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Prevalence and associated factors of human leishmaniasis in Amudat district, Uganda

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ABSTRACT
Leishmaniasis is endemic in Uganda and most commonly found in the remote areas of the Karamoja sub-region. Despite efforts put in by the government and other non-governmental organizations in the fight against human leishmaniasis, the disease remains one of the major health challenges in the Karamoja sub-region, where Amudat district is inclusive, with no leishmaniasis burden and associated factors clearly understood. Thus, in this study, we aimed to determine the prevalence of leishmaniasis and its associated factors among patients receiving healthcare services in Amudat district healthcare facilities. STATA software version 14 was used for descriptive data analysis and Ashur's scale to assess participants' knowledge. A total of 200 study participants were purposively sampled and recruited from 10 health facilities in Amudat district. Of the 200 capillary blood samples collected from the participants and screened for leishmaniasis, 18 tested positive by serology (rK39), and only 11 were confirmed positive by bone marrow microscopy, giving a leishmaniasis prevalence of 5.5% (11/200), with males being the most affected at 4.0% (8/200) and females at 1.5% (3/200). The low level of disease awareness and livestock grazing in sandfly-infested areas are associated with the widespread spread of leishmaniasis. Information regarding community knowledge levels on transmission and prevention is crucial for disease control, as human leishmaniasis is a public health concern, particularly in Amudat district.

Keywords: Occurrence; Leishmaniasis; causes; Amudat; Uganda

INTRODUCTION
Human Leishmaniasis is a vector-borne disease that is transmitted by sandflies and caused by obligate intracellular protozoa of the genus *Leishmania* (Steverding, 2017). According to the World Health Organization (WHO), it is classified as one of the neglected tropical diseases (NTDs) affecting poor people in low- and middle-income countries, and it manifests in three different clinical forms: cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis (MCL), and visceral leishmaniasis (VL) (Anversa et al., 2018). In Uganda, leishmaniasis has been endemic, mainly in the Karamoja sub-region, where Amudat district is one of them. The semi-arid climatic conditions, together with the lifestyle of the occupants

in this sub-region of Uganda, which is basically nomadic pastoralism in nature, favor the breeding of sandflies and the transmission of the disease (Tidman et al., 2021).

The disease has a worldwide distribution, affecting many countries on the continents of Asia, Europe, and Africa. In Europe, leishmaniasis prevalence has been reported at 29% in Italy (Bruno et al., 2022), 15.6% in Spain (Alcover et al., 2021) and 6.9% in Greece (Theocharidou et al., 2019), while in Spain, the disease prevalence of 20.7% was reported (Ibarra-Meneses et al., 2019) and the disease is linked to environmental changes, such as those caused by deforestation, construction of dams, irrigation schemes, and climate change. According to one of the cross-sectional surveys conducted by (Piyaraj et al., 2018) in southern Thailand Asia, established leishmaniasis had a prevalent rate of 25.1% among the study participants. In Africa, leishmaniasis prevalence stands at 41.8% in Ghana (Akuffo et al., 2021), 9.13% in Ethiopia (Haftom et al., 2021), 12.5% in southern Sudan (Salih et al., 2020), 31.4% in Kenya (Kanyina, 2020), 4.35% in Somalia (Sunyoto et al., 2017), and 5.41% in Uganda (Sagaki, 2022). However, most of these leishmaniasis studies in Africa have not established the possible factors for leishmaniasis occurrence, so this study aimed at addressing this missing gap.

Previous studies have demonstrated leishmaniasis to be associated with poor household characteristics, a low level of education, lack of cleanliness in the surrounding environment, and poor awareness about the disease (Kasili et al., 2016). Housing conditions such as cracked walls, dark humid corners, damp floors, and mud-plastered walls, which permit the easy entry, resting, and breeding of sand flies, are known to increase the risk of infection for the occupants (Nazari et al., 2017). Furthermore, a study from Kurunagala, Sri Lanka, reveals that poor awareness of insect vector behavior measures against the disease due to a poor level of education is also associated with a high risk of acquiring the infection (Wijerathna et al., 2020).

In Uganda, there is limited information about the possible factors linked to the occurrence of leishmaniasis in the country. Understanding the prevalence of leishmaniasis and its associated factors is important for the control of this disease in any endemic area. However, such vital information is missing in an endemic area like Amudat district.

Thus, in this study, we aim to determine the prevalence rate of leishmaniasis and its associated factors in the Amudat district to avail the district authorities with information that can help in planning and guiding resource allocation needed in the fight against the disease in the district.

MATERIALS AND METHODS

Study area and design

A descriptive cross-sectional hospital-based study was carried out between March to April 2023. This sampling period (March –April) was chosen because of the high number of expected patients due to the high human movement during the dry season. Amudat district has ten (10) healthcare facilities in total and all of them were considered for this study to give the whole district coverage. These ten healthcare facilities from which participants were sampled included Amudat Hospital, Karita HCIV, Loroo HC III, Abilyep HC III, Katabok

HC III, Kosike HC III, Achorichor HC II, Amudat Town Council HC II, Alakas HC II, and Lokales HC II. Amudat district is located in the Karamoja sub-region, in Northern Uganda. It is bordered by Moroto district to the north, the Republic of Kenya to the east, Bukwa district and Kween district to the south, and Nakapiripirit district to the west (Figure 1).

