Research and Reports in Tropical Medicine

Dovepress
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ORIGINAL RESEARCH

Determining Etiology of Elephantiasis and Associated Factors in Hawella Tula, Sidama Region, Ethiopia

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Background: Podoconiosis and lymphatic filariasis are the most frequent causes of elephantiasis.

Objective: The purpose of this study is to determine the etiology of Elephantiasis and associated factors in Hawella Tula, Sidama Region Ethiopia.

Methods: From February to May 2024, a community-based cross-sectional survey was carried out to determine etiologies of elephantiasis in selected kebeles (the lowest administrative units) in Hawella Tula district, Sidama region, Ethiopia. Seven kebeles were included in the study because elephantiasis cases were quite high, according to woreda's neglected tropical disease (NTD) information office report. Each respondent was interviewed and physically examined, a filariasis test strip (FTS) antibody test was performed for all elephantiasis cases diagnosed clinically, thick blood film was performed for only FTS-positive cases, and a soil study from selected kebeles (based on office's report) was conducted to identify the irritant soil mineral responsible.

Results: Among the 361 respondents, elephantiasis (Podoconiosis and lymphatic filariasis) accounted for 100 (27.7%). Podoconiosis accounted for 94 (94%) of the 100 elephantiasis cases, whereas lymphatic filariasis accounted for 6(6%). Forty percent of those affected were men, while 60% were women. Walking barefoot raised the chance of developing elephantiasis (AOR=40.088, 95% CI = 8.198, 146.484, P<0.001). Spending the majority of time outdoor raised the risk of having elephantiasis (AOR=6.252, 95% CI= 3.507, 11.144, P<0.001) and staying in the district (mentioned kebeles) for prolonged time increased the chance of having elephantiasis (AOR=2.753, 95% CI=1.545, 4.903, P=0.001). Podoconiosis cases observed in Tulla geter (25), Finchawa (25) and Harenfama (16) kebeles were directly related to the greatest proportion of silicon mineral concentration.

Conclusion: Both Podoconiosis and lymphatic filariasis were observed as causes of elephantiasis in Hawella Tula district. Further study is recommended, and steps should be made to prevent and treat both causes of elephantiasis.

Keywords: neglected tropical disease, Hawassa, Ethiopia, lymphatic filariasis in Hawella Tula

Introduction

Elephantiasis is classified by the World Health Organization (WHO) as a neglected tropical disease.[1] It is often caused by filarial worms in tropical locations, whereas Podoconiosis is typically caused by soil irritation in low-income nations. The WHO reports that parasitic infection is the most frequent of all NTDs. Filarial worms, which dwell in human blood and lymph vessels, cause filarial elephantiasis.[2]

Asia and Africa account for more than half of all endemic nations.[3,4] There are several chronic and acute signs and symptoms of elephantiasis, but the major chronic characteristics are lymphatic blockages.[4–6] Filarial worm is usually carried by Ades mosquitoes.[4–8] Filarial elephantiasis is caused by seven parasite species, although Wuchereria bancrofti contributes majority of the morbidity.[4,6,9] An endemic area for filariasis is defined as one where more than 1% of the population is infected and which requires mass medication administration irrespective of filarial tests at least 4–6 times per year.[5,10] Overall, the measures that should be done are to reduce transmission, morbidity, and impairment.[11]

Received: 3 August 2025
Accepted: 1 November 2025
Published: 18 November 2025

Commonly affected body parts are genitalia, legs, and breasts.[12] Filarial elephantiasis seldom occurs below the knee.[12–15]

Even though several Asian countries have eliminated elephantiasis, it remains a burden in African countries.[2–4] Lymphatic filariasis is the third most frequent vector-borne illness, producing substantial morbidity, although it has gotten little attention by the government because of its low fatality.[4,6] According to research conducted in Ethiopia's Jeldu area, Podoconiosis and lymphatic filariasis prevalence rates were 69.5% and 30.5%, respectively, which is much higher than in other endemic countries.[12] As people move from place to place, there is overlap between Podoconiosis and lymphatic filariasis.[12,16] Ethiopia is a nation of highlands with certain volcanic materials, placing large individuals at risk for Podoconiosis.[12–15]

