

**UNIVERSITY OF GHANA
COLLEGE OF HEALTH SCIENCES
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**EPIDEMIOLOGY OF *LEISHMANIA* INFECTION AND INSECTICIDE
TREATED BED NET USE IN THREE COMMUNITIES OF OTI REGION,
GHANA**

BY

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ABSTRACT

Background: Leishmaniasis is a neglected tropical disease caused by parasites of the genus *Leishmania* and is transmitted by various species of female sand flies. In Ghana, the DNA of *Leishmania* parasites has been identified in skin lesions from some patients suspected to have cutaneous leishmaniasis (CL) and also from some female sand flies sampled from the Ho municipality of the Volta Region. Systematic reviews have demonstrated that the application of insecticides against sand fly vectors is effective in reducing incidence of leishmaniasis.

Methods: Using a community-based cross-sectional study design, the prevalence of *Leishmania* infection, insecticide treated bed (ITN) use, and the occurrence of sand flies in three communities of the Oti region of Ghana were investigated. Awareness about CL, CL experience, and CL related knowledge among household heads were also investigated. **Results:** A total of 3,440 participants from 587 households comprising 189 (32.2%), 200 (34.1%), and 198 (33.7%) households from Ashiabre, Keri, and Sibi Hilltop respectively, participated in this study. Leishmanin skin test (LST) results for 1091, 848, and 1132 participants from Ashiabre, Keri, and Sibi Hilltop, indicated an overall prevalence of *Leishmania* infection of 41.8% and individual community prevalence of 39.4%, 55.1%, and 34.2% respectively. An overall prevalence of 31.9% and individual community prevalence of 23.2%, 29.8%, and 36.8% for CL in Ashiabre, Keri, and Sibi Hilltop respectively was observed. Being male (AOR=1.27; CI: 1.09, 1.49), and living in Keri (AOR=1.83; CI: 1.43, 2.34) were associated with an increase in the odds of exposure to *Leishmania* infection using LST. Being 5-15 years old (AOR=1.49; CI: 1.31, 1.98), 16-45 years old (AOR=3.31; CI: 2.44, 4.47), and >45 years old (AOR=4.85; CI: 3.29, 7.15) were also significantly associated with increased odds of being exposed to *Leishmania* infection. Non-use of ITN was not significantly associated with *Leishmania* infection. The proportion of all

study households that owned at least one ITN was 97.1%. 97.4% of households in Sibi Hilltop and 97.0% of households in both Ashiabre and Keri owned at least one ITN. Cumulatively, the number of households having at least one ITN for every two members was 386 (65.8%) while 63.5%, 68.0%, and 65.7% of households in Ashiabre, Keri, and Sibi Hilltop owned at least one ITN for every two household members. Of the 3639 de facto household population comprising 1116, 864, and 1179 in Ashiabre, Keri, and Sibi Hilltop, the overall population with access to ITN was 3159 (86.8%) while 87.3%, 87.9%, and 85.6% of the household populations in Ashiabre, Keri, and Sibi Hilltop respectively, had access to ITN. The overall household population that slept in ITN the night before this survey was 2370 (65.1%) while in Ashiabre, Keri, and Sibi Hilltop, it was 66.4%, 65.1%, and 64.0% respectively. Of 2181 population in households with ITN access, 1581 (72.5%) persons slept in ITN the night before the survey. Lack of household access to ITN (AOR=1.80; CI: 1.31, 2.47), having a family size of more than 10 members (AOR=2.53; CI: 1.20, 4.24), having more than 10 rooms for sleeping in a household (AOR=10.18; CI: 1.28, 81.00), having 2-4 screened windows (AOR=1.49; CI: 1.00, 2.20), and having 8-10 screened windows (AOR=3.57; CI: 1.25, 10.17) were significantly associated with increased odds of not sleeping in ITN the night before the survey. All household heads were aware of CL with 243 (41.4%) of them demonstrating good knowledge about it. A total of 45.3% of household heads (57.1%, 35.0%, and 44.4% in Ashiabre, Keri, and Sibi Hilltop) indicated that at least one member of their household had experienced CL two years prior to this study. A total of 193 female sand flies were trapped from various locations within the study communities.

Conclusions: This study demonstrated exposure to *Leishmania* infection in the study communities and confirmed CL which suggests an active cycle of transmission of *Leishmania* infection. Being male, living in Keri and being five years or older were associated with

Leishmania infection. The non-use of ITNs was not significantly associated with *Leishmania* infection. Household ITN access of 65.8% and usage by 65.1% of the study population suggests a need for strategies to improve both access to ITN and its usage. Factors associated with non-use of ITN were Lack of household access to ITN, having a family size of more than 10 members, having more than 10 rooms for sleeping, and having 2-4 or 8-10 screened windows. The occurrence of sand flies was confirmed and suggests a need for investigation of the sand fly species and their possible role in *Leishmania* transmission. Demonstration of good knowledge about CL by less than half of household heads calls for strategies to improve knowledge about CL.



DEDICATION

I dedicate this work to my wife Caroline and our children: Winifred, Raymond, and Caren Akuffo.

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LIST OF ABBREVIATIONS

ACL- Active cutaneous leishmaniasis

ANC - Antenatal clinic

CL - Cutaneous leishmaniasis

DALYs - Disability adjusted life years

DCL - Diffuse cutaneous leishmaniasis

DHS – Demographic and health survey

DNA - Deoxyribonucleic acid

GHS – Ghana Health Service

ITM - Insecticide treated materials

ITN - Insecticide treated bed net

LLIN - Long lasting insecticidal net

LCL - Localized cutaneous leishmaniasis

LST – Leishmanin skin test

MCL – Muco-cutaneous leishmaniasis

MST - Montenegro skin test

NAMRU-3 - U.S Naval medical research unit three

NMCP – National Malaria Control Program

NMIMR - Noguchi memorial institute for medical research

NTDs - Neglected tropical diseases

NW - New World

OW - Old World

PCR - Polymerase Chain Reaction

PKDL - Post-kala-azar dermal leishmaniasis

TDR - Special Programme for Research and Training in Tropical Diseases

VL - Visceral leishmaniasis

WHO – World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background

Leishmaniasis is a neglected vector borne disease caused by parasites of the genus *Leishmania* and is endemic in over 98 countries with 350 million people estimated to be at risk of contracting the disease globally (Alvar et al., 2012; Steverding, 2017).

Depending on the area of localization of the parasite in mammalian tissues, two broad categories of leishmaniasis exist: visceral and cutaneous, with cutaneous leishmaniasis (CL) being the most common. Globally, it is estimated that between 0.7 to 1.3 million new cases of CL are reported every year (Alvar et al., 2012; de Vries, Reedijk, & Schallig, 2015; Savoia, 2015; Steverding, 2017).

Although ulcers due to CL are often self-healing, they could take three to six months to heal and secondary bacterial infections cause pain and may leave permanent scarring after healing (de Vries et al., 2015; Masmoudi et al., 2013).

Leishmaniasis is geographically classified as New World or Old World depending on the distribution of the infecting *Leishmania* parasites. The New World species are usually found in Central and South America, whereas the Old World group is found in the Middle East, Asia, Africa, and the Mediterranean (Lysenko, 1971; Masmoudi et al., 2013; Mitropoulos et al., 2010).

Natural transmission of the *Leishmania* parasites to humans and other mammals occurs through the bite of various species of infected female phlebotomine sand flies belonging to the genus *Phlebotomus* in the Old World and the following genera in the New World: *Lutzomyia*, *Psychodopygus* and *Nyssomyia*. Majority of the *Leishmania* infections in humans are transmissible only from animals (zoonotic leishmaniasis) but some can be transmitted between humans (anthroponotic leishmaniasis) (de Vries et al., 2015; Maia & Depaquit, 2016; Maroli et al., 2013; Masmoudi et al., 2013; Ready, 2013).

Vector control with insecticides against the sand fly vectors of leishmaniasis is effective in reducing the incidence of the disease (Boakye, Wilson, & Kweku, 2005; González et al., 2015; Reyburn, Ashford, Mohsen, Hewitt, 2000; Wilson et al., 2014). In Ghana, the National Malaria Control Programme recognizes and promotes the use of insecticide treated materials (ITM) including long lasting insecticidal nets as one of the multiple preventive tools in the control of the malaria vectors in Ghana with the aim of 100% household ownership of at least one insecticide treated bed net (ITN) and 80% usage by the general population (GHS, 2015).

A localized outbreak of skin ulcers suspected to be cases of CL was first reported in Ghana from the Ho municipality of the Volta Region. in 1999 based on the identification of *Leishmania* amastigotes in some skin lesion biopsies obtained from the patients and examined using microscopy (Kweku et al., 2011).

In 2002, the DNA of *Leishmania major* was detected in a suspected CL patient from the Ho area of the Volta Region using polymerase chain reaction (PCR) (Fryauff et al., 2006).

A follow up study involving nine biopsies from five suspected CL cases in 2006 and one biopsy from another suspected CL case in 2007 from Taviefe, a community located about 10km north of

Ho, however did not confirm *L. major*. Instead, uncharacterized species of *Leishmania* were observed (Villinski et al., 2008).

An additional study in some other parts of the Ho municipality successfully cultured and obtained three isolates from individuals suspected with active cutaneous leishmaniasis. Using DNA sequencing and phylogenetic analysis, the isolates were confirmed to be part of the *Leishmania enriettii* complex, a new subgenus of *Leishmania* parasites (Kwakye-Nuako et al., 2015). Also, *L. tropica*, and *L. major* DNA have been identified in *Sergentomyia* sand flies sampled from the Ho municipality (Nzenu et al., 2014a). Identification of *L. major*, uncharacterized *Leishmania* species, and recently, members of the *Leishmania enriettii* complex from suspected CL cases in the Ho municipality suggests a complex epidemiology of CL in the region.

Also, study of awareness about CL as well as its related knowledge and experience among people living in areas with reports of the disease provides data to inform the implementation and or scale up of the use of insecticide treated bed net and possibly indoor-residual spraying to control CL.

1.2 Problem Statement

In the year 2018, researchers at the Noguchi Memorial Institute for Medical Research who have been involved in CL research in the Volta Region of Ghana, received reports from some disease control officers about cases of skin ulcers which were suggestive of CL in some communities of the Oti region which until 2019 was part of the Volta Region, and which had no previous documentation of *Leishmania* infection (Naiki Puplampu-Attrams personal communication).

Although the reservoir(s) and putative vector(s) of CL in the Oti and Volta Regions are yet to be confirmed, detection of suspected cases of the disease in the region coupled with limited data on the magnitude and distribution of *Leishmania* infection in Ghana, calls for control measures to protect the population at risk of *Leishmania* infection (Boakye et al., 2005; Kweku et al., 2011; Racznik et al., 2008).

Currently, there is no organized leishmaniasis disease control program in Ghana except during the suspected outbreak of CL in 1999 when chemotherapeutic treatment and mass spraying with insecticides were conducted in southern communities of the Volta Region which recorded suspected CL cases (Boakye et al., 2005; Landau, 2008).

Furthermore, no vaccine is currently approved for leishmaniasis and there is paucity of research evidence regarding potentially beneficial treatment options for Old World CL in particular. As a result, measures which prevent infection by the *Leishmania* parasites need to be prioritized as a disease control option (González et al., 2008; Olliaro et al., 2013).

1.3 Justification

Vector control using insecticides against sand fly vectors of CL has been proven as an effective way of reducing incidence of the disease (González et al., 2015; Wilson et al., 2014).

The insecticide treated bed net, particularly the long-lasting insecticidal net (LLIN) has been proven for malaria control and several countries including Ghana are currently promoting its use. As a result, it is cost effective to prioritize its promotion in areas where ITN use has the potential

of preventing other insect borne diseases (Adjei, 2012; Baume & Franca-koh, 2011; GHS, 2015; Wilson et al., 2014).

On account of CL specifically, systematic review suggests considerable benefits of the roll out of ITN in areas where the CL is co-endemic with malaria, such as Ghana (Wilson et al., 2014).

Implementing proven interventions such as the insecticide treated bed net in real world settings is often not without challenges due to varying contextual issues from one setting to another (Peabody, Taguiwalo, Robalino, 2006).

Hence the need to evaluate the use (when the evidence based intervention has already been introduced in a given setting) as well as context specific factors associated with the use/non-use of such proven interventions to inform the choice of implementation strategies needed to promote uptake and sustainability of the interventions (Proctor et al., 2013).

