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Visceral Leishmaniasis and Associated Risk Factors in Libo Kemkem, Bura Egzi Abhier Ab Kebele, Northwestern Ethiopia

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Abstract

Background: Leishmaniasis is a disease with broad range of clinical manifestations. The impact of visceral leishmaniasis is progressively an accelerating public health concern in Libo Kemkem (a district of Amhara region, Ethiopia) where no cases of kala-azar had ever been reported until 2005 when an outbreak occurred.

Methods: A total of 398 study participants with 192 males and 206 females were selected by systematic random sampling method and included in the study as a source of blood samples and for questionnaire survey. All blood samples collected from the study participants were examined for the presence of antibody against *Leishmania donovani* using Napier's formol-gel test.

Results: The overall prevalence of visceral leishmaniasis among study participants was 6.5% (26/398). Of these, the prevalence of visceral leishmaniasis among male and female study participants was 9.9% (19/192) and 3.4% (7/206), respectively. The prevalence of visceral leishmaniasis in age groups: 6 - 12, 13 - 19, 20 - 34, 35 - 50 and 51 and above years was 2.7%, 7.7%, 11.8%, 6.9% and 1.4% respectively. The study showed that leishmaniasis infection has significant association with risk factors like presence of termite hill (P = 0.003), Presence of VL infected family members (P = 0.041), outdoor sleeping habit (P = 0.001), migration to endemic areas (P = 0.001) and being a farmer in occupation (P = 0.003).

Conclusion: The overall current study showed that Visceral leishmaniasis remained as a major public health concern in the area. Hence, there should be a need of implementing a sound control program, strengthened behavioral change, communication and social mobilization related activities.

Keywords: *Visceral Leishmaniasis; Antibody; Leishmania donovani; Napier's Formol-Gel Test; Prevalence and Risk Factors*

Abbreviations

LCL: Localized Cutaneous Leishmaniasis; DCL: Diffuse Cutaneous Leishmaniasis; MCL: Mucocutaneous Leishmaniasis; VL: Visceral Leishmaniasis; SNNPR: Southern Nations and Nationalities People's Region; HC: Health Centers; HP: Health Posts; NFGT: Napier's Formol-Gel Test; KAP: Knowledge Attitude Practice; Rpm: Revolution Per Minute; w/v: Weight Per Volume; SPSS: Statistical Package for the Social Sciences; CI: Confidence Interval; WHO: World Health Organization

Background

Leishmaniasis is a disease caused by several species of parasites belonging to the genus *Leishmania*. The disease is transmitted by the bite of female infected sand flies that belongs to the *Phlebotomus* or *Lutzomyia* [1]. Clinical manifestations of the disease depend on com-

plex interactions between virulence factors of the infecting *Leishmania* species and cell mediated immune response of the mammalian host. The disease is characterized by a spectrum of clinical manifestations: ulcerative skin lesions developing at the site of the sand fly bite named as localized cutaneous leishmaniasis (LCL); multiple non-ulcerative nodules or diffuse cutaneous leishmaniasis (DCL); destructive mucosal inflammation (mucosal leishmaniasis, MCL); and disseminated visceral infection (visceral leishmaniasis, VL) [2].

Visceral leishmaniasis (Kala-azar) is a deadly parasitic disease caused by infection with protozoan parasites of the *Leishmania donovani* complex (Kinetoplastidae: Trypanosomatidae). Diagnosis and treatment of the disease are difficult; and about 95% of VL patients are likely to die if left without appropriate treatment [3]. Humans, wild animals and domestic dogs are known to act as reservoir hosts. Its generalized clinical syndrome involves the reticulo-endothelial system infection (spleen, bone marrow and liver), weight loss and anemia.

East Africa has the second highest number of VL cases next to the Indian sub-continent and the disease is endemic in parts of Eritrea, Ethiopia, Kenya, Somalia, Uganda, North and Southern Sudan [3]. Now days, VL is a growing health related crisis in Tigray, Amhara, Oromia, Afar, Somali and SNNPR with the burden of 4,000 new cases per annum [4]. Northern part of Ethiopia has recently experienced epidemics to VL in previously unaffected sites which might be from long recognized endemic foci as Metema and Humera [5]. Documented outbreak of the disease with 2,500 cases and high mortality rate was recorded in Amhara Region particularly in Libo Kemkem [6,7]. The outbreak started at least as early as 2004, but was initially misdiagnosed as malaria [6]. In 2010, many cases of VL were also documented from Tigray, predominantly in Tahtay Adiabo district and in East Lemey, a district in Somali Region [8]. Nevertheless, there was no previous study reported on the prevalence of VL in the selected study area so that this study was objectively targeted to assess the prevalence and socio-demographic risk factors of visceral leishmaniasis in Bura Egzi Abhier Ab kebele.

