**COLLEGE OF MEDICINE AND HEALTH SCIENCES**

**PUBLIC HEALTH ACADEMIC AND SERVICE DIRECTORATE**

# DETERMINANTS OF CUTANEOUS LEISHMANIASIS IN GAMO ZONE, SOUTH ETHIOPIA- UNMATCHED CASE CONTROL STUDY

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**A RESEARCH THESIS SUBMITTED TO HAWASSA UNIVERSITY, COLLEGE OF MEDICINE AND HEALTH SCIENCES, PUBLIC HEALTH ACADEMIC AND SERVICE DIRECTORATE, IN PARTIAL FULFILMENT OF MASTER OF PUBLIC HEALTH IN FIELD EPIDEMIOLOGY**

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## Declaration and Approval Sheet

I hereby declare that this thesis work about the determinants of cutaneous leishmaniasis in Daramalo and Dita districts, Gamo Zone, South Ethiopia is my original work and has not been presented as a study or else in any other university, and all sources of materials used for this work have been duly acknowledged.

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As member of the board of examiners of the final MPH open defense, we certify that we have read and evaluated the thesis prepared by Semalignnuguse Yohanis, under the title "DETERMINANTS OF CUTANOUS LEISHIMANIASIS IN GAMO ZONE SOUTHERN ETHIOPIA" UNMATCHED CASE CONTROL STUDY, and examined the candidate. This is therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement for the degree of Master of Public Health in Field Epidemiology.

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## Abbreviations and Acronyms

| | |
|---|---|
| AOR | Adjusted Odds Ratio |
| CDC | Center for Disease Control and Prevention |
| CI | Confidence Interval |
| CL | Cutaneous Leishmaniasis |
| COR | Crude Odds Ratio |
| DCL | Diffuse Cutaneous Leishmaniasis |
| EFY | Ethiopian Fiscal Year |
| ETB | Ethiopian Birr |
| HH | Household |
| HU-CMHS | Hawassa University, College of Medicine and Health Sciences |
| IRB | Institutional Review Board |
| KM | Kilometers |
| MCL | Muco-cutaneous Leishmaniasis |
| NTD | Neglected Tropical Diseases |
| NW | New World |
| OW | Old World |
| PHASD | Public Health Academic and Service Directorate |
| PI | Principal Investigator |
| PKDL | Post Kalazar Dermal Leishmaniasis |
| SNNPR | South Nations, Nationalities and People's Region |
| SPSS | Statistical Package for Social Sciences |
| VIF | Variance Inflation Factor |
| VL | Visceral Leishmaniasis |
| WHO | World Health Organization |

# Abstract

**Background**: Leishmaniasis represents a major health problem for the public with a wide range of clinical symptoms, epidemiological variety, and a spectrum of aggressiveness with cutaneous leishmaniasis type being the commonest across the world, especially in developing countries**.** Up to 1.5 million cases are recorded annually, and more than 350 million individuals are thought to be at risk of cutaneous leishmaniasis. Gamo Zone is one of those areas in Ethiopia currently hit by high burden of the disease, but did not get the necessary attention due to different reasons.

**Objectives:** This study aimed to assess the determinants of cutaneous leishmaniasis in Deramalo and Dita districts of Gamo Zone, South Ethiopia.

**Methods and Materials:** Unmatched case control study design was used in this study. Total of 285 participants with 95 cases and 190 controls with case to control ratio of 1:2 were included. A structured questionnaire adapted from previous literatures was used to collect the data by electronic tool with Kobo Collect. The collected data were exported and cleaned in MS excel, and were imported to SPSS for descriptive and regression analyses. Variables having significant association with development of cutaneous leishmaniasis were tested by binary logistic regression and P-value of 0.25 in bivariable logistic regression was used to select candidate variables for multivariable logistic regression. AORs were calculated at 95% CI to determine the variables having significant associations with CL, and variables having p-value of <0.05 were declared to have significant associations and hence determinants of CL.

**Results:** A total of 285 participants with 95 cases and 190 controls were included in this study and the response rate was 100%. The mean age of the cases was 21.42 and the mean age of the controls was 28.45. Moreover, age categories of less than 20 years (AOR=3.15; 95% CI: 1.42-6.95) and 20 to 34 years (AOR=3.4; 95% CI: 1.4-8.8), availability of gorges in the vicinity (AOR=2.51; 95% CI: 1.22-5.13), presence of active cutaneous leishmaniasis case in the household (AOR=9.27; 95% CI: 4.23-20.33), and presence of previous cutaneous leishmaniasis scar cases in the household (AOR=4.49; 95% CI: 2.03-9.96) were found to be significantly associated with CL.

**Conclusion:** Our study found that people living where gorges are in their vicinity and in the presence of other active or scar cases of the disease in the household, and youth and adult age groups of age less than 50 years are significantly at higher risk of developing cutaneous leishmaniasis. Environmental management with appropriate case managements including awareness creations to limit contacts between cases is recommended to control the disease.

# 1. Introduction

## 1.1. Background

Leishmaniasis is a vector-borne disease spread by the protozoan parasite of the genus Leishmania, which is carried by female sandflies (1). It has been classified as one of about 20 neglected tropical diseases (NTDs) by the World Health Organization (WHO), highlighting its significant effects on the health and other aspects of the community as a whole, with a significant financial cost (1–3). Visceral or kala-azar leishmaniasis (VL), cutaneous leishmaniasis (CL), and mucocutaneous leishmaniasis are the three principal kinds of the disease. The most prevalent kind is CL, while the most dangerous type is VL (4).

In addition, leishmaniasis is described as collective term representing a group of diseases that are frequently categorized by world regions: New World (NW) leishmaniasis, which is endemic in the Western Hemisphere and spreads from south-central Texas to Central and South America (excluding Chile and Uruguay); and Old World (OW) leishmaniasis, which is found in the Eastern Hemisphere and is endemic in Asia, Africa, and southern Europe. Affected female sandflies belonging to the genera Phlebotomus in the Old World and Lutzomyia in the New World are the carriers of leishmania parasites (5).

One of the most typical signs of CL is a single, self-healing skin lesion that sometimes extends throughout the dermatological system (6,7). This lesion has the potential to become granulomatous nodules that impact several additional areas on the skin and result in sensitive face mucosa, as well as a persistent, metastatic disease (6,7). The overwhelming majority of CL lesions have been located on the hands (62.75%), head/neck (24.8%), and body (2.7%) (6,8). Such a broad spectrum of illnesses is caused by intricate elements such as parasite tree structure, host immune capacity, and the surrounding circumstances (7,9).

Besides, the disease represents a major health problem for the public with a wide range of clinical symptoms, epidemiological variety, and a spectrum of aggressiveness relying on the cellular pathogen linked and the immune reaction of the host (10,11). The illness is seldom deadly, albeit being grueling and deforming in those who are afflicted. As such, health officials often do not give much emphasis to prevention and control efforts (12).

Coming to Ethiopia's context, since the Italian epidemiologist Martoglio originally identified the condition in 1913, a number of researchers have recorded the existence of CL in various regions and studied its distribution in the country in the late 1960s and early 1970s (13,14). As such it has been documented that CL is endemic to Ethiopia since 1913 (15,16). It appears as a serious public health issue in in the country that affects up to 50,000 new cases annually and is expected to put over 29-30 million people at risk (15,17). The disease is more common in the highlands between 1400 and 3175 meters above sea level (8,18,19) . To name a few, there are various locations of broad CL foci in the north and northwest in Tigray and Gondar, in the west in Dembidolo (Wollega), in the south in Silti, Sidama, Gamo Gofa and in the center in Addis Ababa and its environs (14).

Isolated lesion and persistent ulcerations following emergence are the most often documented clinical features of CL in Ethiopia (16,19). Nonetheless, the majority of CL patients experience skin color changes, localized swelling, and hardened lesions with uneven spread (8,16,20) Alongside lesions on the skin, it progresses to the mucosa. Individuals with CL have had the lesion for decades, and it finally develops into diffused cutaneous leishmaniasis (DCL). A large patch of the skin is affected by DCL, which frequently lacks ulceration and manifests as a variety of popular, nodular, or plaque lesions (8).

Gamo Zone is one of those areas in Ethiopia currently hit by high burden of CL. Official reports from the former SNNPR Public Health Institute in August 2023 showed that CL is prevalent in Deramalo and Dita districts of Gamo Zone with over 252 cases recorded. Due to the stress in the region in managing other multiple emergency situations including malaria, measles, cholera, drought, flooding, and others, CL did not get the due attention, and sufficient targeted investigations have not been conducted (21). The aim of the current study was to assess the CL situation in Deramalo and Dita districts of Gamo Zone, South Ethiopia.

## 1.2. Statement of the Problem

Leishmaniasis causes major morbidity and mortality worldwide, yet there exists presently no preventive vaccine, and the treatments that are offered have drawbacks such as adverse effects, low adherence among individuals, and parasite resistance (22). Though not fatal, CL is also a condition that needs to be identified and treated as it may end in lasting psychological effects, discrimination, diminished satisfaction with life, and enduring scarring (2).

