Determinants of cutaneous leishmaniasis among students in Delanta district, Northeast Ethiopia: A case–control study

Abebe Dires1 | Sisay Gedamu1 | Prem Kumar1 | Wondosen Yimam1 | Sewunet Ademe1 | Tadila Dires2

1Department of Comprehensive Nursing, School of Nursing and Midwifery, College of Medicine and Health Sciences, Wollo University, Dessie, Ethiopia
2Department of Nursing, Debre Tabor University, Debre Tabor, Ethiopia

Correspondence
Abebe Dires, Department of Comprehensive Nursing, School of Nursing and Midwifery, College of Medicine and Health Sciences, Wollo University, Dessie, Ethiopia.
Email: abede9907@gmail.com

Abstract
Background and Aims: Cutaneous leishmaniasis (CL) is the most common form of leishmaniasis that causes skin lesions on exposed parts of the body. It is endemic in over 170 districts and highly prevalent in the northern and southern parts of Ethiopia. Thus, the aim of this study was to assess the determinants of CL among students of Wegeltena secondary school in Delanta district, Northeast Ethiopia.

Methods: This unmatched case–control study was conducted from January 4 to 20, 2021 at Wegeltena secondary school. Cases were students who had an active lesion of CL and controls were students who had never been infected with CL (no active lesions). A simple random sampling technique was utilized to select participants in the control group. Data were collected by using a pretested, interviewer-administered structured questionnaire. Bivariable and multivariable logistic regression analyses were performed and variables were declared determinants of CL at a p value of <0.05.

Results: A total of 225 students (58 cases and 167 controls) participated in the study. The mean age of cases and controls was 18.6 (SD ± 0.99 years) and 18.5 years (SD ± 1.17 years), respectively. In this study, 74.1% of cases and 51.5% of controls have been living in rural areas. Furthermore, being male (adjusted odds ratio [AOR] = 4.11; 95% confidence interval [CI]: 1.94–8.69), rural residents (AOR = 2.95; 95% CI: 1.33–6.52), living in areas where caves (AOR = 3.63; 95% CI: 1.24–10.59), nearby forest (AOR = 4.04; 95% CI: 1.42–11.51), and hyrax available (AOR = 2.43; 95% CI: 1.16–5.08) were significantly associated with CL.

Conclusion: In our study, sociodemographic and environmental factors were found to be determinants of CL. Therefore, reducing outdoor activities, wearing protective clothes, use of insecticide-treated nets, and destruction of sand fly breeding sites shall be implemented targeting the rural population that resides in areas where forests, caves, and hyraxes are prominent.

KEYWORDS
cutaneous leishmaniasis, Delanta district, determinants, Northeast Ethiopia, students
1 INTRODUCTION

Leishmaniasis is a vector-borne and neglected tropical disease transmitted to human beings by the bite of sand flies. More than 20 Leishmania species have been identified and over 90 sandfly species were known to transmit the disease. Globally, about 700,000 to one million new cases of leishmaniasis have been reported annually. It is prevalent in east Africa where Ethiopia, Kenya, Somalia, Sudan, and Uganda were the highly burdened countries in the region.

Cutaneous leishmaniasis (CL) is the predominant form of leishmaniasis that causes skin lesions on exposed parts of the body. America, Central Asia, the Middle East, and the Mediterranean basin were accounts for about 95% of the global burden of the disease. Leishmania (L) tropica, L. major, L. amazonensis, L. braziliensis, and L. aethiopica were the most common etiological agents for CL. Phlebotomus (P) martini, P. orientals, and P. celiae were the main sand fly vectors that transmit the disease in Ethiopia.

In Ethiopia, CL was mainly caused by L. aethiopica with a typical presentation of localized lesions. CL was highly prevalent in the northern and southern parts of Ethiopia. Moreover, areas having an altitude of 810–3563 m above sea level and environmental temperature of 10.6°C to 23.8°C were perceived to be vulnerable to leishmaniasis. Though the true burden of CL was not well known in Ethiopia, over 170 districts were suspected to be endemic areas. Moreover, it was estimated that about 29 million people who have been living in the highland areas of Amhara, Tigray, Oromia, and south regions were susceptible to the disease. CL can be diagnosed by its clinical presentation, epidemiological distribution, and laboratory investigations. However, demonstration of the parasite using biopsy and scraping smears have been used to confirm the disease in developing countries.

A study conducted in Ethiopia at Alert Hospital revealed that CL was the third most common cause of skin disease and it was the leading cause among all infectious skin diseases. Although CL could affect people of all ages, children were the most vulnerable groups affected by the disease. Sleeping outside the house and being involved in outdoor activities were the most behavioral risk factors for the acquisition of infection. A cross-sectional study conducted in eastern Tigray showed that the prevalence of active lesions of CL was about 6.7%. Another study reported from southwest Ethiopia among primary school students revealed that about 64.8% of participants had acquired CL. Despite its morbidity, CL has a significant psychological impact and social stigma, particularly in young individuals and children due to the remnant scar.