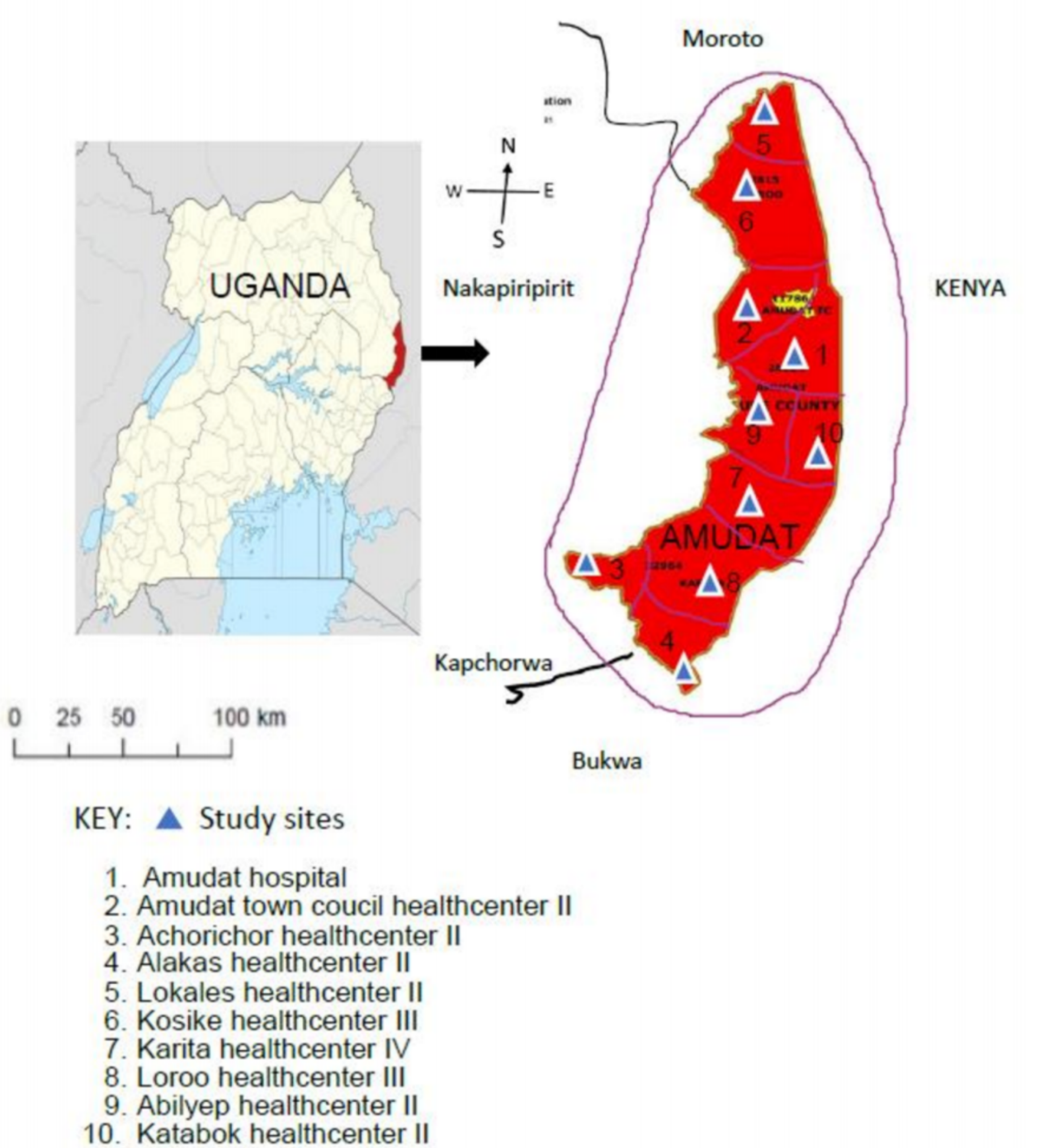

Fig. 1. A map of Uganda showing Amudat district and the study sites.

Study population and sample size

The target population included both male and female patients seeking healthcare services in Amudat district health care facilities and have met the case definition of Leishmaniasis (prolonged irregular fever of two or more weeks with no response to a full course of anti-malarial treatment and/or splenomegaly and weight loss). The sample size was estimated using the Kish formula (Kish, 1965), taking a precision of +/- 0.05 at 95% level of confidence. The expected prevalence of 17.2% (Olobo-Okao and Sagaki, 2014) was used to calculate the sample size. A total of 220 study participants were planned for the study, taking into consideration those who decline to take part in the research. Of the planned sample size, only 200 participants accepted to be part of this study and gave their consent to participate in it.

Sampling technique

A Consecutive non-probability sampling technique was used to recruit the participants for this study. Participants were first interviewed following the case definition of leishmaniasis. Only those that met the inclusion criteria (Fever of two or more weeks with no response to a full course of anti-malarial treatment, or splenomegaly and weight loss) and were conveniently available at the time of data collection were all included into the study.

Sample collection and processing

Twelve (12) μl of capillary blood sample was aseptically collected by finger prick from each of the consented study participants and tested with the Bio-Rad IT LEISH rapid dipstick for *Leishmania* antibodies following the recommended protocol by the manufacturer (Bio-Rad Diagnostic solutions). Bone marrow Aspirates (BMA) were aseptically collected by a trained clinician. Thin BMA smears were made and stained following the rapid modified field's technique (Bioresearch BS003 field stain) and examined microscopically for *Leishmania* amastigotes.