Investigating prevalence and distribution of *Leishmania* infections, presence of sand flies, indicators related to the use of ITNs, and CL related knowledge, experience and awareness in three communities of the Oti region of Ghana without previous documentation of *Leishmania* infection provides insight into the epidemiology of *Leishmania* infections, provides a basis for identifying contextual factors associated with the infections, and also provides a basis for assessing other contextual factors which may be associated with the use or non-use of the insecticide treated bed net (ITN) as a potential evidence based intervention for control of CL in the region.

1.4 Conceptual Framework of *Leishmania* Infection

Leishmania infection in a given area is influenced by several factors. The conceptual framework below (Figure 1) illustrates the key factors that are associated with the magnitude and distribution of *Leishmania* infection in a given area.

The factors could be at the individual behavioural level that includes occupation, daily activity, sleeping habit, use of a mosquito net, application of insecticide to the sleeping area and frequency of the insecticide use.

Household factors are also known to play important roles in the distribution of leishmaniasis. Some household factors include number of rooms, the number of rooms with screened windows, dwelling wall type, dwelling roof type, dwelling ceiling type, application of insecticide to household animals' sleeping area.

Furthermore, some community level factors are also known to be associated with leishmaniasis and these include the availability of alternative treatment options, cultural beliefs and perceptions about ITN use, perception of ITN generating heat, and the presence or absence of indoor residual spraying activities in a given endemic area.

Knowledge factors such as knowledge of symptoms and transmission of leishmaniasis in a given affected area are also associated with *Leishmania* infection and subsequently the manifestation of the infection such as CL.

Furthermore, leishmaniasis is a vector borne disease with other vertebrate reservoirs. Thus, vector and reservoir factors such as vector abundance, vector feeding habit and reservoir type and habitat significantly influence *Leishmania* infection in a given area. As a result, roll out of

any intervention for control of leishmaniasis needs to take into consideration the multiple factors which could be associated with it.

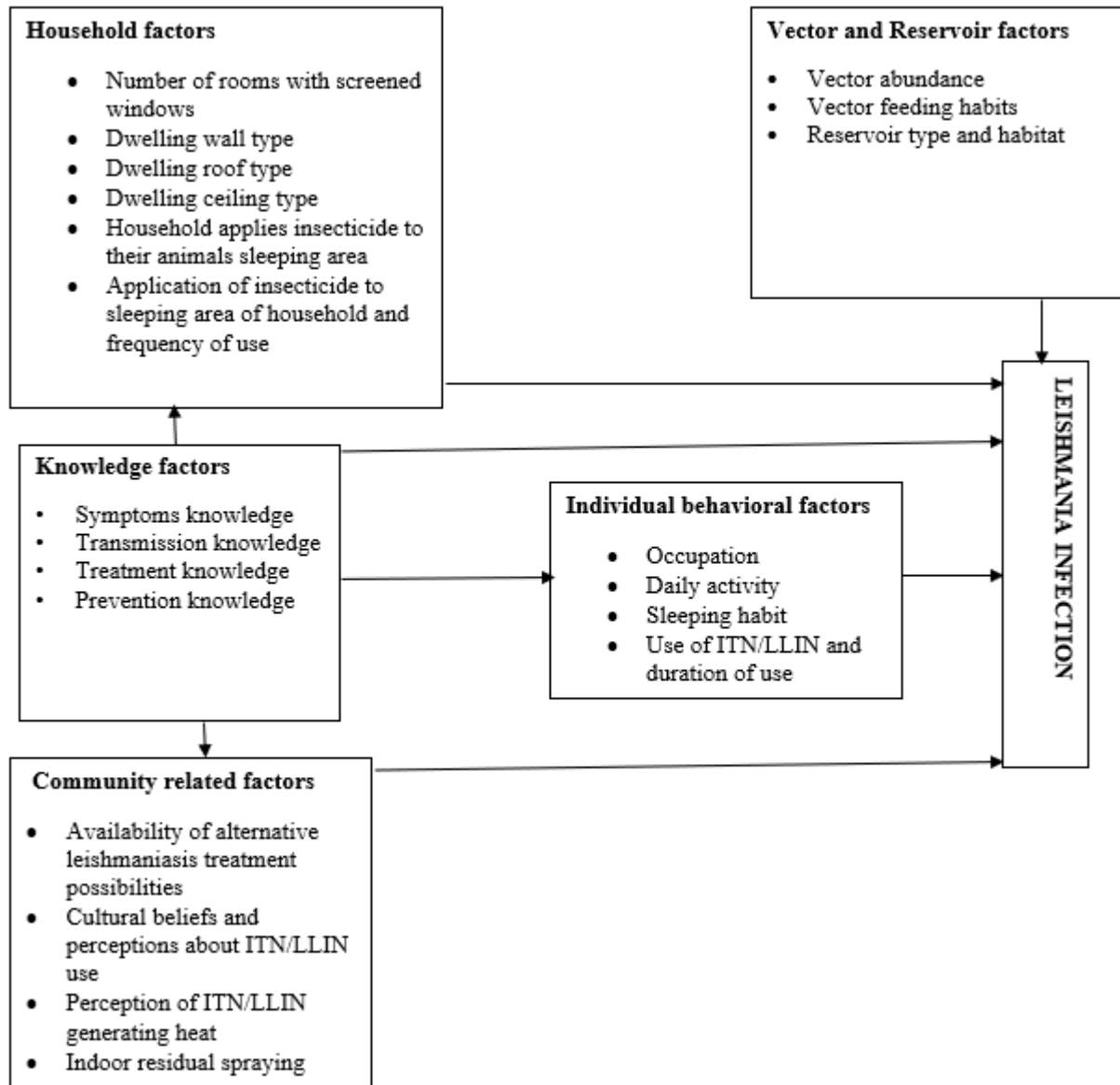


Figure 1: Conceptual framework of *Leishmania* infection

1.5 Research Questions

- i. What is the prevalence of *Leishmania* infection in three selected communities of the Oti region, Ghana?
- ii. Which household factors are associated with *Leishmania* infection in three communities of the Oti Region?
- iii. Is there a relationship between ITN usage and *Leishmania* infection in three communities of the Oti Region?
- iv. Are there sand flies in the three study communities of the Oti region?

1.6 Objectives

1.6.1 Main objective

To investigate the epidemiology of *Leishmania* infection and its relationship with ITN usage in three communities of the Oti Region, Ghana.

1.6.2 Specific objectives

- i. To determine the prevalence of *Leishmania* infection in study communities
- ii. To assess household factors associated with *Leishmania* infection
- iii. To determine the association between ITN usage and *Leishmania* infection
- iv. To investigate the occurrence of sand flies in the study communities

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of Leishmaniasis

Leishmaniasis is a neglected disease caused by a heterogenous group of parasites of the genus *Leishmania* and is generally considered to be a disease of the poor (Pace, 2014; Savoia, 2015).

Globally, it is present in 98 countries in Africa, America, Asia, and Europe with an 350 million people estimated to be at risk of infection and about 14 million people directly affected (Alvar et al., 2012; de Vries et al., 2015).

Ranked ninth in the burden of parasitic and infectious diseases globally, leishmaniasis ranks third after malaria and African trypanosomiasis, with the greater disease burden reported among children under 15 years (Stockdale & Newton, 2013).

Leishmaniasis is generally divided into Old World and New World forms and is often found in remote locations with a focal distribution. The Old World group is endemic in Africa, Asia, the Mediterranean region, and the Middle East, while the New World forms are found in areas from Texas through South America (Lysenko, 1971; Masmoudi et al., 2013; Mitropoulos et al., 2010).

Incidence data on leishmaniasis is reported by about a third of countries affected, with the lowest proportion of country reports coming from Africa (J Alvar et al., 2012; Desjeux, 1996). In

addition, available data suggests a geographical expansion of leishmaniasis to previously non-endemic areas, with the emergence of new species of the parasite being observed in places such as Ghana, and the USA (Faiman et al., 2013; Kwakye-Nuako et al., 2015; Müller et al., 2009; Reuss et al., 2012).

A review of intervention studies on various preventive methods against human leishmaniasis has revealed a paucity of data on human specific outcomes, and suggests a need for more studies highlighting human leishmaniasis infection as a primary outcome compared with surrogate markers (Picado et al., 2015; Stockdale & Newton, 2013).

2.2 Transmission of *Leishmania* Parasites

Transmission of the *Leishmania* parasite is either zoonotic (transmissible only from animals) or anthroponotic (spread between humans) (Masmoudi et al., 2013), with the primary hosts of human leishmaniasis being vertebrates. These include domestic cats, dogs, opossums, the crab-eating fox, the common black rat, goats, sheep, cattle, and equids among others (Bhattarai et al., 2010; Kenubih et al., 2015; Quinnell & Courtenay, 2009; Truppel, et al., 2014)

Leishmaniasis is transmitted mainly by infective bite of female sand flies belonging to the genus *Lutzomyia* and *Phlebotomus* in the New World and Old World respectively (Figure 2) (Goto & Lindoso, 2010a; Maroli et al., 2013).

There are five sand fly genera and over 700 species of sand flies globally. Of these, approximately 98 species belonging to the genera *Phlebotomus* and *Lutzomyia* have been implicated as putative vectors of human leishmaniasis (Desjeux, 1996; Maroli et al., 2013).

The sand flies are about a third of mosquitoes in size and measure about 2-3mm in length. They usually breed in organic matter and in rodent burrows (Sharma & Singh, 2008).

Sand fly categorization is often based on either their feeding or resting habit (Figure 2). Endophagic sand flies bite indoors whilst exophagic ones bite outdoors. Also, sand flies which rest indoors are classified as endophilic whilst those which rest outdoors are classified as exophilic (Desjeux, 2010).



Figure 2: Sand fly (*Phlebotomus papatasi*) feeding on human blood (Available at <https://www.google.com/search?q=sandfly+feeding+on+human+blood+papatasi&prmd=ivn&sxsrf..>)

The infective stage of the *Leishmania* parasite, the promastigote, is injected into the human host during blood meal of infected female sand flies. The injected promastigotes are then transformed into amastigotes after being phagocytized by macrophages. The amastigotes then multiply in the infected cells and also affect different tissues and cause the clinical manifestation of the disease depending on the *Leishmania* species involved (Mitropoulos et al., 2010). The life cycle of *Leishmania* parasite in sand fly and human is illustrated in Figure 3 below.

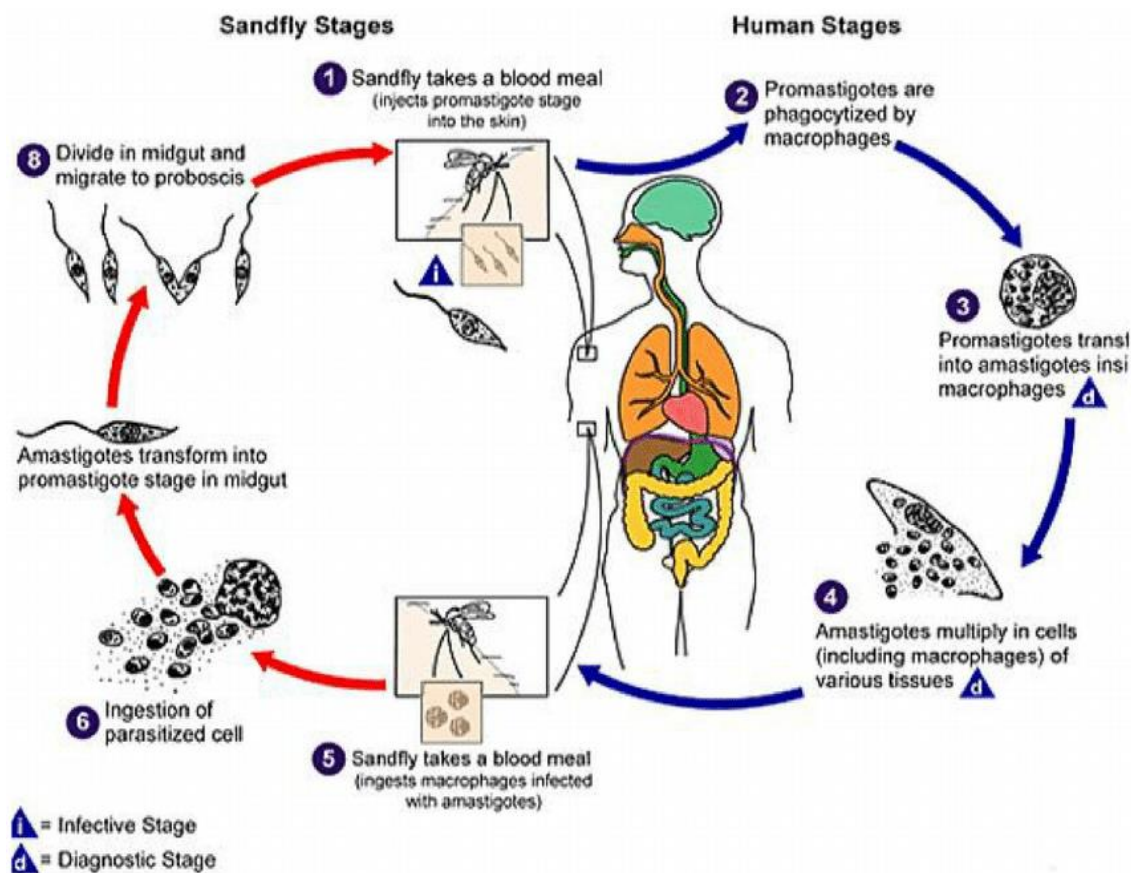


Figure 3: Illustration of life cycle of *Leishmania* parasite in sand fly and human (Available at <https://www.google.com/search?q=life+cycle+of+leishmania+species&tbm=isch&ved...>)

2.3 Types of Leishmaniasis

2.3.1 Overview of different types of leishmaniasis

Leishmaniasis occurs in three main forms; Visceral (Kala-azar), cutaneous, and muco-cutaneous (Savoia, 2015). Visceral leishmaniasis (VL) is systemic and involves internal organs such as the liver, spleen and bone marrow. Cutaneous leishmaniasis (CL) usually begins as painless nodules and is usually characterized by skin ulcers which may be single or multiple. Muco-cutaneous leishmaniasis (MCL) refers to the occurrence of cutaneous leishmaniasis with mucosal involvement (Bailey & Lockwood, 2007).