Materials and Methods

Description of the Study Area

The study was undertaken in Bura Egzi Abhier Ab Kebele, Libo Kemkem district, South Gondar Zone of Amhara Regional State, North Ethiopia. Bura Egzi Abhier Ab Kebele is about 628 kilometers far apart from Addis Ababa, and 23 kilometers from the nearby town, Addis Zemen- located along the major route of Sudan-Metema-Gondar-Bahir Dar-Addis Ababa (Figure 1). The elevation of the study area ranges from 1800 - 2000 meters above sea level. The mean annual temperatures and relative humidity range from 25 - 28^{o}C and 31 - 52.7%, respectively. The study area receives an average annual rainfall ranging from 900 - 1200 mm, with a bimodal distribution pattern, peaking in mid-April and mid-August every year [9].

The local activities of the societies are related to intensive cultivation of teff, maize, beans, oilseeds, rice and cotton. The area has also reduced natural vegetation and scattered clumps of acacia trees. Most of the area is flooded during the rainy season (July–September) and dries up during the dry season (November–March), resulting deep cracks of the soil surface which could turn to breeding sites for the putative vector *Phlebotomus orientalis* [10].

According to the 2007 National Census [11], Libo Kemkem district has 32 kebeles inhabited by a total population of 196,813. The health infrastructure in this district includes two health centers (HC), ten health posts (HP) and a few private drug vendors.

