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Low castes have poor access to visceral leishmaniasis treatment in Bihar, India

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Abstract

OBJECTIVES Bihar, the poorest state in India, concentrates most of the visceral leishmaniasis (VL) cases in the country. A large proportion of the poor rural communities where VL is endemic are marginalized by their socio-economic status, intrinsically related to the caste system. In this study, we evaluated whether people from low socio-economic strata had difficulties accessing VL treatment in Bihar. As a secondary outcome, we evaluated whether people delaying their VL treatment had poorer clinical indicators at admission.

METHODS Data on 2187 patients with VL treated by Médecins Sans Frontières (MSF) in Vaishali district from July 2007 to December 2008 were analysed. Patients who reported having onset of symptoms ≥8 weeks before admission were defined as 'late presenters'. Logistic regression models were used to evaluate whether low castes had higher risk to be 'late presenters' compared to the rest of castes and whether 'late presenters' had poorer indicators at admission (i.e. haemoglobin level, spleen size).

RESULTS After adjusting for age, gender and distance to VL treatment facility, Mushars (the lowest caste in Bihar) had twice the odds to be 'late presenters' compared to the rest of castes (OR 2.05, 95% CI: 1.24–2.38). Subjects that had VL symptoms for ≥8 weeks had a larger spleen and lower haemoglobin level than those that were treated earlier.

CONCLUSION Low castes have poor access to VL treatment in Bihar, and late presenters have poorer clinical indicators at admission. These findings have implications at individual and community levels and should stimulate targeted VL control programmes to ensure that marginalized communities in Bihar are properly treated.

keywords Kala azar, visceral leishmaniasis, caste, Bihar, Mushar

Introduction

Visceral leishmaniasis (VL; kala azar) is a disease caused by a systemic infection of parasites of the genus *Leishmania* transmitted to humans via phlebotomine sandflies (Heymann 2008). The annual burden of VL is estimated to be 500 000 new cases and 51 000 deaths (WHO, 2004). Approximately half of VL cases globally occur in India, where 165 million people residing in 52 VL-endemic districts are at risk of infection (Desjeux 2004) (India., M.o.H.a.F.W.G.o, 2009). Bihar is the most affected state accounting for more than 90% of India's cases (Ranjan *et al.* 2005) with an annual incidence rate of 22.3 cases per 10 000 people (Mondal *et al.* 2009). Bihar's Vaishali district is endemic for VL with an estimated incidence of 29.8 cases per 10 000 per year (S. J. Seena, J. F. Saint Sauveur, P. K. Sinha, M. C. Viñoles, R. K. Topno, P. Das, P. Roddy, L. Flevaud, M. A. Lima, P. P. Palma, unpublished data).

In India, VL is caused by *Leishmania donovani* transmitted by *Phlebotomus argentipes* (Dedet 2008) in an anthroponotic cycle (Desjeux 2004). Current VL control measures are based mainly on indoor residual spraying (IRS) of households with dichlorodiphenyltrichloroethane (DDT) and early diagnosis and treatment for those infected. To date, these measures have been insufficient to control the disease (Ostyn *et al.* 2008). A series of available new tools, namely rapid diagnostic tests and therapeutics such as liposomal amphotericin B, should facilitate the implementation of a more effective control strategy for high VL risk communities. The active detection of and treatment for VL cases should be an indispensable control programme component (Mondal *et al.* 2009). However, this strategy requires accessing VL-affected communities, which tend to be marginalized, extremely poor (Boelaert *et al.* 2009) and lack access to both diagnosis and treatment. In India, marginalized communities typically

comprise the lower castes (Van de Poel & Speybroeck 2009).

Caste, as a proxy for socio-economic status (Van de Poel & Speybroeck 2009), is an important determinant of social position and affects numerous aspects of daily life, including access to public health services (Babu *et al.* 2001). The lower strata in the caste system may have difficulties accessing health facilities, not only for financial reasons but also because of social segregation (Alvar *et al.* 2006). This may reduce awareness and expectations of treatment and discourage or delay presentation to a health facility in the event of disease. Delayed treatment for VL has consequences at community level as infectious cases help maintaining the transmission cycle of the disease. Similarly, delayed treatment may be related to poor clinical parameters at admission (Collin *et al.* 2004), which may adversely affect the clinical outcome.