Due to the difficulties with reporting and monitoring, the load of CL is greatly overlooked. Though the number of CL patients worldwide is believed to be about 12 million, barely 19–37% of patients really get reported to health care officials (14). In developing nations, NTDs including CL pose a serious threat as the people have poor opportunities for therapy along with elevated rates of intimate contact with disease vectors and sources (22). Approximately 102 nations have reported instances of leishmaniasis, with eight of those countries accounting for over 90% of newly reported cases. Up to 1.5 million new cases of CL are recorded each year, and more than 350 million individuals are thought to be at risk of CL (12,23,24) . Six countries accounted for more than 95% of all new cases of CL in 2017, including Afghanistan, Algeria, Brazil, Colombia, Iraq, the Syrian Arab Republic, and the Islamic Republic of Iran, according to a 2019 WHO report (23).

CL is greatly affected by a number of demographic and socioeconomic factors, such as sex, rural life, impoverishment, and relatively young age (9,23) . Concurrently, CL affects the patients' psycho-social lives by producing disfiguring scars on their body parts, causing prejudice and stigma that lasts a lifetime and results in serious psychological and social issues (23).

Unfortunately, because CL disproportionately impacts the impoverished population segment, biopharmaceutical corporations do not invest much in research projects that could result in breakthroughs in medication, vaccination, and diagnostic technologies (1). One of the main causes of the persistent health disparities and the uninterrupted spread of diseases associated with poverty is the incapacity to create novel solutions to endemic health concerns and the dependency on foreign assistance. Among the main issues are political unpredictability, haphazard research endeavors, persistent underfunding of academic institutions, stringent laws and regulations, and poor dissemination and application of knowledge. No new drugs have been discovered for CL for several decades due to these reasons (25,26).

Notably, the common paradigm of CL ignores the vast majority of patients who experience ongoing stigma and psychological distress after infection as the disease inflicts a scar as lifelong sequalae (27,28). Studies have demonstrated how this has significant ramifications for the calculation for worldwide prevalence statistics, which in turn affects the computation of the cost of the condition (27–29). The long-term effects of CL on endemic and conflict-affected nations remain particularly unsettling as is the role that CL plays in perpetuating poverty in these environments—a role that has not received enough attention (27,29).

In Ethiopia, CL is a serious public health issue, and various investigations demonstrated the existence of CL and the risks that it poses. Around twenty to fifty thousand instances of infection occur each year, and roughly thirty million individuals are at risk (30). In addition, individuals with active CL lesions or healed scars can be seen in cities and villages, as well as in marketplaces, schools, and other public spaces.

Although routine species identification is rarely carried out, epidemiological and medical researches indicated that Leishmania aethiopica is the primary cause of CL in Ethiopia. However, L. donovani, L. tropica, and L. major, which are also present across the country, can also cause the condition (19,31–33). There is a tight genetic link between African strains of L. tropica and L. aethiopica (19,34). Affected persons have persistent, granulomatous lesions on the skin on exposed regions of the body, especially the face. Skin lesions heal with scars. Children and young adults are predominantly susceptible (8,29,35).

According to WHO, CL is a neglected tropical disease as well as an emerging illness that has been difficult to control. The large-scale, carefully executed investigations that are needed to supply ample clinical and epidemiological evidences are not sufficiently available (1,23). Health systems need to advance vector management, examinations, and vaccine development in order to further control and perhaps even eliminate CL (1,36). Additionally, healthcare workers must move promptly to care for the sick, eliminate the vectors, and enhance health awareness among the community in the effort to contain the disease (11).

Ethiopia is more impacted by NTDs including CL than other SSA countries. Although several studies have been conducted across Ethiopia in the past 50 years about cutaneous leishmaniasis, still a big knowledge gap remains about the condition, especially in the current study area (19,21). Doing operational research on the co-implementation of intervention packages,

integrating maps, scaling up public health actions quickly will be essential in order to successfully achieve comprehensive control of NTDs (26,37). This study is expected to address the gaps mentioned above, and would try to assess the determinants of CL in the selected districts of Gamo Zone.

## 1.3. Significances of the Study

This study identified the major determinants of CL in the area. The results of the study are supposed to be used by government and nonprofit organizations, legislators, programme planners, representatives of the health sector, regional and local health authorities, and researchers to create effective implementation tools for the control CL in the study area and beyond.

The findings might also help programme developers and public health planners to create appropriate training materials for health extension workers, the health development army, and overall healthcare providers.

In addition, this study gives a concise overview of the current CL associated factors in the area and can be used as a starting point for similar future researchers to find out new issues there. CL is a common health problem in Ethiopia, including in the current study areas, yet little research has been done to identify its determinants. This study aimed towards addressing this problem.

## 2. Literature Review

CL can be either anthroponotic or zoonotic in its life cycle. Literature data revealed that the digenetic lifespan of leishmania parasites has led to the evolution of a sophisticated mixed mating reproduction mechanism (38,39). It has a dimorphic life cycle in which the parasites grow into obligatory internal amastigotes inside parasitophorous vacuoles in cells of infected macrophages and extracellular promastigotes in the midgut of sand flies (40).

The following figure describes the life cycle of the leishmania parasites as described in US Center for Disease Control and Prevention (CDC): The sandflies inject the infective stage (i.e., promastigotes) from their proboscis during blood meals ❶. Promastigotes that reach the puncture wound are phagocytized by macrophages ❷ and other types of mononuclear phagocytic cells. Promastigotes transform in these cells into the tissue stage of the parasite (i.e., amastigotes) ❸, which multiply by simple division and proceed to infect other mononuclear phagocytic cells ❹. Parasite, host, and other factors affect whether the infection becomes symptomatic and whether cutaneous or visceral leishmaniasis results. Sandflies become infected by ingesting infected cells during blood meals (❺, ❻). In sandflies, amastigotes transform into promastigotes, develop in the gut ❼ (in the hindgut for leishmanial organisms in the *Viannia* subgenus; in the midgut for organisms in the *Leishmania* subgenus), and migrate to the proboscis ❽ (41) . (Figure 1)

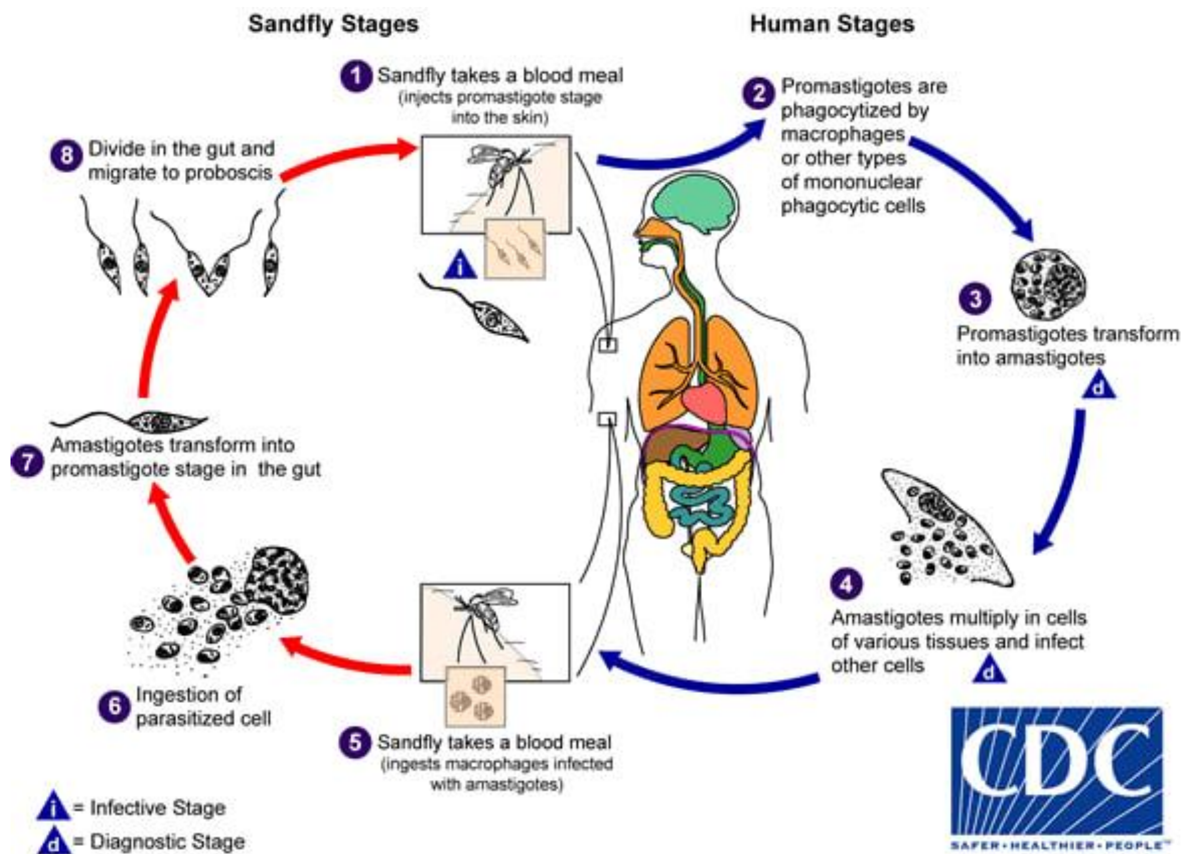


**Figure 1:Description of life cycle of leishmania (Source: Center for Disease Control and Prevention, available at: https://www.cdc.gov/dpdx/leishmaniasis/index.html)**

Potential Leishmania reservoirs include a wide variety of wild and domestic animals, including dogs, as well as marsupials, birds, and other vertebrates (42). The vector sand flies also consume on hens because they frequently find shelter in chicken coops, but these animals are not believed to be Leishmania reservoirs (42,43).

