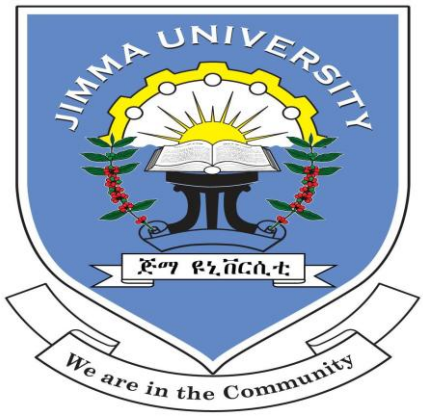

JIMMA UNIVERSITY

COLLEGE OF NATURAL SCIENCE

SCHOOL OF GRADUATE STUDIES

DEPARTEMENT OF BIOLOGY

ZOOLOGICAL AND ECOLOGICAL UNIT

Prevalence of *Tunga peneterans (*Siphonaptera: Tungidae) infestation and disease out come in some selected kebeles of Gulliso woreda**,** West Wollega Zone, Western Ethiopia.

BY: TAYE BERHANU OTTA

A Thesis Submitted to the Department of Biology, College of Natural Science Jimma University in Partial Fulfillment for Requirements of the Degree of Masters of Science in Biology (Ecological and systematic Zoology)

August, 2015

Jimma, Ethiopia.

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DECLARATION STATEMENT OF THE AUTHOR

I hereby, declare that this thesis is my original work and has not been presented in degree in any other Universities, and that all sources of materials used for the thesis have been fully acknowledged. This thesis has been submitted in partial fulfillment for requirements of the Degree of Masters of Science in biology Ecological and systematic unit at Jimma University.

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Abbreviations and Acronyms

BDS: Birbir Dilla Synod

DA: Developmental Agency

EECMY: Ethiopian Evangelical Church Mekana Yesus

EPSD: Epidermal Parasitic Skin Diseases

HH's: Households

FGD: Focus Group discussion

NTDs: Neglected tropical diseases

PHCC: Primary Health Care Center

USAID: United States Agency for International Development

WHO: World Health Organization

Abstract

This study was conducted to assess the prevalence of Tunga penetrans (Siphonaptera: Tungidae) infestation, intensity and disease out come in some selected kebeles of Gulliso woreda, West Wollega Zone, Western Ethiopia from September 2014 to June 2015.Data were collected by using structured questionnaire. Observation was also made to search the affected body part and counting the number of lesions, data were collected during the wet season, September 2014 and dry season in February 2015.Chi-square test was employed to compare variation between the categorical variables. A total of 272 individuals were interviewed, and of these, 94.9% were males and 5.1% females. Of the total 272 respondents participated in the study, 29.8% and 14.3% respondents were infested during dry and wet season, respectively. $p<0.05$ significant during the analysis was considered. Among 81 individuals infested during the dry season and 39 individuals infested during the wet season, the age group 18-24 and age group above 42 were the most infested with 19.8% and 29.6% during the dry season and 17.9% and 30.8% during the wet season, respectively. Of the 81 and 39 infested individuals, the most infested occupational groups during both seasons were farmers. Individuals with low educational status (write-read and 1-4 grade level) were the most affected constituting 79.0% and 84.6% during dry and wet season, respectively. Most lesions were observed on feet and hands during both seasons (85.1% dry season and 89.7% during wet season). Fifty one percent of the respondents knew that tungiasis is a disease, the remaining 48.9% did not know about Tungiasis. Twelve percent of the respondents had the practice of wearing shoes while 4.8% of them never wore shoes. Regarding feet washing practice most (87.9%) of them had the practice of washing their feet every day, 12.1% washed their feet sometimes. In conclusion this study could contribute to the basic understanding of prevalence of the T. penetrans infestation, intensity, disease outcome and KAP of the community towards T. penetrans infestation for the Eka, Kusae and Woradale kebeles which will be use to design and implement disease prevention and control strategy.

Keywords: - Tungiasis, jigger flea, prevalence, parasitic load, Wollega, Ethiopi

1. Introduction

Jigger flea, *Tunga peneterans (*Siphonaptera: Tungidae), also known as sand flea, or *Chigoe* is an ectoparasite which causes Tungiasis, parasitic condition of humans and animals (Heukelbach, 2001). The jigger flea, *T. peneterans*, causes debilitating disease in resource-poor populations throughout Latin America, the Caribbean, and sub-Saharan Africa (Heukelbach, 2005 and Heukelbach, 2001). Hundreds of millions of people are at risk of infection in more than 70 nations, mostly in developing countries (Heukelbach *et al.*, 2001). Tungiasis is a common, but neglected, health problem in economically depressed communities in South American and sub-Saharan African countries (Heukelbach and Feldmeier, 2002). The importance of Tunga infestation is localization in the foot causing serious difficulty in walking, reducing the infected person's ability to work normally. In endemic areas, prevalence ranges from 15-40% (Pampiglione *et al.*, 2009).

In Africa, the ectoparasite is found in the whole sub-Saharan region: from Sierra Leone, Ivory Coast, Nigeria and Ethiopia to South Africa; it also occurs in Zanzibar and Madagascar (Spradbery *et al*., 1994; Douglas-Jones *et al.*, 1995; Nte & Eke, 1995). The physical factors limiting the geographical distribution of *T. peneterans* remain unknown. In Mexico and Colombia, tungiasis has been observed at altitudes above 2000m (Karsten, 1865; Guyon, 1870; Hesse, 1899). Tungiasis, results from infestation by the fertilized female sand flea (*T. peneterans, (*Siphonaptera: Tungidae, Tunginae), which embeds into the epidermis (usually of the feet), feeds on lymph and swells as the eggs grow (Hoeppli, 1963).

Ethiopia as part of Sub-Saran Country, not an exception to the problem, however, there was no systematic study that has been done to date particularly in western Wollega zone as far as prevalence of tungiasis is concerned. Thus, this study was designed to assess the prevalence of *T.penetrans* (Siphonaptera: Tungidae) infestation and disease out come in the study area.

1.1 Statement of the problem

Tungiasis infections still continue to be the health problem in developing countries such as Ethiopia however, the ministry of health of Federal Democratic Republic of Ethiopia, have not included Tungiasis in the five years health master plan for neglected tropical diseases (NTDS, 2013). Despite its utter negligence, the diseases continues to affect 1.2% of school

children in Ethiopia (National survey, 2008).This urges intensive efforts to develop a road map that delivers a clear vision towards designing low-cost prevention and control strategies. Besides, there is an urgency to develop culturally appropriate communication techniques and workable collaboration on a global scale by bringing all the stakeholders of endemic countries (Kaliyaperumal, 2013).

Even though various studies on prevalence of Tungiasis were done in different part of the world, none of them try to correlate the prevalence of *T.penetrans* (Siphonaptera: Tungidae) infestation and disease outcome which facilitate the prevalence and distribution of Tungiasis parasitic infections among individuals in Ethiopia. To fill this gap for a typical *T. peneterans* in area Gulliso Woreda, a cross sectional study was conducted with the following research questions.

1. What is the prevalence of the jigger flea infestation in relation to age in the study area?
2. What is the association between the jigger flea *(T.penetrans*) infestation intensity and socio-demographic factors in the study area?
3. Which part of the body is mostly affected by jigger flea?
4. What is the distribution of lesions on the body?
5. What is the knowledge, attitude and practice of the study area towards jigger flea infestation and its impact?

1.2 Objectives

1.2.1. General Objective

To investigate *Tunga peneterans* (Siphonaptera: Tungidae) infestation, its intensity and disease outcome in the selected kebeles of Gulliso woreda, West Wollega zone, West Ethiopia.

1.2.2. Specific objectives

The specific objectives of the study were to:

- To determine the age prevalence of *T.penetrans* infestation in the study area.
- To determine the intensity of *T. penetrans* infestation in the study area.
- To determine the association between *T.penetrans* infestation and socio-demographic factors in the study area.

- To determine the distribution of *T. penetrans* infestation in the study area.
- To determine the body parts affected by *T.penetrans* in the study area.
- To determine knowledge, attitude and practice regarding *T.penetrans* and the outcome disease in the study area.

1.3 Significance of the study

To our knowledge there is no documented information with regard to *T.penetrans* infestation and the disease out come and thus this study will be helpful in providing a base line data on tungiasis prevalence in the study community for possible intervention. Estimating the prevalence of jigger flea (*T. peneterans*) infection is relevant for preventing and controlling of the distribution of this parasitic infection and their effects for developing control strategies. In addition, collecting information concerning the ectoparasite and the Tungiasis might help to select adequate and possible control strategies. So, this study can generate information regarding the prevalence of *T.penetrans* (Siphonaptera: Tungidae) infestation and disease outcome among individuals in the study area. Finally, the result would give brief recommendation regarding problem facing the community, especially for the concerned body, so that they can look for the control of the parasite according to the designed recommendation.

