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Identifying the Risk Factors and Their Contribution for Visceral Leishmaniasis: A Rural Community Based Study

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Abstract
Introduction: Visceral leishmaniasis (VL) is a chronic and potentially fatal parasitic disease of the internal organs. According to the latest estimate, approximately 0.2 to 0.4 million VL cases occur each year. In India, it is endemic in the Bihar.

Objective: To indentify the risk factors and their contribution for VL.

Methods: A case-control study was used. A total of 142 Kala-azar cases and 142 apprently healthy controls were selected from the neighbourhoods of cases.

Results: We find that majority of the VL cases (40.85%) were in the age group 6-15years. 53.52% of the VL cases were males. Sleeping near cattle, granary, banana tree and improper drainage system were associated with increased risk of VL.

Conclusion: Our findings have implications for planning and control of VL. Improving housing conditions, removing granary outside the living room, and also do not sleep near the cattle would help to reduce risk of VL.

Keywords: Visceral leishmaniasis, Bihar, Risk factor, Case-Control

1. Introduction

Visceral leishmaniasis (VL) is a vector-borne disease caused by Leishmania parasites. The clinical signs and symptoms of VL include recurrent fever often with double rise, loss of appetite, pallor and weight loss with progressive emaciation, weakness, splenomegaly, hepatomegaly and anemia [1].

According to the latest estimate, approximately 0.2 to 0.4 million VL cases occur each year. The Indian subcontinent, East Africa and South Americas are worst affected by VL. Over 90% of new cases occur in six countries: Bangladesh, Brazil, Ethiopia, India, South Sudan, and Sudan. The case-fatality rate is estimated to be 10%, with an estimated number of deaths to be 20,000 to 40,000 each year [2]. Three VL endemic countries - India, Nepal and Bangladesh- have committed to eliminate VL as a public health problem from the region by 2015.

Fifty percent of visceral leishmaniasis cases worldwide occur in India [2]. In India, it is endemic in the states of Bihar, West Bengal, Uttar Pradesh and Jharkhand, but only Bihar state contributes more than 90 % of the cases of visceral leishmaniasis [3].

The epidemiological situation in Bihar, one of the poorest states in India, is therefore of major importance. Currently 33 out of 38 districts of Bihar are endemic for VL (Figure 2). Major epidemics occurred in this state with an interval of 10-15 years, the first around 1977, and the second and biggest one in 1991-92 with over 250,000 cases reported and more recently in 2006-2007 [4].

After several months, the untreated visceral leishmaniasis will result in the death of the infected individual mainly due to cachexia, bleeding and/or from secondary infections [5].

About 5-10% and 50% of patients that improve from VL after treatment in the Indian subcontinent and East Africa respectively, develop a skin condition named post kala-azar dermal leishmaniasis (PKDL) [6,7]. Depending on the grade of severity, PKDL develops as a rash, usually around the mouth and spreading to other parts of the body such as the arms and the upper torso [7]. Because parasites can be found within the lesions, PKDL is considered an important reservoir for the human transmission of the disease between epidemic cycles [8]. Visceral leishmaniasis are spread by the bite of an infected female sandfly (*Phlebotomine argentipes*). VL is an important public health problem and a significant cause of mortality and morbidity in the Indian subcontinent and East Africa.

Since the turn of the century, scientists have believed the sand fly to be a vector for leishmaniasis, but the transmission of visceral leishmaniasis and cutaneous leishmaniasis via sand flies was not proven until the 1940s [9]. Sand flies responsible for transmission of leishmaniasis are divided in two genera: *Phlebotomus* in the Old World and Lutzomyia in the New World [10]. In India, *Phlebotomus argentipes* is the primary vector, but there are reports of *P. papatasi* as a secondary vector [11]. Hence we use case-control data from East Champaran district of Indian state of Bihar to study about the visceral leishmaniasis cases and their associated risk factors.