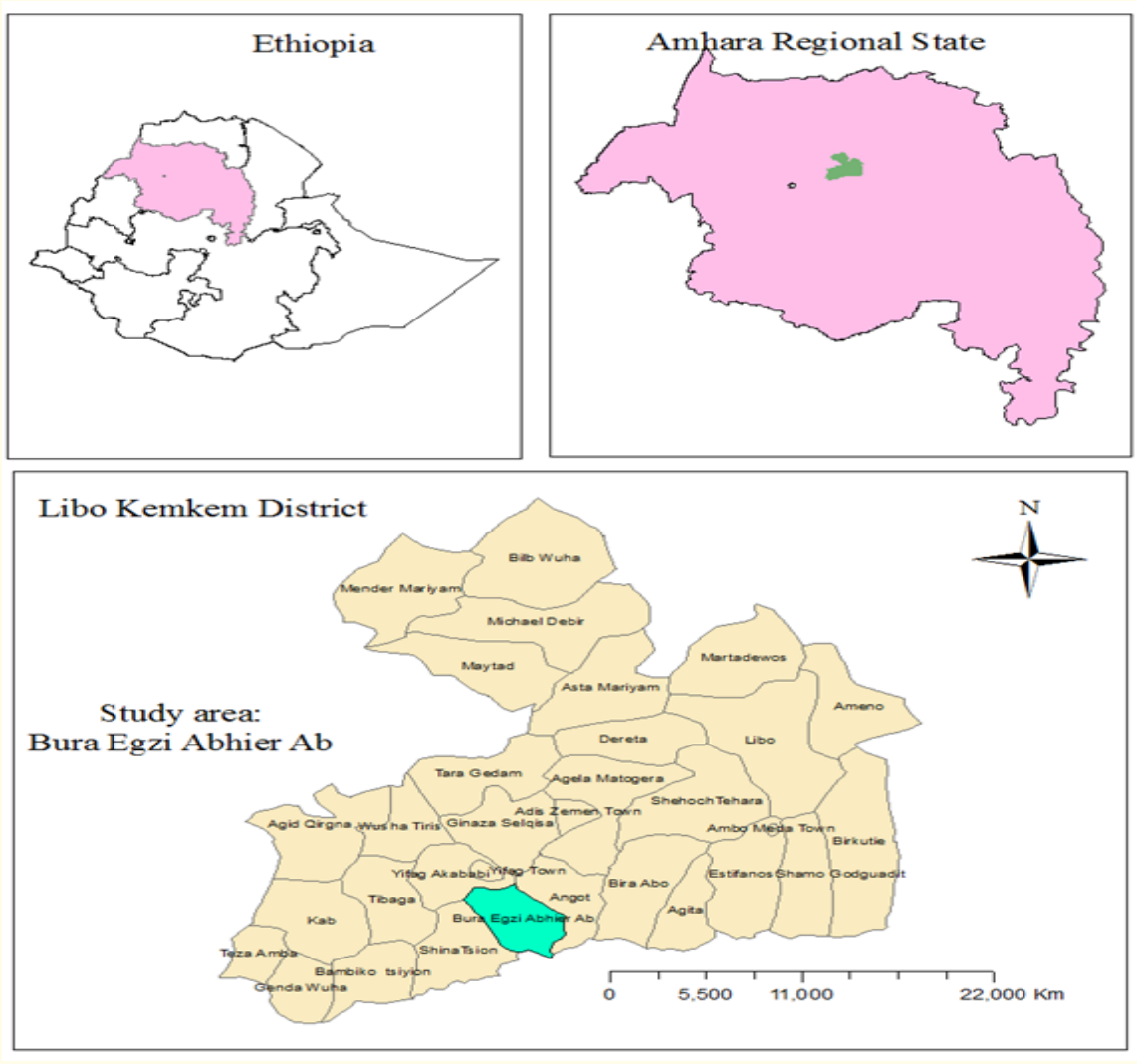

Figure 1: *Map of Libo Kemkem district that show the study site (Bura Egzi Abhier Ab) , January 2014.*

Design of the study

The present study was community-based cross-sectional survey of visceral leishmaniasis using Napier's formol-gel test (NFGT), administration of pre-tested questionnaires, and structured interviews. Prevalence and its associated risk factors in the study area were determined from June-July 2013. Laboratory test of the blood samples were carried out in the nearby Addis Zemen Health Center.

Study population and sample size determination

The study site, Bura Egzi Abhier Ab kebele, has a total of eight villages (Gots) as Gorguadit, Guhaye, Quara, Choreye, Aba mdoreye, Medereye, Gerdim, and Neybado with 1643 households and a total population of 7214; among which 3693 and 3521 are females and males, respectively (Table 1). The entire residents who live in Bura Egzi Abhier Ab kebele and volunteered to participate in the study were considered as the study population for the present investigation.

Study villages (sites)	Total No of households	Total Population			Sample Size		
		Male	Female	Total	Male	Female	Total
Aba mdoreye	183	341	460	801	20	25	45
Choreye	257	600	533	1133	31	30	61
Gerdim	203	445	446	891	24	25	49
Gorguadit	197	465	400	865	25	23	48
Guhaye	211	459	468	927	24	26	50
Medereye	173	400	356	756	22	21	43
Neybado	207	359	550	909	21	30	51
Quara	212	452	480	932	25	26	51
Total	1643	3521	3693	7214	192	206	398

Table 1: *Total population of the study villages in Bura Egzi Abhier Ab kebele and their sample size.*

Between August 1997 and February 2005, a prospective study of human visceral leishmaniasis (VL) was undertaken in two villages in the Konso district of south–western Ethiopia and the overall prevalence of VL was 30.0% [12]. The sample size was calculated based on the previous prevalence of visceral leishmaniasis. Accordingly, the following formula [13] was used to determine the sample size:

$n = Z^2 P (1-P)/ d^2$, where:

n= number of study subjects enrolled in the study

Z= 95% confidence interval = 1.96

d = marginal error between the samples and the population = 0.05

P= prevalence of VL= 30%

The sample size obtained using the above formula was 323. But to make the study as more representative an extra study subjects were used and the overall sample size was 403. However, because the blood samples of five individuals were discarded due to contamination, the actual sample size used in this study was 398.

Inclusion criteria

Individuals who were permanent residents of the present study area, whose ages > 6 years, without history of hepatitis infection during the past 3 - 4 months at the time of blood sample collection, who were not treated for VL and willing to participate in the study were included.