Currently, there is no vaccine used to prevent the infection of leishmaniasis worldwide. Thus, early diagnosis and treatment of cases, vector control, surveillance, and social mobilization were the recommended prevention methods. Awareness and perception of people toward leishmaniasis have a great impact to prevent the disease in endemic areas. However, a significant proportion of individuals in Ethiopia had a lack of awareness about CL and they primarily used herbal medications for treatment.

CL is endemic in many highland areas of Ethiopia. South Wollo zone, particularly Delanta district, is one of the endemic areas. A cross-sectional study in northeast Ethiopia at Borumeda Hospital showed that adolescents and young adults accounted for about 70% of all cases of CL. Majority of patients who attended dermatologic clinics at Borumeda Hospital were usually from Kutaber and Delanta districts and the number of cases has been increasing significantly. Numerous studies indicated that socioeconomical and environmental factors had a significant contribution to the occurrence of the disease. Though CL was known to be endemic in highland areas of Ethiopia, its main risk factors were not well known, particularly in the study area that may help to prevent and control the disease. In addition, all previous studies conducted in Ethiopia regarding CL were cross-sectional studies and there was a recommendation by researchers to further investigate the risk factors of the disease in Northern Ethiopia. Hence, the aim of this study was to assess the determinant of CL among students of Wegeltena secondary school in Delanta district, Northeast Ethiopia.

2 METHODS

2.1 Study design

A facility-based unmatched case–control study was conducted from January 4 to 20, 2021 at Wegeltena secondary school in Delanta district, Northeast Ethiopia.

2.2 Settings

The study was conducted at Wegeltena secondary school in Delanta district, Northeast Ethiopia. Delanta district has an altitude ranging from 1500 to 3819 m above sea level. The major town of the district is Wegeltena and it is found 494 km far from Addis Ababa (the capital city of Ethiopia). Wegeltena secondary school is the only secondary school in the district and a total of 2545 students were enrolled during the study period.

2.3 Source population

The source populations for cases were all high school students who had an active lesion of CL in Delanta district. Whereas all high school students in the district who had never been infected with CL were the source population for controls.

2.4 Study population

All Wegeltena secondary school students who had an active lesion of CL were the study population for cases and all students in Wegeltena secondary school who had never been infected with CL and had no active lesion were the study population for controls.
2.5 | Sample population

All Wegeltena secondary school students who had an active lesion of CL were the sample population for cases and randomly selected students in Wegeltena secondary school who had never been infected with CL were the sample population for controls.

2.6 | Inclusion and exclusion criteria

Inclusion criteria: All students who had an active lesion of CL were included in the case group and students who had never been infected with CL were included in the control group.

Exclusion criteria: Students who had CL scar, unidentified skin lesions, critically ill, and those who were not voluntary to be screened were excluded from the study.

2.7 | Sample size

The sample size was calculated by using the Kelsey formula for case-control studies in Epi-Info version 7 with the following assumptions: a proportion of 68.1% of controls were living in a cracked wall house with an odds ratio of 3.9, which was taken from a previous study with a two-sided confidence level of 95%, power of 80%, and the case-to-control ratio of 1:4. With this information, the sample size was 220. After adding 5% nonresponse rate, the total sample size was 231, of which 58 were cases and 173 were controls.

2.8 | Data collection procedures

Data were collected in two phases. In the first phase, trained health professionals (clinicians with a master's degree) made clinical diagnoses of CL for students after orientation and awareness creation had been given in groups. The clinical screening was conducted in a private room having good illumination to allow for easy inspection and palpation of the skin. A focused skin examination of the face, neck, ears, and upper and lower limbs was conducted to identify CL.

Finally, the clinical screening result of students with their name, sex, and grade level was recorded in a data abstraction format in four categories: (1) clinically screened positive with an active lesion of CL; (2) remnant CL scar with no active lesion; (3) screened negative and no other skin lesions; (4) unidentified skin lesions. Thus, of the total of 2545 students in the school, 2372 were screened voluntarily. Of those screened, 61 students were found to have an active lesion of CL, 2268 had no active lesion of CL or any other skin lesion, and 24 students had a remnant scar of CL. Unfortunately, three cases were not voluntary and did not participate (Figure 1). Finally, a pretested, interviewer-administered structured questionnaire adopted from previous studies was used to collect the data.

The data collection tool had four sections, which include the sociodemographic, housing condition, environmental, and behavioral characteristics of participants.

2.9 | Data quality assurance

To preserve the data quality, the questionnaire was translated from English to Amharic (the local language of the study area) and then back to English to check its consistency. Six health professionals (four data collectors and two supervisors) were trained about CL, how to do clinical screening, the objective of the study, ethical issues, and how to collect the data. In addition, the tool was pretested on 12 (5% of the total sample size) students from Mehonegna secondary school to evaluate face validity, clarity of language, and to ensure that the questionnaire was understandable.