As described by studies, the transmission of CL is aided by sandflies. The disease results from a complex interaction between the immune system of the host and the infectious organism. An infection could result in a pleiomorphic skin condition or show no symptoms at all (38). The effectiveness of transmission by less proficient hosts may change when there are several hosts present, complicating transmission cycles. Because of artificial movement, the transmission occurs most frequently in rural, peri=urban, and naturally sylvatic settings; it is rarely seen in urban areas (42,44).

Studies have also reported that CL is not sufficiently researched and hence lacks a vaccine that could have been the hallmark of prevention and control efforts (1). Two strategies to stop the spread of the disease include reservoir control, which involves lowering the number of infectious animals, and vector control, which involves minimizing human contact with infected sandflies (44).

Globally, literatures estimating overall burden of CL are scanty. Moreover, there are few investigations on the prevalence and risk factors of CL in sub-Saharan Africa. However, some existing regional, national and subnational literatures have mainly assessed the burden and determinants of leishmaniasis across the world.

Studies have usually indicated that host variables, vector ecology, human activities in geographic space, and the process by which the link between these is generated are the essential components that sustain CL transmission. Leishmaniasis has now spread outside of its typical ecotypes due to anthropogenic ecological changes, possibly as a result of increasing vector interactions (19,20,45). Numerous environmental and socioeconomic conditions can either promote or hinder the development and maintenance of the CL dissemination cycle. These factors also operate as obstacles to the existence of carriers, reservoirs, and parasites, which further prevents or facilitates the onset of illness (29).

Valero, N.N.H., and Uriarte, M. in 2020 made a systematic review of literatures on leishmaniasis published since 1900 majorly focused on environmental and social risk factors. Environmental and climatic circumstances had a substantial correlation with the occurrence of CL in all studies that included them. While the climates that are conducive to the spread of disease vary by place, being close to natural vegetation remnants raised the danger of contracting the illness (18).

Another systematic literature review carried out in Brazil by Buzanovsky LP et al. indicated that one of the major factors associated with CL was an increased frequency of occupational risk including forestry activities, fishing, military training activities, hunting, catch fire wood and forest incursion habits (46). Similarly, the risk of CL occurrence and transmission was linked to places with agricultural operations, such as the farming of poultry, pigs, and horses as well as the planting of banana, cocoa, coffee, sugar cane, and fruit crops (47,48).

Moreover, a case-control study conducted in Morocco by Amane M. et al. in 2022 found that active CL in Morocco was associated with a number of socioeconomic features, such as residing in a rural area, visiting an endemic area, coming from leishmaniasis foci in the Essaouira focus, and being poor. Environmental factors that were found to increase the risk of CL in Morocco include the presence of animals in the area of residence, being near greenery, having poor domestic hygiene, particularly when it comes to not having a drainage system or waste management, and inadequate hygiene (49).

On the other hand, in ecological observational study conducted by Maia-Elkhoury ANS to find out risk of cutaneous leishmaniasis in Latin America, urban bundles that are at risk of spreading CL were better characterized by combining environmental factors like rainfall, temperature, elevation, and types of vegetation with aspects of human life like possession of drinking water, basic hygiene, overpopulation, education, and farming and mineral extraction operations (50).

The epidemiology of CL is not well understood in most of Ethiopia's endemic areas, and medical facilities did not thoroughly document several recent cases of CL(26). A few studies tried to describe the epidemiology of CL in the country. In a household level field survey in Tigray by Yohannes M, Abebe Z, and Boelee E found notable differences in the frequency of active CL based on various host characteristics and their environmental interactions like age groups, sleeping outdoor, settlements and the geographical characteristics of the place of residence such as the existence of gorges, caves, and hyraxes within a distance of 300 meters of the home (37).

In 1973, Bray granted Ethiopian CL a distinct particular status. He identified the parasite as Leishmania aethiopica, including hyraxes as reservoir hosts, Phlebotomus longipes and P. pedifer as sandfly vectors, and an often-confined geographic distribution to the highlands of Ethiopia and the slopes of Mount Elgon, Kenya (19). In another survey in the district of Silti, Central Ethiopia by Negera E. et al., living in an enclosure with domestic animals, having plants like Adhatoda schimperiana and Acacia species nearby, and being close to a gorge where hyraxes reside were all strongly associated with the development of CL (32).

Additionally, an institution-based cross-sectional study by Eshetu, B., and Mamo, H. in north-central Ethiopia about the pattern, medical manifestations, spatial dispersion, and contributing factors of CL found that staying in mud and grass houses, having holes in the walls, lying on the floor, not using a bed net while resting, having plants and irrigation channels close to homes,

having pets and other animals in the residence, and having visited endemic areas in the past are all strongly linked to CL (14).

Moreover, in a case-control study carried out in North East Ethiopia by Dires A. et.al., CL had a significant association with sociodemographic and ecological variables such as being male, living in a rural area, being adjacent to a forest, and existence of hyrax in the surrounding (51).

On the other hand, an institution-based geo-climatic and spatial analysis carried out in the eastern Iranian deserts in 2021 by Karamian M, indicated that the presence of high-velocity winds, agricultural land cover, and urban settings were the main factors for the dispersion of CL (52).

In a systematic review of the burden of cutaneous leishmaniasis in sub-Saharan Africa, Sunyoto T. et al. found that between 0.1 and 14.2% of probable cases in hospital settings had CL. Although it was predicted to be less than 5% in the majority of research, the prevalence of CL at the community level varied greatly between the studies in the review. Furthermore, outbreaks involving several hundreds of infections happened in Sudan, Ethiopia, and Ghana (53).

On the other hand, there are also few researches published in Ethiopia to provide an accurate national estimate of the prevalence of cutaneous leishmaniasis infection. Assefa A. examined multiple publications in a systematic review and meta-analysis, and thirty studies were deemed eligible for the final review. They determined that the overall random pooled prevalence of cutaneous leishmaniasis in the country was nearly 19 percent (15).

In a household level field-based survey about the prevalence and risk factors of CL in Tigray region by Yohannes M, Abebe Z, and Boelee E, the prevalence of active CL was found to be 2.3%, while 20.9% of participants had the appearance of scarring (34). Similarly, in a retrospective prevalence research carried out in the Kutaber district of Ethiopia, the prevalence of CL as high as 21.7% was observed in the year 2016 among the five-year retrospective data (2015–2019), with 1718 of the 7911 health facility visitors testing positive (31,37).

Moreover, a survey was conducted in 1989 in the Ocholo district, located on the western side of the Ethiopian Rift Valley by Mengistu G. etal. This area is known to be endemic for Leishmania aethiopica infection. Of the population then in the area, 3022 people, or more than 95%, were interviewed and examined. The overall prevalence of localized cutaneous leishmaniasis (LCL) was 3·6-4·0% and about 34% of the people have scars from LCL (31).

Another study in April 2006, by Negera E. et al. conducted as house-to-house survey of 1907 residents in three subdistricts of Silti district, Central Ethiopia, found that the prevalence of CL in the area was about 4.8%. Additionally, the cross-sectional study in Tigray by Bisrat A et. al reported overall prevalence of CL in the Saesie Tsaeda-emba area to be about 14.0% (6.7% for active lesion and 7.3% for scar) (32).

In summary, we can conclude that though not sufficient, various studies were conducted across the world about the prevalence and determinants of CL in different regions. Generally, we can categorize the determinants of cutaneous leishmaniasis identified by different literatures in to four groups as factors related to the socioeconomic aspects, those related to the vector ecology and the surrounding environment, host factors, and factors associated with the geography and climate of the study area. The conceptual framework below illustrates this scenario.