In India, castes and sub-castes are categorized into three groups: (i) scheduled castes and tribes (SC/T), which include the former 'untouchables' (or 'Dalit'), the lowest castes; (ii) other backward classes (OBC); and (iii) other castes (OC), which include those groups higher in the socio-economic scale. In rural communities in particular, the caste system has a rigid hierarchical structure. *Mushars* are the lowest caste among the SC/T in Bihar (A. Juan, P. Duch, unpublished report) with an average daily income of 50 Indian rupees (1.1 USD) and poor literacy rates: 2% among males and 0.9% among females compared with 59.7% and 33.1%, respectively, for the entire state of Bihar (India., G.o, 2001). Moreover, *Mushars* report suffering from acts of violence (Watch 2007). In Bihar, *Mushars* comprise approximately 2.5% of the total population (India., G.o, 2001).

The primary objective of this study was to determine whether low castes, and *Mushars* in particular, had poorer access to VL treatment in Vaishali district (Bihar) compared to other castes. The secondary study objective was to determine whether patients with VL who delayed their treatment had poor clinical indicators at admission.

Materials and methods

Study population

Our study population included patients with VL treated by Médecins Sans Frontières (MSF) at Hajipur Hospital in Vaishali district (Bihar) from July 2007 to January 2009. Patients with VL symptoms who self-presented to the hospital's outpatient department (OPD) or who were referred to the hospital from one of the Primary Health Centres (PHC) in the district or from the Rajendra Memorial Research Institute of Medical Sciences in Patna (RMRI) were included in the study. Patients with VL identified at MSF mobile clinics, thus by active case detection campaigns, were not included in the analyses. No transportation fees were paid for the first visit. Patients with VL who completed their VL treatment received an insecticide-treated net.

Visceral leishmaniasis-suspected patients were confirmed by a positive rK39 rapid diagnostic test (DiaMed-IT-Leish®; DiaMed) or by demonstration of the parasite in the spleen or bone marrow aspirates. All patients with VL were treated with liposomal amphotericin B (Ambisome®; Gilead Sciences), given according to the current World Health Organization (WHO) recommendation (WHO, 2005a): a total dose of 20 mg/kg administered intravenously at 5-mg/kg doses on days 0, 1, 4 and 9. An extended schedule with liposomal amphotericin B was used as second-line treatment. MSF provided free diagnosis and treatment. Only VL-confirmed individuals living in Vaishali district and treated at Hajipur Hospital were included in this study (Figure 1).

Study variables

For each patient, demographics (i.e. age in years at admission, gender, sub-district of residence and caste), clinical data (i.e. spleen size, nutritional status and haemoglobin levels), date of onset of symptoms and co-infections at admission were recorded.

Castes were categorized following the 2001 census designation (India., G.o, 2001) as SC/T, OBC and OC in ascending social order. *Mushars*, the lowest caste in Bihar included in the SC/T group, were also identified and compared to the rest of castes.

The primary outcome was the number of weeks between the onset of VL symptoms and presentation to the treatment site. This variable was divided into quintiles. Patients in the last quintile, that is, patients who reported onset of symptoms ≥8 weeks before admission, were defined as 'late presenters'.

Clinical variables were defined as follows. Patients' spleen size and haemoglobin levels were divided into quintiles per age group: 6 months to 4 years, 5–18 years and older than 18 years for spleen size; and 6 months to 5 years, 6–11 years, 12–14 years, pregnant women of any age, non-pregnant women over 15 years and men over 15 years for haemoglobin levels. Patients whose spleen size was in the 5th quintile were considered to have a very large spleen. Similarly, patients whose haemoglobin level was in the 1st quintile were considered to have a very low haemoglobin level. Poor nutritional status was defined according to WHO standards and included patients that were both severely acute (below $-3z$ scores of the median WHO growth

