Risk Factors of Visceral Leishmaniasis among Residents of Chemolingot, Baringo Kenya

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Background and study aim: Visceral leishmaniasis (VL) is a neglected tropical infectious disease transmitted by the bite of a female phlebotomine sand fly. Globally, over 350 million people are estimated to be at risk annually, approximately 4000 are from Kenya. Baringo County has been identified as a VL endemic focus, but its associated risk factors are yet to be well established. **Patients and Methods:** 331 respondents (200 males and 131 females) who presented with signs and symptoms of VL were consecutively recruited into the study. A questionnaire was administered, the variables of interest were: age, gender, socioeconomic characteristics, and type of housing among other variables. Blood samples were drawn from the respondents and tested by immuno-chromatographic technique (ICT) Kinensin rk39 antigen test kit (IT LEISH, France) for confirmation. **Results:** VL positive cases were 131 and negative cases were 200. There was a significant positivity difference in gender; males 88 (44.2%) females 43 (32.6%) (χ24.500 df1 P = 0.034). Pastoralism (45.6%) (χ2= 46.50 df 7 p = 0.001), housing conditions; grass thatched houses (89.74%) (χ2= 64.0, df.1, p = 0.001), stick walled houses (66.3 %) (χ2 =179.120, df4, P=0.001) and Presence of animals in homes (89.6%) (χ2 =210.167 df1 P< 0.001). No significant difference in age (χ2 =2.184 df3 p = 0.535). **Conclusion:** Male gender, Pastoralism, poor housing, and the presence of animals in homes increased the risk of VL infection.

INTRODUCTION

Visceral Leishmaniasis (VL) is a disease caused by a protozoan, Leishmania, and is transmitted to humans and other mammals by the bite of a female phlebotomine sand-fly (*Phlebotomus* species). Three forms of the disease affect humans; cutaneous, mucocutaneous, and visceral forms (Kala azar). The disease is considered a neglected tropical disease mainly affecting the rural poor. Cutaneous leishmaniasis (CL) commonly occurs in clusters among destabilized or migrant populations in low socio-economic settings with the current trend in the distribution of new infections indicating a progressive spread of the disease to previously non-endemic areas [1–5].

Worldwide, over 350 million people are estimated to be at risk of CL, and up to 1.5 million new infections are reported annually [6]. Approximately 90% of the global burden for VL is found in just 7 countries, 4 of which are in Sub-Saharan Africa, 2 in Southeast Asia (India and Bangladesh), and Brazil [7]. In Kenya, an estimated 4,000 cases are reported annually though the figure may not reflect the actual numbers due to poor surveillance.

The most critical transmission foci are currently Baringo, Isiolo, Marsabit, West Pokot, Turkana, Kitui, Garissa, and Wajir counties [8]. Visceral leishmaniasis is the most lethal manifestation of Leishmania disease. It is most often associated with *L donovani* (East Africa, India) and *L infantum* (Mediterranean, Middle East, and the Americas), although other species more prone to cutaneous disease have caused VL in immunosuppressed patients [9, 10]. The typical clinical presentations of VL include prolonged fever, weight loss, pancytopenia, anemia, hypergammaglobulinemia, and hepatosplenomegaly [11].

Studies have shown that low socio-economic status and treatment of livestock with insecticide as some of the risk factors associated with visceral leishmaniasis [12]. Sleeping near animals, and social-cultural factors such as sleeping under an acacia tree during the day and sleeping outside at night have also been identified to increase exposure to visceral leishmaniasis. Other risk factors include large family size and number of days spent in the farm [13]. A study in India showed that some of the risk factors of visceral leishmaniasis include poor housing, ownership of goats, delay in seeking health care, and poverty [14]. Other studies in Ethiopia have pointed out that the ecosystem and animal ownership are among the risk factors associated with visceral leishmaniasis [15]. Studies in Kenya have shown that there is inadequate information on the risk factors and burden of the disease [16]. Therefore, this study was conducted to elucidate the risk factors associated with leishmaniasis among patients attending Chemolingot Health Center, Baringo County.

PATIENTS AND METHODS

This was a Hospital-based cross-sectional study conducted between October and December 2022 in Chemolingot (latitude 0°58'20.94"N and longitude 35°58'39.20" E) Tiaty sub-County of Baringo County. The respondents were patients who presented with features of Visceral leishmaniasis i.e. irregular bouts of fever, weight loss, enlargement of the spleen and liver, and anemia. The sample size for the study was 331; this was determined using Fisher's formula($n=(Z^2 (pq))/d^2$.)

Patients who presented with features of VL were screened by clinicians and referred to the laboratory for confirmation. Blood samples were drawn and tested by immuno-chromatographic technique (ICT) Kinensin rk39 antigen test kit (IT LEISH, France).