2.10 | Operational definitions

- **Cases**: Individuals who had a skin lesion with raised edges and a depressed center or plaque that was circumscribed, nodular, or palpable.
- **Controls**: Individuals who had never been infected with CL and had no active lesion.
- **Presence of cave in the vicinity**: The existence of caves within a 5 km radius of the house.
- **Presence of construction waste and deposition of garbage near the house**: The presence of waste and deposition of garbage within a 15 m radius of the house.
- **Urban area**: All administrative capitals of regions, zones, and districts, as well as localities with 2000 or more inhabitants and whose inhabitants are primarily engaged in nonagricultural activities.
- **Rural area**: Localities with less than 2000 inhabitants and mainly engaged in agricultural activities.

2.11 | Ethics statement

Ethical approval was obtained from the ethical review committee of the College of Medicine and Health Sciences, Wollo University. Communication with administrators of Wegeltena secondary school was held through a formal letter. The purpose of the study and potential benefits...
were explained to study participants and parents. In addition, they were informed that they had the right not to participate in the study or not to answer any questions that they were not willing to respond to. Students aged ≥18 years old gave informed written consent to participate in the study. However, for students below 18 years of age, written consent from their parents/guardians/and verbal assent was obtained to participate in the study. Confidentiality was maintained at all times and no unauthorized person had access to the information obtained from the study participants. This study was conducted in accordance with the Declaration of Helsinki.

2.12 | Statistical analysis

Data were entered in EpiData version 4.6 and exported to IBM SPSS version 25 for further statistical analysis. The mean value and standard deviations were used to describe continuous variables and categorical variables were presented in tables using frequency and percentages. We performed crosstab, bivariable and multivariable logistic regression analyses. Variables that had a p value of <0.25 in the bivariable logistic regression analysis were adjusted in the multivariable logistic regression model and Hosmer–Lemeshow statistic was used to test the goodness fit of the model (p > 0.05). In addition, the multicollinearity of variables was assessed by calculating the variance inflation factor (VIF). Variables with VIF > 10 were considered to have multicollinearity. Multivariable logistic regression analysis was used to identify sociodemographic, household, environmental, and behavioral factors that were significantly associated with CL by controlling for potential confounding factors.

In multivariable analysis, adjusted odds ratio (AOR) with a 95% confidence interval (CI) was used to determine the strength of association, and variables were declared determinants of CL at a p value of <0.05.

3 | RESULTS

3.1 | Sociodemographic characteristics of participants

A total of 225 students (58 cases and 167 controls) participated in the study. The mean age of cases and controls was 18.6 (SD ± 0.99 years) and 18.5 years (SD ± 1.17 years), respectively. In this study, 70.7% of cases and 81.4% of controls were under 20 years. About
29.3% of cases and 17.4% of controls were Grade 10 and the majority of cases (74.1%) and 51.5% of controls were living in the rural area. The majority of cases (93.1%) and controls (72.5%) were orthodox Christianity followers. Moreover, 91.4% of cases and 93.4% of controls were Amharas in their ethnicity (Table 1).

### 3.2 Household and indoor condition of cases and controls

In this study, 46.6% of cases and 21% of controls had more than five family members per household, and nearly a similar proportion of cases (74.1%) and controls (75.4%) were living in houses having three or more rooms. In our study, 29.3% of cases and 40.1% of controls were living in a thatched house. About 36.2% of cases and 27.5% of controls have been living in a house having cracked walls. Many of the cases (82.8%) and controls (75.4%) were living in houses that had no window nets. Furthermore, 75.9% of cases and 65.9% of controls have been living with animals. About 29.3% of cases and 28.7% of controls were living in a house with someone having an ulcerating disease (Table 2).

### 3.3 Environmental and outdoor characteristics of cases and controls

In this study, caves around the vicinity were available in about 87.9% of cases and 71.9% of controls. Whereas the presence of construction wastes and nearby deposited garbage was reported in 46.6% of cases and 34.1% of controls. Similarly, the presence of hyrax in the vicinity was reported in 48.3% and 24.6% of cases and controls, respectively. In the majority of study participants, 86.2% of cases and 71.9% of controls have been living in areas where forests are present. However, 20.7% of cases and 28.1% of controls were living in settings where irrigation or open water source are available near their houses. In addition, crop farm was available around their vicinity in about 77.6% of cases and 57.5% of controls (Table 3).

### 3.4 Behavioral characteristics of cases and controls

In this study, 25.9% of cases and 15.6% of controls utilized insecticide-treated bed nets while sleeping. Nearly a similar proportion of cases (24.1%) and controls (25.1%) had a history of sleeping outdoors in the last 2 years. About 37.9% of cases and 26.9% of controls had a history of sleeping with windows open in the last 2 years. Furthermore, the majority of cases (87.9%) and controls (74.3%) had a habit of spending time outside their home after sunset (Table 4).