Data analysis and management

The collected data was entered into an MS Excel spreadsheet; cross-checking and data cleaning was done, and the data exported to STATA software version 14 for analysis. Descriptive data was presented in the form of charts, graphs, tables, and bar graphs. The prevalence of leishmaniasis was calculated as the total number of participants infected with the *Leishmania* parasite divided by the total number of participants recruited into the study and multiplied by 100%.

The possible associated factors of *Leishmania* infections were analyzed using both univariate and multivariate logistic regression analysis. Factors that were statistically significant by univariate analysis ($p < 0.25$) were included in the multivariate analysis to eliminate confounding factors. The odds ratio (OR) and 95% confidential interval (CI) were calculated for both univariate and multivariate analyses. Factors indicating $p \leq 0.05$ by multivariate analysis were considered associated factors for *Leishmania* infection. For the level of knowledge about leishmaniasis, Ashur`s scale of knowledge assessment (Ashur, 1977) was used.

Ethical considerations

The study was approved by the Research Ethics Committee (REC) of Mbarara University of Science and Technology (MUST-2022-722). Clearance was obtained from Faculty Research Committee (FRC) of Mbarara University of Science and Technology and the Department of Medical Laboratory Science Research Committee. In addition, permission from the District Health Officer of the Amudat district was obtained. Furthermore, written informed consent was obtained from the patients using Assent and consent forms before enrolment, and confidentiality was assured to each study participant.

RESULTS

Socio-demographic characteristics of the study participants

A total of 200 study participants were recruited from the ten healthcare facilities. Of the recruited participants, 49.0% (98/200) were male and 51.0% (102/200) were female. A majority of study participants were in the age group of less than 19 years 25.0% (50/200). Unmarried participants were more compared to the married ones 51.5% (103/200) versus 48.5% (98/200). Most participants 46.0% (92/200) had not attained any form of education. Of the 11 sub-counties, Amudat sub-county had the highest number of study participants 15% (30/200) and the majority 85.0% (170/200) of the participants were Christians (Table 1).

Table. 1. Socio-demographic characteristics of the study participants (n=200).

Characteristics number	Categories	Number (n)	Percentage (%) of the total
Gender:	Female	102	51.0
	Male	98	49.0
Age (years):	<19	50	25.0
	20-29	44	22.0
	30-39	46	23.0
	40-49	33	16.5
	50+	27	13.5
Marital status:	Married	97	48.5
	Not married	103	51.5
Place of residence (sub-county):			
	Abilyep	24	12.0
	Achorichor	16	8.0
	Amudat town council	21	10.5
	Amudat	30	15.0
	Kangrok	15	7.5
	Karita	12	6.0
	Karita town council	10	5.0
	Katabok	19	9.5
	Lokales	22	11.0
	Loroo	20	10.0
	Losidok	11	5.5
Education level:	No formal education	92	46.0
	Nursery	8	4.0
	Primary	73	36.5
	Secondary	20	10.0
	Tertiary	7	3.5
Religion:	Christian	170	85.0
	Muslims	21	10.5
	Others	9	4.5

Laboratory analysis findings

Of the 200 participants tested serologically for *Leishmania* antibodies, 9.0% (18/200) tested positive, while 91% (182/200) were negative. On microscopy, 5.5% (11/200) tested positive, and 94.5% (189/200) negative as shown in Table 2.

Table. 2. Serology (Dipstick, rK39) and Bone marrow Microscopy laboratory findings.

Test	Positive n (%)	Negative n (%)	Total
Dipstick (rK39)	18 (9.0)	182 (91.0)	200
Microscopy (BMA)	11 (5.5)	189 (94.5)	200

rK39: recombinant Kinase 39 enzyme, BMA: Bone Marrow Aspirate

Prevalence of human leishmaniasis among the study participants in the Amudat district health facility

The overall prevalence of leishmaniasis in the study was computed by dividing the total confirmed positive cases on bone marrow microscopy by the total number of study participants. An overall leishmaniasis prevalence rate of 5.5% (11/200) was established in this study (Figure 2), with the infection rate among the male and female study participants being 4.0% (8/200) and 1.5% (3/200), respectively (Figure 3). Participants in the age group of 20–29 years had the highest *Leishmania* infection rate of 2.5% (5/200), followed by those below 19 years old at 1.5% (3/200). No infection was detected among those above 50 years old (Figure 4). Amudat sub-county had the highest number of participants infected with *Leishmania* parasites than any other sub-county, 3.0% (6/200) (Figure 5).

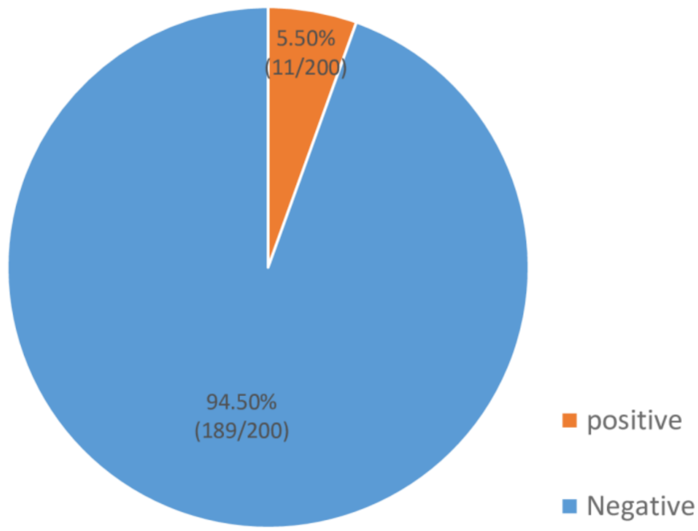

Fig. 2. A pie chart showing the overall leishmaniasis prevalence among study participants receiving healthcare services in Amudat district healthcare facility.