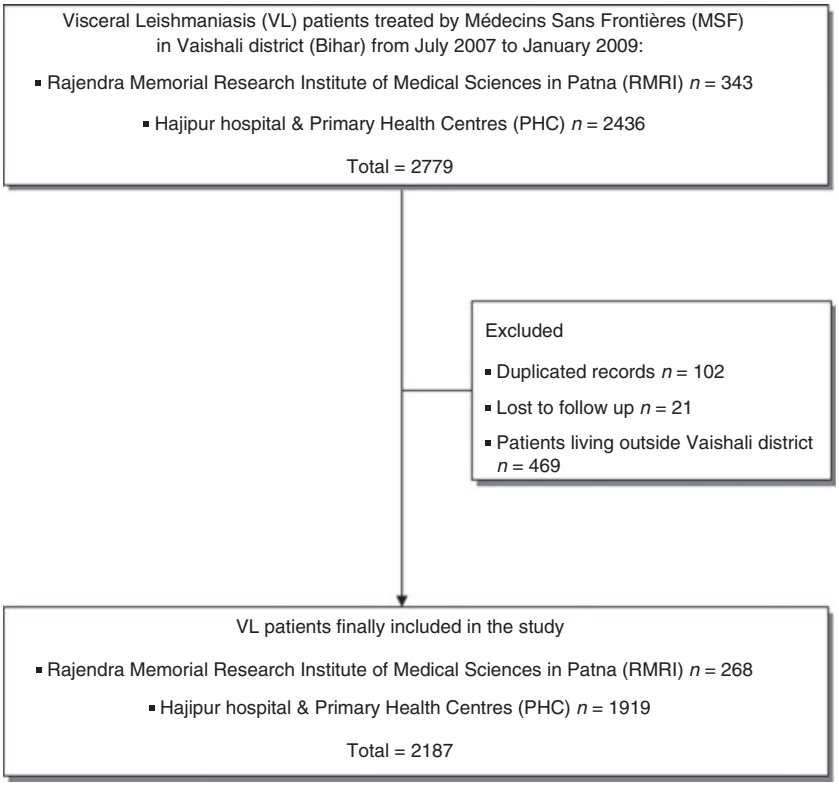

Figure 1 Schematic flow of study participants. Study participants were selected among patients with visceral leishmaniasis (VL) treated by Médecins Sans Frontières (MSF) project in Vaishali district from July 2007 to January 2009.

standards) and moderately malnourished (weight-for-age between −3 and −2 *z*-scores below the median of the WHO child growth standards) (de Onis *et al.* 2007; WHO/UNICEF, 2009). Patients suffering from one or more of HIV, malaria, tuberculosis or pneumonia at admission were considered as 'co-infected'.

Other variables considered in the analyses were gender, age at admission and distance to treatment site. Age was divided into six categories (0.5–5, 6–10, 11–15, 16–25, 26–35 and >35 years). The distance between the subdistrict of residence and the site of initial admission (i.e. Hajipur Hospital, PHC or RMRI) was estimated in Euclidian distance (km) using Google Earth© and categorized (0–10, 11–20, 21–30 and 31–40 km).

Statistical analyses

Caste and late presenters. For univariate analyses, the chi-square and ANOVA tests were used to evaluate baseline differences among castes divided into three groups (SC/T, OBC and OC) and castes divided into four groups (*Mushars*, SC/T w/o *Mushars*, OBC and OC). Unadjusted analyses were conducted to assess the crude association between late presenters (outcome) and caste (explanatory variable) and between late presenters and the following variables (covariates): gender, distance to treatment site and age. Unadjusted odds ratios (OR) and their 95% confidence intervals (CI) were calculated.

For multivariate analyses, a logistic regression model was used to assess the association between late presenting patients and caste (comparing Mushar and SC/T against the rest). Gender, distance to the treatment site and age were included as covariates in the model. The interaction among variables in the final model was checked. Adjusted OR and their 95% CI were calculated.

Late presenters and clinical parameters. Three multivariate logistic regression models, one for each clinical parameter (i.e. haemoglobin level, spleen size and nutritional status), were used to evaluate whether late presenters had poorer clinical indicators at admission than patients seeking treatment earlier (<8 weeks after the onset of VL symptoms). The models were adjusted for gender, age and multiple co-infections. Adjusted OR and their 95% CI were calculated. All analyses were performed using Stata 11.

Ethical considerations

Ethical approval was obtained from the Indian Ministry of Health and by the ethical review board at the London School of Hygiene and Tropical Medicine. All data were anonymized before the analyses were conducted.