**TABLE 1** Sociodemographic characteristics of cases and controls, Delanta district, 2021 (n = 225)

| Variables               | Category | Cases | Control |
|-------------------------|----------|-------|---------|
|                        |          | N     | N       |
| Sex                     |          |       |         |
| Male                    |          | 37    | 70      |
| Female                  |          | 21    | 97      |
| Age (in years)          | <20      | 41    | 136     |
|                         | ≥20      | 17    | 31      |
| Grade level             | 9        | 14    | 24      |
|                         | 10       | 17    | 29      |
|                         | 11       | 13    | 22      |
|                         | 12       | 14    | 24      |
| Residence               | Urban    | 15    | 81      |
|                         | Rural    | 43    | 86      |
| Religion                | Orthodox Christian | 54 | 121 | 72.5 |
|                         | Muslim   | 1     | 21      |
|                         | Protestant Christian | 3 | 25 | 15.0 |
| Ethnicity               | Amhara   | 53    | 156     |
|                         | Others* | 5     | 11      |

*Oromo, Tigre.

**TABLE 2** Household and indoor characteristics of cases and controls, Delanta district, 2021 (n = 225)

| Variables                          | Category                | Cases | Control |
|------------------------------------|-------------------------|-------|---------|
| Household family members (in number)| <3                      | 10    | 24      |
|                                    | 3–5                     | 21    | 108     |
|                                    | >5                      | 27    | 35      |
| Number of rooms (in number)        | <3                      | 15    | 41      |
|                                    | ≥3                      | 43    | 126     |
| Made up of house roof materials    | Corrugated iron         | 41    | 100     |
|                                    | Thatched                | 17    | 67      |
| Living in a house with cracked wall| Yes                     | 21    | 46      |
|                                    | No                      | 37    | 121     |
| Living in a house with cracked floors| Yes                   | 43    | 136     |
|                                    | No                      | 15    | 31      |
| Window of the house                | With net                | 10    | 41      |
|                                    | Without net             | 48    | 126     |
| Shared house with someone having an ulcerating disease| Yes| 17 | 48 |
|                                    | No                      | 41    | 119     |
| Presence of animals in the house    | Yes                     | 44    | 110     |
|                                    | No                      | 14    | 57      |
TABLE 3  Environmental and outdoor characteristics of cases and controls, Delanta district, 2021 (n = 225)

| Variables                                      | Category          | Cases N | %     | Control N | %     |
|------------------------------------------------|-------------------|---------|--------|-----------|--------|
| Presence of a cave in the vicinity            | Yes               | 51      | 87.9   | 120       | 71.9   |
|                                                | No                | 7       | 12.1   | 47        | 28.1   |
| Presence of construction waste and the deposition of garbage near the house | Yes | 27 | 46.6 | 57 | 34.1 |
|                                                | No                | 31      | 53.4   | 110       | 65.9   |
| Presence of hyraxes in the vicinity           | Yes               | 28      | 48.3   | 41        | 24.6   |
|                                                | No                | 30      | 51.7   | 126       | 75.4   |
| Presence of wild jackals in the vicinity      | Yes               | 21      | 36.2   | 41        | 24.6   |
|                                                | No                | 37      | 63.8   | 126       | 75.4   |
| Presence of a nearby forest or thicket in the vicinity | Yes | 50 | 86.2 | 120 | 71.9 |
|                                                | No                | 8       | 13.8   | 47        | 28.1   |
| Presence of irrigation or open water source nearby the house | Yes | 12 | 20.7 | 47 | 28.1 |
|                                                | No                | 46      | 79.3   | 120       | 71.9   |
| Neighbors have typical skin lesions of CL     | Yes               | 16      | 27.6   | 24        | 14.4   |
|                                                | No                | 42      | 72.4   | 143       | 85.6   |
| Presence of crop farms in the vicinity        | Yes               | 45      | 77.6   | 96        | 57.5   |
|                                                | No                | 13      | 22.4   | 71        | 42.5   |

TABLE 4  Behavioral characteristics of cases and controls, Delanta district, 2021 (n = 225)

| Variables                                      | Category          | Cases N | %     | Control N | %     |
|------------------------------------------------|-------------------|---------|--------|-----------|--------|
| Use insecticide-treated bed nets while sleeping | Yes               | 15      | 25.9   | 26        | 15.6   |
|                                                | No                | 43      | 74.1   | 141       | 84.4   |
| Ever sleeping outdoors in the last 2 years     | Yes               | 14      | 24.1   | 42        | 25.1   |
|                                                | No                | 44      | 75.9   | 125       | 74.9   |
| Ever sleeping with windows open in the last 2 years | Yes | 22 | 37.9 | 45 | 26.9 |
|                                                | No                | 36      | 62.1   | 122       | 73.1   |
| Had a habit of spending time outside the home after sunset | Yes | 51 | 87.9 | 124 | 74.3 |
|                                                | No                | 7       | 12.1   | 43        | 25.7   |

3.5  Factors associated with CL

A total of 24 variables were tested in the bivariable logistic regression analysis. In bivariable logistic regression analysis: sex, residence, had been living in cracked wall houses, shared houses with someone who had an ulcerating disease, presence of animals in the house, presence of hyrax, nearby forest, cave, and crop farms in the vicinity, neighbors who had typical skin lesions of CL, and habit of spending time outside the home had a p < 0.25 and were entered in multivariable logistic regression analysis. After adjusted in multivariable analysis: being male (AOR = 4.11; 95% CI: 1.94–8.69), rural residents (AOR = 2.95; 95% CI: 1.33–6.52), had been living in areas where caves (AOR = 3.63; 95% CI: 1.24–10.59), nearby forest (AOR = 4.04; 95% CI: 1.42–11.51), and hyrax (AOR = 2.43; 95% CI: 1.16–5.08) are available were significantly associated with CL (Table 5).