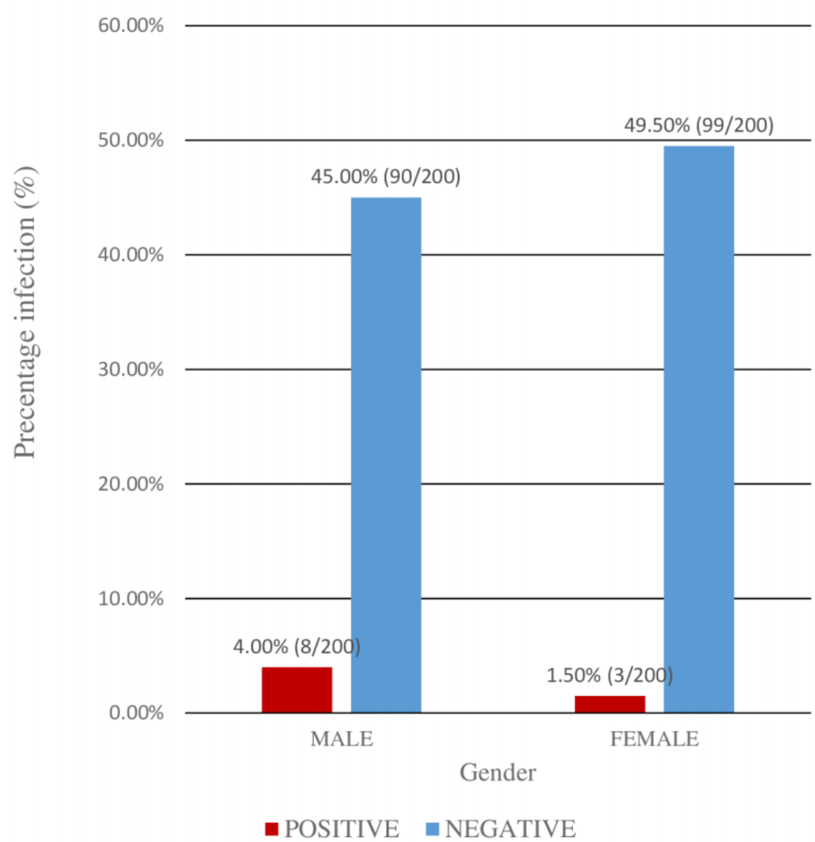

Fig. 3. A bar graph showing the distribution of leishmaniasis by gender among the study participants.