1.4. Limitation of the study

In order to incorporate the housing conditions of the respondents in study, most of the study participants were not willing to respond and to show their housing conditions. Though the incorporation of the housing conditions of the study made the study more valuable, the current study was limited for the incorporation of the housing conditions in the study.

2. Literature Review

2.1 Biology and Ecology of Jigger flea (*T. peneterans*)

T. penetrans belongs to the genus Tunga of the order Siphonaptera and is unique in that the female flea permanently penetrates underneath the skin of its hosts and remains there until it dies in situ after four weeks Within two weeks of penetration, the burrowed flea increases its volume by a factor of 2,000, eventually reaching a diameter of up to 12 mm. By its abdominal cone through which it breathes, defecates, and expels the eggs. The flea remain in contact with the air, leaving an opening of 250 to 500 μm in the skin, the latter being an entry point for microorganisms. After the death of the parasite, the remains of the female sand flea are discarded from the epidermis by tissue repair mechanisms. The off-host life cycle is similar to that of other Siphonaptera species and involves larvae, pupae, and adults. Development requires dry and warm soil with an optimal temperature range between 22 and 31°C in the upper level of the soil (Eisele *et al*., 2003).

Sand fleas or jiggers, *T. peneterans,* are the smallest known fleas (Connor, 1976), the basic body length of adults being only 1 mm, although the gravid female becomes 80 x bigger and, relative to its body size, the male *T. penetrans* has the longest intermittent organ known in the whole animal kingdom (Durden &Traub, 2002). True to its Latin name, the adult female *T. penetrans* burrows into the skin of a mammalian host, which may be human or animals such as dogs, cats, pigs and rats (Hopkins & Rothschild, 1953; Heukelbach *et al.,* 2004a). After penetrating the host epidermis, the female Tunga undergoes peculiar hypertrophy to become a globular neosome (Audy *et al.,* 1972). Within a period of 3 weeks, thousands of eggs are produced and expelled through the posterior abdominal segments protruding above the stratum corneum (Linardi, 2000). After oviposition, the neosome involutes and the dead parasite is sloughed from the host epidermis by tissue repair mechanisms (Eisele *et al.,* 2003).

In humans, the swelling of Tunga females causes a very irritating condition known as tungiasis, usually due to *T. penetrans* but also the recently described *T. trimamillata* (Durden &Traub, 2002) in Andean villages. Of the five species of Tunga known from Brazil (Linardi, 2000), only *T. penetrans* parasitizes humans. In many poor communities of Africa, the Caribbean and especially the American tropics, human tungiasis is locally prevalent, associated with sandy soils, and causes considerable human morbidity (Heukelbach *et al.,* 2001, 2004b; Durden & Traub, 2002; Eisele *et al*., 2003; Feldmeier *et al*., 2003; Muehlen *et*

al., 2003). Mating and insemination of *T. penetrans* occur after not before the female enters the host epidermis (Geigy, 1953; Geigy & Suter, 1960). It has been suggested that fecal material released by embedded Tunga females could have phermonal properties attracting others, which might explain the aggregation of females embedded in clusters (Eisele *et al.*, 2003), as well as helping males to find embedded females.

2.2 Taxonomy of *T.penetrans*

Among the 13 known species of Tunga, *T. penetrans* is the most promiscuous, having been found on hosts belonging to eight different orders of mammals, including Cingulata, Pilosa, Artiodactyla, Perissodactyla, Carnivora, Rodentia, Primates, and Proboscidea; in total, *T. penetrans* has been found on 27 genera of wild and domestic animals (De Avelar, 2010) in addition to two occurrences that have only recently been recorded (Frank *et al.*, 2012; Widmer and Azevedo, 2012). Identification requires an extensive knowledge of flea morphology. New molecular data have explored phylogenetic relationships at the ordinal, familial, and generic level. Whiting *et al*, (2008) showed that the order Siphonaptera is monophyletic and most closely related to Boreidae (snow fleas, Mecoptera) (Dunnet and Mardon, 1999). Their recent analyses based on four genes show that many extant families are paraphyletic and thus warrant a reorganization of taxonomy (Whiting *et al.*, 2008*).*However, in spite of the broad spectrum and category of hosts, the pig is considered the most important animal reservoir for *T. penetrans* (Pampiglione *et al*., 1998; Ugbomoiko *et al*., 2008).

Humans and dogs might be considered secondary hosts or even true or essential hosts undergoing the process of adaptation. The parasitism of *T. penetrans* on elephants (Ruthe, 1961), gorillas and monkeys Fitzsimmons, (1966) should be seen as accidental. However, because the identification of this species is not always performed by experts and is sometimes based on the sole criterion of "penetrating fleas," some misidentifications may have occurred. In fact, records of *T. penetrans* on bats Blanchard, (1890) may be attributed to the sessile flea *H. Pulex*. Similarly, the infestation of this species on Galluscited by Macchiavello (1948) might have been confused with the stick-tight flea *Echidnophaga gallinacean* and the parasitism. Similarly, the occurrence of *T. bondari* on *Cariama cristata*, cited by Hopkins and Rothschild, (1953) is likely an accidental finding.

Concerning domestic animals, until now, only three species of sand fleas have been found as ectoparasite: *T. penetrans* on the pig, cow, dog, cat, and horse; *T. trimamillata* on the cow, goat, sheep, and pig; and *T. hexalobulata*, which was recently found on cattle. Only *T. penetrans* and *T. trimamillata* parasitize humans. The other 10 species exclusively infest wild animals, regardless of the number of host species (Gamerschlag *et al.*, 2008).Tungiasis is endemic or potentially endemic to 89 countries with varying degrees of incidence and prevalence which varies in relation to area and population studied. In fact, recent evidence indicates that at least two variants of *T. peneterans* occur that show a considerable degree of genetic heterogeneity (Feldmeier and Heukelbach 2009; Gamerschlag *et al.*, 2008). Recently, a new pathogenic Tunga species (*Tunga trimamillata*) has been described from Ecuador and Peru that can parasitize humans while other species exclusively parasitize wild animals (Pampiglione *et al.*, 2003).

2.3 Behavior of *T. penetrans*

Little is known about the feeding behavior of adult males, although it has been assumed that Tunga males need to feed on mammals (Wolffhu¨ gel, 1910), as other families of fleas have hematophagous males and females (Marshall, 1981; Kraemer & Mencke, 2001). Hitherto, only (Brothers & Heckman, 1980) had documented blood-feeding by males of *T. penetrans*.

Tungiasis, is a neglected ectoparasitic disease, arises when the female jigger flea, *T. peneterans*, burrows into the epidermis of its host (Feldmeier *et al*., 2004). Having entered its host (both humans and domesticated animals), the gravid female flea undergoes substantial growth, growing to around 2000 times its size in six days. Embedded with its hindquarters at the surface of the skin, the flea is evident as a distinct, characteristic lesion on the skin; a globular white mass with a black dot at its center (Joseph *et al.*, 2006). This slight perforation of the skin not only allows for the flea to respire, but also for the discharge of newly made eggs. Within a week, up to 200 eggs are deposited onto the ground. These eggs then hatch into *T. peneterans* larvae which feed on organic detritus and develop, via a pupa stage, into a fully grown jigger flea. Severely infested and inflamed toes with deformation of digits and finger nails. A chain of feces is expelled from the flea at the center. Re-infestation occurs and the cycle is complete (Gordon, 1941).

Despite its notoriety, the jigger flea is not regarded as a serious threat to health (Ugbomoiko, Ofoezie &Heukelbach, 2007). Unfortunately this is a common misconception. Tungiasis

results in significant morbidity, manifesting itself in a number of symptoms such as severe local inflammation, auto-amputation of digits, deformation and loss of nails, formation of fissures and ulcers, gangrene and walking difficulties. Secondary infection also poses considerable risk; many lacking immunization are vulnerable to tetanus (*Clostridium tetani*), often proving fatal. Complaints of insomnia are also not uncommon due to the intolerable itchiness of the infestation (Muehlen *et al*., 2006).