4  DISCUSSION

This study was conducted in Delanta district of the South Wollo zone in Northeast Ethiopia so as to identify the determinant factors of CL among school students. Being male, rural residents, presence of caves, nearby forest, and hyrax were factors significantly associated with CL. In this study, the likelihood of developing CL in males was four times (AOR = 4.11; 95% CI: 1.94–8.69) higher than in females. This finding was in agreement with studies conducted in Ethiopia,30 Brazil,28 Bolivia,31 and Saudi Arabia.32 This could be due to the high engagement of males in outdoor activities like farming and other agricultural activities than females. Another study in highland areas of Ethiopia also showed that involvement in outdoor activity was the main risk factor for the acquisition of CL.18 However, this finding was contradicted by studies conducted in Yemen,33 Morocco,34 and Sri Lanka35 that CL was observed more likely in females than in males. This discrepancy might be due to the difference in the sociodemographic characteristics of study participants and the study designs employed. However, studies reported in Kenya and Nigeria reveal that there was no gender difference in the occurrence of the disease.27,36

In our study, the likelihood of developing CL in rural residents was 2.9 times (AOR = 2.95; 95% CI: 1.33–6.52) higher than in urban residents, which was similar to a study conducted in Brazil.28 This might be related to the substandard housing condition and extensive agricultural activities in rural settings. In Africa, poor housing conditions like muddy-grassy houses and cracked house walls were significantly associated with the occurrence of the disease and those problems are common in the rural population.26,27 However, urbanization also contributed to the distribution of leishmaniasis in Africa.37

In our study, the likelihood of developing CL in those who have been living in areas where caves existed was 3.6 times (AOR = 3.63; 95% CI: 1.24–10.59) higher than their counterparts. This finding was supported by a study conducted in the Tigray region of Ethiopia.38 This could be due to the mining activities conducted in Delanta district to get Opal using traditional methods. Studies conducted in Brazil indicated as caves were important for the protection, feeding, and breeding of sand flies.39,40 Another study conducted in Thailand also supported that caves are potential breeding sites for sand flies.41 In addition, rocky territories have been identified as the preferred ecology of the vectors.42

In this study, the likelihood of developing CL was four times (AOR = 4.04; 95% CI: 1.42–11.51) higher in those who have been living in areas where nearby forests are available than those who reside in forest-free settings. This finding was similar to studies.
conducted in Kenya$^{27}$ and Colombia.$^{43}$ The same association between CL and plantation around houses was observed in Yemen$^{33}$ and with the presence of a gardening area in Sri Lanka.$^{35}$ In addition, studies conducted in Ethiopia showed that plants, dry river banks, farm fields, and dry irrigation tanks are the preferred breeding sites of sand flies.$^{44}$

Furthermore, the likelihood of developing CL in those who reside in areas where hyraxes have existed was 2.4 times (AOR = 2.43; 95% CI 1.16–5.08) compared to those who did not. A similar trend was observed for the presence of a nearby forest or thicket (AOR = 4.04; 1.42–11.51) and a cave (AOR = 3.63; 1.24–10.59). The presence of animals in the house and a nearby forest or thicket were also associated with an increased risk of CL (AOR = 2.00; 0.85–4.69 and AOR = 4.04; 1.42–11.51, respectively).

### Table 5: Bivariable and multivariable analyses of factors associated with cutaneous leishmaniasis in Delanta district, 2021 (n = 225)