**Conceptual framework**

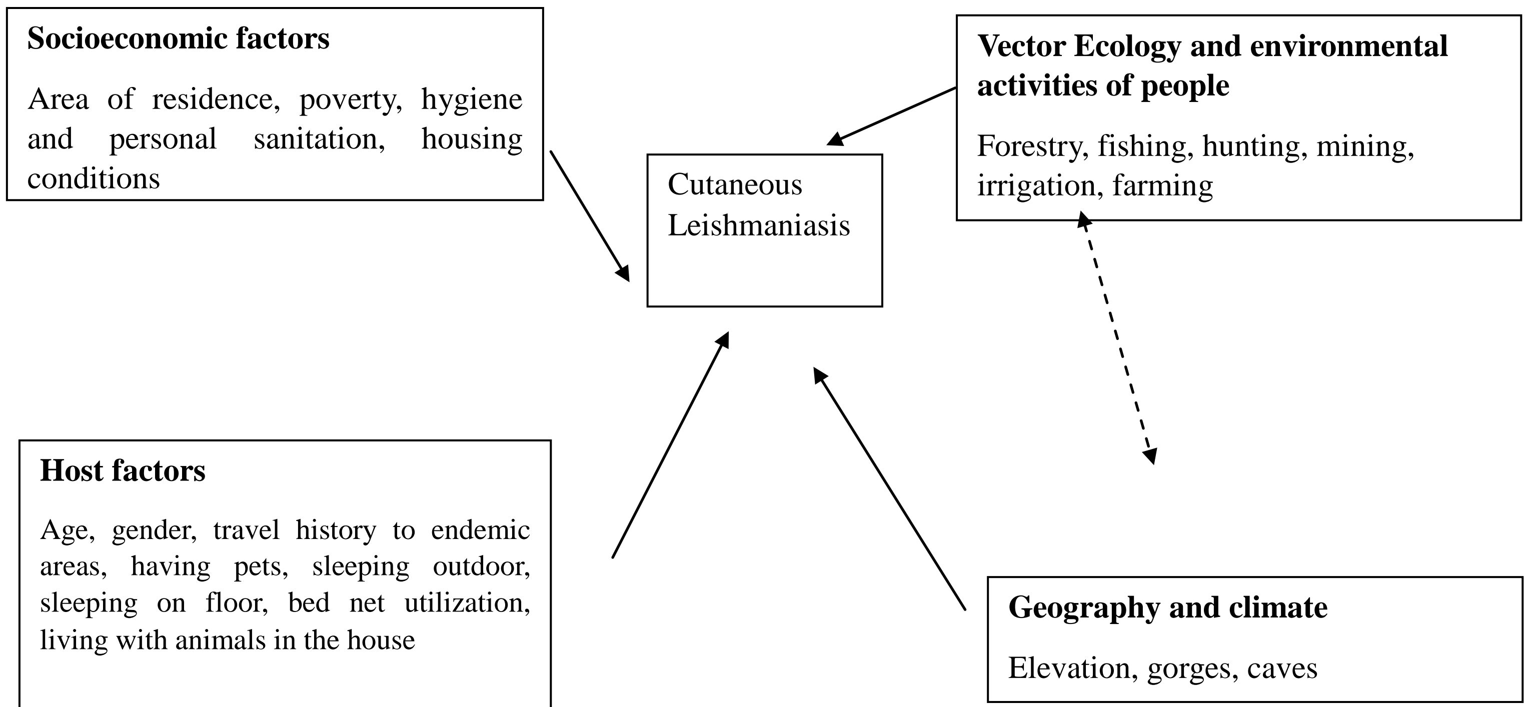


Figure 2: Conceptual framework to assess the determinants of cutaneous leishmaniasis adapted from previous literatures (46,50–52,54).

# 3. Study objectives

The objective of this study was to assess the determinants of cutaneous leishmaniasis in Gamo Zone, South Ethiopia, 2024

# 4. Methods and Materials

## 4.1. Study area

This study was conducted in two districts of Gamo Zone, Deramalo and Dita woredas, South Ethiopia. Dita Woreda is one of the districts in Gamo Zone. Its administrative capital is Zada town, located about 53 KMs from the zonal capital, Arbaminch town. The total population of the district is estimated to be 125,999 for EFY 2016. The district has about 19 subdistricts (Kebeles). It has 5 health centers and 19 health posts.

The other district Deramalo is also one of the districts in the Zone with its administrative center being Wacha town and about 214 KM from the zonal capital. It has estimated total population of 121,625. The district has 21 subdistricts (kebeles) with 4 health centers and 21 health posts.

The administrative map of the study area in the new region of South Ethiopia is shown below.

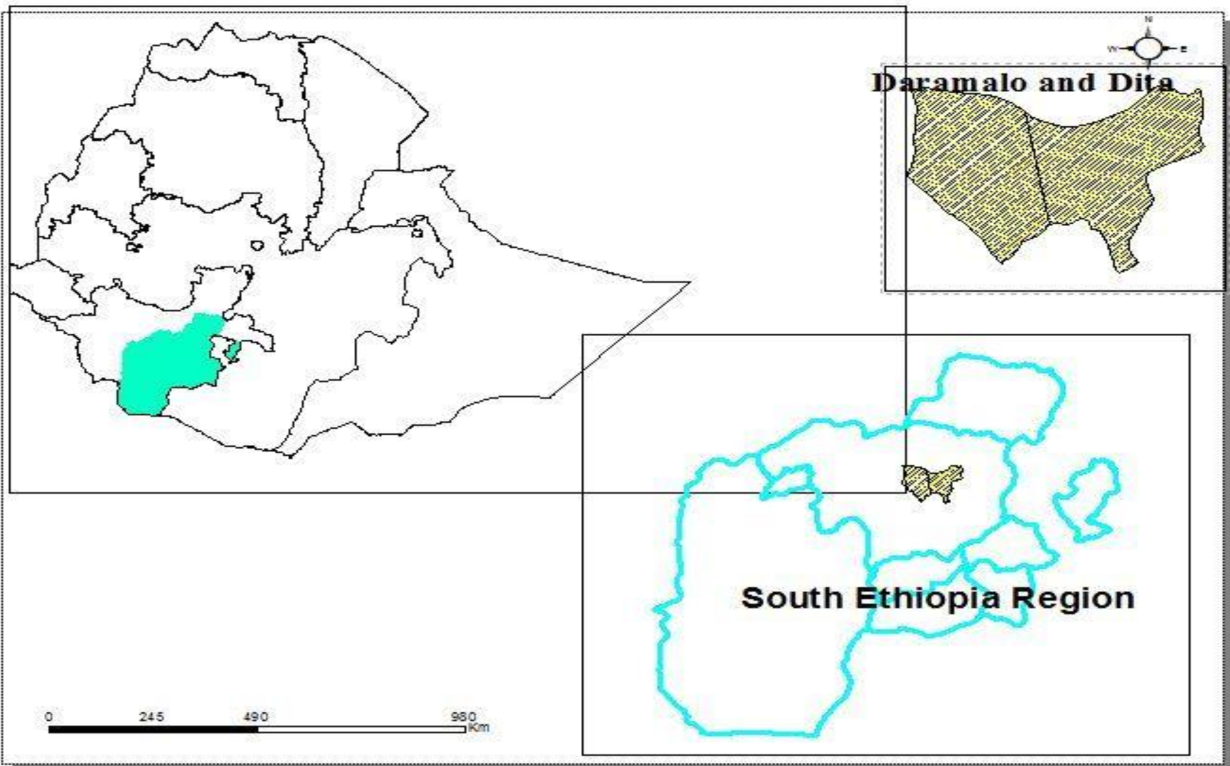


Figure 3: Map of study area, Daramalo and Dita districts, in South Ethiopia region, South Ethiopia

## 4.2. Study design

Unmatched case-control study design was employed to assess the determinants of cutaneous leishmaniasis in Deramalo and Dita districts, Gamo Zone, South Ethiopia.

### 4.3. **Study period**

This study was conducted in April 2024.

## 4.4. Source Population

All population in Deramalo and Dita districts of the South Ehiopia Region by the study time were taken as the source population.

## 4.5. Study Population

**4.5.1. Study population-cases:** The study population for cases were those persons of age 1 year or above living in Deramalo or Dita districts who have stayed in the area for 1 year or above during the data collection period. A case of CL is defined as a patient aged 1 year or more living in Deramalo or Dita districts with clinical manifestations of CL (a skin lesion) and with parasitological confirmation of the diagnosis (positive smear or culture) during the investigation period. For those case participants of age less than 14 years, their caregivers were interviewed and for those less than 18 assent was taken from their guardians before they were interviewed.

**4.5.2. Study population-Controls:** study controls are defined as persons aged 1 year or above without history of CL clinical manifestations (skin lesion) by the investigation time. For both case and control study participants of age less than 14 years, their caregivers will be interviewed and for those less than 18 their guardians will be interviewed. For control participants of age less than 14 years, their caregivers will be interviewed and for those less than 18 their guardians will be interviewed.

#### 4.5.3. Criteria for Inclusion and Exclusion

**Inclusion for cases and controls**

Cases are those residents of the selected districts who have an active CL lesion or a CL scar during the study time, while those in the control group are the ones who have never had a CL infection or lesion.

**Exclusion for cases**

Individuals who have skin lesions undetermined to be that of cutaneous leishmaniasis were not included as cases.

**Exclusion criteria for controls**

Those individuals who have a previous CL scar, suspicious skin lesions, or were unable to actively take part in the screening process were not eligible to be included in the study as controls.

## 4.6. Sample size determination

The study sample size is calculated using double population proportion formula with the following assumption: Type 1 error of 0.05 at 95% Confidence Interval, study power taken to be 80%, the percentage of controls exposed for each of the four determinant variables considered from previous studies, adjusted odds ratio, and with controls to cases ratio of 2. The variable with the biggest sample size (285) was selected, as indicated in the table below.