2.3.2 Cutaneous leishmaniasis

Globally, CL is the most prevalent clinical form of leishmaniasis with 0.7-1.3 million incident cases recorded annually (de Vries et al., 2015; Steverding, 2017).

Three forms of CL exist: diffuse cutaneous leishmaniasis (DCL), localized cutaneous leishmaniasis (LCL), and mucocutaneous leishmaniasis (MCL). LCL results in ulcers and other skin lesions which may result in scars. DCL on the other hand is less common and involves the whole body. It is characterized by the multiple nodules without ulceration. In MCL which so far has been restricted to Latin America, the disease affects the mucous membranes of the nose, throat, and mouth after the initial skin lesion has healed. As a result, the mucosal ulcers often cause wide spread disfiguring of the face because of the associated destructive effects on the lips, nasal septum, and palates (Steverding, 2017). An example of localized cutaneous leishmaniasis is illustrated in figure 4 below.



Figure 4: Examples of localised cutaneous leishmaniasis (LCL) (Picture by Richard Akuffo)

The Old World CL is mainly due to infections by *L. tropica* (anthroponotic cutaneous leishmaniasis), *L. major* (zoonotic cutaneous leishmaniasis), *L. aethiopica* and some zymodemes of *L. infantum*. (Masmoudi et al., 2013).

Although, sand flies of the genus *Sergentomyia* have not been confirmed as putative vectors of CL, some studies have suggested a need for investigations into their possible involvement in *Leishmania* transmission, given that *Leishmania* parasites have been observed in these sand flies in various parts of the world including Ghana (Berdjane-Brouk et al., 2012; Campino et al., 2013; Maia & Depaquit, 2016; Mutinga et al., 1994; Nzelu et al., 2014b; Parvizi & Amirkhani, 2008).

2.4 Cutaneous Leishmaniasis (CL) Research in Ghana

In 1999, a cluster of suspected cases of CL were reported in the Ho District of the Volta Region of Ghana (Kweku et al., 2011).

Of the specific communities affected by the 1999 CL outbreak, three namely Klefe in the Ho-Shia sub-District with a population of 3,450; Taviefe and Hlefi both in the Kpedze-Vane sub-District with populations of 5,097 and 826 respectively, had the highest suspected infection rates (Kweku et al., 2011).

Figure 5 below illustrates the 1999 suspected CL outbreak area in the Volta Region of Ghana.

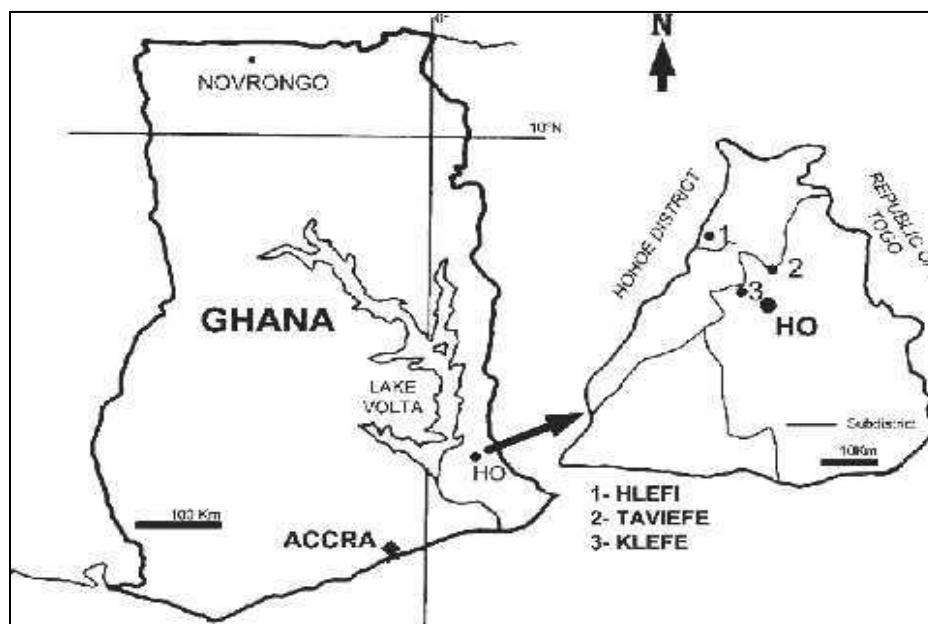


Figure 5: Illustration of the three communities which recorded the highest number of CL cases in the Ho municipality during the 1999 suspected CL outbreak (Kweku et al., 2011)

Sand fly vector surveillance conducted from 1997 to 2002 in Navrongo in the Upper East Region of Ghana identified 13 species of *Sergentomyia* and one *Phlebotomus* species (*P. duboscqui*). Additional sand fly surveillance in the Volta region from 2004-2005 (after the outbreak) yielded 17 species including *P. duboscqui* and *P. rodhaini*, with majority being *Sergentomyia* (Boakye et al., 2005).

A study in 2002 conducted by the Noguchi Memorial Institute for Medical Research (NMIMR) and the U.S Naval Medical Research Unit-3 (NAMRU-3), Cairo, Egypt, identified *Leishmania* amastigotes in 10 of 15 biopsies of chronic cutaneous ulcers from the Ho district. Additional needle biopsy collections from the same district in 2004-2005 were sequenced for the internal transcribed spacer region (ITS-1), confirming the presence of *L. major* in Ghana (Fryauff et al., 2006).

A field investigation conducted in January 2006 for leishmaniasis in Taviefe in the Ho municipality which included 9 biopsies from 5 suspected CL cases revealed an uncharacterized species of *Leishmania* using PCR and DNA sequencing analysis (Villinski et al., 2008). A recent study in the Ho municipality which identified new CL foci, detected *Leishmania* species (GH5) which was related to non-pathogenic *Leishmania enriettii* but different from other known species (Kwakye-Nuako, 2016; Kwakye-Nuako et al., 2015).

In an effort to identify CL reservoirs, a study conducted in 2006 in the 1999 outbreak area of the Ho municipality collected and tested tissue and sera from 33 small mammals and 44 livestock using real time PCR for the presence of *Leishmania* DNA. However all the samples tested negative to the *Leishmania* DNA (Raczniak, et al., 2008) .

Furthermore, blood meal analysis of sand flies (all *Sergentomyia* species) collected in 2008 from human dwellings in the 1999 CL outbreak areas in the Volta Region of Ghana, showed that some

of the sand flies had fed on multiple blood meal sources including chicken, human , and goat. (Kweku et al., 2011).

Although proximity of hen houses and chickens have been identified as possible environmental factors for transmission of leishmaniasis, other studies have also confirmed that several physiologic characteristics of chickens do not make them suitable for sustaining *Leishmania* infections (Alexander, et al., 2002).

In spite of the identified gaps in the CL knowledge in Ghana, the disease has been reported as an important emerging disease in the Volta Region of Ghana to the extent that it had acquired a local name, “agbamekanu” (Kweku et al., 2011).

The detection of *Leishmania. major* in humans and *Sergentomyia* sandflies in the Ho district of Ghana, as well as the identification of *L. tropica* in *Sergentomyia* sand flies in the same district (Fryauff et al., 2006; Nzelu et al., 2014), emphasize the public health importance of CL in the Volta region of Ghana.

Generally, in Ghana, like many other developing countries where leishmaniasis is a neglected tropical disease, there is no organized CL disease control effort except during suspected outbreaks when chemotherapeutic treatment and mass spraying with insecticides indoors is conducted (Boakye et al., 2005; Landau, 2008).

2.5 CL Clinical Manifestations

Not all *Leishmania* infections are clinically symptomatic. If symptomatic however, the extent of the manifestation varies depending on the infecting species, host genetic factors as well as the extent of immune activation. Typically, CL usually occurs on exposed parts of the body such as the neck, limbs and face, which may be easily accessible to sandflies (Pace, 2014).

The clinical manifestation of CL in the Old World usually starts as a painless papule which may progress into a nodule after several weeks. Sometimes, the nodule develops a central crust underneath resulting in an indurated ulcer. At other times, the lesions do not ulcerate and rather remain as a smooth nodule or the surface may become hyperkeratotic (ie. a high level of keratin on the surface of the lesion). The lesions which are usually oval or circular may become large but are rarely larger than 10cm in diameter. Generally, in the absence of secondary infections, the CL lesions do not often cause pain. Healing of the lesion usually self occurs over several months and may leave a scar in the skin pigmentation in the Old World. There are several patterns of clinical manifestation of CL in the New World which tend to be less likely to resolve without treatment (Bailey & Lockwood, 2007; Pace, 2014)

2.6 Diagnoses of Cutaneous Leishmaniasis

2.6.1 Microscopy, culture and histopathology

In view of the high specificity, parasitological methods are considered the gold standard for CL diagnosis. Direct identification of amastigotes in Giemsa-stained lesion smears of scrapings or biopsies are used for microscopical diagnosis of CL (de Vries et al., 2015).

On the other hand, CL diagnosis of suspected lesions using parasite culture in tubes containing Novy-MacNeal-Nicolle medium is difficult, time consuming, requires significant technical expertise, and is prone to contamination. In addition, the sensitivity of culture tends to be variable and low. Some recently developed culture technologies, namely mini and micro culture have been observed to present an advantage of being less costly, more sensitive, and relatively easier to use compared with the conventional culture method. An assessment of the performance of micro-culture for CL diagnoses produced sensitivity and specificity of 98.4 % (95 % CI = 96.1–99.1 %) and 100.0 %, respectively (Boggild et al., 2008; Pagheh et al., 2014).

2.6.2 Immunologic diagnostic methods

2.6.2.1 Serological diagnosis

Although serologic tests are not widely used for CL diagnoses because of their relatively low sensitivity due to the poor humoral response elicited by CL infection, some common serologic tests used include enzyme-linked immunosorbent assay, indirect immunofluorescence, lateral flow assay, indirect fluorescent antibody, western blot, and direct agglutination tests. (Goto & Lindoso, 2010a; Kar, 1995; Masmoudi et al., 2013; Zeyrek et al., 2007).

2.6.2.2 Leishmanin Skin Test or Montenegro Skin Test

The Montenegro skin test (MST) or Leishmanin intradermal skin test (LST) can be used for CL diagnosis especially in epidemiologic surveys because it is simple to use and it also has high sensitivity of 86.4 % up to 100 %. The LST or MST are able to detect CL infections within 2-6 weeks of infection. (Antonio et al., 2014; Manzur & Bari, 2016; Sadeghian et al., 2013).

Administration of the LST test consists of intradermal inoculation of 0.1 ml of the antigen (*leishmania*) into the anterior face of the forearm. The results of the test is read after 48 or 72

hours for delayed-type hypersensitive skin reactions, and induration(s) of size equal to or more than 5 mm is considered positive while those less than 5mm are considered negative. The composition of a given LST is based on the target species of CL, hence it is important to know the composition of a given LST prior to administration (da Costa et al., 1996; Manzur & Bari, 2016; Reis et al., 2008).