Sampling techniques and methods of data collection

Sampling was done at every fourth house for this study. The study participants from each study village 'Got' were selected by systematic random sampling technique. Assuming that a minimum of one person per household was used following the inclusion criteria, the total number of sample households per study site was equivalent to the estimated sample size for that study site. Thus, the study participants in each village were selected by choosing every fourth household and those members of the chosen households following the inclusion criteria were kindly requested to provide blood samples for VL examination. In addition, the individual member from the chosen household was requested to fill and return the questionnaire as well.

Questionnaire survey and interviews

A structured questionnaire was first developed in English and then translated into local language (Amharic). The questionnaire was pre-tested using 10% (40) of study participants outside the study area (yifage kebele) before the beginning of the actual survey. Finally, the questionnaire was administered to all (398) sampled household members of the study area in order to obtain information related to

personal information such as age, sex, occupation, level of education and marital status, their KAP related to VL and risk factors of VL such as type of house/roof/floor, presence of cattle shed, education level, migration, occupation, presence of any domestic animals, termite hills, acacia trees, sleeping habit, farming (working) system and others.

Blood sample collection

4 ml of venous blood from the upper surface of the forearm of each study participant was collected using 5 ml sterile disposable syringe by trained laboratory technician to determine the prevalence of visceral leishmaniasis in the study area. A total of 403 blood samples were collected but later 5 blood samples were contaminated and discarded. Name, age, sex, occupation, level of education and village of the participant were recorded on the spot of sample collection and labeled by using a special code. All blood samples were then transported to Addis Zemen Health Center for laboratory test.

Detection of antibody against VL from blood samples using Napier's Formol-Gel test

A total of 398 blood samples were subjected to the Napier's Formol-Gel Test. Each collected blood sample was allowed to clot and later centrifuged for three minutes at 5000rpm. Then after, the serum sample was collected and transferred to nunc tube (serum collection tube) and two drops of concentrated formalin solution [37% formaldehyde (w/v)] was added into it using micropipette. Finally, a gel formation and turning to white was noticed 30 minutes after addition of the concentrated formalin. Results were recorded as positive when the serum was coagulated (gel was formed or solidified) immediately and turned white; otherwise they were considered as negative when serum remains unchanged or coagulation appears after 30 minutes [14]. Immuno-chromatographic strip test (rk39) (Sanken Electric co. Ltd, Tokyo) was used for 26 NFGT positive samples to check and confirm the infection as VL.

Data analysis and quality control

The prevalence of visceral leishmaniasis was analyzed using descriptive statistics. Possible associations between prevalence of VL and socio-demographic characteristics were determined using the chi-square (X^2) test. All data analysis was done using SPSS version 16 software. P-values less than or equal to 0.05 were considered as statistically significant.

All laboratory procedures including collection of blood samples, centrifuging and handling of blood samples were carried out in accordance with standard protocols [15]. Necessary reagents (formalin solution) and blood samples were kept in proper conditions and checked for contamination every time before handling. General safety rules and universal bio-safety precautions were strictly followed at all times [16]. The collected blood samples were transported to Addis Zemen Health Center safely within 24 hours after collection.

Ethical Approval and Consent to Participate

The study was carried out after ethical clearance paper was obtained from Ethical Review Committee of Amhara Regional Government Health Bureau and Libo Kemkem district. Oral informed consent of the participants and their guardians was also obtained from selected household heads and family members after explaining the objectives and the methodology of the study in details.

Results

Socio-demographic characteristics of study participants

Socio-demographic characteristics of the study participants are summarized in Table 2. The male to female ratio was 1:1.07. The mean and median age of the participants was also 29.5 and 28 years, respectively. Majority of the study subjects 61 (15.3%) came from the village Choreye and the least 43 (10.8%) came from the village Medoreye. In addition, majority (25.6%) of the study participants were in the age group of 20 - 34 years old.