Table 1: Sample size determination to assess determinants of cutaneous leishmaniasis in Deramalo and Dita districts, Gamo Zone, South Ethiopia, 2024.

| SN | Variable | Proportion of outcome in unexposed | AOR | CI | Power | Ratio of cases to control | Sample size | References |
|---|---|---|---|---|---|---|---|---|
| 1 | Staying outdoor at night | 50 | 4.1 | 95 | 80 | 1:2 | 285 | (55) |
| 2 | Male gender | 49 | 4.11 | 95 | 80 | 1:2 | 281 | (51) |
| 3 | Rural residence | 50 | 4.17 | 95 | 80 | 1:2 | 281 | (49) |
| 4 | Presence of hyraxes | 50 | 4.15 | 95 | 80 | 1:2 | 282 | (37) |

## 4.7. Sampling technique and Sampling procedures

Deramalo and Dita districts are first selected from the region for this study as they were the only districts reporting confirmed cutaneous leishmaniasis cases to the zone and region. According to the earlier existing reports, Deramalo has seven kebeles (subdistricts, the lowest administrative level in Ethiopia) affected by CL while Dita has 6 subdistricts affected. Accordingly, a total of four kebeles randomly selected from the list of affected subdistricts (two from each district) were included in this study.

Cases were randomly selected from the selected subdistricts from the list of the cases in the weekly reporting line list prepared for CL reporting at district level. The controls, who are the attendants or the neighbors of the cases, were selected from the population in the affected subdistricts, ensuring that the total number of individuals taking part equals the sample size.

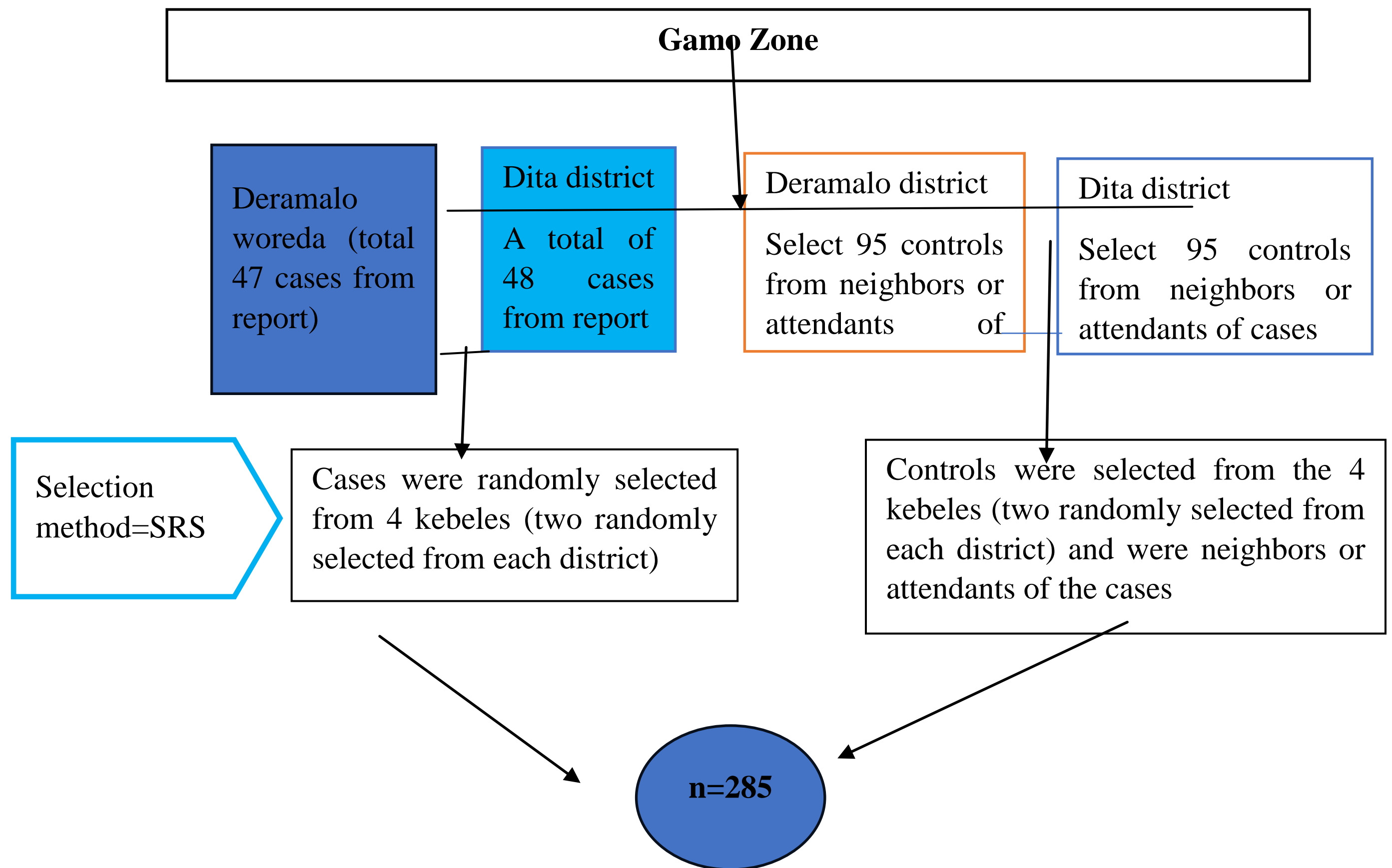


Figure 4: Diagrammatic representation of sampling procedure to assess determinants of CL in Deramalo and Dita districts, South Ethiopia, 2024

### 4.8. Study variables

The dependent variable is the occurrence of cutaneous leishmaniasis disease (CL).

The independent variables include sociodemographic and personal/family characteristics as age, sex, educational status, knowledge about the disease, travel history to endemic area, occupation, presence of forest nearby, type of housing, use of bed nets, sleeping outdoors, presence of hyraxes near residential area and other variables.

### 4.9. Data collection and tools

Patients with the necessary test confirmation and constitutional clinical signs and symptoms were first selected in order to confirm the diagnosis. To address the aim of the current research, a line list and structured questionnaire adapted from other studies with similar purposes was used, after making some adjustments. As the data collectors, appropriately trained healthcare workers chosen from the districts have been recruited. Electronic data collection methods Open Data Kit and Kobo Collect were used.

### 4.10. Data Quality Management

In order to prevent misclassification bias, standard case definitions were applied while classifying the study participants as cases and controls. The primary investigator regularly verified the consistency and completeness of the data by going over it again. The raw data collected and compiled in the online server were finally exported in Microsoft Excel for further observation and management.

### 4.11. Data Entry and Analyses

The gathered data were exported from the online server in Microsoft Excel format, cleaned, and then were imported into SPSS for descriptive and regression analyses. Model fitness was tested by Nagelkerke r square and Hosmer and Lemeshow tests, and the values showed good-fits of the model for our data (the Nagelkerke values was 0.53, and the Hosmer and Lemeshow significance value was 0.61). Moreover, multicollinearity between predictor variables was tested by collinearity diagnostics in linear regression, and both the tolerance and Variance Inflation Factor (VIF) values show that no significant multicollinearities exist. The VIFs ranged from 1 to 6, and less than 1.5 in most cases.

The backward elimination method was used in multivariable logistic regression to discover statistically significant risk factors for CL while controlling for potential confounders, once candidate variables with a P-value of less than 0.25 have been selected. In the multivariable binary logistic regression, Adjusted Odds Ratios (AORs) were calculated at 95% CI to determine the variables having significant associations with CL, and variables having p-value of <0.05 were declared to have significant associations and hence the determinants of CL. The findings are then presented using narrations, tables and graphs.

## 4.12. Operational and Standard Definitions

**Active CL cases:** People with a confined, nodular, or palpable cutaneous active lesion with elevated margins and a depressed center.

**Former CL lesions/" scars":** Healed lesions with rubbery margins, a depressed appearance, and none or hypopigmentation.

**DCL (Diffuse Cutaneous Leishmaniasis):** A clinical variant of CL manifested by the appearance of hundreds of atypical, widespread infiltrated skin lesions.

**MCL (Muco-cutaneous Leishmaniasis):** Leishmaniasis with both skin and mucosal involvement of mouth, nose and throat.

**PKDL (Post-Kalazar Dermal Leishmaniasis):** a sequalae of VL characterized by the occurrence of nodules or maculo-papular rash that usually appears on the face, upper arms, and chest.

**VL (Visceral Leishmaniasis):** A type of leishmaniasis with involvement of internal organs

**Controls:** People without an active lesion and no history of CL infection.

## 4.13. Ethical Clearance

The study obtained appropriate ethical approval from Hawassa University, College of Medicine and Health Sciences, Institutional Review Board (IRB). Additional permissions for data collection from the study participants and administrative structures were also obtained from the relevant regional and local authorities. At household or respondent level, the head of each home chosen for the study gave informed oral consent, and individual participants (the guardians of children of age less than 12 years) were also requested formal consent after hearing the consent

form. For participants of age 12-18 years, assent was taken. Personal identifying information like name of the subject were excluded being replaced by appropriate codes.

# 5. Results

## 5.1. Sociodemographic characteristics of the respondents

A total of 285 participants with 95 cases and 190 controls (with case to control ratio of 1 to 2) were included in this study. Most households of the respondents of both cases and controls had family size of 5 to 10 persons per household (true in 82% of the cases and 77% of the controls). The mean age of the cases was 21.42 with SD of ±12.82 and the mean age of the controls was 28.45 with SD of ±13.33. The majority of the cases, 52 (57.9%) were in the age group of less than 20 years while the majority of the controls or 72 (37.9%) were in the age group of 20 to 34 years. Gender wise, male cases accounted for 47 (49.5%) of the total cases, whereas male controls made up 90 (47.4%) the total controls in the study. Sixty percent of the cases followed Protestant Christianity and the remaining 40% of them were Orthodox Christians. Similarly, 51.1% of the controls were also Protestant Christianity followers while about 48% were Orthodox Christians, and the remaining less than 1% of them were in traditional beliefs. All of the respondents were Gamo in their ethnicity (Table 2).