2.4 Control of *T. peneterans* infestation

Behavioral, socioeconomic, and environmental factors have been identified as the major risk factors associated with the prevalence and severe pathology of tungiasis. Therefore, appropriate intervention measures must be instigated to reduce prevalence and intensity of the infestation substantially (Muehlen *et al*., 2006; Ugbomoiko *et al*., 2007). Daily inspection of the feet and immediate extraction of embedded fleas protect against complications. Closed shoes and socks seem to prevent tungiasis to a certain degree although complete protection cannot be achieved by these means. There is no drug on the market with satisfactory clinical efficacy. A randomized controlled trial realized more than 20 years ago showed a good efficacy of oral niridazole, an anti schistosomal compound with severe adverse events which has been taken from the market since long (Ade-Serrano *et al.*, 1982). In the cited study, the therapeutic efficacy of niridazole was claimed to be very good. However, the outcome measures were not well defined and the study showed other methodological problems which limit the interpretation of results.

In northeast Brazil many dermatologists claim a good efficacy of ivermectin in tungiasis and support their notion by anecdotal observations. Causal prophylaxis consists of using closed shoes whenever the feet touch contaminated soil. However, in those communities where tungiasis prevails, shoes are frequently unaffordable, or, even if available, are not used by young children. Possible interventions to control *T. peneterans* can be targeted towards treatment of the infested areas (off-host treatment), such as mixing insecticidal dusts into infested soil or spraying its surface with liquid insecticides (Matias, 1989, 1991). However, there is only one study in which compounds against fleas such as Ctenocephalides spp. and Pulex spp. have been tested against *T. peneterans* (Matias, 1991). Appropriate studies are overdue. Treatment of domestic animals with anti-flea compounds (on-host treatment) is another possibility. This will limit the available reservoir and might help reduce the total

population of *T. peneterans.* Impregnating clothes might be a cost-effective option in areas where long garments are worn.

2.5 Global situation of Tungiasis

T. penetrans is endemic in Latin America, the Caribbean and sub-Saharan Africa. Sporadic occurrence has been reported in parts of Asia and Oceania (Goldsmid, 1981; Sane & Satoskar, 1985; Mazzini *et al*., 1988; Ibanez- Bernal & Velasco-Castrejon, 1996). In Latin America, it is found in regions spanning Mexico to Northern Argentina and Chile (Soria & Capri, 1953; Taubman & Spielman, 1979; Zalar & Walther, 1980; Spielman *et al*., 1986; Basler *et al*., 1988; Mazzini *et al*., 1988; Milgraum & Headington, 1988; Rietschel, 1989; Chadee *et al*., 1991a; Ibanez-Bernal & Velasco-Castrejon, 1996; Veraldi *et al*.. 1996; Oliver Llull *et al*., 1997).

According to the study conducted in a Shawaytownin Fortaleza in north east Brazil, the data study show that tungiasis is hyper endemic in the country. So far, the only published prevalence study from Brazil is from the far South of the country where socio-economic conditions are different from the northeast. Nevertheless, in four poor communities in Rio Grande and Gravitas (Rio Grande do Sul State) prevalence rates ranged from 40% to 83% (Matias,1989). The physical factors limiting the geographical distribution of *T. penetrans* remain unknown. In Mexico and Colombia, tungiasis has been observed at altitudes above 2000 m (Karsten, 1865; Guyon, 1870; Hesse 1899).

2.6 Tungiasis situation in Africa

In Africa, the ectoparasite is found in the whole sub-Saharan region: from Sierra Leone, Ivory Coast, Nigeria and Ethiopia to South Africa; it also occurs in Zanzibar and Madagascar (Hoeppli 1963; Tan-Lim & Pluis 1972; Fuga *et al*., 1977; Pfister,1977; & Stroothenke ,1981; Ejezie 1981; Goldsmid 1981; Peschlow *et al*., 1983; Arene,1984; Obengui, 1989;Tonge, 1989; Fimiani *et al*., 1990; Pilgrim & Brown, 1993; Spradbery *et al*., 1994; Douglas-Jones *et al*., 1995; Nte & Eke. 1995). In poor communities in Nigeria and in Trinidad, prevalence rates have been observed from 21% to 42% (Nte & Eke, 1995; Chadee, 1998; Ade-Serrano, & Ejezie, 1981; Ejeziem, 1981). However, it remains uncertain whether morbidity was similar in the different areas studied so far. Morbidity depends mainly on the number of lesions present. Twenty eight percent of the examined individuals had one lesion, whereas

59% had three or more lesions. The median number of lesions was 7.8 (males: 8.7, females: 6.6). Similar 24 information is only available from five communities in Trinidad, where the mean number of lesions has been reported to be 8.0 (8.8 in males and 6.7 in females).

2.7 Tungiasis situation in Ethiopia

Poverty-promoting diseases have recently been designated as the neglected tropical diseases, the magnitude of the problem and the status of intervention in Ethiopia, only two cases of which have recently been reported in Ethiopia. Pediculosis, tungiasis and non-parasitic conditions such as podoconiosis and goiter are also presented as neglected diseases of public and socioeconomic importance in Ethiopia.(Erko *et al*., 2013).Typically, the disease occurs in poor communities found mostly in rural part of Ethiopia and in the lowlands of rural Ethiopia, jigger fleas are common, and their problems of entering into the skin of humans cause inflammation, and pain, and ultimately deformity of the feet, tetanus, gangrene, amputation.

Disease transmitted by fleas; Bubonic plague and Murine typhus (endemic flea-borne typhus). Flea control is a little bit challenging. It involves the control of a wide range of flea reservoirs including household pests' effect of socio-economic condition (Haddis, 2004). Regarding our country Ethiopia, no recorded data is obtained which shows the prevalence of Tungiasis. As there was no document on prevalence of *T.penetrans* infestation and disease out come in the selected study area, this study was designed to investigate the prevalence of *T.penetrans* (Siphonaptera: Tungidae) infestation and disease out come in selected kebeles of Gulliso woreda, West Wollega zone, West Ethiopia.

2.8 Diagnosis and Treatment

The diagnosis of tungiasis is made clinically (Heukelbach *et al.*, 2001). Even the untrained physician can diagnose the ectoparasite taking into account the typical topographic localizations and the natural history of the disease. The patient typically complains about local itching, pain and the sensation of a foreign body. Patients commonly report having walked in infested places such as beaches and farms. Most lesions occur on the nail rim. Eggs being expelled or eggs attached to the skin and the release of brownish threads of feces are path gnomonic signs. Feces threads are of a helical structure and often spread into the dermal papillae.

The standard treatment of tungiasis is surgical extraction of the flea under sterile conditions (Heukelbach *et al.*, 2001). However, this is not an easy task, as it requires a skilled hand and good eye-sight. The opening in the epidermis should be carefully widened with an appropriate instrument such as a sterile needle to enable the extraction of the entire flea. If the flea is torn during extraction or if parts are left in the sore, severe inflammation is the rule. After extraction the sore should be treated with a topical antibiotic. In resource-poor settings, strict hygiene is often not applied and appropriate instruments are unavailable with the consequence that attempts removing the fleas often do more harm than good (Feldmeier *et al.*, 2003).

A biopsy of the lesion and histopathological examination is not indicated. However, histological sections are often done to confirm the diagnosis in European and North American travelers after their return from the endemic area (Frank *et al.*, 2003; Smity & Procop, 2002). The sections usually demonstrate the presence of the parasite, eggs or chitnous fragments (Frank *et al.*, 2003; Fimiani *et al.*, 1990; Douglasjones *et al.*, 1995; Burke *et al.*, 1991; Reiss, 1966; Poppet *et al.*, 1983; Macias & Sash Ida, 2000; Smith & Procop, 2002). In single cases of a typical tungiasis, a biopsy may be indicated, for example lesions with a pseudo epitheliomatous appearance at ectopic sites (Heukelbach *et al.*, 2004d). Differential diagnoses include verrucae, myiasis, phylogenic infection/abscess, foreign bodies, acute paronychia, coetaneous larva migrans, dermoid cysts, dracontiasis, melanoma, deep mycosis and bites or stings of other injurious arthropods (Franck *et al.*, 2003; Heukelbach *et al.*, 2001; Warhaugh & Norris, 1994; Golouh & Spiller, 2000; Sansui *et al.*, 1989). Other authors suggested oral thiabendazole as an effective drug against embedded sand fleas, but controlled studies are unavailable (Cardoso, 1981; Valenca *et al.*, 1972). There is also a case series using a natural repellent based on coconut oil showed an impressive regression of clinical pathology in severely infested patients by prevention of re-infestation (Schwalfenberg *et al.*, 2004). The twice-daily application of this plant-based repellent reduced the infestation rate in an area with extremely high transmission rates by almost 90% (Feldmeier *et al.*, 2005). In endemic communities the use of an effective repellent would probably be a better approach to reduce tungiasis-associated morbidity than treatment after infestation.