Non-filarial elephantiasis (Podoconiosis) is caused by irritating compounds in volcanically erupted soil coming into direct, extended contact with exposed skin and is a disease of low socioeconomic communities that is frequent in the highlands.[17–21] It has a strong coexistence with filarial elephantiasis.[22] It is usually linked to exposure to sodium, potassium, aluminum, iron, silicon, and calcium and has a substantial societal stigma in Ethiopia and other nations globally.[12–14] Podoconiosis has a major impact on persons' productivity, according to a study conducted in Ethiopia.[16] Globally, there is still insufficient intervention and separation between Filarial and non-Filarial elephantiasis.[12]

Later in age, painful and profoundly deforming conditions such as lymphedema and scrotal swelling develop and may result in lifelong disability. These people suffer emotional, social, and financial losses in addition to physical limitations, which add to stigma and poverty. Lymphatic filariasis impacted 25 million males with hydrocele and more than 15 million persons with lymphedema worldwide.[4,5,11] The symptoms of these chronic illnesses continue to impact at least 36 million individuals. Eliminating lymphatic filariasis can save people from unnecessary suffering and help eradicate poverty.[6,12] Peoples in impacted areas typically reject and shun people who are disfigured by the sickness. Individuals with disabilities are often unable to work, which has a detrimental impact on their families and communities.[2,7,15,23] Finally, lymphatic elephantiasis can be cured if discovered early, whereas Podoconiosis can be avoided. The purpose of this study is to establish the etiology of elephantiasis in Hawella Tula, Sidama Region Ethiopia.

Methods and Materials

Study Setting and Period

This study was conducted in Hawella Tula, the eighth sub-city of Hawassa town, located approximately 10 kilometres South of the main municipal office. As the only sub-city functioning as woreda with in Hawassa town, it comprises one urban and ten rural kebeles. Situated at a high altitude (latitude 7°3'N, longitude: 38°28'E), the area is characterized by its highland topography and volcanic soil, factors associated with Podoconiosis endemism. However, prior to this study, no serological, parasitological, or soil investigations had been conducted to confirm the presence of lymphatic or non-lymphatic elephantiasis in the area, according to the woreda's NTD office. Due to the recent establishment of the Sidama region, comprehensive demographic data for Hawella Tula were limited. Participant selection was based on previous epidemiological report, with individuals from each kebele included in the study.[1] Data collection was carried out between February and May 2024.

Study Design

A community-based cross-sectional study was carried out to determine the etiology of elephantiasis and associated factors in Hawella Tula district.

Populations

Source Population

All residents living in Hawella Tula were considered as the source population.

Study Population

All individuals with age 15 years and above in Hawella Tula and fulfill the inclusion criteria.

Study Unit

Each selected adult individual above 15 years.

Inclusion and Exclusion Criteria

Inclusion Criteria

All residents aged 15 years and above living in the selected study area.

Exclusion Criteria

Those critically ill patients were excluded from the study.

Those come to visit with in 6 months from other woreda, zone and region of Ethiopia.

Sample Size Determination, Sampling Technique and Procedure

Sample Size Determination

For first specific objective (elephantiasis):

The sample size for lymphatic filariasis is determined using the p-value 30.5% from study done in Jeldu district,[12] Ethiopia; with 95% confidence interval (1.96); α=0.05; 5% marginal of error (5%).

$N = \frac{(Z\alpha/2)2\ p(1-p)}{d2}$; Therefore, N=326

The sample size for Podoconiosis is determined using the p-value 69.5% from study done in Jeldu district,[12] Ethiopia; with 95% confidence interval (1.96); α=0.05; 5% marginal of error (5%). $N = \frac{(Z\alpha/2)2\ p(1-p)}{d2}$; Therefore, N=326

By considering 10% non-response rate, total sample size was 378.

Sampling Technique and Procedures

The neglected tropical disease (NTD) office in Hawella Tula woreda provided well-organized information regarding elephantiasis for the district, after which affected kebeles were designated and a pilot study on the illness was conducted. Seven kebeles were chosen from a total of eleven kebeles due to comparatively low illness spread in the other four. Purposive household selection was conducted using the elephantiasis report, and all elephantiasis cases from the households were included because our main aim is to know etiology of elephantiasis (either Podoconiosis or lymphatic filariasis) in mentioned area.

Each patient from a household was selected utilizing a triangulated data gathering strategy that included a semi-structured questionnaire, clinical observation, and a serological test. Respondents without features of elephantiasis on interview and physical examination did not get serology or thick film parasitology tests. Those who tested positive for antibodies had a thick blood film test for blood microfilariae (Wuchereria bancrofti larva) at night (8:30pm–10pm). If the antibody test is negative, only a soil investigation is performed to identify the irritating mineral causative for Podoconiosis. Those who test positive for the fast antibody test are diagnosed with lymphatic filariasis. Those who tested negative for antibodies were diagnosed with Podoconiosis.