This analysis revealed important socio-economic and demographic factors associated with the visceral leishmaniasis population. These factors and the study from which they originate are presented in an effort to provide a clear means of inquiry and path for future visceral leishmaniasis prevention and research.

1.1. Objectives

1. To determine the socio-economic and demographic profile of the study subjects.
2. To indentify the risk factors and their contribution for VL in the study area.

2. Methodology:

2.1. Study Design

A retrospective case-control study design was carried out based on visceral leishmaniasis cases and apparently healthy controls and the study was based on the primary data and quantitative nature.

2.2. Study Duration, Study subjects

The data had been collected in the phase of June 2016 to November 2016 from the East Champaran, Bihar. The registered visceral leishmaniasis cases at primary health centres during the period, January 2014 to December 2014 of the East Champaran, Bihar. The informed consent was obtained from all cases and controls subjects previous to including them in the study.

2.2. Selection of study subjects

For each case we take one controls without VL case history from the neighbouring house of the VL case.

2.3.1. Cases

Visceral leishmaniasis cases were selected from the study population, registered in East Champaran, Bihar during calendar year 2014.

2.3.2. Controls

Controls were selected from neighborhood of the cases other than visceral leishmaniasis or they were apparently healthy.

2.4. Inclusion & Exclusion criteria

All the visceral leishmaniasis cases aged 2 years and above were included in the study. And those cases that were severely sick and were not able to communicate were excluded from the study.

2.5. Study area

This study was conducted in the rural area of the East Champaran district in the north Bihar.

2.6. Sample size & Sampling technique

The study was based on 284 subjects out of whom 142 were cases and the same were controls and they were neighborhood of the cases. There were 27 Blocks in the East Champaran. Out of which 12 blocks had reported visceral leishmaniasis cases more than 20, in the year 2014. Seven Block having larger number of visceral leishmaniasis cases were chosen randomly. From each block 20 visceral leishmaniasis cases were taken as per convenience.

2.7. Data collection

Schedules methods were used for the data collection in the study district, East Champaran, Bihar. And to capture data regarding their demographic and socio economic characteristics (age, gender, occupation, education, marital status, occupation and per capita income), types of houses and its condition, cattle ownership and their number per house, kinds of animals kept, sleeping habits and individual activity in the agricultural fields.

2.8. Study Variables

The study variables are divided in two parts: Dependent variable and independent variable.

2.9. Statistical technique

The data was primarily entered into MS-excel and after that transferred into trail version of SPSS 16.0. The number and percentage of socio-economic and demographic profile for the cases and controls group were calculated with chi-square. The risk factors of visceral leishmaniasis were estimated by calculating the odds ratio (OR) with 95% confidence intervals (CIs) for each variable. Variables with $p < 0.05$ in the univariate analyses were consequently tested using multiple binary logistic regression analysis models. All statistical tests were carried out at a significance level of 0.05.

Results

Age and gender distribution of visceral leishmaniasis cases

The pie chart (figure-1) shows the age group of the visceral leishmaniasis cases of East Champaran. We find that majority of the study subjects (40.85%) were in the age group 6-15 year, 12.68% VL cases were in the age group 16-25 year, 11.97% VL cases were in the age group 26-35 year, 17.61% VL cases were in the age group 36-45 year, 10.56% VL cases were in the age group above 45 years and only 6.34% of vl cases were in the age group 2-5 years.

The pie chart (figure-2) shows the gender of the visceral leishmaniasis cases of East Champaran. We find that 53.52% of the VL cases were male and 46.48 % VL cases were female. In this study males are more affected from this disease with respect female.

Socio-economic and demographic characteristics

A total of 284 subjects were taken in this study out of which 142 were cases and the same were controls. The Socio-economic and demographic profile of study subjects in the East Champaran, Bihar were shown in the (table 1). Majority of the study population belongs to age group 6-15 year i.e. 36.6%.