A structured questionnaire was used to collect the data. The questionnaire administered had provisions for age, gender, socioeconomic characteristics, and type of housing among other variables.

Sampling technique

Patients who presented with the signs and symptoms of Visceral Leishmaniasis i.e. irregular bouts of fever, weight loss, enlargement of the spleen and liver, and anemia during the study period were consecutively recruited into the study.

Data analysis

Statistical analysis was done using IBM SPSS statistics, version 20 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were computed as means, frequencies, and percentages. The association between sociodemographic variables was determined by the Chi-squared (X^2) test. The odds ratio was calculated with a 95% confidence interval for each variable. All statistical tests were carried out at a significance level of 0.05

RESULTS

There were 331 respondents involved in this study. Positive for VL were 131 and negative were 200. In terms of gender, a large proportion of them were male 200 (60.4%) while females constituted 131 (39.6%). In terms of age, the majority of the participants were less than twenty years of age 214 (64.7%) while only 2 were aged more than 61 years 2 (0.60%). On education level, the majority of the respondents had no formal education 165 (50.1%) and for those with formal education, the majority had only attained primary level 92(55.4%). Only a small proportion of them had attained a diploma degree, postgraduate and certificate .

A large proportion, 276 (83.4%) of the respondents were unemployed while 55 (16.6%) were employed with either self or formal employment. Occupation-wise, 144 (43.5%) practiced pastoralism, 52 (15.7%) mixed farming, and 33 (10%) beekeeping. Others practiced business 23 (6.9%), charcoal burning 22 (6.6%), and nursing 19 (5.7%) as illustrated in

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table 1 below. In terms of housing, the majority (64.9%) lived in temporary structures with either mud or stick-walled houses with grass-thatched roofs and only (25.10%) resided in iron sheet roofed houses. The categorical data analyzed using the Chi-square test established some statistical association between the various categories. Participants in the age <20 had the highest positivity rate of VL 90 (42.1%). There were only two participants above 60 years of age; one was positive and one was negative for leishmaniasis. The lowest positivity rate of 5 (27.8%) was observed in the age groups 41-60, .The difference in positivity by age group was not statistically significant ($\chi 2$ 2.184 df3 p = 0.535). The prevalence rates significantly varied between males 88 (44.2%) and females 43 (32.6%) (χ24.500 df1 P = 0.034). There is a statistical difference between those who were employed 4 (7.3%) and the unemployed 127(46.0%), where employed respondents had few of positive cases than unemployed with a significant difference ($\chi 2$ 28.784 df1 P=0.001).On education, those who had above secondary level were least affected 13 (9.93%) compared to those with lower than secondary education 118(90.07%) with a significant difference ($\chi 2$= 22.039 df 6 p=0.001). Occupation-wise, pastoralists 62 (45.6 %) and casual laborers 7(100%) were affected more than those with employment 8(14.5%) ($\chi 2$= 46.501 df 7 p = 0.001).

Influence of Housing as a risk factor for the spread of leishmaniasis

In terms of housing, grass-thatched houses reported more positive cases 117 (89.74%) compared with iron sheet roofed 14 (10.26 %) with significant difference ($\chi 2$= 64.0, df.1, p = 0.001). Those residing in mud-walled houses and stick-walled recorded a positivity rate of 31.8 % and a 66.3 % significant difference ($\chi 2$ =179.120, df4, P=0.001). The presence of animals in homesteads recorded 89.6% positivity ($\chi 2$ 210.167 df1 P< 0.001).

Table 1: Demographic characteristics of the respondents

Demographic characteristics	Attribute	Male (n)	Female (n)	Total frequency	%
Age range	Less than 20 years	130	84	214	64.70
	21-40 years	59	38	97	29.30
	41-60 years	10	8	18	5.40
	Above 60 years	1	1	2	0.60
	Total	200	131	331	100.00
Education level	No education	100	65	165	49.80
	Primary	56	36	92	27.80
	Secondary	20	13	33	10.00
	Certificate	14	9	23	6.90
	Diploma	8	5	13	3.90
	Degree	2	1	3	0.90
	Postgraduate	1	1	2	0.60
	Total	200	131	331	100.00
Occupation	Mixed farming	31	21	52	15.70
	Herder	87	57	144	43.50
	Health worker	11	8	19	5.70
	Casual labourer	4	3	7	2.10
	Teacher	14	9	23	6.90
	Accountant	3	2	5	1.50