3. Material and Methods

3.1 Description of the study Area

The study area is located in Gulliso woreda ,west Wollega Zone, Oromia regional state, West Ethiopia, 035^{o} $35^{'}5''$ E and $09^{o}10^{'}$ N located at distance of 521Kms from capital city of the country, Addis Ababa. The current population of Gulliso woreda was 91,471 (45,526 males and 45,945 females). The total area of the woreda was 63,640 hectare and bordered on North West direction by Jarso woreda, North by Boji Chokorsa woreda, west by Dale Wabera woreda, south by Aira woreda, South west by Yubdo Woreda and east by Lalo Asabi and Genji woreda. The number of households in the woreda was estimated to 13,138. The climatic condition of the woreda was 39% covered by high land "dega" and the remaining portion 61% is covered by "Weyina dega" Annual rain falls of the woreda was range from 1300 mm to 1600 mm, has an altitude from 1650m to 1700m and temperature from 13^{o}C to 18^{o}C. In the woreda, there are 25 kebeles and 3 administrative towns, total of 28 kebeles existed in the woreda. Like in other parts of the country different ethnic groups live in the area. Of the different ethnic groups living in the woreda, Oromo, dominant, whereas Amhara and Guraghe were exist in scarce amount.

3.2 Study design

Cross sectional study was carried out to assess *T. peneterans(*Siphonaptera: Tungidae)infestation and disease out come in some selected kebeles of Gulliso woreda**,** West Wollega Zone, Western Ethiopia(*T. peneterans*) among three purposively selected kebeles (smallest administrative unit in Ethiopia). The three kebeles were selected purposely because of their high population size, density and their accessibility for transportation, the selected kebeles are Challiya Eka, Challiya Woradale and Challiya Kusae. There were 933 house heads in the three kebeles with the total population of 5598 of this 2861 male and 2737 were females. The house heads were selected as the source population for sampling.

3.3 Sample size and sampling techniques

The sample size of the study was determined by using single population proportion formula (Cochran,1977) by assuming 95% confidence level with 0.05 marginal error and p=0.5.

$n = \frac{Z^2 PQ}{D^2}$, Where; n = sample size

$= \frac{(1.96)^2 (0.5)(0.5)}{(0.05)2}$ $D =$ Margin of error

= 384.16 $N =$ number of house holds

= 384

$P =$ Proportion of *Tunga peneterans* (Siphonaptera: Tungidae) infestation and disease outcome $Z =$ Level of confidence

$$Q = 1\text{- P}$$

$$D = 0.05$$

$$P = 0.5$$

$$Z = 1.96$$

Since the source population was smaller than 10, 000, I used the following correction formula.

$$nf = \frac{n}{1 + \frac{n}{N}}$$

$$= \frac{384}{1 + \frac{384}{933}}$$

= 272

Thus, 272 study participants were randomly selected from the source population for this study.

Three kebeles were selected purposively. Sample size for the study was determined using standard formula for single population proportional and the sample size was allocated to each selected kebele depending on the proportionality basis. Accordingly, a sample size of 272 household from three kebeles was obtained. Samples were allocated to each Kebele based their population size. Thus 111 samples HHs were selected from Challiya Eka, 91 from Woradale and 70 from Kusae respectively for each kebeles. Sample households were picked systematically from the three kebeles by using the following systematic formula. 933/272=3.4

In each kebele the 1st house was identified by using lottery method which was used for identification of where to start. Thus, the first 1-3 houses were included in the lottery method. Then the third house head was identified as the study population. The method was applicable in all selected kebeles in the same manner. After identifying the first house, the calculated sample of each kebeles was selected until the desired sample was met.

3.4 Data Collection tools

A community based longitudinal household survey was conducted during two seasons, one in dry season and the other during wet season. Each of 272 study participants (HH's) was contacted. During each contact data including demographic information (age, sex, religion, etc.) were collected. Observation was made for each respondent on their status of personal hygiene. Respondents were asked to wash their feet and then checked every part of the foot systematically. Jigger lesions were examined and counted. In addition to observation, the respondents were further administered with a structured questionnaire in order to collect relevant information knowledge, attitude and practice towards tungiasis. Focus group discussion including health workers and each kebele officials aimed to identify if any risk factors or preventive measures and assess their impact on overall welfare of the community.

Data collection was made in two rounds the first being in September 2014 for wet season and the second in February, 2015 for dry season. The study utilized a pre-coded questionnaire administered to the respondents on some aspects of Tungiasis in that specific area. The questionnaire that includes demographic information such as name, age, sex, place of residence, housing system etc. was filled by the respondents.

3.4.1 Survey for infestation

All the respondents were interviewed at their residence using a structured questionnaire. The questionnaire requested the individuals' socio-demographic information, experience to Tungiasis infection, and use of Tungiasis preventive measures, place of residence relatedto issues of Tungiasis. A pre-tested structured Afan Oromo language questionnaire comprising 32 multiple-choice items of "yes" or "no" response with some reasoning answers was/ developed for the study. The questionnaire was originally developed in English and then translated into Afan Oromo. The Afan Oromo version was later translated back into English. The questionnaire included 8 items of socio demographic parameters, 10 knowledge, attitude

and practice toward jigger flea, 7 items on economic data and 7 items behavioral data on awareness aspects of Tungiasis.

To evaluate the scale of this neglected problem, the study aimed to ascertain the prevalence of the Tungiasis in a number of rural settings in the study area through observation, a comprehensive locally administered questionnaire, also focus group discussion (with elders and health extensions, of each kebele.) aimed to identify if any risk factors, or preventive measures and assess their impact on this well known, but poorly handled health problem. Observation procedure was made, samples were asked to wash and dry their feet properly, then started to check every part of the body systematically. Looking for jigger was critical even below the nails lesions were counted with the total number of jigger flea lesions and were categorized as 1,2,3,4,5 and into 6 and above.

A questionnaire was distributed to gather the following: socio-demographic data; usage of shoes and personal sanitation, educational level and occupational condition. Behavioral practices including feet washing practices after taking off shoes and before wearing shoes was observed. Focus group discussion was structured in local language Afan Oromo to communicate and get information easily which needed to complete the work. Personal interview was made with some selected health workers as well as the respected officers regarding knowledge of how jigger flea infect the people, whether the patients visit the health center if the community had habits of using shoes regularly, and the general sanitary condition of the community.

3.5 Data analysis

The data were analyzed using SPSS software package version 20 and proportions of categorical data is used for the analysis of the overall collected data test used to assess the Significance of associations between demographic characteristics data, behavioral risk factors and sex factors with the prevalence of the tungiasis. The significant level can be based on the collected data. The outcome of the study was expressed using tables, Chi-square test and p-value at 5% probability level tests has been considered significant at ($p<0.05$) of confidence interval 95%.

3.6. Ethical consideration

The study was carried out after obtaining ethical clearance from ethical committee from Jimma University, college of natural science, Department of Biology. An official letter was written to the all concerned body from Department of Biology. Collaboration letter was written to the responsible zonal, Woreda, kebeles administrative officers and other responsible personnel, so that I accomplished my study smoothly with good communications. Thus, the study communities were asked for verbal consent after being introduced to the purpose of the study and informing about their right of answering or rejecting the questions. The objectives of the study were explained to the recruited and trained individuals for the data collection activities, lecturing related to impacts of tungiasis, how the parasites was infest and other related issues were given to the households of the kebele, especially to the Positive individuals for tungiasis. Codes were used instead of names for each volunteer participant during sample collection and all information was not exposed to external observer.

4. Results

4.1 Socio demographic characteristics of respondents

Out of two hundred seventy two study participants, 41(15.1%) in age gap 18-24, 82(30.1%) in age gap 25-30, 68(25%) in age gap 31-36, 49 (18%) in age gap 37-42 and 32 (11.8%) were aged above 42 (table: 1). Out of the total of two hundred seventy two respondents examined, male accounted258(94.9%) and females accounted 14(5.1%). A total of 185(68%) of the study participants depend on agriculture for their livelihood, 5(1.8%) were merchants, recruited 25(9.2%), daily work 5(1.8%) and the rest 52(19.1%) depend on other types of occupational characteristics, such as solders, carpenters, government employees. With regard to their educational characteristics 75 (27.6%) respondents completed primary level (1-4) education, followed by read and write community group 71(26.1%) and the third large group relatively was grade level 9-12, 49(18%). Respondents with Certificate and above were the least figure with 36(13.2%) (Table-1).