There are however some aspects of the LST which could become a disadvantage if not properly taken into consideration. Firstly, the LST requires culture facilities for the production of the LST antigen with a possibility that different antigen preparations may impact test sensitivity. It is therefore important that the LST source is verified prior to its use. Also, it is not possible to differentiate between past *Leishmania* infections from current infections when using the LST (Weigle et al., 1991).

2.6.3 Molecular methods for CL diagnosis

2.6.3.1 Polymerase chain reaction (PCR)

Several molecular diagnostic tests for leishmaniasis diagnosis are available, with the sequences within the kinetoplast DNA of *Leishmania* genus or ribosomal DNA internal transcribed spacer 1 sequence as the main targets (Monroy-Ostria et al., 2014; Reithinger & Dujardin, 2007).

In addition to serving diagnostic and prognostic purposes, PCR allows for identification of parasite species, and this often results in a better understanding of the epidemiology of CL (Masmoudi et al., 2013).

Furthermore, the use of PCR overcomes the requirement for previous isolation which tend to be a challenge in resource constrained settings. However, the molecular techniques tend to be sophisticated and expensive, requiring specialized skills (Foulet et al., 2007; Reithinger & Dujardin, 2007).

Furthermore, a need for a comparison of the different PCR methods for diagnosing leishmaniasis has been identified since there are currently no universally accepted protocols and each laboratory tends to develop and apply its own protocol (Israel Cruz et al., 2013; de Vries et al., 2015).

Table 1 below summarizes the sensitivity and specificity of key techniques for diagnosing cutaneous leishmaniasis.

Table 1: Cutaneous leishmaniasis diagnostic tests (Antonio et al., 2014; Masmoudi et al., 2013)

Technique	Sensitivity (%)	Specificity (%)
Smear	64-80	100
Culture	40-84	100
PCR	98.8 in CL; 47.4 to 83.3 in ML	100
Histopathology	68	-
Montenegro's reaction	86.4-100	100

2.7 Clinical Specimen Collection Methods for Diagnosing Cutaneous Leishmaniasis

Most of the commonly available techniques for clinical sample collection for cutaneous leishmaniasis diagnoses tend to be invasive and require technical expertise. Some of the invasive

methods include punch biopsies, obtaining aspirates of the ulcers, and the process of obtaining scrapings from the surface of the skin ulcers (Adams et al., 2015; Boggild et al., 2010).

Recently however, a non-invasive sampling technique based on the use of sequential tape strips have been identified for sampling and isolation of DNA from skin lesions of CL patients (Taslimi et al., 2017).

2.8 Treatment of Cutaneous Leishmaniasis

Several treatments options have been reported for CL, yet no single ideal therapy has so far been recognized (Bailey & Lockwood, 2007). Some of the treatment options reported include a combination of intra-lesional antimony and cryotherapy instead of antimony or cryotherapy alone (Asilian et al., 2004; Hodiamont et al., 2014).

Other studies have reported heat therapy as being effective in treating CL, requiring special equipment and skills (Aronson et al., 2010). Meanwhile, in many CL endemic communities in West Africa including Ghana, self-medication has been widely reported as the treatment option for many people with CL (Boakye et al., 2005; Landau, 2008).

A systematic review of CL treatment trials has revealed weaknesses in many trial methodologies including poor dosing and reporting of most of such trials, leading to a lack of consensus on the evidence regarding treatments for CL (Bailey & Lockwood, 2007; González et al., 2008).

Some efforts have been made to provide guidance for the design, implementation, analyses and reporting of clinical trials seeking to identify effective treatments for (Olliaro et al., 2013).

Until then, there is a need to emphasize the implementation of proven CL control measures to reduce the disease incidence and possibly eliminate it from endemic areas.

2.9 Control and Prevention of CL

Vector control and reservoir control are key approaches to preventing the transmission of leishmaniasis. While a recent systematic review indicated that the use of insecticides could reduce the number of sand fly vectors of CL and lead to reduction in incident cases (González et al., 2015), an earlier systematic review by Wilson et al., 2014, indicated benefits of insecticide treated bed net (ITN) roll out in particular on reducing the incidence of cutaneous leishmaniasis, especially in areas where CL is co-endemic with malaria; such as Ghana.

The findings of the systematic reviews stated above do not imply that the use of insecticides alone or insecticide treated materials such as the insecticide treated bed net in particular, would automatically lead to a reduction in the incidence of CL. The World Health Organization has recommended the adoption of the following integrated approach to accelerate efforts at overcoming the global impact of neglected tropical diseases including CL: vector and intermediate host control, preventive chemotherapy (where available), intensified case-detection and case management, provision of safe water, sanitation and hygiene, veterinary public health at the human–animal interface, and strengthening of capacity to control neglected tropical diseases (WHO, 2012).

A scoping review of some interventions applied at the community level for control of non-helminthic neglected tropical diseases (NTD) such as CL, trypanosomiasis, dengue, and buruli

ulcer among others, suggest insecticide spraying, insecticide treated bed nets and curtains; community education and cleanliness campaigns; chemoprophylaxis and treatment, as having the potential to reduce the incidence and burden of non-helminthic NTDs in particular (Das et al., 2014).

The above illustrates the need for an integrated approach for controlling NTDs such as CL by ensuring that the appropriate context specific strategies and interventions are applied and where possible, maximizing the benefits of proven interventions which have the potential of controlling multiple NTDs such as the use of insecticides and insecticide treated materials (González et al., 2015; Hailu, 2016; Menezes et al., 2015; WHO, 2013).

Furthermore, country wide and sometimes regional efforts may be required to ensure that gains in disease reduction in one area or region are not reversed by inaction from other regions. The strategic framework for leishmaniasis control in the WHO European region is one of such efforts (Ejov & Dagne, 2014).

2.10 Control of CL in the context of ITN for Malaria Control

Cutaneous leishmaniasis (CL) and malaria are important vector borne parasitic diseases (Alvar et al., 2012; Pinna et al., 2016; WHO, 2016c). Vector control approaches are among the effective ways of controlling vector borne diseases (Wilson et al., 2015).

Although various vector control approaches such as insecticide treated bed nets and indoor residual spraying have been proven for controlling the mosquito vectors of malaria, ITNs are considered as the mainstay of malaria prevention especially in sub-Saharan Africa (WHO Global Malaria Programme, 2014a).

The World Health Organization recommends the use of ITNs particularly the long lasting insecticidal nets which have also been shown to be cost effective (World Health Organization, 2017b).

Furthermore, vector control has been identified as a key component of many leishmaniasis control programs and is likely to remain so until an effective vaccine is available (Claborn, 2010; Faraj et al., 2016).

Hence it is important and cost effective to implement vector control measures that have the potential of targeting multiple vector borne diseases, especially in resource constrained settings.

The insecticide treated bed net (particularly those with pyrethroids such as permethrin and deltamethrin treated nets) has been shown to be efficacious against sand fly vectors of leishmaniasis (including cutaneous leishmaniasis) such as *Lutzomyia longipalpis*, *Phlebotomus duboscqi*, *Phlebotomus argentipes*, *Phlebotomus tobbi* among others, and subsequently in reducing the incidence of leishmaniasis (Bray & Hamilton, 2013; Gunay et al., 2014; Kayedi et al., 2017; Mondal et al., 2016; Rowland, et al., 2015; Tayeh, Jalouk, & Al-Khiami, 1997).

Since the insecticide treated bed net is known to be an effective intervention against the vectors of malaria, its use is even more encouraged in areas where CL is co-endemic with malaria, such as Ghana (Binka et al., 1996; Browne et al., 2001; Wilson et al., 2014).

However, it has been observed that there is a need for sustainable implementation of ITN-based control of CL since interruption of the ITN control measure may restore the pre-intervention disease incidence within 1-2 years (Jalouk et al., 2007).

Over the years, a lot of investment has been made into improving access to the insecticide treated net and more people now own and use the ITNs than a few decades ago, especially in Africa (Escamilla et al., 2017; Liu et al., 2015; Samadoulougou et al., 2017). This investment has led to significant gains such as the reduction in global malaria incidence and mortality by 21% and 29% respectively between 2010 and 2015 (World Health Organization, 2017b).

However, in many parts of the world especially in sub Saharan Africa, there is still low coverage of ITN in large populations at risk (Flaxman et al., 2010). In some areas which have achieved universal coverage of ITN (at least one ITN for every two people in 80% of households), recent data suggests gaps in usage among different age groups. For instance, some studies observed a higher usage among children under five (which is to be encouraged) than those between 6-14 years (which is not desirable) (Wanzira et al., 2016).

It is still important to prioritize vulnerable groups including children under 5 and pregnant women in ITN programs. However, there is also a need to promote and evaluate the communal benefits of wide-scale ITN use by older children and adults in order to achieve greater reductions of the malaria burden globally and in Africa in particular (Killeen et al., 2007).

In several countries including Ghana, insecticide treated bed net campaigns have been observed to be effective strategies for rapidly increasing insecticide treated bed net coverage (Bennett et al., 2012; Ghana Health Service, 2017; Ntuku et al., 2017; World Health Organization, 2009).

However, in both malaria and CL control, insecticide treated bed net campaigns alone may not be sufficient to sustain high net usage as several contextual factors may influence people's decision to use or not to use the insecticide treated bed nets or particular types of it (Atkinson et al., 2009; Jalouk et al., 2007; Larsen et al., 2010; Ngwibete & James, 2016).

As a result, several countries have attempted other strategies to complement the insecticide treated bed net campaigns to increase ownership and usage (Grabowsky et al., 2007; Kilian et al., 2015, 2016; May-boucher & Tenikue, 2015).

In Ghana for instance, a voucher scheme introduced in the Volta Region as a potential sustainable delivery system for increasing ITN coverage among pregnant women attending antenatal clinic (ANC) resulted in about 50% of such women receiving the nets (Kweku, Webster, Taylor, Burns, & Dedzo, 2007).

The World Health Organization has recommended effective behavior change communication strategies as a potential for increasing use and proper maintenance of the ITNs among people at risk, in addition to insecticide treated bed net distribution campaigns (World Health Organization, 2017b).

In addition, community engagement including the involvement of community based volunteers in assisting with bed net hang ups and door-to-door monitoring of bed net hang-up and use have

been recommended as effective strategies for improving insecticide treated bed net use (Desrochers et al., 2014; Kilian et al., 2015, 2016; World Health Organization, 2009).

Implementing ITN use programs are not as straight forward because context plays a major role. For instance, whether to use a community based point of distribution of bed nets or door to door distribution may not be a question with the same answer in all contexts although some studies have suggested that the community based point of distribution is more cost effective (Desrochers et al., 2014).

2.11 Factors Associated with *Leishmania* Infection

Several factors are associated with the emergence and spread of leishmaniasis in various parts of the world. These factors are broadly categorized as being associated with the host, reservoir, vector(s), and environment within which the disease is observed. Examples of environmental factors associated with leishmaniasis include deforestation, climate change, increase in travel to leishmaniasis endemic regions, and the presence of known reservoirs of leishmaniasis such as dogs. Additionally, poverty and its related factors such as poor housing have been associated with the spread of leishmaniasis (de Araujo, et al., 2016; Oryan & Akbari, 2016).

Household level characteristics such as livestock ownership, household main source of water supply, and household member's age have been shown to act as risk factors for cutaneous leishmaniasis in other studies. Because these factors are specific to particular areas, and what may be a risk factor in one community might not necessarily be a risk factor in another, it is important to know the context specific factors in order to conduct assessment of household level

variation in risk of CL for the purpose of designing preventive measures (de Araujo, et al., 2016; Reithinger et al., 2010).

Biological factors, socio-economic factors, peri-domestic factors, and human behavioral factors are also among the identified risk factors for CL (Oryan, 2014; Pedrosa & Ximenes, 2009; Yadon, et al., 2003). Living in houses which are close to vegetation, sleeping outside or on the floor, and living in houses with cracked mud walls can facilitate the survival of sand fly vectors of leishmaniasis by providing breeding sites which can lead to an increase in the vector abundance for *Leishmania* parasite transmission (Oryan et al., 2014; Reithinger et al., 2010). Living close to previous cases of leishmaniasis and lack of insecticide use are also associated with increased risk of *Leishmania* infection (Reithinger et al., 2010).

A study conducted in Tunisia identified family and personal history of CL, age of participants and whether a community was an old or emerging foci of leishmaniasis among factors associated with *Leishmania* infection (Bettaieb et al., 2014).

Regardless of the factors associated with leishmaniasis in a given setting, effective and sustainable control of the disease depends on the preventive behaviors of people affected. Evaluation of affected peoples preventive behavior and implementation of context specific strategies such as education using the BASNEF (Belief, Attitude, Subjective Norm, and Enabling factors) model has proven effective in improving leishmaniasis preventive behaviors (Hazavehei, et al., 2016; Saghafipour, et al, 2017)

There is therefore a need to evaluate potential risk factors for *Leishmania* infection in a given setting in order to design appropriate control strategies.