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	Security	2	1	3	0.90
	Beekeeper	20	13	33	10.00
	Charcoal burning	13	9	22	6.60
	Trader/business	14	9	23	6.90
	Total	200	131	331	100.00
Type of housing roofing	Grass thatched	154	94	248	74.90
	Iron sheet	46	37	83	25.10
	Wall bricks	60	30	90	27.19
	Timber	15	11	26	8.15
	Sticks	125	90	215	64.95
	Total	200	131	331	100.00

Table 2: Sociodemographic characteristics of the positivity of leishmaniasis

Characteristics	**Leishmaniasis**		**Chi-square value (pf)**	**95%CI**	**p-value**
	Negative	Positive			
Age (Years)					
<20	124(57.9)	90(42.1)	2.184(3)	0.521-0.627	0.535
21-40	62(63.9)	35(36.1)			
41-60	13(2.2)	5(27.8)			
Above 60 years	1(50.0)	1(50.1)			
Gender					
Male	111(55.8)	88(44.2)	4.500(1)	0.00-0.009	**0.034**
Female	89(67.4)	43(32.6)			
Employment					
Employed	51(92.7)	4(7 .3)	28.784(1)	0.00-0.009	**0.001**
Unemployed	149(54.0)	127(46.0)			
Education level					
No education	89(53.9)	76(46.1)	22.039(6)	0.00-0.009	**0.001**
Primary	50(54.3)	42(45.7)			
Secondary	24(72.7)	9(27.3)			
Certificate	21(91.3)	2(8.7)			
Diploma	11(84.6)	2(15.4)			
Bachelors	3(100.0)	0(0.0)			
Postgraduate	2(100.0)	0(0.0)			
Occupation					
Herder	80(54.4)	64(45.6)	24.521(7)	0.00-0.009	**0.001**
Casual laborer	0(0.0)	7(100)			
Beekeeping	18(54.5)	15 (45.5)			
Charcoal burning	13(56.5)	10(43.5)			

Health worker	51(92.7)	4(7.3)
Livestock	5(71.4)	2(28.6)
Mixed farming	25(48.1)	27(51.9)
Others police, and bankers.	8(77.7)	2(22.3)

*** df – degree of freedom * CI – Confidence interval * P <0.05 statistically significant**

Table 3: Housing as a risk factor for the positivity of Leishmaniasis

Characteristics	**Leishmaniasis**		**Chi-square value (df)**	**95%CI**	**p-value**
	Negative	Positive			
House roof material					
Grass thatched	113(49.8)	114(50.2)	43.343(1)	0.00-0.009	**0.001**
Iron sheet	87(83.7)	17(16.3)			
House wall material					
Mud	104(61.9)	64(38.1)	179.120(4)	0.00-0.009	**0.001**
Iron sheet	6(100.0)	0(00.)			
Bricks	45 (88.2)	6(11.8)			
Sticks	30(33.7)	59(66.3)			
Timber	15(83.3)	3(16.7)			
Number of rooms					
1-2	124(56.3)	96(43.7)	21.169(1)	0.00-0.009	0.001
More than 2 rooms	76(68.4)	35 (31.6)			
Sleeping habit					
Inside House	22(66.7)	11(33.3)	0.5989(1)	0.00-0.009	0.440
Outside House	178(59.7)	120(40.3)			
Presence of animals					
No	187(90.8)	19(9.2)	210.167(1)	0.00-0.009	**0.001**
Yes	13(10.4)	112(89.6)			

***df – Degree of freedom *CI – confidence interval * P <0.05 statistically significant**

DISCUSSION

Analysis established some statistical associations between the various categories. The age group below 20 years reported the highest positivity rate of VL 90 (42.1%). The lowest positivity rate of 5 (27.8%) was observed in the age groups 41-60. The difference in positivity by age group was not statistically significant ($\chi 2$ 2.184 df3 p = 0.535). The prevalence rates significantly varied between males 88 (44.2%) and females 43 (32.6%) ($\chi 2$4.500 df1 P = 0.034). There is a statistical difference between those who were employed 4 (7.3%) and the unemployed 127(46.0%), where employed respondents had fewer positive cases than unemployed with a significant difference ($\chi 2$ 28.784 df1 P=0.001). Education-wise, respondents with at least secondary level were least affected 13 (9.93%) compared to those with lower than secondary education 118(90.07%) with a significant difference (χ2= 22.039 df 6 p=0.001), Occupation-wise, pastoralists 62 (45.6 %) and casual laborers 7(100%) were affected more than those with employment 8(14.5%) (χ2= 46.501 df 7 p = 0.001).

The current study reported a high positivity rate of 90 (42.6%) among respondents below age 20, the findings are similar to that of a study by Argaw et al (2013) and Priyamvada et al (2021) that reported age as a risk factor for 59% of those below 20 years [17,18]. Justification for this age group being more infected may be due to the active nature of these groups of people and therefore they are involved in many outdoor activities like herding of cattle, charcoal burning, and beekeeping that are likely to increase exposure to the sand-fly bites.