Results

Study population

A total of 2187 patients were enrolled in the study; 74.3% were admitted at Hajipur Hospital, 13.5% at the PHCs, and 12.2% were referred from RMRI. 57.2% were boys, and the study population median age was 16 years (IQR 8.0–32.0). 10.2% of patients were under-fives; 47.7% were under 15. Nearly a quarter (23.2%) of patients belonged to SC/T; of those, 43.2% were *Mushars*. The median number of weeks ill prior to admission was 4 (IQR 3.0–8.0) (Table 1). 95.7% of patients in the study presented with a palpable spleen at admission (median cm 5.0 IQR 3.0–8.0). Patients with spleen size over 8 cm in subjects ≤18 years and over 9 cm in subjects >18 years were considered to have a very large spleen. Haemoglobin levels below 5 g/dl in 0.5- to 5-year-olds or pregnant women, 5.9 g/dl in 6- to 11-year-olds, 6.3 g/dl in 12- to 14-year-olds, 6.0 g/dl in non-pregnant women over 15 years and 7.2 g/dl in men over 15 years were considered very low. Severe acute malnutrition was present in 6.6% and moderate malnutrition in 11.5% of the population. 3.4% of patients were diagnosed with one or more co-infections at admission.

The percentage of missing values was low in most of the variables considered (ranging from 0.1% for age to 1.9% for multiple co-infections), but relatively high for two covariates: distance to health centre (21.3%; 467/2187) and nutritional status (22.7%; 496/2187). The missing values in distance to health centre were evenly distributed among caste groups ($P = 0.726$ and $P = 0.769$ for caste divided into 3 and 4 groups, respectively). However, there were fewer missing values in the group of late presenters (15%; 130/718) than in the group of people seeking treatment earlier (20%; 350/1794). The difference was statistically significant ($P = 0.001$).

Statistical analyses

Table 1, which shows baseline characteristics of the caste groups, reveals that gender was equally distributed in all. The percentage of males was 57.2 in OC, 57.5 in OBC, 58.1 in SC/T without *Mushars* and 55.1 in *Mushars* ($P = 0.59$). There were no statistically significant differences between castes in distance to treatment site either. OC, OBC, SC/T w/o *Mushars* and *Mushars* lived at 24.4, 24.5, 23.7 and 24.5 km from the treatment site, respectively ($P = 0.6962$). *Mushars* were younger than the rest. The mean age was 25.1, 21.8, 21.6 and 19.9 years for OC, OBC, SC/T w/o *Mushars* and *Mushars*, respectively ($P = 0.0026$).

Caste and late presenters. The median time (in weeks) between onset of VL symptoms and admission was similar between SC/T, OBC and OC groups ($P = 0.099$) but was different between *Mushars* and the rest of castes ($P = 0.044$) (Figure 2). The results of the analyses are detailed in Table 2. *Mushars* had more late presenters (40.9%) than the other castes. In the unadjusted analysis, *Mushars* had 1.7 the odds of suffering from VL symptoms for ≥8 weeks before admission compared to OC ($P = 0.017$). When SC/T including *Mushars* were compared to OC, the OR was reduced to 1.42 and was not statistically significant anymore ($P = 0.078$). Females (OR = 1.27 $P = 0.01$) and subjects over 35 years

Table 1 Characteristics of the study population. Details on the number of study participants per caste group and their characteristics (i.e. gender, age and distance to treatment site)

	Number (% total)	Num. males (%)	Age in years – mean (SD)	Mean distance to treatment site (km) (SD)
OC	153 (7.0)	87 (57.2)	25.1 (16.6)	24.4 (14.9)
OBC	1456 (67.0)	838 (57.5)	21.8 (16.4)	24.5 (14.0)
SC/T (w/o Mushars)	320 (14.7)	186 (58.1)	21.6 (15.5)	23.7 (15.4)
Mushars	243 (11.2)	134 (55.1)	19.9 (14.3)	24.5 (12.3)
P-value	–	0.5878	<0.0026	0.6962
OC	153 (7.0)	87 (57.2)	25.1 (16.6)	24.4 (14.9)
OBC	1456 (67.0)	838 (57.5)	21.8 (16.4)	24.5 (14.0)
SC/T	563 (25.9)	320 (56.8)	20.9 (15.0)	24.1 (14.1)
P-value	–	0.9579	<0.0025	0.4867

OBC, other backward classes; OC, other castes; SC/T, scheduled castes and tribes.