Protestant was very dominant religion in the study area with 264(97.1%) of the respondents and followed by Orthodox Christian followers making 5 (1.8%). Regarding the ethnicity of the study area Oromo was the dominant constituting (99.6%) and Amhara constitute scarce figure 1(0.4%) (Table-1).From 272 study participants two hundred fifty three (93.01%) of the respondents were married followed by 11(4.04%) widowed. Divorced individuals accounted 3(1.1%). Regarding the family size of the households majority 111(40.8%) had 2-4 family size, 91(33.5%) and 70(25.7%) house heads had family size above six members respectively.

Table 1 Socio-demographic characteristics of respondents (February, 2015).

Variables	***Characteristics***	***Number N=272***	***Percentage (%)***
Gender	Male	258	94.85
	Female	14	5.15
Age group	18-24	41	15.1
	25-30	82	30.1
	31-36	68	25
	37-42	49	18
	>42	23	118
Occupation	Farmer	185	68
	Merchant	5	1.8
	Recruited	25	9.2
	Daily work	5	1.8
	Other	52	19.1
Education	Write & read	71	26.1
	1-4	75	27.6
	5-8	41	15.1
	9-12	49	18
	>Certificate	36	13.2
Marital status	Married	253	93.0
	Divorced	3	1.1
	Widowed	11	4.0
	Widower	5	1.8
Religion	Protestant	264	97.1
	Orthodox	5	1.8
	Muslims	0	0
	Other	3	1.1
Ethnicity	Oromo	271	99.6
	Amhara	1	0.4

4.2 Prevalence of Tungiasis and its association with Socio-demographic characteristics

From a total of two hundred seventy two individuals participated in the study 81 (29.8%) and 39(14.3%) individuals were infested during dry season and wet season respectively. With regard to the impact of age on the prevalence of tungiasis, Among 81 during dry and 39 during wet infested individuals age 18-24and age above forty two being most infested in dry seasons constituting 16(19.8%) and 24(29.6%), age gap 37-42 and age gap 25-30 were constitute 15(18.5%) and 14(5%) infestation recorded, age gap 31-36 became the least infested age group with 12(14.8%) infestation recorded. Likewise infestation for wet season age above 42 was identified as the major infested age group with 12(30.8%), age 37-42 and

age group 18-24 constitute 10(25.6%) and 7(17.9%) infestation recorded respectively. Age group 31-36 reduced to 6(15.4%) and age group 25-30 became the least in infestation with 4(10.3%) of infestation recorded during wet season.

The study participants who were included in the analysis were 272. The significance was considered for the age groups. The result showed that the age groups of the house hold had a statistical significance, age above 42 were more vulnerable to suffer from tungiasis at $p<0.05$ during both seasons(Table 2 & 3). Farming was highly associated with tungiasis with 66(81.5%) of respondents out of 81 during dry and 33 (84.6%) during wet seasons positive individuals being farmers. Merchants become none infested occupational groups in both dry and wet season. The significance was considered for the occupation.

The result showed that the occupation characteristics of the house hold had a statistical significance, farmers were more vulnerable to suffer from tungiasis at $p<0.05$ during both seasons. With regard to the impact of education on the prevalence of tungiasis, individuals with least educational status (both write-read and 1-4 grade level) being most infested educational characteristic constituting 64(79%) and 33(84.6%) of the affected grade levels during dry and wet season respectively. The least infestation during the same season was grade level 9-12 and above certificate constituting (4.9%) and (5%) respectively. The significance was considered for the educational characteristics. The result showed that the educational characteristics of the house hold had a statistical significance, grade level read write were more vulnerable to suffer from tungiasis at $p<0.05$ during both seasons. (Table 2 & 3).

Table 2 Demographic characteristics of respondents and Jigger flea infestation during the dry season (February, 2015).

Variables		Infestation status		Total N (%)	Chi-square	P-value
		Infested N (%)	Not infested N (%)			
Age	18-24	16(19.8)	25 (13.1)	41 (15.1)	15.34	0.00
	25-30	14 (17.28)	68 (35.6)	82 (30.1)		
	31-36	15(18.5)	56(29.3)	71 (26.1)		
	37-42	15 (18.5)	34(18.8)	49 (18)		
	>42	24(29.6)	8 (4.2)	32(11.8)		
Education	Write-read	35 (43.2)	36 (18.8)	71 (26.1)	31.6	0.00
	1-4	29 (35.8)	46 (24.1)	75(27.6)		
	5-8	13 (16)	28 (14.7)	41 (15.1)		
	9-12	3 (3.7)	46 (24.1)	52 (19.1)		
	Certificate	1 (1.2)	35(18.3)	36 (13.2)		
Occupation	Farmer	66(81.5)	119 (63.3)	185 (68)	61.76	0.00
	Merchant	0(0)	5 (2.6)	5 (1.8)		
	Recruited	2 (2.5)	23 (12)	25 (9.2)		
	Daily worker	1 (1.2)	4(2.1)	5 (1.8)		
	Other	12 (14.8)	40 (20.9)	52 (19.1)		

Table 3 Demographic characteristics of respondents and Jigger flea infestation during the wet season (June, 2015).

Variables		Infestation status		Total N (%)	Chi-square	P-value
		Infested N (%)	Not infested N (%)			
Age group	18-24	7(17.9)	34(14.6)	41(15.1)	175	0.00
	25-30	4(10.3)	78 (33.5)	82(30.1)		
	31-36	6 (15.4)	62 (26.6)	72 (26.5)		
	37-42	10 (25.6)	39 (16.7)	49 (18)		
	>42	12 (30.8)	20 (8.6)	32 (11.8)		
Education	Write-read	19 (48.7)	52(22.3)	71(26.1)	168	0.00
	1-4	14(35.9)	61(26.2)	75(27.6)		
	5-8	4(10.3)	37(15.9)	41(15.1)		
	9-12	1(2.6)	48(20.6)	49(18)		
	Certificate	1(2.6)	35(15)	36(13.2)		
Occupation	Farmer	33 (84.6)	152 (65.2)	185(68)	105	0.00
	Merchant	0 (0)	5(2.1)	5 (1.8)		
	Recruited	1 (2.6)	24(10.3)	25(9.2)		
	Daily worker	0 (0)	5(2.1)	5(1.9)		
	Other	5 (12.8)	47(20.2)	52(17.3)		

4.3 Distribution of *T. peneterans* infestation on the body of respondents

From the total 81 and 39 individuals identified as infested during dry and wet seasons respectively 10 (1.2%) had jigger lesions only on their feet, 2 (2.5%) had lesions on their hands and 69 (85.1%) had jigger lesions simultaneously on their hand & feet during dry season. Likewise 4 (10.3%) had jigger lesions only on their feet, 3(7.7%) had lesions on their

hands and 35 (89.7 %%) had jigger lesions simultaneously on their hand & feet during wet season. According to this observation, lesions were more common to the feet and hands (Table-4).

Table 4: Lesion distribution on different body parts among respondents (September 2014 Wet season and February 2015 Dry season).

Season	Infested Body part	Lesions on Feet	Lesions on hand	Lesions on both hand and Feet	Un infested
Dry	Infested(N= 81)	10	2	69	191
	Infestation in (%)	1.2	2.5	85.1	
Wet	Infested(N=39)	3	4	35	233
	Infestation in (%)	7.7	10.3	89.7	

4.4 Intensity of infestation of *T.penetrans*

From a total of 81 infested individuals during dry and 39 infested during wet season, 24 (29.6%) had one lesion, 16(19.8%) had two lesions, 21 (25.9%) had 3 lesions, 19(23.5%) had 4 lesions and 1 (1.2%) had 5 lesions either on their hands or on their feet. From the total 39 infested individuals during wet season 12 (30.8%) had 1 lesion, 7(17.9%) had 2 lesions, 10 (25.6%) had 3 lesions, 9(23.1%) had 4 lesions and 1 (2.6%) had 5 lesions either on their hands or feet. During the study 200 lesions were recorded on 81 infested individuals during dry season. Thus the intensity of infestation during dry season was 200/272=74% lesions per individual. Likewise 97 lesions were recorded from 39 infested individuals during wet season. The intensity of infestation during the wet season was36 % (97/272) (Table: 5)

Table 5: Number of lesions and their frequencies (September 2014 and February 2015)

Number of lesion/person	Frequency (N=81) February 2015	Frequency (N=39) September 2014
1	24(29.6%)	12(30.8%)
2	16(19.8%)	7(17.9%)
3	21(25.9%)	10(25.6%)
4	19(23.5%)	9(23.1%)
5	1(1.2%)	1(2.6%)

4.5 Knowledge, attitude and practice of respondents towards *T. penetrans* infestation

Concerning the perception of the respondents toward jigger flea, the study participants responded for the question presented for them, if tungiasis is a disease or not, one hundred

thirty nine (51.1%) of respondents knew that tungiasis is a disease. Though they perceived as a disease none of them visited healthcare for the case in their life. The remaining 133(48.9%) did not know, they perceived as it is not disease. Of a total of 81 and 39 study population identified as infested during dry and wet season respectively, 11(84.6%) respondents had no practice of wearing shoes at all during dry and 9(28.2%) during wet seasons. Individuals who wore shoes sometimes 67(29.8%) in dry and 29 (12.9%) in wet identified as tungiasis cases. Out of a total 34 respondents wear shoes always 3(8.8%) dry and 1(2.9%) identified during wet as tungiasis cases.

