n | % (95% CI) |
| Relationship with patient | Husband/ wife | 28 | 15.82 (10.42-21.22) | 43 | 29.66 (22.19-37.12) | 41 | 34.17 (25.65-42.69) |
| | Daughter/ son | 28 | 15.82 (10.42-21.22) | 21 | 14.48 (8.73-20.23) | 18 | 15.00 (8.59-21.41) |
| | Mother/ father | 6 | 3.39 (0.71- 6.07) | 5 | 3.45 (0.47- 6.43) | 5 | 4.17 (0.58- 7.76) |
| | Brother/ sister | 3 | 1.69 (0.00- 3.60) | - | - | 3 | 2.50 (0.00- 5.30) |
| | Friend | 112 | 63.28 (56.15-70.41) | - | - | 3 | 2.50 (0.00- 5.30) |
| | Neighbour | - | - | 76 | 52.41 (44.25-60.57) | 50 | 41.67 (32.81-50.52) |
| Body part affected with disability | Hand | - | - | 25 | 17.24 (11.05-23.43) | 18 | 15.00 (8.57-21.43) |
| | Foot | - | - | 46 | 31.72 (24.10-39.35) | 68 | 56.67 (47.74-65.59) |
| | Hand and Foot | - | - | 53 | 36.55 (28.66-44.44) | 26 | 21.67 (14.25-29.09) |
| | Foot and Eye | - | - | 21 | 14.48 (8.72-20.25) | - | - |
| | Hand, Foot and Eye | - | - | - | - | 3 | 2.50 (0.00- 5.31) |
| | Hand and Eye | - | - | - | - | 5 | 4.17 (0.57- 7.77) |
| Delay in reporting (months)* | < 6 | 127 | 71.75 (65.09-78.41) | 3 | 2.07 (0.00- 4.39) | - | - |
| | 6-12 | 50 | 28.25 (21.59-34.91) | 95 | 65.52 (57.75-73.28) | 38 | 31.67 (23.31-40.02) |
| | > 12 | - | - | 47 | 32.41 (24.77-40.06) | 82 | 68.33 (59.98-76.69) |

**79**

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

| Reasons for delay in reporting | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lack of information | No | 5 | 10.00 (1.64-18.36) | - | - | - | - |
| | Yes | 45 | 90.00 (81.64-98.36) | 142 | 100.0 (100.0-100.0) | 120 | 100.0 (100.0-100.0) |
| Distant health facility | No | 29 | 58.00 (44.24-71.76) | 28 | 19.72 (13.14-26.30) | 41 | 34.17 (25.63-42.70) |
| | Yes | 21 | 42.00 (28.24-55.76) | 114 | 80.28 (73.70-86.86) | 79 | 65.83 (57.30-74.37) |
| Expenditure issue | No | 13 | 26.00 (13.77-38.23) | 31 | 21.83 (15.00-28.66) | 25 | 20.83 (13.53-28.14) |
| | Yes | 37 | 74.00 (61.77-86.23) | 111 | 78.17 (71.34-85.00) | 95 | 79.17 (71.86-86.47) |
| Waiting in health facilities | No | 48 | 96.00 (90.54-100.0) | 124 | 87.32 (81.82-92.83) | 108 | 90.00 (84.60-95.40) |
| | Yes | 2 | 4.00 (0.00- 9.46) | 18 | 12.68 (7.17-18.18) | 12 | 10.00 (4.60-15.40) |
| Health staff's absence | No | 50 | 100.0 (100.0-100.0) | 142 | 100.0 (100.0-100.0) | 117 | 97.50 (94.69-100.0) |
| | Yes | - | - | - | - | 3 | 2.50 (0.00- 5.31) |
| Health staff's behaviour | No | 50 | 100.0 (100.0-100.0) | 139 | 97.89 (95.51-100.0) | 114 | 95.00 (91.08-98.92) |
| | Yes | - | - | 3 | 2.11 (0.00- 4.49) | 6 | 5.00 (1.08- 8.92) |
| Doctor's absence | No | 50 | 100.0 (100.0-100.0) | 139 | 97.89 (95.51-100.0) | 115 | 95.83 (92.24-99.43) |
| | Yes | - | - | 3 | 2.11 (0.00- 4.49) | 5 | 4.17 (0.57- 7.76) |
| Doctor's behaviour | No | 50 | 100.0 (100.0-100.0) | 142 | 100.0 (100.0-100.0) | 114 | 95.00 (91.08-98.92) |
| | Yes | - | - | - | - | 6 | 5.00 (1.08- 8.92) |
| Issue of wage loss | No | 12 | 24.00 (12.10-35.90) | 27 | 19.42 (12.81-26.04) | 9 | 7.50 (2.76-12.24) |
| | Yes | 38 | 76.00 (64.10-87.90) | 112 | 80.58 (73.96-87.19) | 111 | 92.50 (87.76-97.24) |
| Social reasons | No | 33 | 66.00 (52.80-79.20) | 92 | 64.79 (56.89-72.69) | 58 | 48.33 (39.34-57.32) |
| | Fear/ stigma/ shame | 17 | 34.00 (20.80-47.20) | 50 | 35.21 (27.31-43.11) | 62 | 51.67 (42.68-60.66) |
| Financial constraints | No | 30 | 60.00 (46.35-73.65) | 50 | 35.21 (27.31-43.11) | 60 | 50.00 (41.00-59.00) |
| | Yes | 20 | 40.00 (26.35-53.65) | 92 | 64.79 (56.89-72.69) | 60 | 50.00 (41.00-59.00) |
| Treatment by | Private practitioner | 42 | 87.50 (78.09-96.91) | 108 | 80.00 (73.21-86.79) | 108 | 92.31 (87.45-97.16) |
| | Exorcist/ priest/ other | 6 | 12.50 (3.09-21.91) | 27 | 20.00 (13.21-26.79) | 9 | 7.69 (2.84-12.55) |