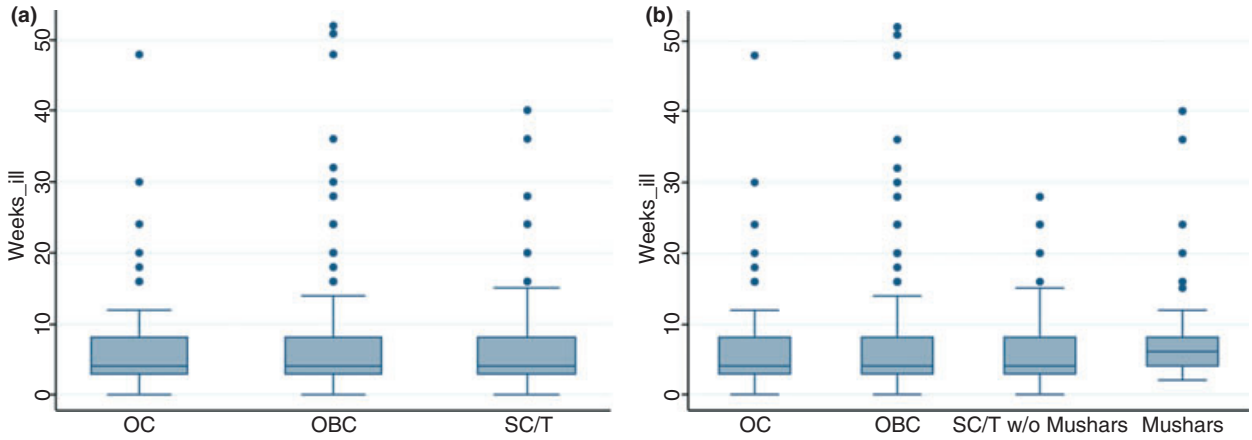

Figure 2 Boxplot of time (in weeks) between onset of symptoms and hospital presentation in function of caste. (a) Caste divided into three groups: scheduled castes and tribes (SC/T), other backward classes (OBC) and other castes (OC), and (b) caste divided into four groups: Mushar, SC excluding Mushar (SC – Mushar), ST and OBC.

Table 2 Crude and adjusted odds ratio (OR) and 95% confidence intervals (CI) for the association between late presenters (patients with VL symptoms for ≥8 weeks), caste and covariates evaluated by logistic regression. Caste divided into (i) three groups as (a) scheduled castes and tribes (SC/T); (b) other backward classes (OBC); and (c) other castes (OC) in ascending social order and (ii) four groups as (a) Mushar, (b) SC/T without Mushar, (c) OBC and (d) OC

	No. of late presenters† (%)	Unadjusted Odds Ratio (95% CI)	*P*-value	Adjusted Odds Ratio (95% CI)	*P*-value
Caste in 4 groups					
OC	44 (28.9)	1		1	
OBC	468 (32.4)	1.18 (0.82–1.70)	0.382	1.30 (0.86–2.00)	0.213
Other SC/T‡	107 (33.4)	1.23 (0.81–1.88)	0.329	1.29 (0.79–2.10)	0.308
Mushars	99 (40.9)	1.70 (1.10–2.62)	0.017	2.05 (1.24–3.38)	0.005
Caste in 3 groups					
OC	44 (28.9)	1		1	
OBC	468 (32.4)	1.18 (0.82–1.70)	0.382	1.30 (0.85–1.99)	0.219
SC/T	206 (36.6)	1.42 (0.96–2.10)	0.078	1.58 (1.01–2.49)	0.045
Sex					
Male	383 (31.0)	1			
Female	335 (36.3)	1.27 (1.06–1.52)	0.010	1.46 (1.18–1.80)	<0.001
Distance (km)					
0–10	108 (32.8)	1		1	
11–20	205 (34.3)	1.07 (0.80–1.42)	0.642	1.08 (0.80–1.44)	0.618
21–30	149 (36.0)	1.15 (0.85–1.56)	0.368	1.15 (0.84–1.57)	0.384
31–40	101 (28.0)	0.80 (0.57–1.10)	0.167	0.84 (0.60–1.17)	0.309
Age					
6 months–5 years	72 (32.1)	1		1	
6–10 years	143 (27.5)	0.80 (0.57–1.12)	0.195	0.87 (0.59–1.29)	0.478
11–15 years	72 (25.3)	0.71 (0.48–1.05)	0.088	0.70 (0.45–1.09)	0.115
16–25 years	155 (37.9)	1.29 (0.91–1.82)	0.149	1.33 (0.89–1.99)	0.157
26–35 years	105 (31.1)	0.95 (0.66–1.37)	0.788	1.00 (0.66–1.53)	0.986
>35 years	171 (44.4)	1.69 (1.19–2.38)	0.003	2.03 (1.35–3.04)	0.001

†Late presenter defined as patients with visceral leishmaniasis (VL) that had VL symptoms for ≥8 weeks before admission.
‡SC/T excluding Mushar caste.