It is noted from this study that more males 88 (67.17%) were affected by visceral leishmaniasis than females 43(32.83%) (OR 0.649; 95% CI 0.385-0.964, p= 0.034) these findings are in concordance with those of a study done in Humera, Western Tigray, where univariate analysis of infection of VL based on potential risk factors found a high male infection rate 132 (87%) than female counterparts [19]. This may be explained by the fact that culturally, in the Pokot community males usually take part in outdoor activities like pastoralism and at times are faced with the fact that they have to sleep outside at night to protect their families and their livestock.

Education level was also significantly associated with VL with those who were more educated, secondary certificate, diploma degree, and postgraduate combined n=75 (22.65%) were less affected with the disease as compared to those with no education combined 257(77.3) with 118 (54.0%) being VL positive and 1.6 times likely to suffer than those who are literate. The findings are comparable to those of a study by Kiptui et al (2021)that reported a risk factor of 60% for the uneducated [20]. The findings are also similar to those of another study in India and Nepal where a prospective study showed seroconversion and risk of VL were strongly associated with illiteracy levels OR=0.63 [21]. The high-risk factor for the uneducated may be explained that they may not be aware of leishmaniasis and how it is transmitted and therefore they don't take any precautions to protect themselves from it .

On occupational activities, participants who engaged in herding were majority 136 (41.1%), with 62(45.6) being positive for VL and 2.0 times more likely to suffer VL than those who engaged in other forms of occupation thus independently associated with risk for visceral leishmaniasis. The findings are in agreement with those of Wijerathna et al (2020) on the assessment of risk factors for visceral leishmaniasis among residents of Baringo [22]. This may be attributed to the harsh scorching effects of the sun at the lowlands of Chemolingot therefore they prefer grazing their animals at night when the temperatures are low coinciding with the feeding time of the sandflies thus get more exposed .

Temporary houses played a key role as regards exposure to VL. The study recorded a threefold likelihood of exposure in temporary houses as compared to living in permanent houses. The findings are comparable to those of a study by Mandal et al (2019) and Kiptui et al (2021) that demonstrated the high-risk factors for visceral leishmaniasis in selected high endemic areas are attributed to poor housing structures and conditions [20,23]. The poor housing structures in this context are mud walls, stick walls, and grass-thatched houses. The mud walls and grass thatched roofs will act as the hideouts and breeding sites for the sandflies and the stick walls allow the sandflies to move into the houses .

It is also worth noting that; Homes with ant hills around the compound (radius 50 meters) were majority 277(83.7%) and significantly influenced the number of cases with 117(42.3%) positive reports and participants were 1.6 times likely to suffer VL than those with anthills far away. These results are consistent with those of a study conducted in eastern Ethiopia which demonstrated that termite mounds near the compound were strongly associated with increased VL risk. Justification for this increased risk to VL among participants with anthills near homesteads is that eroded anthills could provide better habitat for sandfly vectors as such kinds of mounds provide small vertical and horizontal channels which are related to termite hill ventilations which provide conducive shelter to sandflies [15].

CONCLUSION

The following risk factors independently associated with VL were male gender, herding, having no education, temporary houses, having 1-2 rooms, grass thatched roof and stick/mud wall, and presence of anthills near the compound .

Recommendation

This study recommends Ministry of Health and the Department of Health Baringo County in conjunction with other partners come up with effective measures in disseminating information on integrated control and prevention with the objective of lowering morbidity and mortality.

Ethical approval:

Ethical approval to conduct the study was granted by Maseno University Scientific Research and Ethics Committee (MUSREC), Nacosti, and the County government of Baringo. Consent was sought from the patients before administering the questionnaire, and anonymity and confidentiality were maintained throughout the study period.

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Author contribution: We declare that all listed authors have made substantial contributions to all of the following three parts of the manuscript:

-Research design, or acquisition, analysis, or interpretation of data؛

-drafting the paper or revising it critically؛

-approving the submitted version.

We also declare that no one who qualifies for authorship has been excluded from the list of authors.

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Conflict of interest

None.

HIGHLIGHTS

- Visceral Leishmaniasis (VL): This is a disease caused by a protozoan, Leishmania, and is transmitted to humans and other mammals by the bite of a female *phlebotomite* sandfly.
- Low socio-economic status, socio-cultural factors, and pastoralism practices have been identified to increase exposure to visceral leishmaniasis.
- Baringo County is an endemic focus of VL, However, its associated risk factors are not well documented.

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