The male population (52.8%) were more than female (47.2%). Further overall illiteracy was high in this area. i.e. 43%, also 31.7% of the respondent were studied upto primary, 22.2% of the study population were upto high school or high school passed. Only 3.2% of the study subjects were studied above high school. Maximum (52.8%) of the study subject were married.

More than fifty percent of the respondent had a joint family i.e. (58.1%). Maximum of the head of the household were farmer (37.0%), private job (30.6%), labour (14.1%) and 9.9% head of the household were unemployed. Only 8.5% of the respondent had pucca houses. Maximum of the respondent had hut (35.6%), kutcha (26.4%) and semi-pucca houses (29.6%).

The socio-economic status of the respondents was very poor. 91.9% of the respondents were belongs to lower class, 6.3% were belongs to lower middle class and only 1.8% were belongs to middle class.

The distribution of the cases and controls by age, gender, education, occupational status, Types of family, types of houses and per capita income is shown in Table 1. Differences in the proportion in each age group (*P*=0.334), gender (*P*=0.812), education (*P* =0.285), occupational status (*P=0.928*), types of family (*P*=0.718), types of houses (*P*=0.260) and per capita income (*P* =0.457) of cases and controls were not statistically significant. The per capita income indicated that most of the cases and controls belonged to very low socioeconomic strata of the community. This result indicated that socio-economic and demographic profiles were similar in both cases and controls.

Risk factors

Table 2 depicts factors associated with visceral leishmaniasis in univariate analysis. Factors associated with boosted visceral leishmaniasis unadjusted odds were: Marital status (OR=1.767; 95% CI (1.103-2.828); *P*= 0.017), absence of sunlight in the living room (OR=1.726; 95% CI (1.061-2.807); *P*= 0.027), presence of granary inside the living room (OR=9.654; 95% CI (5.361-17.380); P= 0.001), presence of vegetation around the house (OR=2.147; 95% CI (1.326-3.474); *P*= 0.002), presence of banana tree near the house (OR=2.504; 95% CI (1.482-4.229); *P*= 0.001), presence of bamboo tree near the houses (OR=1.796; 95% CI (1.011-3.193); *P*= 0.044)were increases the odds of VL. Equally, animal ownership such as presence of cattle (OR=1.794; 95% CI (1.083-2.971); *P*= 0.022) was found to significantly increase the odds of VL. Individual behaviour in the domestic and in the farm fields like sleeping outside the house near animal shelters (OR=7.755; 95% CI (3.846-15.630); *P*= 0.001) also associated with higher odds of VL risk. And also improper drainage system in the house (OR=6.396; 95% CI (3.708-11.030); *P*= 0.001) had increased the odds of VL.

The significant risk factors on the basis of adjusted ORs used for visceral leishmaniasis in multiple binary logistic regression analysis were identified. Several factors, which were significant in univariate analysis, were not significant risk factors in multiple binary logistic regression analysis. The adjusted ORs and 95% CIs for each significant variable are also shown in Table 2. The marital status was significantly associated with visceral leishmaniasis (OR =2.696, 95% CI (1.402-5.183), *P*=0.003). Absence of natural light in the house also a risk factor (OR =2.728, 95% CI (1.374-5.418), *P* =0.004). The presence of a granary, a pot made of soil that is generally used for storing grains in rural areas of East Champaran, inside the houses was a also significant risk factor (OR=9.654, 95% CI (3.845-16.030), *P* =0.001). The presence of vegetations near the house such as small seasonal crops, herbs, and bushes in the surrounding area of houses was a significant risk factor in the univariate analysis but, did not show significance in the multiple binary logistic regression analysis.

However, presence of banana trees in the surrounding area of houses was significantly associated with visceral leishmaniasis (OR =2.308, 95% CI (1.117-4.770), *P* =0.024). Sleeping near the cattle (OR =4.904, 95% CI (1.117-2.014-11.940), *P* =0.001) and improper drainage system (OR =4.789, 95% CI (2.354-9.744), *P* =0.001) in the houses were significantly associated with the visceral leishmaniasis.