Data Collection Methods

Data Collection Instruments

Data was obtained utilizing Kobo collect through interviewer-administered structured questions, an observational and laboratory finding checklist that are developed and modified from peer-reviewed research.[12] Six experienced BSC nurses were chosen for data collection, and the overall data collection on the field was overseen by the Principal Investigator and NTD focal team from the woreda. Two specialist laboratory technicians accompanied data collectors and conducted FTS (Alere Filariasis Test Strip) and parasitology tests. A rapid kit was used to check every eligible patient for serology at the time of the contact. Those who tested positive for FTS had their blood samples examined for the presence of Wuchereria bancrofti larvae.

A 300-gram sample of soil from four elephantiasis-infested kebeles was submitted to the Areka agricultural research institution (Wolayta zone, Ethiopia) to be tested for chosen minerals and soil acidity. Each kebele's mineral in mg/10gm soil was reported and each sample ph. was recorded.

Data Management and Analysis

Data Quality Assurance

Data quality was maintained through a variety of mechanisms, including pre-testing the tool with a 5% sample size, recruiting data collectors and a site supervisor with data collection experience, and providing all data collectors with two days of intensive training on how to administer the data collection process as well as ethical issues encountered during the data collection process. On a daily basis, the primary and co-investigators provided direct supervision while collecting data. They checked each filled questionnaire on a daily basis. The principal and co-investigators oversaw the overall activities. Data input was done using Epi Data version 3.1.

Data Processing and Analysis

All obtained data were visually reviewed, and standard classification was performed within the context of elephantiasis. Data were coded, inputted, and cleaned with Epi-Data Version 3.1 software. Before analyzing the data, a double input was done to ensure that it was full and consistent. Inconsistency errors were validated using data cleansing procedures. The entered data was exported to SPSS (version 25) for statistical analysis. The analyses were carried out in numerous phases. First, the socio-demographic data and other characteristics of the research participants were reported using mean/median or percentages, as applicable. Bivariate logistic regression was used to select out potentially significant factors for inclusion in multivariable logistic regression ($p < 0.25$ for each independent and outcome variable). After completing the bivariate analysis, variables were chosen for the multivariate analysis to adjust for confounding and interaction effects. A variable with a bivariate test p-value of 0.25 is selected for a multivariable model alongside all other variables. In addition, context and prior research were considered while selecting factors for multivariable analysis. Once the variables had been determined, a multivariable analysis was conducted using a model that included all of the specified variables. Efforts were undertaken to determine if the required assumptions for the use of multivariable models were met. Model fitness was assessed using the Hosmer and Lemeshow tests. Variables with a p-value of 0.05 were judged significant and were thus included in the final model. To establish the strength of the link, the crude and adjusted odds ratios (COR and AOR) were calculated and interpreted, along with their corresponding 95% confidence intervals.

Results

Sociodemographic Data

Out of 378 respondents, 17 refused to provide blood samples, resulting in a response rate of 95.5% (361). Majority (99; 27.4%) of respondents were in age range of 26 to 35 years Table 1. Among the seven assessed kebeles, 96 (26.6%) are from Tulla geter that is the highest number of respondents. The majority of the respondents were married 290 (80.3%) and 328 (90.9%) did not get a formal education Table 1. Only 13 (3.1%) of the 361 respondents were from urban, while the remaining 348 (96.9%) were from rural communities. More than half of respondents earn less than 1000 Ethiopian birr (less than $20 USD) per month, which has direct impact for development of elephantiasis Table 1. The majority of elephantiasis cases were from Tulla geter, Finchawa, and Harenfama, which coincided with soil test findings indicating that silicone mineral content, was greater in these kebeles than in others.

Elephantiasis

Out of 361 respondents, 100 (27.7%) had elephantiasis. Of the 100 elephantiasis cases, 94 (94%) were Podoconiosis and 6 (6%) were lymphatic filariasis based on clinical assessment and rapid antibody test. All six patients tested positive for the Alere Filariassis test strip but negative for the thick film parasitological blood larvae test (Wuchereria bankrofti microfilariae blood examination). Of the elephantiasis patients, 99 (99%) had bilateral below-knee swelling, whereas only 1 (1%) had unilateral below-knee swelling (Table 2).