**Table 2:Socio-demographic characteristics of the respondents in Deramalo and Dita districts, South Ethiopia, 2024**

| Socio-demographic characteristic variable | Variable category | Case | Control | P Value |
|---|---|---|---|---|
| | | Frequency (%) | Frequency (%) | |
| Family Size | Large | 8 (8.4) | 19 (10.0) | 0.64 |
| | Moderate | 78 (82.1) | 147 (77.4) | |
| | Normal | 9 (9.5) | 24 (12.6) | |
| Age category | Less than 20 | 52 (57.9) | 58 (30.5) | <0.0001 |
| | 20-34 | 22 (23.2) | 72 (37.9) | |
| | 35 to 49 | 14 (14.74) | 42 (22.1) | |
| | 50 and above | 4 (4.2) | 18 (9.5) | |
| Gender | Female | 48 (50.5) | 100 (52.6) | 0.42 |
| | Male | 47 (49.5) | 90 (47.4) | |
| Religion | Orthodox | 38 (40.0) | 92 (48.4) | 0.3 |
| | Protestant | 57 (60.0) | 97 (51.1) | |
| Marital status | Single | 62 (65.3) | 89 (46.8) | 0.01 |
| | Married | 33 (34.7) | 94 (49.5) | |
| | Divorced | 0 (0.0) | 4 (2.1) | |
| | Widowed | 0 (0.0) | 3 (1.6) | |
| Educational status | No formal education | 32 (33.7) | 71 (37.4) | 0.005 |
| | Primary education | 52 (54.7) | 69 (36.3) | |
| | Secondary education | 11 (11.6) | 48 (25.3) | |
| | College level | 0 (0.0) | 2 (2.1) | |
| Occupation | Child/student | 60 (63.1) | 82 (43.2) | 0.005 |
| | Farmer | 26 (27.4) | 71 (37.4) | |
| | 0ther | 9 (9.5) | 37 (19.5) | |

## 5.2. Household and environmental conditions

About 86 (91%) of the cases and 166 (89%) of the controls had corrugated iron-roof type of houses, while the remaining minority had thatch-style houses. On the other hand, 70 (74%) of the cases and 131 (69%) of the controls kept livestock at home. Moreover, 54 (57%) of the cases and 103 (54%) of the controls owned pets in their house.

**Table 3: Household conditions of the respondents, Deramalo and Dita districts, South Ethiopia, 2024**

| Household characteristics | Variable category | Case Frequency (%) | Control Frequency (%) | P value |
|---|---|---|---|---|
| Type of residential house | Wood and mud wall, corrugated iron roof | 86 (90.5) | 169 (88.9) | |
| | Thatch | 9 (9.5) | 19 (10.0) | |
| | Stone wall with wood and earth roof | 0 (0.0) | 2 (1.1) | 0.93 |
| Keeping cattle at home | Yes | 70 (73.7) | 131 (68.9) | |
| | No | 25 (26.3) | 59 (31.1) | 0.49 |
| Pets at home | Yes | 54 (56.8) | 103 (54.2) | |
| | No | 41 (43.2) | 87 (45.8) | 0.71 |
| Bed nets availability | Yes | 15 (15.8) | 38 (20.0) | |
| | No | 80 (84.2) | 152 (80.0) | 0.42 |
| Bed nets utilization | Yes | 6 (6.3) | 17 (8.9) | |
| | No | 9 (93.7) | 21 (91.1) | 0.64 |
| Sleeping outdoor | Yes | 4 (4.2) | 1 ((0.5) | |
| | No | 91 (95.8) | 189 (99.5) | 0.04 |
| Availability of sewage system | Yes | 7 (7.4) | 23 (12.1) | |
| | No | 88 (92.6) | 167 (87.9) | 0.31 |
| Availability of dry waste management | Yes | 6 (6.3) | 22 (11.6) | |
| | No | 88 (92.6) | 168 (88.4) | 0.13 |

Regarding the environmental conditions, we have assessed availability of gorges, caves, hyraxes, greenery area, and agricultural irrigation centers in the household vicinity within estimated 300 meters of radius. Accordingly, 68% of cases and 50% of controls reported availability of gorges, 98% of cases and 86% of controls reported availability of caves, all the 95 cases and 87% of controls reported availability of hyraxes, 99% of cases and 96% of controls reported availability

of greenery area in their vicinity and around half (50%) of both cases and controls reported availability of agricultural irrigation centers in their vicinity.

**Table 3: Environmental conditions of the respondents, Deramalo and Dita districts, South Ethiopia, 2024**

| Environmental characteristic variable | Variable category | Case | Control | |
|---|---|---|---|---|
| | | Frequency (%) | Frequency (%) | P value |
| Availability of gorges in the vicinity | Yes | 65 (68.4) | 98 (51.6) | |
| | No | 29 (30.5) | 92 (48.4) | 0.003 |
| Availability of caves in the vicinity | Yes | 93 (97.9) | 164 (86.3) | |
| | No | 2 (2.1) | 26 (13.7) | 0.001 |
| Presence of hyraxes in the vicinity | Yes | 95 (100.0) | 165 (86.8) | |
| | No | 0 (0.0) | 24 (12.6) | <0.0001 |
| Greenery area in the village | Yes | 94 (98.9) | 182 (95.8) | |
| | No | 1 (1.1) | 8 (4.2) | 0.03 |
| Availability of agricultural irrigation centers in the area | Yes | 47 (49.5) | 90 (47.4) | |
| | No | 48 (50.5) | 100 (52.6) | 0.8 |

## 5.3. Description of CL in cases

Out of the total 95 cases included in this study, 41 of them had active CL lesion(s) and 54 of them have CL scar(s). On average, the cases had the CL lesions for a period of 5.07 months with SD of ±2.56 months. Moreover, a case had an average of 1-2 lesions with the face, especially cheeks, being the commonest site of involvement, followed by forehead, legs and hands.