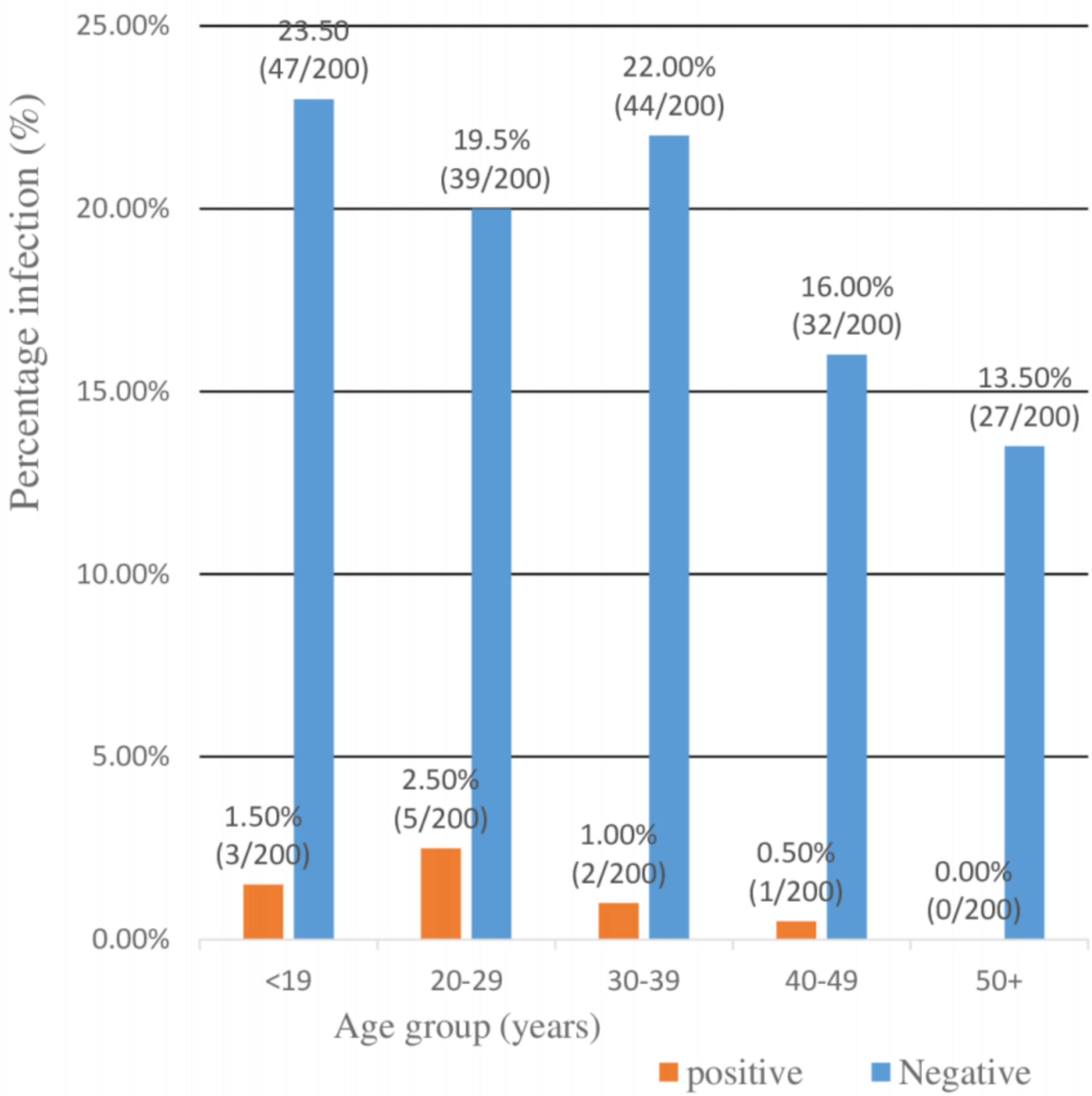

Fig. 4. A bar graph showing the distribution of leishmaniasis by age group among study participants.

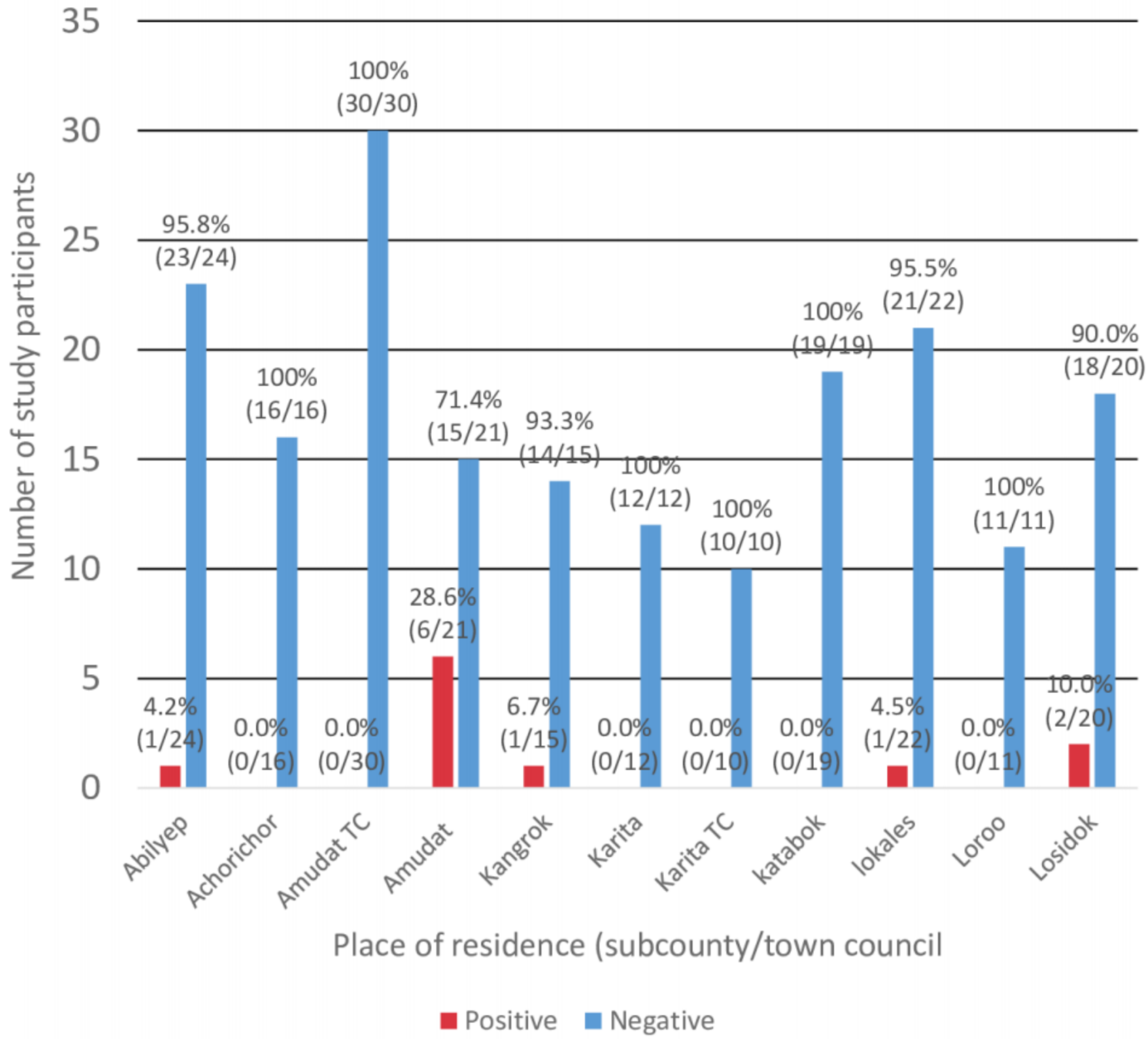

Fig. 5. A bar chart showing the distribution of leishmaniasis by place of residence among study participants.