The significance was considered for the shoe wearing practices. The result showed that shoe wearing practices of the house hold had a statistical significance, individuals had not practiced shoe wearing were more vulnerable to suffer from tungiasis at $p<0.05$ during both seasons. Regarding feet washing practice, those who wash feet sometimes 31(93.9%) in dry and 28(84.9%) in wet season exposed to tungiasis case. Individuals practiced feet washing always 50(20.9%) in dry and 11(28.2%) were exposed to tungiasis case (Table: 6).The significance was considered for feet washing practices. The result showed that the feet washing practices of the house hold had a statistical significance, individuals washed their feet sometimes more vulnerable to suffer from tungiasis at $p<0.05$ during both seasons (Table: 6).

Table 6: Association among behavioral characteristics and Jigger flea infestation among respondents during the dry season (September 2014 Wet season) and(February 2015 dry season)

Season	Variables		Infestation status		Total N (%)	Chi-square	P-value
			Infested N (%)	Not infested N (%)			
Dry	Shoes wear	Never Sometimes Always	11 (84.6) 67 (29.8) 3 (8.8)	2 (1.4) 158(58.09) 31(93.9)	13 (4.8) 225 (82.7) 34 (12.5)	136.5	0.00
	Washing feet	Sometimes Always	31 (93.9) 50 (20.9)	2 (6.01) 189 (79.1)	33 (12.1) 239 (87.9)	152.9	0.00
Wet	Shoes wear	Never Sometimes Always	9 (69.2) 13 (38.2) 17 (7.6)	4(30.8) 21 (61.8) 208 (92.4)	13 (4.8) 34(12.5) 225 (92.4)	57.32	0.00
	Washing feet	Sometimes Always	28 (84.9) 11 (28.2)	5 (15.2) 228 (95.4)	33 (12.1) 239 (87.9)	73.93	0.00

Source: SPSS Result

Thus, behavioral practices and infestation by jigger flea has great correlation with each other. According to the observation made, jigger flea was extracted by unsterilized needle purchased from nearby shop and in most cases the extraction was accomplished by a spiny plant, like, *Dovyalis caffra*. (Plate 1 and plate 2).

Plate 1 Extraction of jigger flea by *Dovyalis caffra*, ***(photo credit Taye Feb.2015)*** ***plate*** **2** *Dovyalis caffra* ***(photo by Taye Feb.2015)***

Plate 1 Practices of extraction of jigger flea and the spiny plant used for extraction among the three kebeles of Gulliso woreda, West Wollega zone, West Ethiopia. Photo by Taye Berhanu (February, 2015)

Focus group discussion was held with kebele administrative workers, government Health workers and a NGO Challiya clinic staff who worked in the surrounding for long time and currently retired. According to the informants, jigger flea was a serious problem in the past, they quoted the serious infestation time was dry season. The health workers raised as there was no drug or medicine used to treat the case. But recently they informed that a drug called ivermectin drug is on process to be distributed by government. During focus group discussion the participants reported that, the magnitude of the parasite was highly reduced. Majority of the community perceived the case caused by the parasite as it was not as serious as the past. The professionals were asked if patients visiting the health station came with tungiasis case, or if they due attention to look toward their body, e.g. their feet. According to the report of the professionals other than giving general health education, they did not stress to observe tungiasis, but incase if they encounter, they never pass by without counseling them. All the professionals agreed that now days, relatively knowledge, attitude and practice toward the parasite is increasing, this was due to health education the government is extending through health extension workers according to the respondents.

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Plate 3. Focus group discussion with Kebele workers ***(photo by Taye Feb.2015)*** **Plate 4.Focus group discussion with Challiya Eka health workers**

5. Discussion

The result of the study showed that Tungiasis was prevalent in the community under study. This prevalence was differing depending on seasons, age gap, occupational characteristics and educational level. Accordingly, the prevalence in the concerned kebeles, Eka, Kusae and Woradale 29.8% in dry season, 14.3% in wet season. Compared to other studies the prevalence was very low, For example, in population-based studies in rural Brazil and Nigeria, prevalence 51% during dry and 45% during wet season were found (Ugbomoiko, 2007; Muehlen *et al., 2003).* In an urban slum in Brazil, prevalence in the peak dry season was as high as 54% (Heukelbach *et al*., 2005). Njeumi *et al*., (2002) reported about 50% of school children to be infested in different communities in Cameroon (Njeumi *et al*., 2002).In north-east Brazil; there was considerable seasonal fluctuation of the attack rate. Matias (1989) in his study, the prevalence of Tungiasis in rainy season, the incidence of new lesions decreases significantly, and during dry months new cases of tungiasis show up every day. The difference was less pronounced than the seasonal variation observed in the only longitudinal study published so Heukelbach *et al*., (2005) in the study the highest prevalence was found in an urban slum in Brazil in the middle of the dry season (54% vs. 17%) (Heukelbach *et al*., 2005).

According to these findings, infestation rate actually increased in the dry season. In Fortaleza, Heukelbach *et al.*, (2002) found almost half of the children infested during the dry season, but less than 10% in the rainy season (Heukelbach *et al.,* 2002). The relatively low prevalence found in the study area may have different reasons. Housing may better than in the other impoverished communities studied in different countries and also the time of study in the quoted countries a bit far or old. In the study area most houses had access to cover the floor of their houses (sleeping room and salon), better sleeping materials such as bed and separation of domestic animals from their residence. Studies reveals that a sandy floor inside the house is known as a major risk factor for the presence of tungiasis and severity of infestation (Ugbomoiko *et al.,* 2007; Muehlen, *et al*., 2006).

Regarding age group and infection by jigger flea of households, among 81 and 39 individuals infested during dry and wet season respectively, age gap 18-24 infested 19.8% dry and 17.9% during wet season, the second larger infested age group was age above 42, 29.6 during dry and 30.8% during wet seasons, age group 31-36 become the least infested with 14.8% during wet season, but the least infested age group during wet season was age gap 25-30 with 10.3%

recorded result. Relatively age above 42 and age 18-24 were identified as a risk group during both seasons. In the selected kebeles of Gulliso Woreda the most relatively infested age groups were age above 42 and age gap 18-24 in both seasons. This seems almost in agreement to a characteristic finding pertaining to many areas especially in increasing at elderly age.

A study conducted in Erekiti, a small resource-poor community in western Nigeria, found that 45.2% of the 557 individuals examined were infested with *T. peneterans the* prevalence was highest between the ages of children, decreased at adult stage and increased among the elderly (Ugbomoiko, Ofoezie &Heukelbach, 2007). In the same manner a study conducted in Ndu sub-division of North-west rural Cameroon on the title, Tungiasis: A Neglected Health Problem by Collins, Prevalence was lowest at adult age and increased again in the elderly age. (Collins, G.2009). This study in agreement with the current findings on increment of prevalence during elderly age. In the selected kebeles of Gulliso Woreda, elderly males are usually retired, stay the whole day in the community, walk barefooted, and put their bare feet on the ground when sitting and chatting

Regarding the occupational characteristics, from 81 and 39 infested in dry and wet seasons respectively, the occupational characteristic that showed highest infestation coverage rate both at dry and wet seasons were farmers during dry 81.5% and 8.6% wet, the least infested occupational group was different occupational styles accounting 14.8% dry and 12.8% during wet season. Merchants were remained as none infested occupational characteristics during both seasons. According to the observation made farmers were highly vulnerable to the infestation, this could be attributed to the lack of adequate information related with cultural practices. Another factor that sustains Tungiasis is that the community lacks appropriate practices such as personal hygiene. In the study area almost all of the farmers plow land being bare footed, low leaving individuals susceptible with little protection. As the majority of the farmers in the village walk barefooted, further infestations result from not wearing closed foot wear. Shoe wearing practices in a podoconosis-endemic setting in rural Ethiopia, brings to light several issues relevant to other foot-related NTDs (Ayode *et al*., 2013).