(OR = 1.69 P = 0.003) had higher risk to be late presenters than males and children (0.5–5 years), respectively.

These results were confirmed in the adjusted model where gender, age and distance were included as covariates. *Mushars* had twice the odds of being late presenters as OC (OR 2.05; 95% CI 1.24–3.38). Similarly, when 3 caste groups were considered, SC/T (including *Mushar*) had 1.58 the odds of delaying their VL treatment compared to OC (95% CI 1.01–2.49). The risk of being late presenters in females and subjects over 35 years increased in the adjusted model (OR = 1.46 and OR = 2.03, respectively). Distance to treatment centre was not associated with delayed presentation in the crude or adjusted models (Table 2). No interactions among variables in the final model were found.

Late presenters and clinical parameters. The results of the multivariate regression models studying the association between late presenters and clinical outcomes are summarized in Table 3. Late presenters had 1.81 the odds of having a very low haemoglobin level (<5 g/dl in 0.5- to 5-year-olds and pregnant women, <5.9 g/dl in 6- to 11-year-olds, <6.3 g/dl in 12- to 14-year-olds, <6.0 g/dl in non-pregnant women over 15 years and <7.2 g/dl in men over 15 years) and 2.34 the odds of having very large spleen (>8 cm in those ≤18 years and >9 cm in those >18 years) at admission compared to people treated earlier. Both results were highly statistically significant (P < 0.001). Haemoglobin level was also associated with multiple co-infections (OR = 3.62, P = 0.013). Late presenters did not have a poor nutritional status at admission, but females (OR = 1.41) and individuals over 35 years (OR = 2.02) had a higher risk of being malnourished than males and under-fives.

Discussion

The main objective of this study was to assess whether marginalized communities in Bihar had difficulties accessing VL treatment using caste and delayed presentation to the treatment as a proxy measures for socio-economic status and access to health system, respectively. *Mushars* (the lowest caste) and SC/T (the lowest caste category) significantly delayed their VL treatment compared to OC (the highest caste category) (OR = 2.05 and 1.58, respectively). These difficulties accessing health services could be related to poverty as low castes are significantly poorer and have worse and more unstable occupations than higher castes (Thakur 2000). Poor access to treatment may also be due to social factors associated with low castes such as poor education, preference for traditional healers or social exclusion (A. Juan, P. Duch, unpublished report). The fact that economic data were not gathered in this study precluded adjusting the risk of delaying VL treatment by poverty. However, in this study, treatment was provided free of charge by MSF (Sinha *et al.* 2010), and the use of liposomal amphotericin B required fewer days of hospitalization than antimonials (Barratt & Legrand 2005). These elements limited the additional costs associated with VL treatment, which disproportionately bear on the poor. Thus, caste, as a social determinant, seems to be a genuine factor determining the access to treatment, at least in this study population. Even if this study is limited to

Table 3 Adjusted odds ratio (OR) and 95% confidence intervals (CI) for the association between late presenters (patients with VL symptoms for ≥8 weeks) and clinical parameters at admission adjusted by covariates (i.e. gender, age and multiple co-infection) assessed by logistic regression. Clinical parameters analysed: (i) very low haemoglobin level (<5 g/dl, <5.9 g/dl, <6.3 g/dl, <6.0 g/dl and <7.2 g/dl in 0.5- to 5-years-olds and pregnant women, 6- to 11-year-olds, 12- to 14-year-olds, non-pregnant women over 15 years and men over 15 years, respectively), (ii) very enlarged spleen (>8 cm in subjects ≤18 years and >9 cm in subjects >18 years) and (iii) poor nutritional status (defined according to WHO standards malnutrition (de Onis *et al.* 2007; WHO/UNICEF, 2009))

	Very low haemoglobin†			Very large spleen‡			Poor nutritional status§		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Late presenters¶	1.81	(1.40–2.35)	<0.001	2.34	(1.87–2.94)	<0.001	1.13	(0.89–1.44)	0.302
Female	1.14	(0.91–1.43)	0.252	0.86	(0.69–1.08)	0.198	1.41	(1.12–1.78)	0.004
Age older than 35 y	1.02	(0.77–1.37)	0.862	0.87	(0.64–1.17)	0.350	2.02	(1.55–2.63)	<0.001
Multiple co–infections**	3.62	(1.31–10.03)	0.013	1.23	(0.69–2.20)	0.489	1.07	(0.58–1.98)	0.836