Associated factors for human leishmaniasis in the Amudat district

The possible associated factors for human leishmaniasis were assessed using both univariate and multivariate logistic regression analysis.

Univariate analysis

At the univariate level, factors with a p-value of less than 0.25 were considered statistically significant. Presence of animal kraals or yards near homesteads (200m), livestock keeping as an occupational activity, age, gender, marital status, the presence of Ant-hills near homesteads (200 meters), and malnutrition as defined by the Body Mass Index (BMA) were all statistically significant at the univariate analysis model (Table 3).

Table. 3. Univariate analysis of the factors associated with Leishmaniasis in the Amudat district.

Variable	Leishmaniasis Uninfected n(%)	Infected n (%)	cOR (95% CI)	p-value
Age (in years)				
<19 years	46 (24.3)	3 (27.3)	Ref.	
20-29	40 (21.2)	5 (45.4)	1.97 (0.44-8.75)	0.211*
30-39	44 (23.3)	2 (18.2)	1.69 (0.11-4.37)	0.700
40-49	32 (16.9)	1 (9.1)	0.48 (0.05-4.82)	0.532
50+	27 (14.3)	0 (0.0)	1 (empty)	
Gender				
Male	90 (47.6)	8 (72.7)		
Female	99 (52.4)	3 (27.3)	0.34 (0.09-1.32)	0.120*
Marital status				
Not married	94 (49.7)	8 (72.7)		
Married	95 (50.3)	3 (27.3)	0.38 (0.10-1.47)	0.161*
Level of Education				
No formal education	87 (46.0)	6 (54.5)	Ref.	Ref.
Nursery	8 (4.2)	0 (0.0)	1 (empty)	
Primary	67 (35.4)	5 (45.5)	1.56 (0.46-5.32)	0.479
Secondary	20 (10.6)	0 (0.0)	1 (empty)	
Tertiary	7 (3.7)	0 (0.0)	1 (empty)	
Occupation				
Business	19 (10.1)	1 (9.1)	Ref.	
Livestock keeping	76 (40.2)	6 (54.5)	3.82 (1.64-4.19)	0.015*
Farming/crop	60 (31.7)	3 (27.3)	1.1 (0.71-20.67)	0.906
Employed	16 (8.5)	0 (0.0)	1	
Others	18 (9.5)	1 (9.1)		
Nutritional status (BMI)				
Healthy	110 (58.2)	1 (9.1)	Ref.	
Malnourished	79 (41.8)	10 (90.9)	20.37 (2.54-2.61)	0.005*
House type				
Mud and wattle	101 (53.4)	7 (63.6)	Ref.	
Bricks & mud houses	17 (9.0)	0 (0.0)	1 (Empty)	
Plastered houses	11 (5.8)	1 (9.1)	1.31 (0.15-11.67)	0.808
Non plastered house	60 (31.7)	3 (27.3)	0.72 (0.18-2.89)	0.645
Household size				
1-5 members	76 (40.2)	5 (45.4)	Ref.	
6-10 members	86 (45.5)	5 (45.4)	0.56 (0.06-5.04)	0.607
>11 members	27 (14.3)	1 (9.1)	0.88 (0.25-3.17)	0.850
Presence of Ant-hills near homesteads				
No	42 (22.2)	1 (9.1)	Ref.	
Yes	147 (77.8)	10 (90.9)	4.86 (1.36-2.96)	0.012*
Grazing livestock				
No	86 (45.5)	1 (9.1)	Ref.	Ref.
Yes	103 (54.5)	10 (90.9)	8.35 (2.15-3.21)	0.045*
Presence of animal kraals/yards near homesteads (200m)				
No	76 (40.2)	4 (36.4)	Ref.	
Yes	113 (59.8)	7 (63.6)	2.11 (1.52-4.34)	0.204*

BMI-Body mass Index cOR-Crude odds Ratio, Ref-Reference Category.

Multivariate analysis

At the multivariate analysis, variables that were statistically significant at the univariate level were included for multivariate logistic regression analysis. The adjusted odds ratios (aOR) and the p-values for each variable were recorded. Variables with $p \leq 0.05$ were considered to be statistically significant at the multivariate analysis as shown in Table 4. Five variables were statistically significant with *Leishmania* spread at this level: grazing of livestock (aOR=12.26, 95% CI=1.04-1.42, p=0.041), nutrition (aOR=22.17, 95% CI=1.92-2.68, p=0.013), age (aOR=3.67, 95% CI=0.56-24.12, p=0.014), occupation (livestock keeping) (aOR=13.43, 95% CI=0.26-2.31, p=0.012), and presence of ant-hills near homesteads (200m) (aOR=6.04, 95% CI=1.09-2.12, p=0.034) (Table 4).

Table. 4. Multivariate analysis of factors associated with Leishmaniasis among patients receiving healthcare services in the Amudat district healthcare facility.