**Table 4. Regression Analysis of Determinants of Leprosy**

| Variable | Category | AOR* (95% CI) |
|---|---|---|
| Caste (ref: General) | SC | 2.41 (1.19-4.88) |
| Education (ref: No formal education) | Above 8th | 0.43 (0.29-0.64) |
| Occupation (ref: Not working) | Labourer | 0.66 (0.48-0.91) |
| Occupation (ref: Not working) | Pvt/ govt salaried | 0.44 (0.31-0.64) |
| House type (ref: Kutcha) | Pucca | 0.37 (0.26-0.52) |
| Window present (ref: Yes) | No | 20.70 (14.45-29.66) |
| Light reaching (ref: Yes) | No | 1.85 (1.33-2.59) |
| Number of rooms (ref: ≤ 2) | 3-5 | 0.52 (0.33-0.84) |
| Number of rooms (ref: ≤ 2) | > 5 | 0.04 (0.01-0.16) |
| Income category (INR per month) (ref: > 16000) | 8000-16000 | 5.18 (2.42-11.07) |

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

80

| Income category (INR per month) (ref: > 16000) | < 8000 | 13.8 (6.67-28.58) |
|---|---|---|
| Animal present (ref: Yes) | No | 0.55 (0.41-0.73) |
| Safe water supply (ref: Yes) | No | 7.57 (5.24-10.93) |
| Towel usage by multiple people (ref: No) | Yes | 2.85 (2.08-3.92) |
| BCG vaccination done (ref: No) | Yes | 0.34 (0.23-0.50) |
| History of leprosy patients in family/ friends (ref: No) | Yes | 17.40 (10.77-27.99) |

*adjusted for religion, caste, education, age, and gender
#bold-faced figures are statistically significant (p<0.05)

**Table 5.Regression Analysis for Type of Disability**

| Variables | Category | Grade 1 Disability (Ref: Grade 0 Disability) AOR* (95% CI) | Grade 2 Disability (Ref: Grade 0 Disability) AOR* (95% CI) |
|---|---|---|---|
| Age (ref: < 14 years) | 14-30 | 4.31 (1.11-16.67) | - |
| Caste (ref: General) | ST | 0.09 (0.01-0.62) | 0.96 (0.16-5.81) |
| Education (ref: No formal education) | Upto 8th | 0.48 (0.26-0.87) | 0.46 (0.25-0.84) |
| Exposure to patient (ref: Husband/ wife) | Neighbour | 0.44 (0.23-0.83) | 0.34 (0.17-0.66) |
| Delay in reporting (Ref: < 6 months) | 6-12 months | 114 (29.46-443.4) | - |
| Distant health facility (Ref: No) | Yes | 4.46 (1.94-10.24) | 4.45 (1.85-10.67) |
| Financial constraints (Ref: No) | Yes | 2.58 (1.19-5.58) | 2.00 (0.89-4.47) |

*adjusted for religion, caste, education, age, and gender
#bold-faced figures are statistically significant (p<0.05)

Regression analysis revealed a significant relationship between subjects' caste, particularly Scheduled Caste (SC) category (AOR = 2.41) and leprosy disease as compared to general categories. Further, persons educated above the 8th class have a protective effect (AOR = 0.43). Similarly working as a labourer (AOR = 0.66)/ pvt/ govt employee (AOR = 0.44), living in a pucca household (AOR = 0.37) are less likely to get leprosy disease as compared to unemployed and those living in kutcha houses. Persons living in houses without windows (AOR = 20.70), where light did not reach (AOR = 1.85), and no supply of safe water (AOR = 7.57) showed a higher likelihood of disease occurrence. People living in a household with more than 3 to 5 rooms (AOR = 0.52) and more than 5 rooms (AOR = 0.04) indicated lower chances of disease occurrence as compared to less than two rooms. Families having income of INR 8000-16000 (AOR = 5.18) and less than INR 8000 (AOR = 13.8) had more risk of leprosy as compared to a family with an income of more than INR 16000. Families with the same towel being used by multiple people (AOR = 2.85) and those who had a history of leprosy patients in family/ friends (AOR = 17.40) had significantly higher odds for leprosy occurrence than their counterparts (Table 4).