Discussions

Identifying the risk factors of visceral leishmaniasis in the East Champaran district, Bihar offers a significant basis of information to design and develop effective control measures. The distribution of the cases and controls by age, gender, education, occupational status, Types of family, types of houses and per capita income is shown in Table 1. The age group, gender, education, occupational status, types of family, types of houses and per capita income of cases and controls were not statistically significant. The per capita income indicated that most of the cases and controls belonged to very low socioeconomic strata of the community. This study is done to identifying the association of various socioeconomic, demographic and environmental factors with occurrence of visceral leishmaniasis using a case-control study design approach. The per capita income showed that 93% of the cases had very low income, but this was not significant in univariate analysis. It was previously reported that most visceral leishmaniasis patients had incomes less than $1 per day (45 Indian Rupees) [12]. Such poverty may not be a risk factor for kala-azar, but it can lead to undernourishment, poor housing conditions, lack of sanitation, and illiteracy. Thus, poverty could be a most important determinant for sustained transmission of visceral leishmaniasis in the East Champaran, Bihar and other parts of country.

The presence of granaries inside the houses was found to be significantly linked with visceral leishmaniasis for the reason that they are generally kept in living rooms. It is the usual practice in villages to commonly clean the outer surface of the granary with water. The mud cracks and crevices on the outer side of granaries preserve the

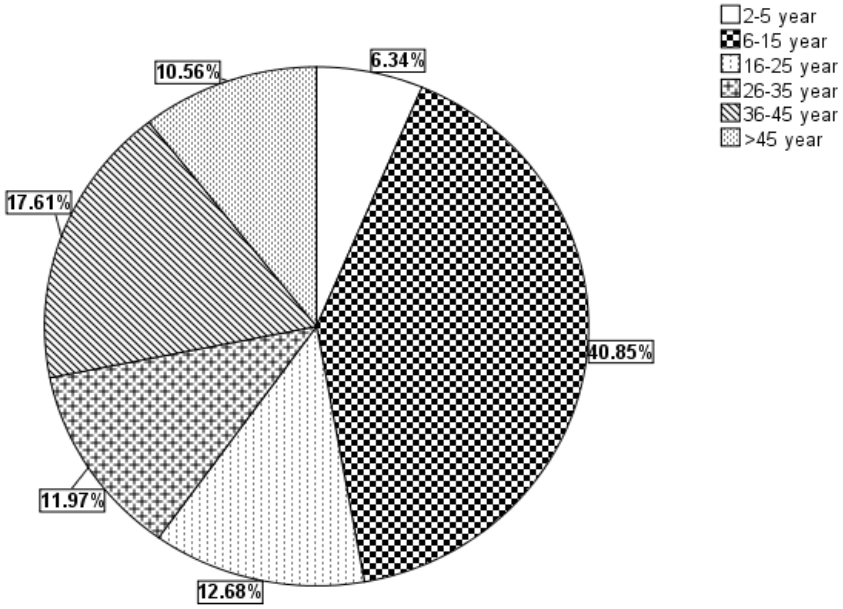
moisture and thus make available enough dampness for breeding and hidden of sand flies. Empty granaries also provide suitable places for breeding of sand flies because of Dampness as a risk factor has also been reported in west Bengal and Nepal [13, 14].

The presence of vegetation near the houses was significantly associated with visceral leishmaniasis in the univariate analysis, but not in the multiple binary logistic regression analysis. The presence of vegetation near the houses as a risk factor of visceral leishmaniasis has also been reported in the past [15]. Bamboo trees are one of the common peridomestic plants that grow in large numbers and in clusters near houses in East champaran, Bihar. In this study, bamboo trees near the houses were found to be a significant risk factor for visceral leishmaniasis in the univariate analysis [16].