Associated Factors

A significant percentage of respondents used soap occasionally to wash their feet (Table 3). The number of Podoconiosis discovered from Tulla geter corresponded directly to the greatest percentage of silicon mineral concentration (Table 4).

Table 1 Sociodemographic Data (N=361) in Hawella Tula, Sidama Region, Ethiopia

Variables	Category	Frequency	Percent
Age in years	15-25	50	13.9%
	26-35	99	27.4%
	36-45	83	23%
	46-55	68	18.8%
	Above 55	61	16.9%
Gender	Male	141	39.1%
	Female	220	60.9%
Residency	Urban	13	3.6%
	Rural	348	96.4%
Occupation	Farmer	297	82.3%
	Daily laborer	37	10.2%
	Government employed	12	3.3%
	Non-governmental organization	2	0.6%
	Private	3	0.8%
	Other	10	2.8%
Educational status	Not attended formal education	328	90.9%
	Grade 1-12	2	0.6%
	Above grade 12	31	8.6%
Monthly income	<1000Ethiopian birr	207	57.3%
	1000-2000 Ethiopian birr	18	5%
	>2000Ethiopian birr	136	37.7%

Table 2 Elephantiasis Assessment Clinical Features (N=100) in Hawella Tula, Sidama Region, Ethiopia

Variable	Category	Frequency	Frequency
Elephantiasis	Podoconiosis	94	94%
	Lymphatic filariasis	6	6%
Serum antibody test(FTS)	Positive	6	6%
	Negative	94	94%
Symptom	Not symptomatic	0	0%
	Burning sensation and swelling	100	100%
Site of swelling	Below knee bilateral	99	99%
	Below knee unilateral	1	1%

(*Continued*)

Table 2 (Continued).

Variable	Category	Frequency	Frequency
Type of swelling	Fibrotic hard	89	89%
	Soft	11	11%

Table 3 Elephantiasis Associated Risk Factors (N=100) in Hawella Tula, Sidama Region, Ethiopia

Variables	Category	Frequency	Percent
Using bed net	Yes	17	17%
	No	83	83%
Staying most time outdoor	Yes	74	74%
	No	26	26%
Walking barefoot	Yes	98	98%
	No	2	2%
Using soap to wash foot	Frequently	2	2%
	Daily	42	42%
	Intermittently	55	55%
	Not at all	1	1%
Soil feature of the kebele	Sandy soil	2	2%
	Normal soil like other places	98	98%
Stay in the area	Prolonged	51	51%
	Not prolonged	49	49%

Table 4 Soil Study Result from Respective Kebele in Percentage and Podoconiosis Number, in Hawella Tula, Sidama Region, Ethiopia

Kebele	Podoconiosis Frequency Number (%)	Type of Minerals (mg/10gm soil) and Ph						
		Silicon	Alum	Fe	Na	Mg	Ca	Ph
Tulla geter	25 (25%)	2.9	0.052	1.92	1.772	4.302	3.890	6
Finchawa	25 (25%)	2.543	0.080	2.367	1.219	3.028	3.120	5.7
Harenfama	16 (16%)	2.75	0.057	2.089	1.357	3.453	3.356	5.9
Chefasine	11 (11%)	2.37	0.117	2.7	1.495	3.903	3.594	5.5

Table 5 Associated Factors for Elephantiasis (n=100) in Hawella Tula, Sidama Region, Ethiopia

Factors	Category	Frequency in Number	Frequency in Percent	COR	(95% CI)	AOR	(95% CI)	P value
Staying most time outdoor	Yes	74	74%	5.317	(3.179, 8.892)	6.252	(3.507, 11.144)	0.000
	No	26	26%	1		1		1
Walking bare foot	Yes	98	98%	36.832	(8.892, 152.573)	40.088	(8.198, 146.484)	0.000
	No	2	2%	1		1		1
Stay in area	Prolonged	51	51%	2.785	(1.728, 4.490)	2.753	(1.545, 4.903)	0.001
	Not prolonged	49	49%	1		1		1

Walking barefoot raised the probability of developing elephantiasis by 40.088 ($p<0.001$). Staying most of the time outdoor raised the risk of elephantiasis by 6.252 times ($p<0.001$) (Table 5).

As the patient spends more time in the affected kebeles, the risk of developing elephantiasis increases by 2.753 times ($p=0.001$). Each respondent's length of stay in impacted kebeles was recorded in years, and the mean (30.2 years) was determined. Those who stayed longer than the mean were classified as having a lengthy stay, while those who stayed shorter were classified as having a short stay.