Variable	*Leishmania* status		aOR (95% CI)	p-value
	Uninfected n(%)	Infected n (%)		
Gender				
Male	90 (47.6)	8 (72.7)	Ref.	
Female	99 (52.4)	3 (27.3)	0.41 (0.75-2.15)	0.286
Age groups (years)				
<19 years	46 (24.3)	3 (27.3)	Ref.	
20-29	40 (21.2)	5 (45.4)	3.67 (0.56-24.12)	0.014
30-39	44 (23.3)	2 (18.2)	2.62 (0.14-19.192)	0.176
40-49	32 (16.9)	1 (9.1)	1.18 (0.14-16.01)	0.471
50+	27 (14.3)	0 (0.0)	1	
(empty)				
Marital status				
Married	94 (49.7)	8 (72.7)	Ref.	
Not married	95 (50.3)	3 (27.3)	0.33 (0.05-2.32)	0.268
Occupation				
Business	19 (10.1)	1 (9.1)	Ref.	
Livestock keeping	76 (40.2)	6 (54.5)	13.43 (0.26-2.31)	0.012*
Farming/crop	60 (31.7)	3 (27.3)	2.31 (0.16-32.75)	0.536
Employed	16 (8.5)	0 (0.0)		
Others	18 (9.5)	1 (9.1)	1.26 (0.13-28.51)	0.481
Nutritional status(BMI)				
Healthy	11 (58.2)	1 (9.1)	Ref.	
Malnourished	79 (41.8)	10 (90.9)	22.17 (1.92-2.68)	0.013*
Presence of animal yards near homesteads (200m)				
No	76 (40.2)	4 (36.4)	Ref.	
Yes	113 (59.8)	7 (63.6)	0.57 (0.08-3.95)	0.568
Grazing livestock				
No	86 (45.5)	1 (9.1)	Ref.	
Yes	103 (54.5)	10 (90.9)	12.26 (1.04-1.42)	0.041*
Presence of ant-hills near homesteads				
No	42 (22.2)	1 (9.1)	Ref.	
Yes	147 (77.8)	10 (90.9)	6.04 (1.09-23.12)	0.034*

*: Denotes statistically significant variables ($p \leq 0.05$), aOR: adjusted Odds Ratio, Ref: Reference category.

Participants' knowledge level about leishmaniasis

The participants' knowledge level about leishmaniasis was assessed using Ashur's scale of knowledge assessment (1977). Participants were asked questions about transmission mode, insect vector, risk population, biting time for sandflies, resting and breeding sites for sandflies, identification of sandflies, signs and symptoms for leishmaniasis, and prevention measures. The responses were categorized into correct or incorrect responses. The percentage of each response (correct or incorrect) was calculated (Table 5). A correct response score of less than 40% is an indicator of a low knowledge, 41–59% average, 60–80% high, and above 81% a very high knowledge level. Participants' knowledge levels on leishmaniasis was generally low, as indicated by an average value of 36.1%, which is below 40% according to Ashur's scale of knowledge assessment. A majority 71.5% (143/200) of the participants had never heard about the disease, 56.5% (113/200) didn't know the vector, 69.5% (139/200) never knew the biting time for sandflies, 75.5% (151/200) had no idea on breeding sites for sandflies, 97.0% (194/200) could not identify sandflies, 73.5% (147/200) failed to correctly tell the signs and symptoms for leishmaniasis, and 64.5% (129/200) of them were unable to correctly tell the control measures for leishmaniasis. Participants were knowledgeable on average about the disease only in the aspect of knowing sandflies as its vector 43.5% (87/200) as indicated by the correct response scores (Table 5).

Table. 5. Study participants' knowledge level about Leishmaniasis.

Variable aspect of Leishmaniasis tested	**Response**			
	Correct		**incorrect**	
	Frequency	percent (%)	Frequency	percent (%)
a. Heard about Leishmaniasis	57	28.5	143	71.5
b. Mode of transmission	123	61.5	77	38.5
c. Insect vector for Leishmaniasis	87	43.5	113	56.5
d. Biting time of insect vector	61	30.5	139	69.5
e. Breeding sites for insect vector	49	24.5	151	75.5
f. People at risk for leishmaniasis	161	80.5	39	19.5
g. Identification of sand-fly	6	3.0	194	97.0
h. Signs & symptoms	53	26.5	147	73.5
i. Prevention & control measures	71	35.5	129	64.5
Average value		**36.1**		**63.9**

DISCUSSION

The prevalence of Leishmaniasis in this study was 5.5% (11/200). This finding is in agreement with a study done in Moroto, Northern Uganda, with leishmaniasis prevalence rate of 5.41% (Sagaki, 2022). This could be attributed to the similarities in the study designs and diagnostic methods used. However, our prevalence result was lower than those of the previous studies within other regions of the world. A study in Italy with 29% prevalence (Bruno et al., 2022), Spain (15.6%) (Alcover et al., 2021) , Greece (6.9%) (Theocharidou et al., 2019) , Sudan (21%) (Ahmed et al., 2022), Ethiopia (9.13%) (Amare et al., 2023), Kenya