†Very low haemoglobin defined as (<5 g/dl, <5.9 g/dl, <6.3 g/dl, <6.0 g/dl and <7.2 g/dl in 0.5- to 5-year-olds and pregnant women, 6- to 11-year-olds, 12- to 14-year-olds, non-pregnant women over 15 years and men over 15 years, respectively)
‡Very large spleen defined as over 8 cm in subjects ≤18 years and over 9 cm in subjects >18 years
§Poor nutritional status defined as below $-3z$ scores of the median WHO growth standards
¶Late presenters defined as who reported having onset of symptoms ≥8 weeks before admission.
**Multiple co-infections defined as one or more of the following diseases at admission: HIV, malaria, tuberculosis or pneumonia.

Vaishali district, its results could be extrapolated to other VL-endemic districts in Bihar with a similar socio-economic structure.

When caste was taken into account, female and older (>35 years) patients with VL delayed their treatment longer than men and children under five (OR = 1.46 and OR = 2.03, respectively). Females may have difficulties accessing health services because of social exclusion, childbearing and rearing and working responsibilities (WHO, 2009). The occupation responsibilities may also explain that older people, who tend to provide the most of the household income, delay their VL treatment.

The results of this study should stimulate specific programmes targeting groups that have difficulties accessing health services in Bihar, especially low castes and females. In the context of VL control, such programmes should ensure that those risk groups are diagnosed and treated properly. Early identification and treatment of VL cases is one of the pillars of the VL elimination initiative in the Indian subcontinent (WHO, 2005b) as symptomatic individuals are infectious and contribute to maintaining the disease in endemic communities.

At individual level, patients with VL delaying their treatment had worse clinical indicators at admission: increased anaemia risk (OR = 1.81) and spleen size (OR = 2.34). In a VL risk factor study in Sudan (Collin *et al.* 2004), these factors were associated with poor prognosis as well. This study showed that adult patients who had symptoms for ≥8 weeks had a higher risk to die (OR = 2.25). As observed in the current study, this group of patients from Sudan also had a lower haemoglobin level (OR = 3.98 for haemoglobin <8 g/dl in adults and OR = 3.65 < 6 g/dl in children) and larger spleen size in children (OR = 2.85 for grade 3 to 5, Hackett spleen classification). We did not evaluate whether late presenters were at higher risk of death, because liposomal amphotericin B is very effective and 98.8% were treated successfully (Sinha *et al.* 2010). However, poor indicators at admission may be related to poor prognosis when less effective or more toxic drugs, such as sodium stibogluconate (SSG), are used (Collin *et al.* 2004; Hasker *et al.* 2010).

Malnutrition has been associated with VL development (Cerf *et al.* 1987; Dye & Williams 1993) and risk of death in patients with VL (Collin *et al.* 2004). In this study, the risk of malnutrition was not significantly increased in patients who had been ill for at least 8 weeks (Table 3). The association with malnutrition may be partially masked by the unbalanced distribution of missing values in the late presenters' variable. Nevertheless, when late presenters were taken into account in the model, female and older (>35 years) patients were more likely to suffer malnutrition than males and children.

The use of caste and reported number of weeks ill as proxy measures for socio-economic status and access to health services has limitations (i.e. recall or misclassification bias). Similarly, the lack of economic data did not allow independent evaluation of the effect of caste in the access to VL treatment in Bihar. Nevertheless, the results of this study indicate that marginalized communities in Bihar had difficulties accessing health services, even when they are provided for free. Further research is warranted to explore the reasons for delaying VL treatment in scheduled castes and tribes and *Mushar* in particular in Bihar, as well as in women. Anthropological studies could help assess the social determinants of treatment seeking and in the design of strategies to improve access to VL treatment among *Mushar* and women in Bihar. VL control programmes should consider targeting the risk groups identified in this study to ensure that they are treated properly. Active VL case detection campaigns (i.e. mobile clinics) in endemic communities could help identifying and treating patients with VL earlier. This strategy should be accompanied by educational activities to increase awareness about VL prevention, diagnosis and treatment in endemic communities. Reducing the time patients with VL remain infectious will help controlling the transmission of *L. donovani* in endemic communities.

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