Character	No (%)	Character	No (%)
Age (years)		**Villages**	
6 - 12	75 (18.8)	Aba Medoreye	45 (11.3)
13 - 19	91 (22.9)	Choreye	61 (15.3)
20 - 34	102 (25.6)	Gerdim	49 (12.3)
35 - 50	58 (14.6)	Gorguadit	48 (18.1)
≥ 51	72 (18.1)	Guhaye	50 (12.6)
		Medoreye	43 (10.8)
Sex		Ney Bado	51(12.8)
Male	192 (48.2)	Quara	51(12.8)
Female	206 (51.8)		
Occupation		**Duration of stay in the village (years)**	
Farmer	143 (35.9)	≤ 3	19 (4.8)
House worker/house wife	148 (37.2)	4-7	56 (14.1)
Student and cattle keeper	107 (26.9)	8-11	62 (15.6)
		≥12	261 (65.6)
Education		**House type**	
Illiterate	284 (71.4)	Mud and wood walled	314 (78.9)
Primary	77 (19.3)	Mud and stone walled	24 (6)
Secondary	37 (9.3)	Wood only	60 (15.1)
Diploma and above	0 (0%)		

Table 2: *Socio-Demographic Characteristics of Study Participants (n = 398) in Bura Egzi Abhier Ab Kebele, LiboKemkem District, South Gondar, North Ethiopia Character.*

Prevalence of Visceral Leishmaniasis among the study participants of *Bura Egzi Abhier Ab* Kebele

The overall prevalence of visceral leishmaniasis among people living in the study area was 6.5% (26/398). The prevalence of VL amongst male and female study participants was 9.9% (19/398) and 3.4% (7/398), respectively. Variation in the prevalence of VL was noted between males and females. The difference in the prevalence of VL between sexes was statistically significant (x^2 =6.892; p=0.009). The prevalence of VL also varied from 11.8% in the age group 20 - 34 to 1.4 % in the age group > 51years. In general, the prevalence of VL increased steadily from 2.7% in age group 6 - 12 years old to 11.8% in age group 20 - 34 years old and then decreased to 1.4% in the age group > 51years. The difference in prevalence of VL in the age group 13 - 19 was statistically significant between males and females (x^2 = 8.000; p = 0.004) (Table 3).

Age group (years)	Male		Female		Both Sexes		X^2	p-value
	No Exam.	No Pos. (%)	No Exam.	No Pos. (%)	No Exam.	No Pos. (%)		
6 - 12	36	0	39	2 (5.1)	75	2 (2.7)	1.897	.168
13 - 19	44	7 (15.9)	47	0	91	7 (7.7)	8.00	.004*
20 - 34	52	8 (15.3)	50	4 (8)	102	12 (11.8)	1.339	.247
35 - 50	26	3 (11.5)	32	1(3.1)	58	4 (6.9)	1.581	.209
> 51	34	1 (2.9)	38	0	72	1 (1.4)	1.331	.287
All age groups	192	19 (9.9)	206	7 (3.4)	398	26(6.5)	6.892	0.009*

Table 3: *Prevalence of Visceral Leishmaniasis by Age and Sex of the Study Participants as Detected by Napier's Formol-Gel Test in Bura Egzi Abhier Ab Kebele, LiboKemkem District, South Gondar, North Ethiopia.*

** = statistically significant (P < 0.05)*

Variation in the prevalence of VL was noted between occupations. Farmers showed the highest prevalence of VL, 17 (11.9%), while house workers/house wives showed the least, 3 (2%). The difference in NFGT positivity between occupations was also statistically significant ($x^2 = 11.788$; $p = 0.003$ which is $P < 0.05$).

Factors associated with occurrence of visceral leishmaniasis in the study area

The risk factors for acquiring visceral leishmaniasis were assessed using questionnaire respondents. The risk factors that were assessed in this study include: environmental and behavioral factors like, housing type; presence of termite hill near their house and work place; presence of acacia trees; habit of sleeping outside the house; occupation; knowledge of symptoms and transmission of VL; migration to endemic areas and sleeping under acacia trees (Table 4).

Out of the 398 participants 227 responded that, there were termite hills near their houses and working places. Of these 22 (9.7%) were found positive for VL infection. On the other hand, 171 of the participants responded that there were no termite hill near their house and working place. Of these, only 4 (2.3%) were positive for VL infection. The presence of termite hill near the houses and working places was significantly and positively associated with VL ($x^2 = 8.635$, $p = 0.003$). The odds ratio was 5.148 (95% CI = 1.4 - 19) for those who had termite hill near their house and working place compared with the risk for those that do not have termite hill near their house and working place.