Further regression analysis for the grade of disability revealed that the age group of 14-30 years (AOR = 4.31) had significantly higher odds for the occurrence of G1D as compared to the age group of less than 14 years. Scheduled Tribe (ST) category (AOR = 0.09) had a lower likelihood to get G1D as compared to the general category. Education level up to 8th class and exposure to patient as neighbour both had less likelihood towards G1D (AOR$_{upto\ 8th}$ = 0.48, AOR$_{neighbor}$ = 0.44) and G2D (AOR$_{upto\ 8th}$ = 0.46, AOR$_{neighbor}$ = 0.34) occurrence as compared to their counterparts. Delay in reporting for 6-12 months (AOR = 114) and financial constraints (AOR = 2.58) both showed a significant likelihood of G1D occurrence. The remoteness from health facilities showed a higher likelihood of reporting of G1D (AOR = 2.58) and G2D (AOR = 4.45) (Table 5).

## Discussion

As per the global leprosy update 2020, a reduction of 27.7% and 37.1% has been recorded in the prevalence and new cases detection respectively as compared with 2019 owing to less case detection during COVID-19. Globally with a case detection rate of 16.4 per million population, a total of 127396 new cases were detected whereas, with a rate

**81**

*Karotia D et al.*
*J. Commun. Dis. 2022; 54(2)*

of 16.6 per million population, a prevalence of 129192 was reported. Southeast Asia Region (SEAR) is the highest contributor for cases on treatment (61.1%) and new cases detected (66.6%). Among the top three countries, Brazil, India, and Indonesia continued reporting more than 10000 cases. India reported the highest number of new G2D cases (1572) followed by Brazil with 1504 G2D cases.[5]

A report of an international summit, 'Leprosy, overcoming the remaining challenges', was released in 2013, where it was suggested to strengthen early case detection and contact management, quality of care, and laboratory services to address the key challenge of occurrence of new cases.[6] In recent years, India has witnessed the introduction and implementation of various innovations, designed to address the challenges of delayed detection, high hidden caseload, and low community awareness and monitoring.[2,7-9] However, there are more than 10 states/ UTs reporting a G2D rate per million more than the national average.[3] In order to achieve the target of NLEP, it is necessary to understand the disease and disability dynamics in the communities where this disease condition is prevalent. Poor hygiene and sanitation, overcrowding, low education level, low awareness regarding leprosy etc. are found to be the key risk factors for continued endemicity of leprosy.[10,11] In compliance, the present study found a significantly lower risk of contracting leprosy disease in subjects who are working, living in pucca households, and are educated above the 8th standard. The risk for leprosy occurrence was higher in the SC category.

In addition, houses without a safe water supply were found significantly associated with leprosy. The plausible explanation for the same is that in rural areas, ponds and other water bodies act as a source of water for daily usage, washing, and bathing purposes by healthy inhabitants as well as leprosy cases. In endemic areas where a cluster of active cases is found, the community persons are in continuous exposure to both cases and the environment, i.e., soil and water, wherein M. leprae survives for several months. M. leprae has the capability to tolerate even adverse environmental conditions, hot, humid conditions, and survive in wet soil and water.[4,12] However, this area needs further exploration. Further, poorly ventilated houses (without windows) show significantly higher risk, i.e., 70% for leprosy occurrence than their counterparts as in the absence of cross ventilation, the pathogen remains suspended in the air for longer and exposure time to household members increases. Likewise, towel usage by several members and the history of patients in the household also had a higher risk for leprosy. Households having a greater number of rooms and persons who had BCG vaccination possess significantly less risk for leprosy.

With respect to disability, it was observed that persons with age more than 14 years had a higher risk of presenting with G1D at the time of reporting. Further education levels of less than 8th class show a significantly higher risk for disability occurrence. As evidenced from several studies, persons with low educational levels have a higher probability of presenting with disabilities to the healthcare system which may be considered as a distant determinant for other exposures such as lack of awareness regarding leprosy's signs and symptoms and hence lead to low demand generation. Delay in seeking care, low accessibility to healthcare services, and financial constraints have been found to have a significantly higher likelihood of disability occurrence. The findings are substantiated by several studies conducted in various settings.[13-16]

## Conclusion

This case-control study in a high endemic district in India found that several environmental, socioeconomic, and individual factors are responsible for the occurrence of disability amongst leprosy patients. These factors such as low education level, delay in seeking care, and accessibility to healthcare services, if targeted with an appropriate strategy may help in eradicating this age-old disease in India.

## Acknowledgement

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82

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