CHAPTER THREE

MATERIALS AND METHODS

3.1 The Study Sites

This study was conducted in three communities of the Oti region (part of Volta region at time of study initiation) of Ghana. The three communities were Ashiabre, Keri, and Sibi Hilltop. Ashiabre is in the Tutukpene sub-district of the Nkwanta south municipality while Keri is in the Keri sub-district of the municipality. Sibi Hilltop is in the Sibi sub-district of the Nkwanta North district of the Region (Figure 6).

3.1.1 Nkwanta South Municipality

The population of Nkwanta South municipality is estimated to be 117,878 with males constituting 49.6% of the population. Covering a land area of approximately 2733 km², the Nkwanta South municipality is located between latitudes 7° 30' and 8° 45' North and longitude 0° 10' and 0° 45' East (Ghana Statistical Service (GSS), 2014).

3.1.2 Nkwanta North District

The population of the Nkwanta North district was estimated to be 64,553 with males constituting 50.2% of the population. The district is located between Latitude 7°30'N and 8°45'N and Longitude 0°10'W and 045'E. It shares boundaries with Nkwanta South municipality to the south, Nanumba South to the north, Republic of Togo to the east, and Kpandai District to the west (Ghana Statistical Service, 2014a). Figure 6 below shows location of the study communities in Nkwanta South and North respectively.

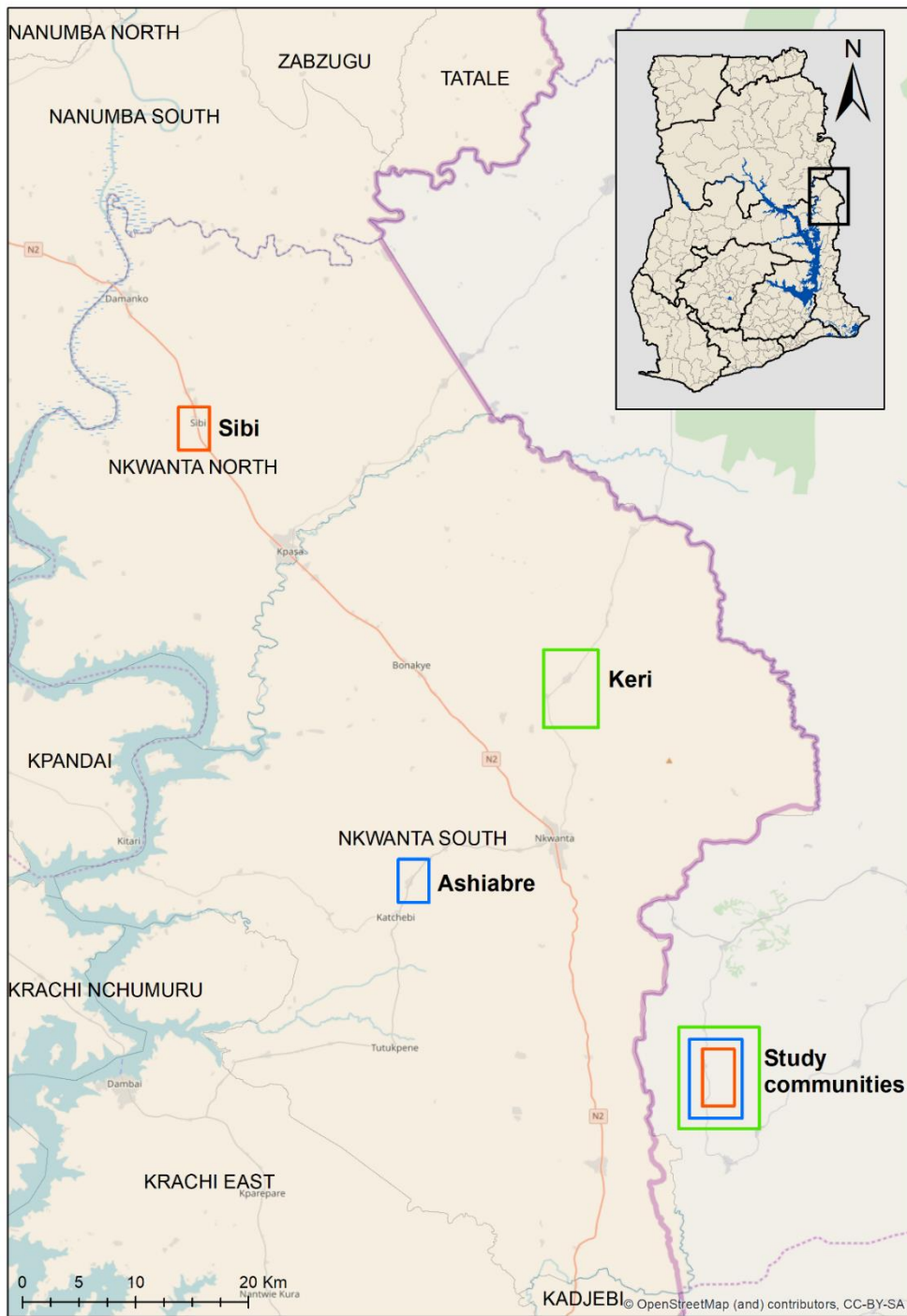


Figure 6: Map showing study communities

3.2 Study Design

A cross-sectional study was conducted in three communities of the Oti Region from October to December, 2018. A household survey was conducted. The survey assessed CL awareness, CL experience, CL related knowledge, and whether household heads considered CL to be a problem in their communities. It also assessed ITN ownership, access, and usage. Factors associated with non-use of the ITN were also investigated.

Prevalence of *Leishmania* infection as well as household factors associated with *Leishmania* infection among study participants were investigated. The occurrence of sand flies in the following locations of each study community was also investigated: households, school, church, and mosque. In addition, a sub-sample of study participants presenting with skin ulcers were also tested for treponemal infection.

3.2.1 Inclusion/exclusion criteria

1. Being resident in the study community for ≥ 12 months
2. Persons aged 2 to 65 years
3. No history of sensitivity to thiomerosal (a component of Leishmanin skin test (LST))
4. Willingness to provide written informed consent by adults or parents or guardians of children

Exclusion criteria:

Being severely ill and unable to provide answers to our questions.

3.2.2 Operational definitions

A household was defined as a person or a persons who live together in the same house and share the same house-maintenance arrangements. The head of a particular household is generally the person with economic and social responsibility for the household. As a result, household relationships were defined with reference the household head (Ghana Statistical Service, 2014b).

3.3 Sample size considerations

To evaluate ownership, access and use of insecticide treated bed nets, a sample size of 475 households was obtained using the following formula and assumptions

$$N = \frac{(Z)^2 P}{D^2} * (1 - P)$$

Where, N= sample size, $Z^2 = (1.96)^2$ for 95% confidence interval (that is $\alpha = 0.05$, P = proportion of household owning at least one ITN (75%) $D^2 =$ maximum tolerable error for the prevalence estimate (0.05), design effect of 1.5 and a non-response rate of 10% (Biadgilign et al., 2012; Campbell & Daniel, 1994; Fokam et al., 2017; Ghana Statistical Service, 2015).

To determine the minimum number of respondents required for questionnaire on cutaneous related (CL) related knowledge, attitude and practices, the following assumptions were considered: Approximately 50% of the study participants would have good knowledge, constructive attitude or good practice towards CL [confidence interval (CI) = 95%, degree of accuracy 5%]. As a result, a minimum sample size of 385 respondents is required (Kebede et al., 2016).

Assuming a 0.05 seropositivity of antibodies against *Leishmania spp.* in the study area, acceptable difference of 0.0175, an alpha error of 0.05, and a design effect of 1.5, a minimum sample of 834 persons was required for LST screening (Wackwella et al., 2013).

For active case detection, assuming a current CL prevalence of 22.1% (Kone et al., 2016; Kweku et al., 2011), $Z^2 = (1.96)^2$ for 95% confidence interval $D^2 = \text{maximum } 0.05$, a minimum sample size of 265 individuals is required for screening for active case detection using the formula

$$N = \frac{(Z)^2 P}{D^2} * (1 - P)$$

The representative sample for this study was based on the minimum household sample size required to evaluate ownership, access and use of insecticide treated bed nets (475) since that was large enough to accommodate all the other sample size considerations. As a result, household members including the heads of households of the selected minimum of 475 households were invited.

An average household size of 4.3 for the Volta Region of Ghana was reported by the 2010 Ghana housing and population census. For Nkwanta South municipal and Nkwanta North districts in particular, a mean household size of 5.1 and 6.4 respectively was determined (Ghana Statistical Service, 2014b). Hence assuming an average of 6.4 inhabitants per household, this study estimated to enroll about 475 heads of households and a total of about 3,040 (475 * 6.4) household participants into the study.

3.4 Sampling Procedure

A multistage sampling approach was used with study community and households as the primary and secondary sampling units respectively.

3.4.1 Study site selection

Using an active CL case search approach in the Oti region, 15 communities were visited out of which suspected cases of cutaneous leishmaniasis were observed in the following communities: Agoufie, Keri, Gekrong, Pawa, Kechiebi, Ashiabre, Sibi Hilltop, and Obunja. The name of each of these communities was then written on separate pieces of paper after which the papers were folded to conceal the community name. The folded pieces of paper were placed in a container and after shaking the container for about a minute, three papers were randomly selected as the study communities using simple random sampling without replacement. The three selected communities were Ashiabre, Keri and Sibi Hilltop.

3.4.2 Determination of minimum household number to select per community

To determine the minimum representative number of households to select from each study community, a proportionate population sampling technique was applied and summarized below in Table 2. The number of households per study community was obtained from the health information unit of the municipal/district health directorate in which the study community was located. The household list was compiled for the national insecticide treated bed net distribution which occurred in the Volta region six months prior to this study initiation.

Table 2: Minimum proportions of households in study communities to be sampled

Community	Household count	Household proportion	Sample calculation	Minimum Household
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				Sample
Ashiabre	945	945/2924	$(945/2924)*475$	154
Keri	795	795/2924	$(795/2924)*475$	130
Sibi Hilltop	1184	1184/2924	$(1184/2924)*475$	193
Total	2924			

3.4.3 Selection of households for study inclusion

Assuming equal probability of finding cases of *Leishmania* infection as well as answering all other study objectives, 200 households were selected from each study community for study inclusion using a systematic sampling approach described below.

Using the sorted list of households in each study community, a sampling interval I was determined, where $I=N/n$ with N being the sum of individual households in the study community (number of units forming the sample frame) and n was the households to be selected (200 for each study community). The I was rounded to 2 decimal places.

Using Microsoft excel, the RANDBETWEEN command was used to generate a random decimal integer R between 0 and 1 rounded up to two decimal points. The sequence of households that were selected in each study community were $R*I$, $R*I + I$, $R*I + 2*I$, $R*I + 3*I$, ..., $R*I + (n-1)*I$, each rounded up to the next highest whole number (Demographic and Health Surveys Methodology, 2012). With the assistance of community based volunteers, the selected households were identified after which invitation was extended to members of the households to participate in the study.

3.5 Pre-Study Field Procedures

3.5.1 Pre-Study training

Prior to field data collection, study team members were taken through a one-week training session comprising in-class training, break out discussion sessions, and field testing of the study questionnaires in the Nkwanta township. The training sessions covered all aspects of the study procedures such as informed consent process, questionnaire administration, and sample collection. The trainees were also taken through a simulation of all study procedures.



3.5.1

Figure 7: Some pre-study team training activities

- A. In class training; B. Break out discussion sessions; C. Evaluation of field practice; D. Discussion of field practice activities.

3.5.2 Community engagement

Prior to the commencement of study procedures, leadership (usually made up of a chief and his elders) of each study community were visited to inform them about the study and to seek information regarding the appropriate forms of community engagement as may apply in their respective communities.

The following approach for community engagement was used in all study communities:

1. The chief and his elders available at the time of initial visit were informed about the study and their permission was sought for active CL case search in the community. None of the leadership of the 15 communities visited declined to grant permission to conduct the active CL case search.
2. Members of visited communities were then informed through an existing community address system about the time and purpose of the visit.
3. At schools, churches, and market places within each visited community, active CL case search using pictures of previously confirmed CL cases from the Volta region was conducted and also a request was made to see people who may have similar skin lesions. (Figure 7 and 8).