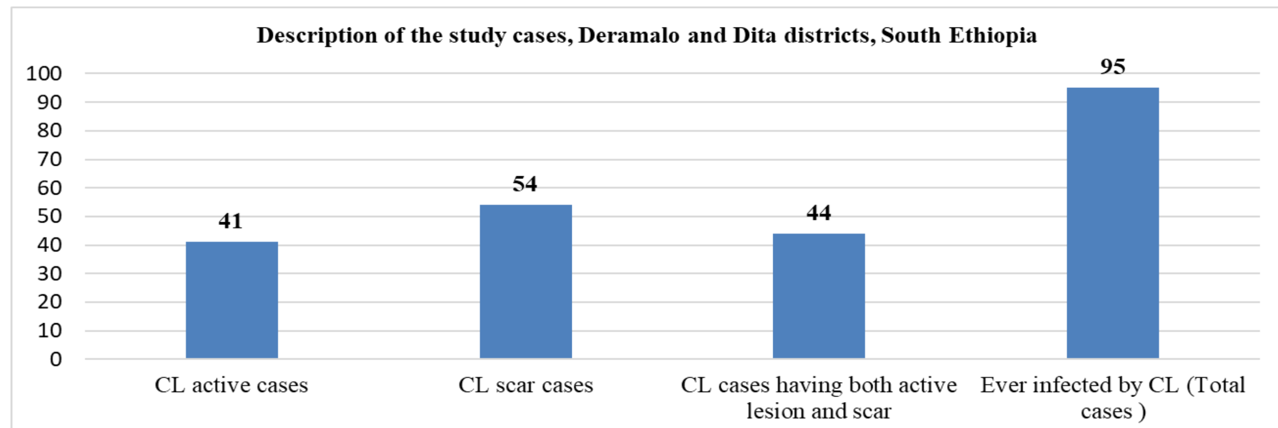


**Figure 5: Description of study cases, Deramalo and Dita districts, South Ethiopia**

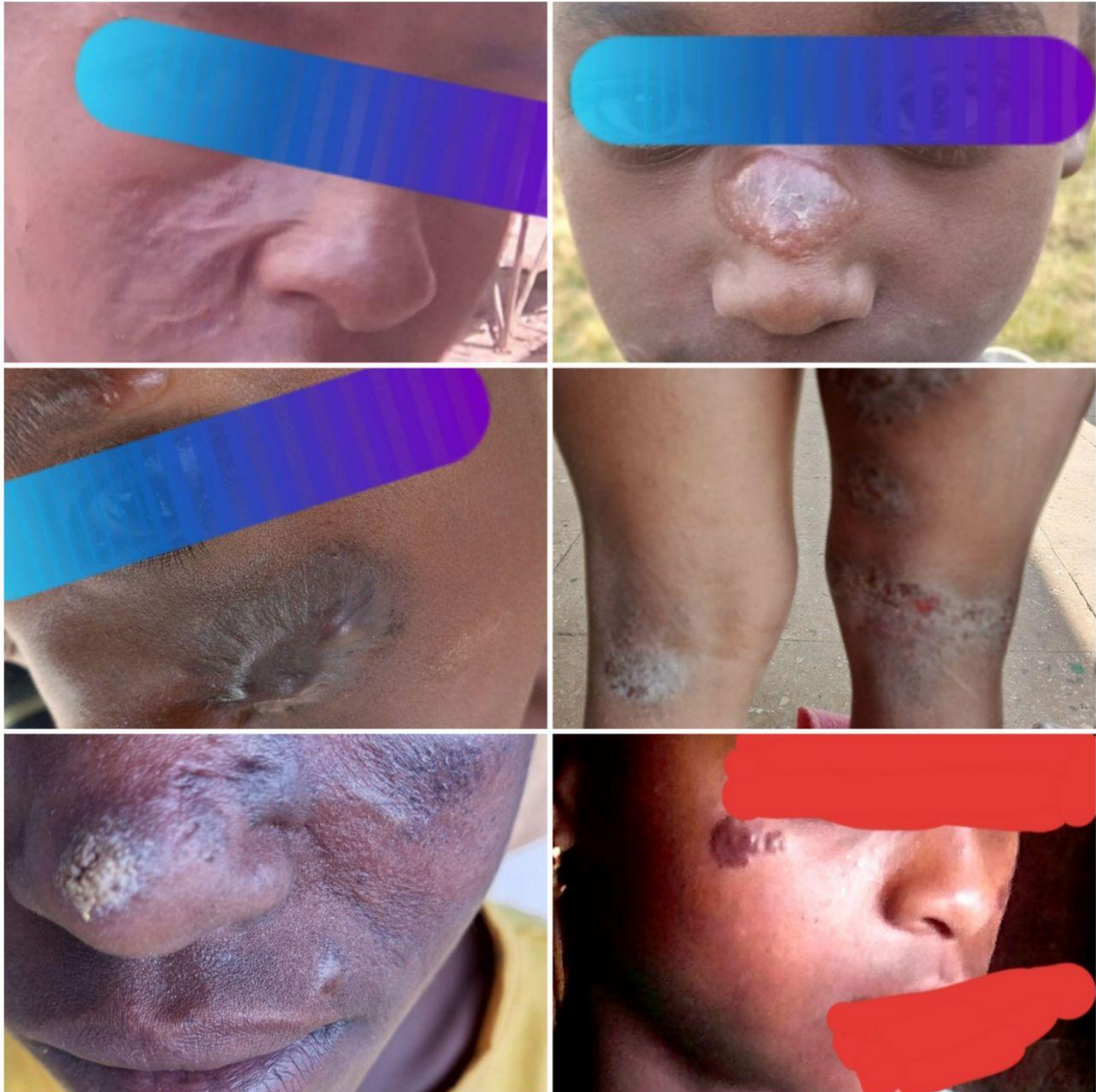

**Figure 6: Some pictures of lesions and scars in CL cases, Deramalo and Dita districts, South Ethiopia**

## 5.4. Determinants of CL

We tested about 26 variables in bivariable binary logistic regression and identified those with P value of less than 0.25 to be included in multivariable binary logistic regression. Accordingly, age of the respondents, occupation, availability of gorges in the vicinity, availability of caves in their village, habit of sleeping outdoors, presence of CL cases in the village, presence of CL cases in the household, presence of CL scar cases in the household, use of soaps for personal

hygiene, availability of sewage system for the household and availability of dry waste management system for the household were found to have P values of less than 0.25 in the bivariable logistic regression.

Once these variables were entered into the multivariable logistic regression, a few factors were found that were associated with the development of CL. Among the sociodemographic characteristics, age was significantly associated with the development of CL. Age groups of under 20 years old (AOR=3.15; 95% CI: 1.42-6.95) and 20 to 34 years (AOR=3.4; 95% CI: 1.4-8.8) were found to have strong association with the development of the disease.

Moreover, the presence of gorges near the household (AOR=2.51; 95% CI: 1.22-5.13), the presence of an active case of cutaneous leishmaniasis in the household (AOR=9.27; 95% CI: 4.23-20.33), and the presence of scar cases from previous cutaneous leishmaniasis in the household (AOR=4.49; 95% CI: 2.03-9.96) were all significantly associated with the disease, as described in the table below.

**Table 4: Bivariable and multivariable Binary logistic regression analysis results of assessment of determinants of CL in Gamo Zone, South Ethiopia**

| Variable | Categories | Case n (%) | Control n (%) | COR (95% CI) | AOR (95% CI) | P value |
|---|---|---|---|---|---|---|
| Age category | Less than 20 | 52 (57.9) | 58 (30.5) | 3.1 (1.7, 5.7) | 5.19 (2.56, 11.94) | <0.05 |
| | 20-34 | 22 (23.2) | 72 (37.9) | 2.8 (1.4, 5.8) | 5.64 (1.67,19.07) | <0.05 |
| | 35 to 49 | 14 (14.74) | 42 (22.1) | 4.3 (1.4, 13.4) | 3.5 (0.5, 24.6) | 0.2 |
| | 50 and above | 4 (4.2) | 18 (9.5) | 1 | 1 | |
| Occupation | Child/student | 60 (63.1) | 82 (43.2) | 1.9 (1.1, 3.5) | 0.9 (0.2, 4.3) | 0.7 |
| | Farmer | 26 (27.4) | 71 (37.4) | 1.2 (0.3, 5.3) | 0.9 (0.2, 3.6) | <0.25 |
| | 0ther | 9 (9.5) | 37 (19.5) | 1 | | <0.25 |
| Presence of gorges in the vicinity | Yes | 65 (68.4) | 98 (51.6) | 2.10 (1.25, 3.55) | 2.85 (1.37, 5.92) | <0.05 |
| | No | 29 (30.5) | 92 (48.4) | 1 | 1 | |
| Presence of caves in the vicinity | Yes | 93 (97.9) | 164 (86.3) | 7.37 (1.7, 31.76) | 0.8 (0.1, 6.8) | <0.25 |
| | No | 2 (2.1) | 26 (13.7) | 1 | 1 | |
| Habit of sleeping outdoor | Yes | 4 (4.2) | 1 (0.5) | 8.31 (0.92, 75.39) | 8 (0.2, 231) | <0.24 |
| | No | 91 (95.8) | 189 (99.5) | 1 | | |
| Presence of CL cases in the village | Yes | 94 (98.9) | 151 (79.5) | 24.3 (3.28, 179.67) | 4.1 (0.5, 34.1) | <0.25 |
| | No | 1 (1.1) | 39 (20.5) | 1 | | |
| Presence of active CL cases in the HH | Yes | 78 (82.1) | 45 (23.7) | 14.78 (7.94, 27.54) | 10.75 (4.81, 24.01) | <0.05 |
| | No | 17 (17.9) | 145 (76.3) | 1 | 1 | |
| Presence of CL scar cases | Yes | 55 (57.9) | 16 (8.4) | 14.87 (7.73, 28.6) | 3.6 (1.63, 7.95) | <0.05 |
| | No | 40 (42.1) | 173 (91.1) | 1 | 1 | |
| Use of soaps for personal hygiene | Regular use | 29 (30.5) | 68 (35.8) | 0.4 (0.1, 1) | 0.9 (0.4, 2.3) | 0.8 |
| | Sometimes | 56 (58.9) | 113 (59.5) | 0.45 (0.17, 1.1) | 0.4 (0.1, 1.5) | 0.2 |
| | Do not use | 10 (10.5) | 9 (4.7) | 1 | 1 | |
| Availability of sewage system | Yes | 7 (7.4) | 23 (12.1) | 0.56 (0.2, 1.4) | 0.29 (0.02, 4.9) | 0.8 |
| | No | 88 (92.6) | 167 (87.9) | 1 | 1 | |
| Availability of dry waste management | Yes | 6 (6.3) | 22 (11.6) | 0.5 (0.2, 1.3) | 2.2 (0.1, 39.9) | 0.5 |
| | No | 88 (92.6) | 168 (88.4) | 1 | 1 | |

# 6. Discussion

This study assessed the determinants of cutaneous leishmaniasis in Gamo Zone, South Ethiopia. In our study, relatively younger age groups of age less than 35 years, presence of gorges nearby, presence of other active and scar CL cases in the household were significantly associated with the disease.

Our study found that age categories of less than 20 years and also those 20 to 34 years of age had more than three times higher odds of developing CL compared to those with age 50 years and above. This result is similar to that of related studies in Ethiopia, Iran and Brazil (30,51,56,57). The higher occurrence of CL in children and younger adults in our study may be due to higher engagements of the people in these age groups in environmental and household tasks that could expose them to the disease.

According to our findings, the presence of gorges in the household vicinity was the commonest environmental risk factor. In this study, people living in areas where gorges are nearby are more than 2 times likely, to develop CL than those who do not live in areas where gorges are found. This result is similar to that of several related studies in Ethiopia and other African and Asian countries where CL is endemic (18,30,32,58). In our study area, gorges are common topographic features associated with people's settlement and day to day lives including some agricultural activities in the canals and beneath such areas (59). The higher occurrence of CL in villages near to gorges may be due to higher possibility of vector sand fly bites in these areas, as they are abundantly found in such areas (33,60) .