Sleeping habit and occupation was the other risk factors identified (Table 4). Out of 228 who have the habit of sleeping outdoors 23 (10.1%) were positive and from 143 who were farmer 17 (11.9%) were positive while from148 who were house worker/house wife only 3 (2%) were positive. The relationship of sleeping habit and occupation with VL infection was statistically significant ($x^2 = 11.049$, $p = 0.001$ and $x^2 = 11.789$, $p = 0.003$), respectively.

Individual who have history of Migration to endemic area and Presence of VL infected family members was also analyzed where, 101of the study participants have history of Migration to endemic area, 14 (13.9%) were positive. On the other hand, 114 of the study participants who had VL infected family members 12 (10.5%) were positive for VL infection. For both factors, the relationship is statistically significant ($x^2 = 11.906$, $p = 0.001$ and $x^2 = 4.173$, $p = 0.041$) respectively.

	Visceral Leishmaniasis		Statistics			
Risk factors	**Nϱ pos. (%)**	**Nϱ Neg. (%)**	**OR**	**95% CI**	**X^2**	**P-value**
A. Environmental Factors						
1.House type(wall)						
Mud and wood	21 (6.7)	293 (93.3)	.417	.086-2.023	1.318	.517
Mud and stone	1(4.2)	23 (95.8)	.928	.046-18.84		
Wood only	4 (3.8)	56 (93.3)				
2.Presence of termite hill						
Yes	22(9.7)	205 (90.3)	5.148	1.39-19.03	8.635	.003*
No	4 (2.3)	167 (97.7)				
3.Presence of acacia trees						
Yes	17 (5.2)	307 (94.8)	.259	.061-1.105	3.306	.069
No	9 (12.2)	65 (87.2)				
4.Presence of domestic animals						
Yes	25 (6.4)	367 (93.6)	.380	.002-72.90	.137	.712
No	1(16.7)	5 (83.3)				
5.Presence of cattle shed						
Yes	1(2.9)	34 (97.1)	.219	.016-3.007	1.568	.211
No	25 (6.9)	338 (93.1)				
6.Presence of VL infected family members						
Yes	12(10.5)	112 (89.5)	1.537	564-4.189	4.173	0.041*
No	14(4.9)	260 (95.1)				
B. Behavioral Factors						
1.Sleeping habit						
Indoor	3 (1.8)	167 (98.2)	.160	.047-.543	11.049	.001*
Outdoor	23 (10.1)	205 (89.9)				
2.Sleeping under acacia trees						
Yes	4 (2.4)	161(97.6)	.415	.101-1.701	1.643	.200
No	22 (9.4)	211(90.6)				
3.Migration to endemic area						
Yes	14 (13.9)	87 (86.1)	3.349	1.298-8.64	11.906	.001*
No	12 (4)	285 (96)				
4.Knows VL symptoms						
Yes	1(5)	19 (95)	7.409	.50-110.69	1.695	.193
No	25 (6.6)	353 (93.4)				
5.Knows about VL transmission						
Yes	1(1.8)	54 (98.2)	.290	.019-4.449	.969	.325
No	25 (7.3)	318 (92.8)				
6. Occupation						
Farmer	17 (11.9)	126 (88.1)	3.380	.798-14.32		
House worker/house wife	3 (2)	145 (98)			11.788	.003*
Students and cattle keeper	6 (5.6)	101(94.4)	1.776	.384-8.204		

Table 4: Association between risk factors and the prevalence of visceral leishmaniasis in study area, June-July 2013.
** = statistically significant (P < 0.05).*

Discussion

The overall prevalence of visceral leishmaniasis among people living in the study area was 6.5% based on NFGT and as confirmed by immuno-chromatographic strip test (rk39) (Sanken Electric co. Ltd, Tokyo) which is lower than that of a study conducted by Kebede [17] in Bira Abo Kebele of Libo Kem kem Woreda, by [18] in India and by [19] in Bangladesh in which the overall prevalence of VL was shown

as 8.4%, 14%, and 35%, respectively. The variability between studies might be due to differences in the time of data collection, where in this study, the entire prevalence data was collected during the summer season and endemicity of areas. In a previous study conducted by [20] it had been indicated that VL transmission was associated with dry season and the cases reached peak in Metema and Humera (north Ethiopia) just after the rainy season.