Figure 8: Some suspected CL cases observed during active CL case search



Figure 9: Engagement of different segments of communities during active CL case search

4. After selecting the three study communities out of the 8 potential study communities observed, leadership of the 3 selected communities were informed about the decision to conduct the study in their communities and they agreed.
5. In each selected study community, a durbar was organized for the study team to interact with a larger number of the community members in order to explain the study objectives and also to answer any questions they may have. After this, announcement about the study was made to the entire community using the existing community address system (Figure 9).



Figure 10: A cross-section of community members at a durbar to explain the study

6. Throughout the interaction with both community leaders and members, information about the study was provided.
7. To confirm validity of the household list obtained from the health information unit of the district/municipal health directorate, opportunity was given over a three days period in each study community for any household(s) (represented by either the household head or any adult member of the household capable of mentioning the name of the household head) which was missed during the household enumeration for bed net distribution, to have their household added to the list of households obtained by going to a central location within the community for their household to be captured. No new households

were added in the study communities. Instead, community members went to the central location assigned to verify that their households were included in the list.

3.6 Study Stages

3.6.1 Study stage 1

3.6.1.1 Household and individual level questionnaire administration

Using interviewer administered questionnaire, household heads awareness about cutaneous leishmaniasis (CL) using pictures of CL as well as community specific names used to refer to CL, was assessed during this phase of the study. Cutaneous leishmaniasis related knowledge and experience were also investigated using the questionnaire.

Data on household ownership, access to and use of insecticide treated bed nets as well as other household factors which may be associated with *Leishmania* infection were obtained using the interviewer administered questionnaire, with household heads as the respondents. In each household, the household head was requested to provide a list of all members of the household, his/her relationship to each member of household, as well as information on each household member's educational level and other demographic characteristics (Figure 7).



Figure 11: A session of household interview

The household questionnaire also included questions on other household characteristics such as presence of electricity, main material of the household dwelling floor, main material of the roof, main material of the exterior wall of the household, number of rooms for sleeping, household number of windows, number of windows with screen/net, place for cooking, main cooking fuel, main source of drinking water and main type of toilet facility.

The household questionnaire also explored possessions of the households. Household ownership of effects such as radio, television, telephone, and refrigerator were determined. In addition, ownership of agricultural land and a means transportation such as bicycle, motorcycle and car were explored. Furthermore, information on specific characteristics of household heads such as religion, ethnicity, sex, and educational level was obtained using the household questionnaire.

Each enrolled study participant (including the household heads) responded to an additional individual questionnaire. For children below 18 years, their parents/guardians assisted them in the provision of response.

Information obtained from the individual level questionnaire included communities of residence in the five years preceding the study, history of skin lesions (ulcers), number of scars on skin, number of active skin ulcers as well as information on some practices and experiences during daily routine. Some of the practices and experiences explored included use of mosquito repellents, use of long sleeves, contact with dogs, contact with goats, contact with other domestic animals, among others.

3.6.2 Study stage 2

3.6.2.1 Sand fly sampling in study communities

In a random sample of enrolled households (approximately 10 households per study community), sand fly collections were conducted for three consecutive nights in the sleeping area(s) of each household using battery powered indoor aspiration method for collection of resting flies from 4am to 6am each collection night (Figure 8). On the compound of the selected households, sand fly collections were conducted for three consecutive nights using battery powered CDC light traps from 6pm to 6am each collection night (John W. Hock Company, Gainesville, FL).



Figure 12: Sand fly collection using indoor aspiration and CDC light trap respectively in households

Beyond the study households, sand flies were trapped outdoor using the CDC light trap at the following locations in each study community: a church compound, compound of a mosque, school compound from 6pm to 6am each collection night for three consecutive nights (Figure 12). Indoor aspiration was performed at the following locations within each study community: inside church building, inside mosque, and classrooms from 4am to 6am for each collection night for 3 consecutive nights. For each school selected, a classroom was selected from the nursery (KG), primary, and Junior high school departments respectively for indoor sand fly trapping using the aspiration method.



Figure 13: CDC light traps for sand fly collections at mosque, school and church compound

Sand flies collected were freeze-killed at -20° C and sorted out into labeled 1.5ml eppendorf tubes containing silica gel for dry preservation. The tubes were secured in sealed Ziploc bags and transported to the entomology Laboratory at Noguchi Memorial Institute for Medical Research (NMIMR), University of Ghana, Legon-Accra. The sand flies were subsequently separated into either male or female on the basis of morphology of their reproductive organ as was observed under a stereomicroscope (Olympus SZ60) at the Instituto de Salud Carlos III in Spain.

3.6.3 Study Stage 3

During this phase, study participants were screened for *Leishmania* infection using leishmanin skin test (LST). The participants were also checked for the presence of any active ulcers which were subsequently sampled for testing for the presence of *Leishmania* infection. Furthermore, the first five study participants presenting with active skin ulcers were screened for potential

treponemal infection which is characteristic of yaws cases, given a history of yaws cases in the region in which the study was conducted. Details of the tests conducted on the study participants are presented below.

3.6.3.1 Leishmanin skin test

All study participants were invited to participate in the Leishmanin skin test (LST) to establish prevalence of *Leishmania* infection. The leishmanin was obtained from the Pasteur Institute of Iran and was prepared with *Leishmania major*. For this study, the leishmanin used was lot number 128, manufactured in February 2016, and expected to expire in February 2021. Details of the LST procedure is provided below:

A 0.1 mL of LST suspension was injected intradermally into the volar aspect of each study participant's left forearm using new sterile tuberculin syringes. Between 48 and 72 hours post-LST placement, the delayed-type hypersensitivity (DTH) reaction was assessed by averaging the greatest diameter of induration and the diameter of induration perpendicular to it, measured in millimeters using calipers/rulers. A positive LST was defined as induration ≥ 5 mm (Figure 10).



Figure 14: Induration on skin 48-72 hours after LST placement and measurement

3.6.3.2 Sampling of suspected active cutaneous leishmaniasis (ACL) lesions (ulcers)

At the time of LST placement, each study participant was examined in order to identify any suspected active CL lesion(s) (ACL). The location, size, and duration of each suspected skin lesion was documented.

A suspected ACL lesion was defined clinically as any open ulcer with diameter bigger than 5mm. For each suspected active CL lesion, a non-invasive diagnostic sampling technique using sequential tape strips with a diameter of 22 mm (D-Squame, CuDerm Corporation, Texas, USA) was used to obtain samples for subsequent DNA isolation (Taslimi et al., 2017).

For the non-invasive skin sampling, one tape disc was placed on each suspected skin lesion after which even pressure was applied to disc on the lesion using a plunger which was gently held on the disc and pressed for approximately 20 seconds. The tape disc was then detached and transferred into a sterile 1.5ml Eppendorf vial and stored at 4°C for transportation to the laboratory for further analysis (Figure 11). Participants received standard wound care after sample collection.



Figure 15:Non-invasive sampling of skin lesions

3.6.3.3 DNA isolation from tape strip disc

DNA extraction was performed using SpeedTools Tissue DNA Extraction Kit (Biotools). A summary of the DNA extraction method is provided below:

a. Sample lysis

With tape disc in 1.5 ml centrifuge tube, 25 μ l of Proteinase K was pipetted (equilibrated to room temperature) into the tube. To each sample tube containing proteinase K, 200 μ l of lysis Buffer BB3 was added. The samples were then vortexed vigorously for 10-20 s after which they were incubated at 70°C for 10 -15 min.

b. Adjustment of DNA binding conditions:

210 μ l of molecular grade ethanol (96-100%) was added to the lysed samples and then vortexed again for 10-20 s.

c. DNA binding

The samples were placed in individual spin columns and then centrifuged for 1 min at 11,000 x g. The collection tubes containing the flow-through were discarded while the spin columns were placed into new Collection tube.

d. Washing of silica membrane:

Two washes were performed during this stage. First, 500 μ l of Buffer BBW was added to the samples after which it was centrifuged for 1 min at 11,000 x g. The flow-through was discarded while the spin columns were placed into new collection tubes.

Next, 600 μ l of Buffer BB5 was added to the samples. This was also centrifuged for 1 min at 11,000 x g. The flow-through containing the collection tubes were discarded at this stage.

e. Dry silica membrane

The spin columns were placed into new collection tubes and centrifuged for 1 min at 11,000 x g. Residual wash buffers was removed during this step.

f. Elute pure DNA

The spin columns were placed in new individually labelled 1.5 ml centrifuge tubes after which 100 µl of pre-warmed elution Buffer BBE (70°C) was added. The buffer was dispensed directly onto the silica membrane which was then incubated at room temperature for 1 min. This was then centrifuged for 1 min at 11,000 x g. The elute now contained pure DNA of the samples which was stored at -20°C until PCR amplification was performed.

3.6.3.4 PCR amplification of *Leishmania* species

A nested polymerase chain reaction (Ln-PCR) approach was used to amplify DNA of *Leishmania* species from the human skin lesions following an adaptation of the protocol by Cruz et al., 2002, with the target being the small subunit ribosomal ribonucleic acid (SSU rRNA) gene. Positive control used was *Leishmania infantum* (JPC strain) with distilled water as negative control.

The following primers below were used for the PCR:

R221 (R1): 5'- GGT TCC TTT CCT GAT TTA CG - 3'

R332 (R2): 5'- GGC CGG TAA AGG CCG AAT AG - 3'

R223 (R3): 5'- TCC CAT CGC AAC CTC GGT T - 3'

R333 (R4): 5'- AAA GCG GGC GCG GTG CTG - 3'

PCR MIX CONDITIONS:

A summary of the master mix used for the first PCR reaction is described below. The master mix together with the extracted DNA from the sample constituted a total of 50 µl reaction volume :

	Master mix	(µl)
H2O	(sterile and distilled)	30.6
Buffer	(Biotools Buffer 10X, 20mM MgCl ₂)	5.0
dNTPmix	(Biotools dNTP mix 10mM each)	1.0
R1	(15 pmol/ µl working solution)	1.0
R2	(15 pmol/ µl working solution)	1.0
Tth	(Biotools Tth DNA polymerase 1U/ µl)	1.4
DNA template		10.0

The following thermocycler program was applied:

30 cycles

94°C	94°C	60°C	72°C	72°C	4°C
5min	30sec	30sec	30sec	5min	infinite

Second Reaction

For the second PCR reaction, 25 µl of the first PCR product was diluted in 1ml of sterile distilled water after which 10 µl of the dilution was used as template for the second reaction. Below is a summary of the master mix for the second reaction making a total of 25 µl reaction volume.

	Master mix	(µl)
H2O	(sterile and distilled)	10.5
Buffer	(Biotools Buffer 10X, 20mM MgCl ₂)	2.5
dNTPmix	(Biotools dNTP mix 100mM each)	0.5

R1	(15 pmol/ μ l working solution)	0.5
R2	(15 pmol/ μ l working solution)	0.3
Tth	(Biotools Tth DNA polymerase 1U/ μ l)	0.7
DNA template		10.0

The following thermocycler program was applied for the second reaction:

30 cycles

94°C	94°C	65°C	72°C	72°C	4°C
5min	30sec	30sec	30sec	5min	infinite

This nested PCR assay described above amplifies all *Leishmania* species and is therefore useful as a first step in confirming the presence of *Leishmania* DNA to inform the next steps of species characterization which was not performed as part of this study (Figure 12).



Figure 16: DNA extraction from skin lesions sampled for PCR

Agarose gel electrophoresis

The products obtained from the PCR amplification were loaded onto 2% agarose gels containing 5 ng/ μ l of ethidium bromide and Tris-acetate (TAE) buffer which was then electrophoresed for 45 minutes at 75 – 100 V. The DNA bands obtained were subsequently viewed under ultraviolet trans-illuminator and photographed.

3.6.3.5 Malaria test

For each study participant screened using the LST, axillary body temperature was checked. Persons with temperature greater or equal to 38.0⁰C were tested for malaria using malaria rapid

test kit given that this study was conducted in an area considered to be malaria endemic and for which the ITN was targeted.

3.6.3.6 Screening for treponemal infection among persons with skin ulcers

The first five study participants presenting with skin ulcers in each study community were also screened for treponemal infection as potential cases of Yaws using a two stage screening process. Additional numbers of study participants presenting with skin ulcers were randomly selected and screened as potential cases of Yaws.