Presence of cattle was associated with a higher risk of visceral leishmaniasis in this study in the univaiate analysis. Cattles (cows, buffaloes or goats) was associated with a higher risk of visceral leishmaniasis [17,18,19]. Studies carried out in Nepal and Bangladesh, found out that ownership of large domestic animals such as cattle and water buffalo was strongly protective [20,21]. On the other hand, a case–control study in Bihar (India) found no significant associations between VL and keeping domestic animals inside the house or ownership of domestic animals [17]. Thus, different studies in different endemic countries have reported different or similar domestic animals as either risk factors or protective. This could be due to the variation of geographical place, the loads of the host, the abundance, feeding preference, breeding environment and resting site of the vector and the leishmanial disease rate.

Tables & Figures

Graph 1: Percentage age distribution of visceral leishmaniasis cases



Graph 2: Percentage gender distribution of visceral leishmaniasis cases

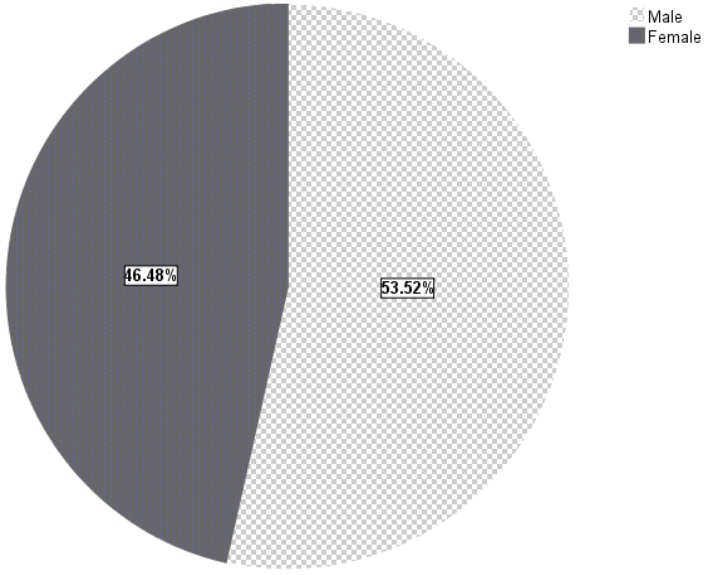


Table 1: Socio-economic and demographic profile of study subjects in the East Champaran

Age group (in years)	Case	Control	Total	Chi-square	P-value
	n (%)	n (%)	N (%)		
2-5	9 (6.3)	14 (9.9)	23 (8.1)	5.726	0.334
6-15	58 (40.8)	46 (32.4)	104 (36.6)		
16-25	18 (12.7)	15 (10.6)	33 (11.6)		
26-35	17 (12.0)	16 (11.3)	33 (11.6)		
36-45	25 (17.6)	25 (17.6)	50 (17.6)		
≥46	15 (10.6)	26 (18.3)	41 (14.4)		
Gender					
Male	76 (53.5)	74 (52.1)	150 (52.8)	0.057	0.812
Female	66 (46.5)	68 (47.9)	134 (47.2)		
Educational status					
Illiterate	66 (46.5)	56 (39.4)	122 (43.0)	3.79	0.285
Primary	43 (30.3)	47 (33.1)	87 (31.7)		
Middle/ High school	31 (21.8)	32 (22.5)	63 (22.2)		
Above High school	2 (1.4)	7 (4.9)	9 (3.2)		
Marital status					
Unmarried	77 (54.2)	57 (40.1)	134 (47.2)	5.652	0.017*
Married	65 (45.8)	85 (59.9)	150 (52.8)		
Types of family					
Nuclear	58 (40.8)	61 (43.0)	119 (41.9)	0.130	0.718
Joint	84 (59.2)	81 (57.0)	165 (58.1)		
Occupation of HOH					
Unemployed	14 (9.9)	14 (9.9)	28 (9.9)	1.371	0.928
House Maker	3 (2.1)	2 (1.4)	5 (1.8)		
Private Job	46 (32.4)	41 (28.9)	87 (30.6)		
Farmer	53 (37.3)	52 (36.6)	105 (37.0)		
Business	8 (5.6)	11 (7.7)	19 (6.7)		
Labour	18 (12.7)	22 (15.5)	40 (14.1)		
Type of houses					
Pucca	8 (5.6)	16 (11.3)	24 (8.5)	4.009	0.260
Semi-pucca	46 (32.4)	38 (26.8)	84 (29.6)		
Kutcha	40 (28.2)	35 (24.6)	75 (26.4)		
Hut	48 (33.8)	53 (37.3)	101 (35.6)		
Per capita income#					
Lower class	132 (93.0)	129 (90.8)	261 (91.9)	0.457	0.796
Lower middle class	8 (5.6)	10 (7.0)	18 (6.3)		
Middle class	2 (1.4)	3 (2.1)	5 (1.8)		