Concerning educational status of the respondents and infection by jigger flea from the total infested individuals 81 during dry season, grade level write-read was the highest, 43.2% dry and 48.7% during wet followed by the grade level between 1-4 which contributed 35.8%dry

35.9%wet seasons. Grade level 9-12 and certificate and above were identified as the least infested educational group with 3.7 % dry and 2.6 % wet, Certificate and above 1.2% dry and 2.6% during wet infested respectively. The result of this finding in line with a study conducted in Ndu sub-division of North-west Cameroon rural by Collins, 59% of illiterate people were infested by tungiasis (Collins, G.2009).From this findings one can understand, education has a great role to develop awareness not only for Tungiasis to defend oneself from other diseases too.

From the total of 81 infested individuals during dry season, 1.2% infestation was on feet, 2.5% on their hands and 85.1% jigger lesions simultaneously on hand & feet during dry and 7.7% infestation was on feet, 10.3% on hand and 89.7 observed simultaneously on hand and feet during wet. According to this observation, infestation was more common to the feet and hands simultaneously; this implies the flea infests both feet and hands. This study was in agreement with the study conducted in Logos, Nigeria, all infested individuals had penetrated fleas on the feet, and almost 95% of the lesions were localized on the feet. About two-thirds of patients had periungual lesions. Ten percent Presented with sand fleas on ectopic sites (hands and elbows) (Ugbomoiko, S. U., 2007).Moreover, according to the information fetched from focus group discussion there is a time when other topographic part of the body is exposed to the infection, e.g. knee, buttocks sometimes chest and other part of the body.

Generally the infestation rate was highly reduced, when compared in the past according to the information gathered from elderly healthy professionals lived for a long time in the community and from inhabitants, the issue of reduction was because of the improved community life associated with technology promotions accompany made by health education government extended home to home health education. According to the observation made, practice of extraction of jigger flea in the study area was made by unsterilized needle purchased on the shop or by any spiny and sharp plant. But in most cases the extraction is accomplished by a spiny plant, like, *Dovyalis caffra*. However, this is not an easy task, as it requires a skilled hand and good eye-sight. On my observation while removing the flea the opening in the epidermis widened carefully with a needle or with the spiny plant to extract the entire flea.

The parasitic load and the maximum number of lesions found in selected kebeles of Gulliso Woreda were with mean value 2.5Which was far different from research conducted in a fishing community of Brazil, the mean parasite load was 8.9 Muehlen *et al., (2003)* and in a

rural community, in Nigeria 12.3 Ugbomoiko, (2007), in an urban slum in Ceará State 7.8 Wilcke *et al*., (2002) and in several communities in Trinidad 8.0 (Chadee, 1998).In all these studies the parasitic load was incomparable, that means there is very great difference between the previous studies and the present findings of parasitic load in the selected kebeles of Gulliso Woreda with mean value 2.5. Parasitic load was disproportionally distributed whereas, the majority had only one or two embedded sand fleas either on their hand or on their feet or on both. In both seasons, only one individual was responsible for5 parasitic load.

The Behavioral practices questions were presented for the respondents, from the total 13 respondents never wear shoes, 84.6% were identified as tungiasis case. Only 8.8% infested from 34 respondents had the shoe wearing practice every day during dry season. According to the questions presented for the respondents, they raised different reasons for not wearing shoes, of the total respondents those wear shoes some times and those never wear shoes out of 238 respondents,63.5 % raised money problem, the remaining 36.5% raised practices, example, their working style did not allow them to wear shoes according to them, for example farming.

Concerning feet washing habit out of 33 respondents 84 % identified as positive case, only 28.2% out of 239 that practiced washing their feet always recorded as positive. The association between habit of feet washing and shoe wearing practice and Jigger flea infestation status among house heads of the three kebeles during both dry and wet seasons analyzed. As it is known that house heads were 272. It was observed that there is significant association between jigger infection and house heads in both habits during wet and dry seasons at $p<0.05$.

According to Ayode *et al*., (2013), shoe wearing practices in a podoconiosis-endemic setting in rural Ethiopia, brings to light several issues relevant to other foot-related NTDs. Ayode *et al*.,(2003) in their discovery they agreed that, despite a clear wish to wear shoes, and to wear them regularly, many practical and social barriers prevent these wishes being translated into practice. Many of the barriers cited will be relevant to those considering distribution of shoes to prevent snakebite, tetanus or helminthiases. They also witnessed inconsistency between reported and actual shoe wearing behavior, confirming the complexities that exist in relation to recording shoe use. They suspect that these complexities may not have been adequately addressed in earlier studies on risk factors for a range of NTDs (Ayode *et al*., 2013). Tungiasis is acquired when walking barefoot on soil, in which off-host stages of *T.*

peneterans have propagated. 99% of all penetrated sand fleas are located at the feet (Heukelbach and Feldmeier2002).Household status and poor hygiene determines the health conditions of the occupants and home hygiene is important in order to control pests and provide pleasant atmosphere to the household members (Dalton, 2006).

Regarding their knowledge on *T.penetrans* and its output diseases infestation impact, from a total of 272 respondents interviewed, if they knew tungiasis is a disease or not 139(51.5%) of them knew that it is a disease and 133(48.9%) of them did not know that it is a disease. Though the respondents reported mixed attitude toward jigger infestation, the jigger problem was often brushed off as a thing of the past, or as a minor problem that can be relegated for more pressing issues. Public health experts warn that heavy jiggers infestations goes beyond mere discomfort and can leads to loss of toe/finger nails and amputation of the digits. It is therefore important to inculcate the right attitude in household members in order to develop a positive behavior change for sustainable jigger prevention and control among household members.

Focus group discussion was held with kebele administrative workers, government health station and a NGO Challiya clinic staff who worked in the surrounding for long time regarding their attitude toward *T.penetrans* and its infestation. According to the informants, jigger flea was a serious problem in the past, they quoted the serious damage time was in dry season. The health workers raised as there was no drug or medicine used to treat the case. But recently they informed that a drug called ivermectin drug is on process to be distributed by government. According to the professionals, especially the NGO clinic staff rose in the past they were encountered patients visiting the clinic with the mass of jigger, in their life they hadn't seen patients visited or came to discuss about the case. All the professionals, the households and kebele workers agree that the disease was one of the problem of their family in past. They responded that the magnitude of the parasite was highly reduced. The informants, particularly the focus group kebele administrative workers and health workers mentioned that they knew what Tungiasis was, the critical problem in the past they were raising that the infestation by jigger flea reduced highly. According to the discussion made falling in manifestation rate was due to the improved life of the community, technology promotion and the extended health education accompany with home to home visiting and counseling made by health workers.

6. Conclusion and recommendations

6.1 Conclusion

Infestation was identified high during dry season and low during wet season. Age 18 -24 and above 42 were among the age which infested than others. Farmers were the occupational characteristic that showed highest exposure rate both at dry and wet seasons. From the body parts jigger flea mostly infest simultaneously hand and feet. Jigger flea was extracted by unsterilized needle purchased on the shop. But in most cases the extraction was accomplished by a spiny plant, like, *Dovyalis caffra*. Infection was more common to the feet and hands, this implies, and that the flea infects both feet and hands. Almost all affected individuals had lesions on their hands and feet, most of which presented in the periungual region. Across the whole study, a total of 200 parasitic lesions were recorded during dry and 97 lesions during wet season. Parasitic load mean of 2.5 was observed during both seasons.

The maximum number of fleas on an individual was 5 and minimum was 1.Most people of the study area wear shoes sometimes, some amount wear always and still there were individuals who never wear shoes. There were individuals share many factors favoring a high attack rate by *T. peneterans*: insufficient or non-existent sanitation. Though the prevalence of Tungiasis was low, without doubt tungiasis is still a prevalent disease of individual and public health relevance in the study area. Many people, especially farmers, mostly walk barefoot or only wear open plastic shoes. Though most people wash their feet regularly there were individuals who wash their feet sometimes. Though, most had the knowledge of the parasite, still there were individuals did not perceived tungiasis as a disease. The disease was one of the problems of the community in the past, now days it seems reduced highly. This may be because of the promoted technology, the extended home to home health education and so on.