The first stage of the suspected Yaws case screening comprised a treponemal only test using a rapid test kit (Syphilis 3.0) manufactured by standard diagnostics, inc, and obtained from the Ghana national Yaws control program of the Ghana Health Service. The Syphilis 3.0 is a one step, rapid test for the detection of syphilis antibodies to *Treponema pallidum* (TP). The following procedure was followed for the treponemal only testing:

1. Alcohol swab was used to clean the area to be lanced (for this study, the middle finger of the left hand was selected) after which a sterile lancet finger prick was done.
2. Using a capillary tube, 20 µl blood sample was drawn.
3. The 20 µl of drawn blood was added into a round sample well after which 4 drops of assay diluent provided with the test kit was added into the sample well.
4. Test result was within 5-20 minutes after adding the assay diluent. The test was considered negative only if one line was observed at the part of the result window of the test kit labelled “C”. The result was considered positive if two lines were observed at the result window at the parts labeled “C” and “T”.

Participants with negative test result at the end of the first stage were not tested further. However, participants who test positive at the first stage were tested at the second stage using the Dual Path Platform (DPP) Syphilis Screen and Confirm assay manufactured by Chembio Diagnostic Systems, Inc, and obtained from the national Yaws control program of the Ghana Health Service.

The DPP Syphilis screen and confirm assay is a qualitative test for the detection of antibodies against both non-treponemal and *Treponema pallidum* antigens in venous whole blood, human finger stick whole blood, plasma, or serum specimens. The following procedure was used for the second stage of screening:

1. The thumb of the left hand of the person being tested was cleaned with alcohol swab after which a finger prick was done using a sterile lancet. The first blood drop was wiped off using a sterile gauze.
2. The second drop of blood was collected with a microsafety tube held in a horizontal position at the punctured site. Capillary action drew the blood sample to the black fill line on the tube.
3. The blood was then transferred to the center of the round Sample + Buffer well 1 of the test kit.
4. The running buffer bottle (red cap) was inverted and held vertically over the Sample + Buffer well 1 after which 2 drops of the running buffer were added into the center of the round Sample + Buffer well 1.
5. There was a waiting time of 5 minutes after the 2 drops of running buffer was added to center of the sample + buffer well 1. The blue and green colored lines at the rectangular window of the DPP test kit was expected to disappear by the end of the 5 minutes waiting

time. If the lines did not disappear after 5 minutes, the test device was discarded and the procedure was repeated.

6. Once the blue and green coloured lines at the rectangular window of the DPP test device disappeared, the running buffer bottle (red cap) was inverted and held vertically over buffer well 2. Five drops of the buffer was then added to Buffer well number 2.
7. The result was read 15 minutes after adding the buffer to well 2.
8. Test was interpreted as non-reactive if one pink/purple line was visible at the control (“C”) area with no line in the Test 1 or Test 2 areas.

The test was considered reactive treponemal and non-treponemal if 3 pink/purple lines, one in the Test 1 area, one in the control area, and one in the Test 2 area were observed.

The DPP test result was interpreted as reactive treponemal nonreactive non-treponemal if two pink/purple lines, one in Test 1 area and another in control area was observed. If two lines, one in Test 2 area, and another in the control area was observed, the test result was classified as reactive non treponemal and non-reactive treponemal. The test was considered invalid if no line was observed at control area regardless of any other lines that may be present after testing (Figure 13). This study paid for the cost of treating all DPP positive participants using azithromycin.



Figure 17: Sample of syphilis first line test and DPP test result

- A. Negative first line syphilis test result; B. Positive first line syphilis test result; C. DPP positive test result

3.7 Data Management and Analysis

Study data were captured using Microsoft Access software version 2013 and analyzed using STATA software version 14. Association between nominal variables in this study was assessed using Pearson's chi square test of association and Fishers exact test where cell counts below 5 were observed. Data analysis for this study was based on a 95% confidence level.

Using descriptive statistics, the following were determined:

- a) Proportion of households having at least one ITN;
- b) Proportion of households having at least one ITN for every two household members ;

- c) Proportion of individuals with access to an ITN within the households;
- d) Proportion of population reporting having slept last night under an ITN/ LLIN (by age, and sex).

A brief explanation of key ITN indicators analysed is summarized below:

Proportion of households with at least one ITN. This indicator was used to measure household ownership of an ITN. The numerator for this calculation was made up of all households having at least one ITN and the denominator was composed of the total of number of households.

Proportion of households having a minimum of one ITN for every two household members. This indicator was used to measure the proportion of households that had enough access to ITN (households having at least one ITN for every two household assuming that each ITN was used by two household members). To calculate this, the number of ITNs belonging to the household was divided by the number of individuals in the household. The numerator was made up of all households that had an ITN to people ratio of 0.5 or higher, while the denominator was the total number of households surveyed.

Proportion of individuals with access to ITN within the households. This indicator was used to estimate the proportion of study population that could use the existing ITNs, assuming that each ITN in a household was to be used by two people. The numerator was composed of all household members who had access to ITN in the study households, and the denominator was the de-facto population in the sample. Calculation of this indicator was done in two steps as outlined below.

First, an intermediate variable “potential ITN users” was calculated by multiplying the number of ITNs in each household by two. To adjust for households with more than one bed net for every two people, the potential ITN users were set equal to the members in that household if the potential users were more than the number of people in the household.

Next, the indicator for individual access was calculated by dividing the potential ITN users by the number of individuals in each household.

Proportion of households with at least one ITN for every two people among households owning any LLIN. This indicator measures the proportion of households owning at least one ITN which had at least one ITN for every two people.

Proportion of individuals who slept under ITNs the previous night. This indicator measured the level of ITN use among all individuals at the time of the survey. The numerator was made up of all individuals who slept under an ITN the night prior to the survey, while the denominator was the total surveyed population.

Ratio of ITN use to ITN access. This indicator compared the indicator of individual ITN use to ITN access. This ratio is helpful in inferring whether the difference between ITN use and access could be explained as due to behavioral factors (Al-Eryani et al., 2017; Seyoum et al., 2017)

For the ITN indicators analyzed, 95% confidence intervals (two sided) were estimated per study community and cumulatively. Binary (simple and multiple) logistic regression was used to estimate factors associated with failure to use the ITN.

Factors evaluated in the simple binary logistic regression for association with failure to use ITN included community of residence, participants’ age sex, educational level, sex of household head, age of household head, household size, main material in household roof, household

number of rooms used for sleeping, number of windows in household, number of screened windows in household, whether household head heard any malaria message in the past 6 months, household access to ITN, being at open field at dawn or sunset, sleeping near forest or farm fields, sleeping in rooms or places with open windows without screen, having mosquito bites, having bites from other insects, having contact with dogs, having contact with goats, having contact with other domestic animals, spraying bedroom with insecticide in the last six months, use of long sleeves, use of mosquito repellents, and sleeping in bed nets.

Factors with p value less than 0.05 in the bivariate analysis were included in the multiple logistic regression analysis. Odd ratios for all variables included in the multiple logistic regression analysis with outcome being failure to use ITN the night before the survey, were adjusted for all covariates included in the model as well as for clustering at the household level using the `vce (cluster clustvar)` command in Stata statistical software version 14.

In addition, prevalence of LST positivity and cutaneous leishmaniasis was described. Furthermore, logistic regression model (simple and multiple) was used to evaluate association between various factors and *Leishmania* infection as observed using the LST, in the study communities.

The factors compared with LST positivity included community of residence, age of study participant, sex of participant, number of scars, number of skin ulcers, family history of CL, use of bed nets, being at open field at dawn or sunset, sleeping near forest or farm fields, and sleeping in rooms or places with open windows without screen. Additional factors included were frequency of mosquito bites, having bites from other insects, having contact with dogs, having contact with goats, having contact with other domestic animals, spraying bedroom with insecticide in the last

six months, use of long sleeves, use of mosquito repellents, and household ownership of livestock.

Factors with p value less than 0.05 in bivariate analysis were included in the multiple logistic regression analysis. Odd ratios for all variables included in the multiple logistic regression analysis were adjusted for all covariates included in the model as well as for clustering at the household level using the vce (cluster clustvar) command in Stata statistical software version 14.

3.8 Ethical Considerations

Ethical approval to conduct this study was obtained from the ethics review committee of the Ghana Health Service (GHS-ERC006/08/18). Permission was also obtained from community leaders and household heads prior to the commencement of the study. Written informed consent was obtained from each study participant.

CHAPTER FOUR

RESULTS

4.1 Socio-Demographic Information

A total of 587 households comprising 189 (32.2%), 200 (34.1%), and 198 (33.7%) from Ashiabre, Keri and Sibi Hill Top respectively, were included in this study. The study households had a total of 3718 members out of which 3,440 (92.5%) consisting of 1,194, 941, 1305 from Ashiabre, Keri, and Sibi Hilltop respectively were enrolled in the study (Table 3).

The average household size was 6.3 with a range of 1 to 18 household members. Ashiabre and Sibi Hilltop had an average household size of 7 while Keri had an average household size of 5 (Table 3).

In Ashiabre, 35.4% of the household members were in households with 7-9 individuals. This was closely followed by 33.4% and 29.3% of households with 4-6 persons, and ten or more persons respectively. In Keri, the majority (58.0%) lived in households with 4-6 persons while in Sibi Hilltop, the majority (40.6%) lived in households with 7-9 members (Table 3).

Regarding educational level of household members, 51.5% at Ashiabre had no formal education which was similar for Keri (54.7%) and Sibi Hilltop (51.5%) (Table 3).

The overall proportion of the household members with tertiary level education in the study area was 0.5% and this observation with Ashiabre, Keri, and Sibi Hilltop recording 0.6%, 0.7%, and 0.1% respectively (Table 3).

The majority of all the household members (61.5%) were children of the household heads. Other household members included sons-in-law/daughters-in-law, grandchildren, parents, parents-in-

law, brothers/sisters, brothers-in-law/sisters-in-law, uncles/aunt, nieces/nephews, other relatives,

Household	Categories	Study Communities
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and adopted/foster/stepchildren (Table 3).

The detailed summary of household population is presented in Table 5. Of the 3718 household members, 1894 (50.9%) made up of 673 (50.9%), 502 (50.0%), and 719 (51.6%) of the participants at Ashiabre, Keri and Sibi Hilltop were males. Four hundred and ninety-eight (13.4%) of them were children under 5 years, and 2394 (64.4%) were less than 20 years old.

Table 3: Household composition by the number of usual household members, educational level, and relationship to head of household

		Ashiabre n (%)	Keri n (%)	Sibi Hill Top n (%)	Total n (%)
Number of household members	1-3 persons	26(2.0)	113 (11.3)	33 (2.4)	172 (4.6)
	4-6 persons	441 (33.4)	582 (58.0)	402 (28.9)	1425 (38.3)
	7-9 persons	467 (35.4)	240 (23.9)	565 (40.6)	1272 (34.2)
	>=10 persons	387 (29.3)	69 (6.9)	393 (28.2)	849 (22.8)
	Subtotal	1321 (100)	1004(100)	1393 (100)	3718 (100)
	Mean size of households	7.0	5.0	7.0	6.3
	Minimum household size	2	1	2	1
	Maximum household size	18	13	16	18
Educational Level	No Formal Education	648 (49.1)	549 (54.7)	718 (51.5)	1915 (51.5)
	Preschool	159 (12)	75 (7.5)	139 (10)	373 (10)
	Primary	370 (28)	285 (28.4)	425 (30.5)	1080 (29)
	Junior High School	101 (7.6)	64 (6.4)	87 (6.2)	252 (6.8)
	Senior High School	35 (2.6)	24 (2.4)	22 (1.6)	81 (2.2)
	Tertiary	8 (0.6)	7 (0.7)	2 (0.1)	17 (0.5)
Relationship to head of household	Head of household	189 (14.3)	200 (19.9)	198 (14.2)	587 (15.8)
	Wife/Husband	189 (14.3)	160 (15.9)	210 (15.1)	559 (15.0)
	Son/Daughter	844 (63.9)	555 (55.3)	886 (63.6)	2285 (61.5)
	Son-in-law/Daughter-in-law	10 (0.8)	10 (1.0)	19 (1.4)	39 (1.0)
	Grandchild	28 (2.1)	36 (3.6)	26 (1.9)	90 (2.4)
	Parent	9 (0.7)	3 (0.3)	15 (1.1)	27 (0.7)
	Parent-in-law	3 (0.2)	3 (0.3)	8 (0.6)	14 (0.4)
	Brother/Sister	20 (1.5)	11 (1.1)	17 (1.2)	48 (1.3)
	Brother-in-law/sister-in-law	3 (0.2)	2 (0.2)	2 (0.1)	7 (0.2)
	Uncle/Aunt	4 (0.3)	11 (1.1)	2 (0.1)	17 (0.5)
	Niece/ Nephew	14 (1.1)	4 (0.4)	3 (0.2)	21 (0.6)
	Other relative	7 (0.5)	5 (0.5)	2 (0.1)	14 (0.4)
	Adopted /Foster/ stepchild	1 (0.1)	4 (0.4)	5 (0.4)	10 (0.3)
Total		1321 (100)	1004 (100)	1,393.00	3718 (100)