Discussion

In this study, we found that among the 361 respondents, elephantiasis accounted for 100 cases (27.7%), revealing significant insights into the prevalence and characteristics of Podoconiosis and lymphatic filariasis in Ethiopia. The results indicate a higher prevalence of podoconiosis (94%) compared to lymphatic filariasis (6%), which contrasts with previous studies, particularly that by Deribe et al in Rwanda, where lower rates of podoconiosis were reported.[18] Females were affected more often 60 (60%) than men 40 (40%), that contradicted Negasa et al's study in Jeldu area, Oromia Ethiopia, where males were usually affected.[12] The reason for this might be males commonly migrate to urban areas in the mentioned region for daily work more commonly but most females stay in the affected district for long time. Another study by Upadhyayula et al indicated lymphatic filariasis was usually discovered on females than men, which was aligned with our finding.[4] Tekola Ayele et al and Bekele et al found that females were often suffered from Podoconiosis in Ethiopia's Bekele zuria and East Wollega zones, which is consistent with our findings.[14,24] The most common age group affected was 26–35 years, and majority was from rural regions, comparable to the majority of respondents reported by Molla et al from Northern Ethiopia.[15] Our study results showed matching the age range affected by Podoconiosis described by Negasa et al.[12] However, another study by Davey et al indicated that age groups of 46 years and above were usually affected.[13] This age group was most typically impacted and exposed to irritating agents while actively engaged in outdoor work. Most of them were farmers (82.3%), as reported by Tekola Ayele et al (92.5%) and Bekele et al (94.5%), which increases the likelihood of exposure to irritating soil minerals.[14,24] In contrast to the findings of Odongo-aginya et al from Uganda, 82.3% of our respondents were married.[5] The majority were making less than $20 per month, which is insufficient to meet their hygienic expenditures. Only 18.6% were utilizing bed nets, which contradicts the findings of Njenga et al from Kenya, where bed net use was by far the highest and protected from mosquito bites.[11] Of the 100 elephantiasis patients, 99 (99%) had bilateral below-knee swelling, while one (1%) had unilateral below-knee swelling but no breast or scrotal edema, which corresponded to the findings of Negassa et al.[12] Of the affected patients, only 11 (11%) had soft, but 89 (89%) had fibrotic hard swelling, which is pretty comparable to the study of Negassa et al.[12] Of the 6 (6%) filariasis cases, all were positive for FTS antibody test, but all were negative for thick film blood examination for microfilaria, which is lower than Negassa et al but higher than what report by Bizhani et al[2,12] In addition, Njenga et al found a 1.3% prevalence of lymphatic filariasis in Kenya, which is lower than our findings.[11] Tulla geter, Finchawa, Harenfama, and Chefasine kebeles contributed the majority of Podoconiosis cases that correlate with high silicon concentration on soil study for responsible minerals with acidic PH, but that contradicts the report by Negassa et al

that is alkaline soil but higher concentration of silicon similarly increased Podoconiosis risk.[12] Staying in the investigated region for several years, walking barefoot, and spending the majority of time outside led to the development of elephantiasis specially Podoconiosis. Unlike our investigation, Negassa et al reported a substantial connection between leg cleanliness and Podoconiosis, but in our study, it was not statistically significant.[12] On the other hand, unlike Negassa et al's study, there was no connection between age and gender of the respondents.[12] Similar to the findings of Tekola AF et al,[14] walking barefoot significantly increases the risk of Podoconiosis in our study.

Conclusion

Among the elephantiasis case records, there is a co-occurrence of Podoconiosis and lymphatic filariasis in Hawella Tula district. Overall, steps should be made to prevent transmission, promote cleanliness, and reduce morbidity and death.

Data Sharing Statement

Data will be available from the corresponding author upon request.

Ethics Approval, Consent to Participate and Publication

Generally, this study complies with the declaration of Helsinki. Before starting data collection, an ethical clearance letter with reference number IRB/380/15 was obtained from the College of Medicine and Health Science institutional review board (IRB), Hawassa University. Samples and data were collected after written informed consent had been obtained from study participants. For those below 18 years old, written informed consent from parents and guardians was taken.

Acknowledgments

We are extremely grateful to the study participants for their valuable time and their willingness to participate in this study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This research project is not funded.

Disclosure

The authors have declared that no competing interests exist.

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