(31.4%) (Kanyina, 2020), Thailand, Asia (25.1%) (Piyaraj et al., 2018), West Africa, Ghana (41.8%) (Akuffo et al., 2021), Spain (20.7%) (Ibarra-Meneses et al., 2019), provinces of Qassim, Saudi Arabia (49.5%) (Rasheed et al., 2019), Yemen (18.5%) (Alkulaibi et al., 2019), and Texas, USA (32%) (McIlwee et al., 2018). The differences in the findings could be attributed to larger sample sizes, laboratory diagnostic methods used, study design, geographical climatic conditions, socioeconomic status, and level of awareness about leishmaniasis among the study participants. Our study also revealed that *Leishmania* infection was relatively higher amongst males 4.0% (8/200) than females 1.5% (3/200). This may perhaps be due to the social predisposition and lifestyles differences between the males and females that puts them at risk for acquiring *Leishmania* infection. In the Amudat district, most of the Pokot men are engaged in pastoralist activities, grazing their animals in sandfly-infested fields, thus increasing their chances of exposure to sandfly bites. This finding of males being more infected than the females is consistent with those reported from previous studies in Kenya (Dulacha et al., 2019) and Sudan (Ahmed et al., 2022). However, other similar study surveys in other regions do not agree with these findings. In Chiang Rai, Thailand, Asia, a similar study showed that females have higher chances of contracting *Leishmania* infection than the male counterparts (Sriwongpan et al., 2021). This higher chance of leishmaniasis infection in females than males is possibly due to the fact that females spent most of their times at home doing domestic work like collecting fire wood and water that exposes them to breeding and resting sites of sand flies.

Regarding the associated risk factors for Leishmaniasis in the Amudat district, this current study survey established that animal grazing, malnutrition, socio-economic activities (pastoralism), and anthills near homesteads (200 meters) were the possible causes for the existing human Leishmaniasis in the Amudat district. The presence of termites' molds (anthills) within 200 meters of the homestead was found to increase the likelihood of contracting Leishmaniasis by 6.04 times higher. This may be due to the fact that anthills (termite hills), especially the dormant ones, act as habitats, hiding places, and breeding sites for sandflies. Similar findings have been reported from studies done in Sudan (Collis et al., 2019), Oromia region of Ethiopia (Ketema et al., 2022), and Baringo, Kenya (Kiptui et al., 2021), where the presence of anthills near the participants' homesteads was found to increase the odds of being infected with Leishmaniasis. According to this study, malnutrition has been statistically associated with higher odds (22.17 times) for *Leishmania* infection. This is because malnutrition reduces the body's immune status, leading to host susceptibility and pathophysiologic severity to infection. Furthermore, a similar finding was reported in Nigeria by (Abdullahi et al., 2018) where individuals who were malnourished were found to be the most affected by leishmaniasis than the healthy ones. The findings in this study further indicated a significant relationship between the grazing of livestock and infection with *Leishmania* parasites. Individuals who had been involved in the grazing of animals had 12.3 times higher chances of developing leishmaniasis than those not involved in the grazing of animals. The same findings have been reported by the previous studies in Turkana County, Kenya, and Moroto, Uganda, by (Lotukoi, 2020) and (Sagaki, 2022), respectively.

The knowledge level of the study participants about leishmaniasis in the current study was found to be low (36.1%) as per Ashur's scale of knowledge assessment, which defines any correct response of 0–40% as having low levels of knowledge. Most of the participants were found unable to answer correctly the questions related to insect's breeding sites 24.5% (49/200), biting time 30.5% (61/200), and sandflies identification 3.0% (6/200), disease signs and symptoms 26.5% (53/200), prevention and control measures for leishmaniasis. The knowledge levels of the participants about the disease mode of transmission and its vector were found to be at average levels (41–59%) as per Ashur's scale, with only 43.5% (87/200) of them able to know sand flies as the vectors for leishmaniasis. These findings are consistent with those observed in Sudan (Al-Salem et al., 2016), Pakistan (Irum et al., 2021), Brazil (Margonari et al., 2020), and Chad (Kodindo et al., 2021), where a majority of the study participants 61.2% (294/480) were well-informed about the role of the sandflies in transmitting leishmaniasis, but most lacked knowledge on the vector's behavior, and nearly a quarter 24.5% (118/480) couldn't answer when asked about appropriate control measures. On the other hand, the findings in this present study showed a higher knowledge rate (60–80%) in terms of transmission mode 61.5% (123/200) and the population vulnerable to leishmaniasis 80.5% (161/200). The differences in knowledge level are attributed to the increase in health education regarding the disease in the current study and the previous ones.

CONCLUSIONS

Human leishmaniasis remains a health challenge in the Amudat district, with a prevalence rate of 5.5% (11/200), and affects mostly the livestock keepers that are involved in grazing livestock in sandflies infested fields. The presence of anthills within 200 meters of the homesteads and malnutrition are the associated factors for the disease spreading in the district. Participants' knowledge levels of leishmaniasis were generally low. Thus, there is a need to address this challenge to reduce the disease burden.

RECOMMENDATIONS

From the findings of this study, we recommend that; (1) Community health education by the district authority and other Non-Governmental Organizations (NGOs) be done to increase community awareness level on the transmission, prevention and control measures of leishmaniasis. (2) Routine screening of the community people for early diagnosis and management is needed to prevent the spread of the disease and its negative impacts. (3) The dormant termites' molds (ant-hills) within 200-meter perimeter of the homesteads should be destroyed so as to eliminate the hiding and breeding grounds for the sandflies that are vectors for the disease.

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CONFLICT OF INTEREST

All authors declare no conflict of interest in the study.

SUBMISSION DECLARATION AND VERIFICATION

The authors declare that this manuscript is original. It has never been published before and is not currently being considered for publication elsewhere.

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