BG Prasad socio-economic classification scale, Januaary 2014, ***** Significant, **HOH**-Head of household

Table 2: Factors associated with transmission of visceral leishmaniasis in the East Champaran, Bihar

Factors	Cases	Controls	Unadjusted	95% CI	P	Adjusted	95% CI	P
	n (%)	n (%)	Odds ratio			Odds ratio		
Marital Status								
Unmarried	77 (54.2)	57 (40.1)	1.767	1.103-2.828	0.017	2.696	1.402-5.183	0.003
Married	65 (45.8)	85 (59.9)	ref.			ref.		
Presence of sunlight								
Absent	62 (43.7)	44 (31.0)	1.726	1.061-2.807	0.027	2.728	1.374-5.418	0.004
Present	80 (56.3)	98 (69.0)	ref.					
Presence of granary								
Yes	123(86.6)	57 (40.1)	9.654	5.361-17.38	0.001	7.853	3.845-16.03	0.001
No	19 (13.4)	85 (59.9)	ref.			ref.		
Presence of vegetation								
Yes	96 (67.6)	70 (49.3)	2.147	1.326-3.474	0.002	1.477	0.708-3.081	0.299
No	46 (32.4)	72 ()50.7	ref.			ref.		
Presence of banana tree								
Yes	112(78.9)	85 (59.9)	2.504	1.482-4.229	0.001	2.308	1.117-4.770	0.024
No	30 (21.1)	57 (40.1)	ref.			ref.		
Presence of bambootree								
Yes	118(83.1)	104(73.2)	1.796	1.011-3.193	0.044	.975	0.415-2.291	0.953
No	24 (16.9)	38 (26.8)	ref.			ref.		
Presence of cattle								
Yes	105(73.9)	87 (61.3)	1.794	1.083-2.971	0.022	1.050	0.518-2.128	0.892
No	37 (26.1)	55 (38.7)	ref.			ref.		
Sleep near cattle								
Yes	56 (39.4)	11 (7.7)	7.755	3.846-15.63	0.001	4.904	2.014-11.94	0.001

No	86 (60.6)	131(92.3)	ref.			ref.		
Drainage system								
Improper	117(82.4)	60 (42.3)	6.396	3.708-11.03	0.001	4.789	2.354-9.744	0.001
Proper	25 (17.6)	82 (57.7)	ref.			ref.		
ref.- reference								

Conclusions

In conclusion, we found sleeping near cattle with presence of granary inside the living room, absence of natural light inside the room, presence of banana tree and improper drainage system were associated with increased VL risk. In contrast, cattle, vegetation and bamboo tree near the houses was associated with decreased odds of VL. Our findings have implications for planning and control of VL. Firstly, individual protective measures such as improving housing conditions such as cracks from houses, removing granary outside the living room, and also do not sleep near the cattle would help to reduce risk of VL. Effective VL control in East Champaran, Bihar and in other parts of India will require a combined approach: effective vector control, improved case detection at community level, through better surveillance and access to prompt diagnosis, regular progress evaluation are necessary for effective management and control of leishmaniasis in East Champaran, Bihar and appropriate treatment to decrease the human infection reservoir.

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Conflict of interest- NA

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