6.2 Recommendations

- The appropriate Tungiasis control policy needs to be tailored according to the local conditions and this study recommends the following as regional and national concerning tungiasis control priorities.
- Since poor sanitation is a risk factor, it must be addressed by providing appropriate services, health education on personal and environmental sanitation like healthcare facilities.
- Health education must focus primary on (using closed shoes wherever the environment is not paved) and secondary prevention, i.e. educating people to inspect their feet daily and take out embedded fleas with a sterile instrument.
- Since poverty is one of the major driving forces for prevalence of tungiasis in the endemic settings, poverty alleviation programs must be initiated not only to minimize the burden of tungiasis but also other poverty-associated parasitic and infectious diseases.
- The physical factors limiting the geographical distribution of *T. peneterans* not yet identified, thus it needs further investigation.
- Generally, effective and sustainable intervention measures addressing these factors need to be implemented in the study area and in other communities throughout Ethiopia where this parasite is available to reduce the burden of this an integrated approach combining the control of housing and environmental factors and health education is necessary.

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Annex-1

Structured Questioners

Questioners presented to House heads

Dear friend, how are you? My name is Taye Berhanu I am a MSc student at Jimma University college of natural science, department of biology, ecological and systematic zoology unit. I am on the process of conducting research on the title "Study of the Prevalence of jigger flea *(T. peneterans)* and its associated risk factors among House Holds in some selected kebeles of Gulliso woreda, West Wollega Zone, West Ethiopia." in your woreda, Gulliso, Particularly in your kebele. This research is being carried out for the partial fulfillment of master's degree in Ecological and Systematic zoology. The purpose of these questionnaires is to gather information on the prevalence and associated risk factors of *T.penetrans* in Challiya Eka kebele, Gulliso woreda. All the information (response) fetched from you play a great role to make the result of the research wonderful. Thus, I respect fully expect your trusted and genuine information and answer from you, promising confidentially to keep your secrete honestly, and you are not required to write your name. Thank you for your cooperation.

Direction for enumerator: put "√" in the box provided for your choose, for close ended question, I request to give your idea and encircle for questions having multiple choices

1. ***Demographic data***

1.1 House Number_____.

1.2 Village "Gooxii"_____.

1.3. Household Code _____.

1.4. Sex: male ☐ Female ☐

1.5. Age ☐

1.6 .Marital status: Single ☐ Maried ☐ Widow ☐ Divorsed ☐

1.7 Number of Children: ☐ Male ☐ Female ☐

1.8 Religion: Protestant ☐ Orthodox ☐ Musilim ☐ Other ☐

2 **Knowledge attitude and practice toward jigger flea.**

2.1. Do know jigger flea? A) Yes ☐ B) No ☐

2.2. Do you think infection by jigger is a disease? A. Yes ☐ B. No ☐ C. Others

2.3. If your answer for question number 2.2 is yes, have you or your family member ever

Attacked by jigger Flea? A) Yes ☐ B) No ☐

2.4 If your answer for question No 2.3 is yes, what part of your body or your family?

member is infected most of the time? A) Feet part B) Hand part C) others

2.5 From your family which age is infected more A. 0-4 B. 5-10 C.11-15 D.16-45 E. >46

2.6 In what season do the infection most of the time very serious? A. Wet B. Dry

2.7. Have you ever visited health station because of the jigger? A. yes ☐ B. No ☐

2.8. If you ever infected by jigger, what kind of treatment do you Practiced?

A) Treating by own selves B) visiting health center C) leave it until end D) Others

2.9. If you are used to take it off, what kind of apparatus do you use? _____

2.10. If your answer for the above question is yes, from what kind of activity?

3. **Socio economic data**

3.1 Do you have a job_____

3.2 If you have job, what is your job? A) Farmer B) Merchant C) Government Employee E) Daily labor F) other.

3.3.What is the main source of income of your family? _____

3.4 Your house is…… A) Private B) Rent C. other

3.5. How many individual are lived in the home? A.2-4 B. 5-6 C. >6

3.6. What kind of sleeping place does your family use? A. in the Bed B. on the mat/ Animal skin C. "Medeb" D. others

3.7. Is there domestic animal that lived together with you and your family in the same House? A) Yes ☐ B) no ☐

4. Behavioral data. (Presented for House heads)

4.1 Do you have habits of wearing shoes?

☐ ☐ ☐

A) Yes, some times. B) Yes, always. C) NO.

4.2. If your answer for question number 4.1 is NO, Why?

A. Lack of many B. Lack of awareness C. Don't have the habit D. others

4. 3. Do you have habits of washing your feet?

A) Yes, some times ☐ B) Yes, always. ☐ C) NO ☐

4. 4. Do you have habit of wearing shoes regularly?

A) Yes B) NO. C) Others

4.5. In your family, is there a habit of cleaning home? A) Yes B) NO

4.6. If your answer is yes at what time interval do you clean or wash the home?

A) Every day B) 1 week C) 2 weeks. D) Other.

4.7. Do you have practice of participating in environmental sanitation in your local area or kebele? A) Yes B) NO

4. Observation

The samples were asked to wash their feet and dry their feet properly, then checked every part of the foot systematically. Looking for jigger has been critical even below the nails lesions counted the number of jigger flea lesions and were counted and categorized into in to (1,2,3,4,5 and greater than 5)Looking for tungiasis was made for checking associated symptoms, like edema (wound). Suppuration, pain, loss of nails, loss of toes, and deformation of the toes has been observed.

Plates

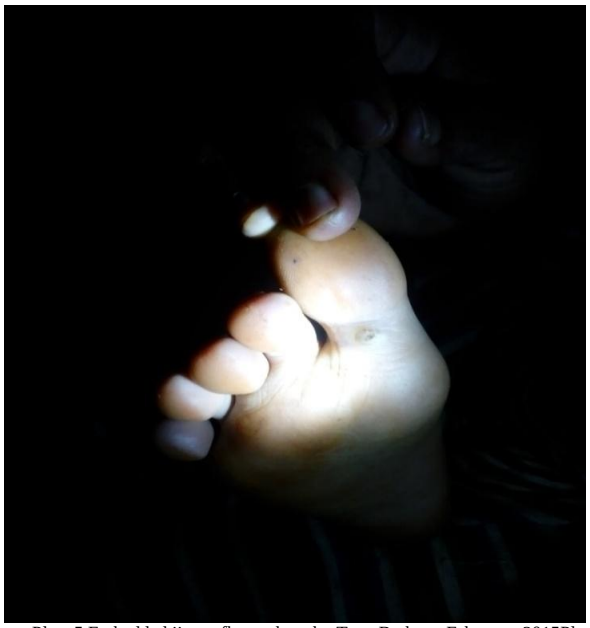

Plate 5 Embedded jigger flea a photo by Taye Berhanu February, 2015

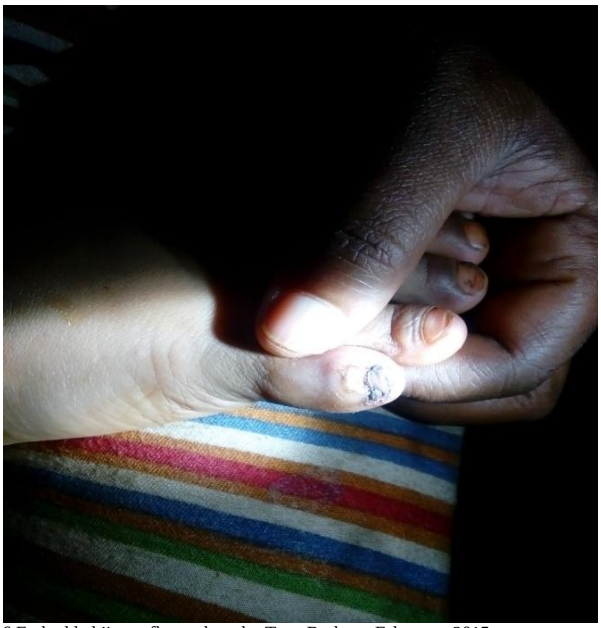

Plate 6 Embedded jigger flea a photo by Taye Berhanu February, 2015

Plate 7 Embedded jigger flea a photo by Taye Berhanu February, 2015

Plate 8 Embedded jigger flea a photo by Taye Berhanu February, 2015


Plate 9 Embedded jigger flea a photo by Taye Berhanu February, 2015 Plate 10 Feet wounded b/c of un saved extraction of flea a photo by Taye Berhanu February,2015


Plate 11 Focus group discussion with kebele workers a photo by Taye Berhanu February, 2015.


Plate 12 Focus group discussion with Challiya Clinic workers a photo by Taye Berhanu February, 2015

Plate 13 Focus group discussion with Challiya Eka Health station workers a photo by Taye Berhanu February, 2015