| Variables                                      | Case (N = 58) n (%) | Control (N = 167) n (%) | COR (95% CI) | AOR (95% CI) | p value |
|------------------------------------------------|---------------------|--------------------------|--------------|--------------|---------|
| **Sex**                                        |                     |                          |              |              |         |
| Male                                           | 37 (63.8)           | 70 (41.9)                | 2.44 (1.31–4.52) | 4.11 (1.94–8.69) | <0.001  |
| Female                                         | 21 (36.2)           | 97 (58.1)                | 1            | 1            |         |
| **Residence**                                  |                     |                          |              |              |         |
| Urban                                          | 15 (25.9)           | 81 (48.5)                | 1            | 1            |         |
| Rural                                          | 43 (74.1)           | 86 (51.5)                | 2.70 (1.39–5.23) | 2.95 (1.33–6.52) | 0.008   |
| **Living in a house with crackled wall**      |                     |                          |              |              |         |
| Yes                                            | 21 (36.2)           | 46 (27.5)                | 1.49 (0.79–2.81) | 2.08 (0.89–4.85) | 0.088   |
| No                                             | 37 (63.8)           | 121 (72.5)               | 1            | 1            |         |
| **Shared house with someone having an ulcerating disease** | | | | | |
| Yes                                            | 17 (29.3)           | 48 (28.7)                | 1.02 (0.53–1.98) | 2.25 (0.90–5.58) | 0.080   |
| No                                             | 41 (70.7)           | 119 (71.3)               | 1            | 1            |         |
| **Presence of animals in the house**           |                     |                          |              |              |         |
| Yes                                            | 44 (75.9)           | 110 (65.9)               | 1.62 (0.82–3.21) | 2.00 (0.85–4.69) | 0.110   |
| No                                             | 14 (24.1)           | 57 (34.1)                | 1            | 1            |         |
| **Presence of hyrax in the vicinity**          |                     |                          |              |              |         |
| Yes                                            | 28 (48.3)           | 41 (24.6)                | 2.86 (1.53–5.35) | 2.43 (1.16–5.08) | 0.018   |
| No                                             | 30 (51.7)           | 126 (75.4)               | 1            | 1            |         |
| **Presence of a nearby forest or thicket in the vicinity** | | | | | |
| Yes                                            | 50 (86.2)           | 120 (71.9)               | 2.44 (1.07–5.55) | 4.04 (1.42–11.51) | 0.009   |
| No                                             | 8 (13.8)            | 47 (28.1)                | 1            | 1            |         |
| **Neighbors have typical skin lesions of CL**  |                     |                          |              |              |         |
| Yes                                            | 16 (27.6)           | 24 (14.4)                | 2.27 (1.10–4.66) | 2.27 (0.96–5.36) | 0.061   |
| No                                             | 42 (72.4)           | 143 (85.6)               | 1            | 1            |         |
| **Presence of a cave in the vicinity**         |                     |                          |              |              |         |
| Yes                                            | 51 (87.9)           | 120 (71.9)               | 2.85 (1.21–6.73) | 3.63 (1.24–10.59) | 0.018   |
| No                                             | 7 (12.1)            | 47 (28.1)                | 1            | 1            |         |
| **Presence of crop farms in the vicinity**     |                     |                          |              |              |         |
| Yes                                            | 45 (77.6)           | 96 (57.5)                | 2.56 (1.28–5.10) | 1.82 (0.81–4.12) | 0.146   |
| No                                             | 13 (22.4)           | 71 (42.5)                | 1            | 1            |         |
| **Had a habit of spending time outside the home after sunset** | | | | | |
| Yes                                            | 51 (87.9)           | 124 (74.3)               | 2.52 (1.06–5.98) | 2.57 (0.94–7.04) | 0.065   |
| No                                             | 7 (12.1)            | 43 (25.7)                | 1            | 1            |         |

Note: 1 represents reference.
Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio.
Cl: 1.16–5.08) higher than in those who reside in hyrax-free areas. This finding was in line with studies conducted in Ethiopia and Palestine. A study finding in Borumeda Hospital also revealed the independent association between CL and the availability of hyraxes in the surrounding areas. The transmission of CL due to L. aethiopica is considered to be zoonotic in highland areas of Ethiopia and rocky hyraxes have been shown the reservoir of the parasite. However, the presence of domestic animals in households was also associated with the development of CL in Brazil, Yemen, and north-central Ethiopia. Despite the risk of disease transmission in outdoor environments, a recent study finding in Brazil indicates that sand flies have adapted to the humans’ indoor environment, which further increases the risk of infection.

Although CL causes significant morbidity among exposed peoples, prevention and control of the disease can be maintained by environmental management, personal protection, and elimination of sand flies. If the disease is not well controlled, it has a considerable financial impact on the victims as well as on the healthcare system. There is a scarcity of CL diagnosis and treatment centers in the Amhara region such that only 10% of healthcare facilities have been providing leishmaniasis diagnosis and treatment services despite the high prevalence of the disease in the region.

This study has the following limitations. Cases and controls were screened clinically and confirmatory laboratory test was not employed to identify cases. There could be a recall and social desirability bias from the side of respondents and it was done in a single institution so that the finding may not be generalized to the overall population of Delanta district.

5 CONCLUSIONS

In our study, sociodemographic and environmental factors were found to be the determinants of CL among school students in Delanta district. Being male, rural dwellers, living in settings where caves, nearby forests, and hyraxes are available were determinant factors of CL. Therefore, reducing outdoor activities, wearing protective clothes, use of insecticide-treated nets, and destruction of sandfly breeding sites shall be implemented in Delanta district targeting the rural population that resides in areas where forests, caves, and hyraxes are prominent. Health professionals shall provide health education about feasible disease prevention methods and behaviors in endemic areas. Further laboratory-based studies are required to identify personal, indoor, environmental, and other factors potentially affecting the disease that was not included in our study. The feasibility and effectiveness of disease-controlling measures with the presence of environmental predictors shall be studied in the future.

AUTHOR CONTRIBUTIONS

Abebe Dires: Conceptualization; data curation; formal analysis; methodology; writing—original draft; writing—review and editing. Sisay Gedamu: Formal analysis; software; writing—review and editing. Prem Kumar: Project administration; resources; supervision. Wondosen Yimam: Investigation; Methodology; writing—review and editing. Sewunet Ademe: Investigation; validation; writing—review and editing. Tadila Dires: Validation; visualization; writing—review and editing.