The existence of prior CL scar cases and active CL cases in the household were also found to be significant variables linked to the occurrence of CL in the area. This result is in agreement with a similar study in Afghanistan which also reported a higher probability of CL occurrence when an active case of CL is present in the household or neighborhood of the respondent (61). Our result of a higher odds of CL occurrence when there are CL active or scar cases in the same household may also indicate that there are higher probabilities of indoor transmission of the disease in the area (62). Some recent studies reported that sand flies are also biting people in the indoor environment (51,62).

Our study, however, did not find association with CL for some factors that were found significant predictors of the disease in other studies. Among sociodemographic variables, only age category was associated with the development of CL in this study. Several other studies reported associations of CL with sociodemographic variables like gender and educational status. Regarding gender, some studies in Ethiopia, Brazil and Bolivia found that the risk of CL is higher in male gender, explained by higher engagement of males in risking environmental activities (51,63,64), while another study in Yemen reported higher occurrence of the disease among females for similar reasons (65). There are also studies that reported same results to ours that there were no gender differences in development of CL (49,55). These differences can be explained by the different sociodemographic characteristics of the study areas involved (51). Our result showing the higher probability of indoor transmission of CL in our study area may also explain the reason for no gender differences in the development of CL in our study.

Educational status which was found protective with its increasing level in other studies like a study in Brazil (66) did not show any association with CL in our study. Some other studies on the other hand also reported similar result to ours that educational status is not associated with the development of CL (49). This might be due to mass similar levels of educational and awareness statuses among the respondents.

In addition, most household environment related factors like the housing type, presence of hyraxes nearby, greeneries in the vicinity, agricultural irrigation centers in the village, and presence of animals and pets in the household were not found significant in this study. This may be due to the global presence of similar conditions with regard to these factors in the area without discrepancies between the respondent groups. Hyraxes in the vicinity of the respondents have been identified as one of the major risk factors in many other studies (51,55,67), and they have been reported to be well known reservoirs of the sand fly vectors in Ethiopia (58). Although the role of hyraxes as reservoir hosts cannot be ruled out in this study, given the possibilities of indoor transmission as explained by higher odds of CL occurrence when there were other CL active or scar cases in the household can be suggestive of possible anthroponotic transmission of the disease in the area. Some studies have reported varieties of CL with anthroponotic transmission where humans could act as incidental or definite reservoirs for the vector (58,61). Further studies in the area may be needed to elaborate this condition.

## 6.1. Limitations of the study

Standard case definitions were used to select CL cases and similar clinical and epidemiological selection criteria were developed to carefully select the controls. Nevertheless, some cases of CL included in this study did not get laboratory confirmations and this might be the limitation of the study. Moreover, recall and social desirability biases may exist in some responses from the participants.

# 7. Conclusion

In this study sharing the same house with other active or scar cases of CL has been found to be a significant predictor of CL occurrence in the area. In addition, availability of gorges nearby the households and age groups less than 35 years were found to have higher risk of development of CL. The higher odds of household transmission among a family member together with absence of association of the condition with some common environmental factors like availability of hyraxes in the vicinity might be suggestive of possible anthroponotic transmission of CL in the area.

## 8. Recommendations

Our findings suggest the need for targeted CL interventions at household level as higher odds of transmissions were reported among family members. Children and younger adults should get special attention as they are more affected than the elderly. Environmental interventions especially in areas where gorges are nearby are also warranted. As such we recommend Local and national health managers to use this model as a reference to design and implement effective strategies to control CL in the area. In addition, we recommend further studies to better elucidate the situation of higher indoor transmission which may be suggestive of possible anthroponotic transmissions.

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# 10. Information Sheet and Questionnaire

## 10.1. Information Sheet

**Hawassa University, College of Medicine and Health Sciences, Public Health Academic and Service Directorate**

A questionnaire developed to assess the determinants of Cutaneous Leishmaniasis in Gamo Zone, South Ethiopia, 2024.

Dear Respondent,

My name is ____________________. I am working as data collector in a study conducted by Hawassa University post graduate studies on assessment of determinants of Cutaneous Leishmaniasis in Gamo Zone, South Ethiopia, 2024. I am going to ask you some questions that are very important for the programmers to plan effectively on controlling strategies of cutaneous leishmaniasis. Your name will not be written on this form and will never be used with any information you may tell me. You don't have to answer any questions that you don't want to answer and you can end this interview at any time you want.

However, your honest answers to these questions are very important for the purpose of the study. It may take 15-20 minutes to complete the questionnaire.

We would like to appreciate your participation in this survey by genuinely responding to the interviews. Would you be willing to participate?

Yes___________

If no, thank and stop here.

## 10.2. Questionnaire to assess determinants of Cutaneous Leishmaniasis in Gamo Zone, South Ethiopia, 2024.

Date of Interview: ________________________________

District/woreda name ______________________________

Name of the Kebele: ______________________________

Type of kebele (urban/rural) _______________________

Gotte/Village: __________________________________

Household Number: ____________________________

Family size of the HH__________________________

Any known chronic illness for the respondent ____________________

Questionnaire identification number: _______________

### A. Socio-demographic characteristics of the family

| S/N | Questions | Alternatives (Choices) | Code | Skip |
|---|---|---|---|---|
| 1. | Age of respondent | _______________ years | | |
| 2. | Gender of the respondent | a, Male<br>b. Female | | |
| 3. | Religion | a) Protestant<br>b) Orthodox<br>c) Muslim<br>d) Catholic<br>e) Traditional beliefs<br>f) Other | | |

4. Ethnicity
   a) Gamo
   b) Gofa
   c) Wolayta
   d) Others, specify ============

5. Marital status of the respondent
   a) Single
   b) Married
   c) Divorced
   d) Widowed
   e) Others

6. Educational status
   a) No formal education
   b) Primary school
   c) Secondary (9-10) school
   d) Secondary completed (up to 12)
   e) College and above

7. Occupation
   a) Farmer
   b) Daily laborer
   c) Household worker
   d) Merchant
   e) Government employee
   f) Private employee
   g) Others

8. Estimated household income in ETB ____

B. **Questions about CL and associated factors**

9. Have you ever been infected by Cutaneous Leishmaniasis? A, Yes B. No
10. Do you currently have a cutaneous leishmaniasis lesion (s)? A. Yes B. No
11. If your answer to question 10 is “Yes”, for how long period in months? ________________
12. If your answer to question 10 is “Yes”, how many? _________________
13. If your answer to question 10 is “Yes”, where are the lesions located in your body?

    a) Cheeks
    b) Chin
    c) Earlobes
    d) Forehead
    e) Legs
    f) Lips
    g) Other, specify ___________________________

14. Do you currently have a cutaneous leishmaniasis scar (s)? A. Yes B. No
15. If your answer to question 14 is “Yes”, how many? ___________
16. What is the type of your residential house

    a) Thatch
    b) Wood and mud wall with corrugated iron roof
    c) Stone wall with wood and earth roof
    d) Stone wall with corrugated iron roof
    e) Other, specify ______________

17. Are there gorges within 300 meters of your village? A.Yes B. No
18. Are there caves within 300 meters of your village? A.Yes B. No
19. Are there hyraxes within 300 meters of your village? A.Yes B. No
20. Is a greenery area available within 300 meters of your village? A. Yes B. No
21. Are there agricultural irrigation centers within 300 meters of your village? A. Yes B. No
22. Do you keep cattle at home? A. Yes B. No

23. Do you have pets at home? A. Yes B. No

24. Do you have bed nets at your house? A. Yes B. No

25. If yes, do you use the bed nets to sleep inside? A. Yes B. No

26. Do you sleep outdoors? A. Yes B. No

27. Have you ever heard of CL? A. Yes B. No

28. Is Cutaneous Leishmaniasis case present in your village? A. Yes B. No

29. Can you identify and differentiate a Cutaneous Leishmaniasis from other skin diseases? A. Yes B. No

30. Do you know the mode of transmission of Cutaneous Leishmaniasis? A. Yes B. No

31. If Yes, what do you think are the modes of transmission?

a) Genetic
b) Insect secretions
c) Other, specify__________________

32. Are there Cutaneous Leishmaniasis cases in your house? A. Yes B. No

33. If yes, how many cases__________

34. Are there people with Cutaneous Leishmaniasis scars in your house? A. Yes B. No

35. If yes how many _________

36. Have you ever traveled to other districts in the past six months? A. Yes B. No

37. If your answer to question number 36 is "Yes", where ____________

38. If your answer to question number 36 is "Yes", had there been any sores appeared on your skin before your travel? A. Yes B. No

39. If you have a Cutaneous Leishmaniasis case, where do you seek treatment? A. traditional B. modern

40. If "traditional" treatment, what type of traditional treatment?

a) Holy water or mud
b) Herbs

c) Hot metal

d) Other, specify ______________________________

41. Do you have clean water access for personal and household hygiene? A. Yes B. No

42. If Yes, how many liters of clean water do you have per day in average for the household? (If in jerrycans, convert to liters)

43. Do you have soaps and/or detergents for personal and household hygiene?

44.If Yes, do you use soaps to keep personal hygiene?

a. Yes always

b. Yes sometimes

c. No (do not use soaps and/or detergents to wash)

45. Do you have sewage system to manage wastages? Observe availability A. Yes B. No

46. Do you have dry waste management/sanitation system (observe availability of waste collection basins and appropriate waste dumping sites) A. Yes B. No