The prevalence of VL amongst male study participants (9.9%) was greater than female (3.4%). The variation in the prevalence of VL by sex implies difference in exposure of males and females due to occupational differences. The present study showed that males were affected more than females which were similar to what has been reported by [17], 72.2% male and 27.8% female; and [21], 1.78% male and 0.3% female. This finding also in agreement with the finding of [22,23] in which VL infection in boys being higher than in girls (13.9% versus 6.1%; P = 0.001) and men contracted the disease more than women (58%). This study in line with study by [24,25] in which majority of VL cases in Ethiopia occur in males, a pattern caused by increased exposure to the sand fly vector during agricultural work and other field works and the cumulative prevalence was higher among men (9.7%) than women (4.5%; $P < 0.05$).

The prevalence of VL also varied from 11.8% in the age group 20 - 34 to 1.4 % in the age group > 51years. The variation in the prevalence of VL among age also implies difference in exposure for the disease due to agricultural activities like herding cattle, farming and migration to other areas. The present study showed difference in prevalence of VL between young and adult individuals. This finding was similar to that of [21] who reported the highest prevalence of VL in children older than 12 years (2.56%). The low prevalence of visceral leishmaniasis in older and young children was probably due to a lower level of exposure to the bite of sand fly, less frequent habit of outdoor sleeping. A recent study by [7] on risk factors associated the outbreak of VL in Libo Kemkem was to habitual outdoor-sleeping. This finding in line with the findings by [28] in which low occurrence of leishmaniasis positivity in the youngest members of the study community possibly indicates an outdoor exposure to the bite of infected sandfly.

Farmers showed the highest prevalence of VL, 17 (11.9%), while house workers/house wives showed the least, 3 (2%) which tells us the existence of variation in the prevalence of VL between occupations. The prevalence of VL in the present study was similar to that reported by [17] in which more than half of the farmers, 58 (53.7%), were found to be VL positive. The variation between occupations probably arose from the exposure of participants to the vector during field work (agricultural works), herding livestock at the time of bask and migration to endemic areas. In this regard, [7] had also suggested that agricultural workers returning from Humera and Metema might have introduced the disease to agricultural areas of the Amhara Region.

The risk factors for acquiring visceral leishmaniasis were assessed in table 4. These were environmental and behavioral factors like, housing type; presence of termite hill near their house and work place; presence of acacia trees; habit of sleeping outside the house; occupation; migration to endemic areas and sleeping under acacia trees. These sites are the breeding habitats for the sand flies that transmit the disease.

Presence of termite hill near their house and working place have an association with the prevalence of VL which is comparable with a study conducted in East Africa (Kenya and Uganda) where odds ratio was 2.06 (95% CI, 0.68 - 6.23) [27]. Previous study reported by [28,29] in Ethiopia identified factors like proximity to termite hills as a great association with increased VL risk. This finding also agrees with the finding of [30] where a pilot entomologic study termite mounds as an important *leishmania* vector breeding and resting sites. The practice of sitting on termite mounds while guarding livestock could also increase the risk of infection.

Migration to endemic area, occupation, habit of sleeping outside house and VL infected individual, all have revealed strong association with the prevalence of VL in this study. This findings in line with the finding by [31] in which, outdoor night activities (sleeping) were associated with VL infection ($p = 0.002$). The study agrees with that of [23] where sleeping outside and proximity to VL patients as having a greatest risk factors. VL in the area predominantly affects young male migrant workers, who tend to sleep outdoors thereby increasing their exposure [32]. Sleeping outside was associated with an increased risk of VL [27]. Presence of acacia tree near house (81.7%), Sleeping near animals and outside house was associated with an increased risk of VL (80.6%) [33]. Ownership of insecticide-treated nets which could protect individuals from sand fly bites and reduce kala-azar transmission was low [29].

Authors' contribution

WA, SM, AK and FG conceived the idea and designed the study; WA collected the data; WA and FG analyzed the data; FG drafted the research findings into manuscript. All authors proofread, commented and approved the final manuscript.

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Conclusion

Prevalence of VL is significant in males, farmers and young adults (20 - 34 years). The presence of termite hill, outdoor sleeping habit, migration to endemic area, presence of VL infected family members and risky working site were strongly associated with prevalence of VL. Hence, immediate establishment of sound control program, strengthened behavioral change communication and social mobilization related activities are vital to minimize leishmaniasis infection.

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