ACKNOWLEDGMENTS

We would like to thank Wollo University, College of Medicine and Health sciences for the ethical approval. We also forward our thanks to the staff of Wogeltenal secondary school for their cooperation and study participants for their valuable information.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article and its Supporting Information: Materials.

TRANSPARENCY STATEMENT

The lead author Abebe Dires affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

ORCID

Abebe Dires http://orcid.org/0000-0002-0186-1123
Sisay Gedamu http://orcid.org/0000-0001-6486-9125
Wondosen Yimam http://orcid.org/0000-0002-8143-987X
Sewunet Ademe http://orcid.org/0000-0003-1136-4101

REFERENCES

1. CDC. Leishmaniasis. CDC; 2020.
2. World Health Organization. Leishmaniasis Key facts. World Health Organization; 2020.
3. Devi SC, Saravanan H, Joseph RE, Koturan S, Srinivasan MV. Leishmaniasis: a review on global epidemiological trends. Res J Pharm Technol. 2014;7(5):569.
4. Eshetu E, Bassa AAT. The public health significance of leishmaniasis: an overview. J Nat Sci Res. 2016;6:48-57.
5. McGwire B, Satoskar A. Leishmaniasis: clinical syndromes and treatment. Int J Med. 2013;107(1):7-14.
6. Salam N, Al-Shaqha WM, Aziz A. Leishmaniasis in the Middle East: incidence and epidemiology. PLoS Negl Trop Dis. 2014; 8(10):e3208.
7. Khatri ML, Di Muccio T, Fiorentino E, Gramiccia M. Ongoing outbreak of cutaneous leishmaniasis in northwestern Yemen: clinicoepidemiologic, geographic, and taxonomic study. Int J Dermatol. 2016;55(11):1210-1218.
8. Veasey JV, Zampieri RA, Lellis RF, Freitas THP, Winter LMF. Identification of Leishmania species by high-resolution DNA dissociation in cases of American cutaneous leishmaniasis. An Bras Dermatol. 2020;95:459-468.
9. Gebresilassie A, Yared S, Aklilu E. Sandfly fauna and ecological analysis of Phlebotomus orientalis and Phlebotomus martini in the
lowland foci of visceral leishmaniasis in Somali Regional State, southeast Ethiopia. Asian Pacific J Trop Med. 2020;13(1):31.

9. FMOH. Guideline for Diagnosis, Treatment and Prevention of Leishmaniasis in Ethiopia. FMOH; 2013.

10. Brat A, Berhe N, Balkew M, et al. Epidemiological study of cutaneous leishmaniasis in Saesie Tsaeda-embà district, eastern Tigray, northern Ethiopia. Parasit Vectors. 2015;8(1):149.

11. Bekele S, Bekele Y, Mulatu F, et al. Recent trends of cutaneous leishmaniasis in Alert Hospital, Addis Ababa. Ethiop Med J. 2014;1(suppl):37-41.

12. Deribe K, Meribo K, Gebre T, et al. The burden of neglected tropical diseases in Ethiopia, and opportunities for integrated control and elimination. Parasit Vectors. 2012;5:240.

13. Ethiopian Federal Ministry of Health. National Master Plan for Neglected Tropical Disease (2013–2015). Ethiopian Federal Ministry of Health; 2013.

14. Seid A, Gadisa E, Tsegaw T, et al. Risk map for cutaneous leishmaniasis in Ethiopia based on environmental factors as revealed by geographical information systems and statistics. Geospatial Health. 2014;8:377-387.

15. Elmahallawy EK, Sampedro Martinez A, Rodriguez-Granger J, et al. Diagnosis of leishmaniasis. J Infect Dev Ctries. 2014;8(8):961-972.

16. Gimbel DC, Legesse TB. Dermatopathology practice in Ethiopia. Arch Pathol Lab Med. 2013;137(6):799-804.

17. Layegh P, Moghiman T, Ahmadian Hoseini SA. Children and cutaneous leishmaniasis: a clinical report and review. J Infect Dev Ctries. 2013;7(6):614-617.

18. Custodio E, Gadisa E, Sordo L, et al. Factors associated with Leishmania asymptomatic infection: results from a cross-sectional survey in highland northern Ethiopia. PLoS Negl Trop Dis. 2012;6(9):e1813.

19. Bugissa G. The current status of cutaneous leishmaniasis and the pattern of lesions in Ochollo primary school students, Ochollo, Southwestern Ethiopia. Sci J Clin Med. 2014;3(6):111.

20. Bennis I, Thys S, Filali H, De Brouwere V, Sahibi H, Boelaert M. Psychosocial impact of scars due to cutaneous leishmaniasis on high school students in Errachidia province, Morocco. Infect Dis Poverty. 2017;6(1):46.

21. Hotez PJ, Pecoul B, Rijal S, et al. Impact of urbanization and socioeconomic factors on the distribution of cutaneous leishmaniasis in the center of Morocco. Int J Dermatol. 2020;59(9):1167-1171.

22. Campos AM, Maia RA, Capucci D, Paglia AP, Andrade Filho JD. Species composition of sand flies (Diptera: Psychodidae) in caves of Southwestern Ethiopia. J Anim Ecol. 2016;58(86:10):783-786.

23. Nasser AA, Abdelrazzaq MH, Almahaqi AH, Al-Amad MA, Al Serouria AA, Khader YS. Cutaneous leishmaniasis outbreak investigation in Hajjah Governorate, Yemen, in 2018: case–control study. JIMIR Public Health Surveill. 2021;7(3):e27442.

24. Asnafi AE, Madhi YL, Naji M, El Rhoouat O, Belghyti D. Epidemiology of cutaneous leishmaniasis in Sidi Kacem Province, Northwestern Morocco (2006–2014). Asian Pac J Trop Dis. 2016;6(10):783-786.

25. Wijerathna T, Gunawardana K, Rodrigo W. Socioeconomic, demographic and landscape factors associated with cutaneous leishmaniasis in Kurunegala District, Sri Lanka. Parasit Vectors. 2020;13:244.

26. Lois DN, Daulk DA, Agwale MS, Pam DD. Human cutaneous leishmaniasis (CL) in plateau and Nasarawa states, North-Central Nigeria. Int J Sci Appl Res. 2017;2(2):103-116.

27. El Omari H, Chahlouei A, Talbi F, Ouarrak K, El Quali Lalam A. Impact of urbanization and socioeconomic factors on the distribution of cutaneous leishmaniasis. Geospatial Health. 2020;10(1):47-59.

28. Yohannes M, Abebe Z, Boelee E. Prevalence and environmental determinants of cutaneous leishmaniasis in rural communities in Tigray, northern Ethiopia. PLoS Negl Trop Dis. 2019;13(9):e0007722.

29. Campos AM, Maia RA, Capucci D, Paglia AP, Andrade Filho JD. Species composition of sand flies (Diptera: Psychodidae) in caves of Quadrilâmero Ferrinho, state of Minas Gerais, Brazil. PLoS One. 2020;15(3):e0220268.

30. Teodoro LM, Carvalho GML, Campos AM, et al. Phlebotomine sand flies (Diptera, Psychodidae) from iron ore caves in the State of Pará, Brazil. Subterr Biol. 2021;37:27-42.

31. Thammaphalo S, Pawestri AR, Kolaeh K, et al. Distribution of phlebotomine sandflies in the cave area of Satun Province, Thailand. Trop Med Infect Dis. 2020;5(4):174.

32. Waiz Y, Paz S, Meir D, Malkinson D. Effects of land use type, spatial patterns and host presence on Leishmania tropica vectors activity. Parasit Vectors. 2019;12(1):320.

33. Gutierrez JD, Martinez-Vega R, Ramoni-Perazzi J, et al. Environmental and socio-economic determinants associated with the occurrence of cutaneous leishmaniasis in the northeast of Colombia. Trans R Soc Trop Med Hyg. 2017;111(12):564-571.

34. Moncz A, Kirstein O, Gebresellassie A, et al. Characterization of breeding sites of Phlebotomus orientalis—the vector of visceral leishmaniasis in northwestern Ethiopia. Acta Trop. 2014;139:5-14.

35. Salah I, Davidovitch N, Kotler B. Risk factors of cutaneous leishmaniasis (CL) caused by L. tropica: a case–control study in Palestine. Eur J Pub Health. 2016;26(suppl 1):95. doi:10.1093/europub/ckw166055.

36. Busetegn Habyte, Zeleke AJ, Gadisa E, et al. Clinical, parasitological and molecular profiles of cutaneous leishmaniasis and its associated factors among clinically suspected patients attending Borumeda Hospital, North-East Ethiopia. PLoS Negl Trop Dis. 2020;18(8):e0008507.
47. Lemma W. Zoonotic leishmaniasis and control in Ethiopia. *Asian Pacific J Trop Med*. 2018;11(5):313.

48. da Silva Sales KG, de Oliveira Miranda DE, Costa PL, et al. Home sweet home: sand flies find a refuge in remote indigenous villages in north-eastern Brazil, where leishmaniasis is endemic. *Parasit Vectors*. 2019;12:118.

49. Hotez PJ, Pecoul B, Rijal S, et al. Eliminating the neglected tropical diseases: translational science and new technologies. *PLoS Negl Trop Dis*. 2016;10(3):e0003895.

50. Okwor I, Uzonna J. Social and economic burden of human leishmaniasis. *Am J Trop Med Hyg*. 2016;94(3):489-493.

51. Federal Ministry of Health. *Ethiopia Services Availability and Readiness Assessment, Summary Report*. Federal Ministry of Health; 2017. https://www.ephi.gov.et/images/pictures/download2009/v6%20Final%20SARA%20Report%20Jan%20202017.pdf

**How to cite this article:** Dires A, Gedamu S, Kumar P, Yimam W, Ademe S, Dires T. Determinants of cutaneous leishmaniasis among students in Delanta district, Northeast Ethiopia: a case–control study. *Health Sci Rep*. 2022;5:e917. doi:10.1002/hsr2.917