Table 4: Summary of household population distribution by sex, age, and community of residence

Age (years)	Ashiabre			Keri			Sibi Hill Top			Total		
	Male n (%)	Female n (%)	Total n (%)	Male n (%)	Female n (%)	Total n (%)	Male n (%)	Female n (%)	Total n (%)	Male n (%)	Female n (%)	Total n (%)
<5	99 (14.7)	90 (13.9)	189(14.3)	62 (12.4)	62 (12.4)	124(12.4)	82 (11.4)	103(15.3)	185(13.3)	243(12.8)	255 (14)	498(13.4)
5-9	136(20.2)	106(16.4)	242(18.3)	121(24.1)	102(20.3)	223(22.2)	171(23.8)	125(18.5)	296(21.2)	428(22.6)	333(18.3)	761(20.5)
10-14	137(20.4)	138(21.3)	275(20.8)	102(20.3)	84 (16.7)	186(18.5)	181(25.2)	136(20.2)	317(22.8)	420(22.2)	358(19.6)	778(20.9)
15-19	90 (13.4)	60 (9.3)	150(11.4)	35 (7)	40 (8)	75 (7.5)	78 (10.8)	54 (8)	132 (9.5)	203(10.7)	154 (8.4)	357 (9.6)
20-24	28 (4.2)	32 (4.9)	60 (4.5)	14 (2.8)	28 (5.6)	42 (4.2)	25 (3.5)	23 (3.4)	48 (3.4)	67 (3.5)	83 (4.6)	150 (4)
25-29	16 (2.4)	36 (5.6)	52 (3.9)	24 (4.8)	27 (5.4)	51 (5.1)	21 (2.9)	42 (6.2)	63 (4.5)	61 (3.2)	105 (5.8)	166 (4.5)
30-34	20 (3)	42 (6.5)	62 (4.7)	20 (4)	42 (8.4)	62 (6.2)	34 (4.7)	62 (9.2)	96 (6.9)	74 (3.9)	146 (8)	220 (5.9)
35-39	39 (5.8)	46 (7.1)	85 (6.4)	31 (6.2)	34 (6.8)	65 (6.5)	28 (3.9)	44 (6.5)	72 (5.2)	98 (5.2)	124 (6.8)	222 (6)
40-44	20 (3)	42 (6.5)	62 (4.7)	27 (5.4)	37 (7.4)	64 (6.4)	33 (4.6)	43 (6.4)	76 (5.5)	80 (4.2)	122 (6.7)	202 (5.4)
45-49	32 (4.8)	26 (4)	58 (4.4)	30 (6)	24 (4.8)	54 (5.4)	22 (3.1)	23 (3.4)	45 (3.2)	84 (4.4)	73 (40)	157 (4.2)
50-54	19 (2.8)	8 (1.2)	27 (2)	22 (4.4)	9 (1.8)	31 (3.1)	19 (2.6)	7 (1)	26 (1.9)	60 (3.2)	24 (1.3)	84 (2.3)
55-59	5 (0.7)	4 (0.6)	9 (0.7)	3 (0.6)	5 (1)	8 (0.8)	6 (0.8)	8 (1.2)	14 (1)	14 (0.7)	17 (0.9)	31 (0.8)
60-64	8 (1.2)	8 (1.2)	16 (1.2)	3 (0.6)	4 (0.8)	7 (0.7)	9 (1.3)	2 (0.3)	11 (0.8)	20 (1.1)	14 (0.8)	34 (0.9)
65-69	7 (1)	0 (0)	7 (0.5)	1 (0.2)	0 (0)	1 (0.1)	2 (0.3)	1 (0.1)	3 (0.2)	10 (0.5)	1 (0.1)	11 (0.3)
70-74	5 (0.7)	2 (0.3)	7 (0.5)	4 (0.8)	1 (0.2)	5 (0.5)	2 (0.3)	0 (0)	2 (0.1)	11 (0.6)	3 (0.2)	14 (0.4)
75-79	2 (0.3)	0 (0)	2 (0.2)	2 (0.4)	1 (0.2)	3 (0.3)	4 (0.6)	0 (0)	4 (0.3)	8 (0.4)	1 (0.1)	9 (0.2)
>80	10 (1.5)	8 (1.2)	18 (1.4)	1 (0.2)	2 (0.4)	3 (0.3)	2 (0.3)	1 (0.1)	3 (0.2)	13 (0.7)	11 (0.6)	24 (0.6)
Total	673 (100)	648 (100)	1321(100)	502 (100)	502 (100)	1004 (100)	719 (100)	674 (100)	1393 (100)	1894(100)	1824(100)	3718(100)

4.1.1 Household characteristics

A total of 536 (91.3%) out of the 587 households had electricity within their households with 178 (94.2%), 185 (92.5%), and 173 (87.4%) households having electricity in Ashiabre, Keri and Sibi Hilltop respectively (Table 6).

The main material of the household dwelling floor observed in 425 (72.4%) of the households was cement, followed by earth/sand 96 (16.4%) and carpet 55 (9.4%) (12). In the study communities, 81.0%, 69.5%, and 67.2% of household dwellings in Ashiabre, Keri, and Sibi Hilltop recorded cement as the main material of the dwelling floor (Table 5).

Majority (90.8%) of the household dwelling across the study communities had metallic roofing while the main material of the exterior wall of the household dwellings of all study communities were cement blocks for 136 (23.2%) households, mud with cement covering for 162 (27.6%) households, stone with mud covering for 149 (25.4%) households, and bamboo with mud covering for 140 (23.9%) households.

In Ashiabre, 34.9% of the household dwellings had exterior wall made of stone with mud covering while 36.0% of household dwellings in Keri had exterior walls made of bamboo with mud covering. In Sibi Hilltop, 27.6% of the household dwellings had exterior wall made of mud with cement covering (Table 5).

The majority of the households (71%) in the study communities used 2-5 rooms for sleeping which ranged from 1 to 18 in Ashiabre and Keri but was 1 to 12 in Sibi Hilltop (Table 5). The number of household windows ranged from 0 to 15 with Ashiabre having a range of 0 to 13 household windows, while Keri had a range of 1 to 15 household widows, and Sibi Hilltop

recorded a range of 0 to 12 household windows. Overall, majority (59.1%) of household dwellings had 2 to 4 windows. This observation was consistent across the study communities as 53.4%, 57.0%, and 66.7% of household dwellings in Ashiabre, Keri, and Sibi Hilltop respectively also recorded 2 to 4 windows (Table 7). The majority of households (71%) had windows with no screen/nets.

The majority of the households (58%) cooked outdoors and the remaining 42% used a separate room as kitchen distributed as follows: Keri and Sibi Hilltop 65.0% and 62.1% cooked outdoors and 55.0% used a separate room as kitchen at Ashiabre.

Wood was the main source of fuel used for cooking in most (91.5%) of the study households with Ashiabre, Keri, and Sibi Hilltop recording 97.9%, 85.0%, and 91.9% respectively (Table 6).

Regarding main source of drinking water and toilet facility, 51% of the households used surface water and 84% lacked toilet facility and so used the bush/field (Table 7).

The use of surface water as main source of drinking water was particularly high among households in Ashiabre (61.9%) and Sibi Hilltop (79.3%). In Keri however, majority (64.5%) of the study households used public tap/standpipe as their main source of drinking water (Table 7).

Table 5: Characteristics of study households (A)

Housing Characteristics	Categories	Study Communities			
		Ashiabre n (%)	Keri n (%)	Sibi Hill Top n (%)	Total n (%)
Electricity	Have Electricity	178 (94.2)	185 (92.5)	173 (87.4)	536 (91.3)
	No Electricity	11 (5.8)	15 (7.5)	25 (12.6)	51 (8.7)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Main dwelling floor material	Earth / Sand	12 (6.3)	44 (22.0)	40 (20.2)	96 (16.4)
	Dung	1 (0.5)	2 (1.0)	3 (1.5)	6 (1.0)
	Wood planks	0 (0)	1 (0.5)	1 (0.5)	2 (0.3)
	Ceramic tiles	1 (0.5)	0 (0)	2 (1.0)	3 (0.5)
	Cement	153 (81.0)	139 (69.5)	133 (67.2)	425 (72.4)
	Carpet	22 (11.6)	14 (7)	19 (9.6)	55 (9.4)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Main roof material	Thatch / Palm leaf	11 (5.8)	18 (9.0)	25 (12.6)	54 (9.2)
	Metal	178 (94.2)	182 (91.0)	173 (87.4)	533 (90.8)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Main material of exterior wall	Bamboo with mud	26 (13.8)	72 (36.0)	42 (21.2)	140 (23.9)
	Stone with mud	52 (27.5)	33 (16.5)	64 (32.3)	149 (25.4)
	Mud with cement	66 (34.9)	42 (21.0)	54 (27.3)	162 (27.6)
	Cement blocks	45 (23.8)	53 (26.5)	38 (19.2)	136 (23.2)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Rooms used for sleeping	1	20 (10.6)	25 (12.5)	16 (8.10)	61 (10.4)
	2 to 5	126 (66.7)	137 (68.5)	151 (76.3)	414 (70.5)
	6 to 10	36 (19.1)	33 (16.5)	27 (13.6)	96 (16.4)
	> 10	7 (3.7)	5 (2.5)	4 (2.0)	16 (2.7)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)

Table 6: Characteristics of study households (B)

Housing Characteristics	Categories	Study Communities			
		Ashiabre n (%)	Keri n (%)	Sibi Hill Top n (%)	Total n (%)
Household number of windows	No windows	3 (1.6)	0 (0)	1 (0.5)	4 (0.7)
	1 window	17 (9.0)	27 (13.5)	15 (7.6)	59 (10.1)
	2 to 4 windows	101 (53.4)	114 (57.0)	132 (66.7)	347 (59.1)
	5 to 7 windows	46 (24.3)	44 (22.0)	36 (18.2)	126 (21.5)
	8 to 10 windows	16 (8.5)	11 (5.5)	11 (5.6)	38 (6.5)
	> 10 windows	6 (3.2)	4 (2.0)	3 (1.5)	13 (2.2)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Windows with screen/net	No screened windows	118 (62.4)	140 (70.0)	158 (79.8)	416 (70.9)
	1 screened window	17 (9.0)	13 (6.5)	9 (4.5)	39 (6.6)
	2 to 4 screened windows	37 (19.6)	32 (16.0)	23 (11.6)	92 (15.7)
	5 to 7 screened windows	10 (5.3)	11 (5.5)	5 (2.5)	26 (4.4)
	8 to 10 screened windows	6 (3.2)	4 (2)	3 (1.5)	13 (2.2)
	> 10 screened windows	1 (0.5)	0 (0)	0 (0)	1 (0.2)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Place for cooking	In a separate room used an kitchen	104 (55.0)	70 (35.0)	75 (37.9)	249 (42.4)
	Outdoors	85 (45.0)	130 (65.0)	123 (62.1)	338 (57.6)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Main cooking fuel	Kerosene	0 (0)	18 (9.0)	5 (2.5)	23 (3.9)
	Charcoal	4 (2.1)	12 (6.0)	11 (5.6)	27 (4.6)
	Wood	185 (97.9)	170 (85.0)	182 (91.9)	537 (91.5)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)

Table 7: Household main source of drinking water and toilet facility

Characteristics	Categories	Study Communities			Total n (%)
		Ashiabre n (%)	Keri n (%)	Sibi Hill Top n (%)	
Main Source of Drinking water					
	Improved source				
	Public tap / standpipe	50 (26.5)	129 (64.5)	18 (9.1)	197 (33.6)
	Tube Well, Borehole	14(7.4)	43 (21.5)	2 (1)	59 (10.1)
	Protected well	2 (1.1)	1 (0.5)	16 (8.1)	19 (3.2)
	Non-improved source				
	Unprotected well	6 (3.2)	0 (0)	5 (2.5)	11 (1.9)
	Surface water	117 (61.9)	27 (13.5)	157 (79.3)	301 (51.3)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Main toilet facility					
	Improved facility				
	Ventilated Improved Pit latrine (VIP)	13 (6.9)	5 (2.5)	5 (2.5)	23 (3.9)
	Pit latrine with slab	24 (12.7)	19 (9.5)	4 (2)	47 (8)
	Non-improved facility				
	Pit latrine without slab / Open pit	12 (6.3)	9 (4.5)	4 (2)	25 (4.3)
	No facility, bush, field	140 (74.1)	167 (83.5)	185 (93.4)	492 (83.8)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)

4.1.2 Household possessions and household head characteristics

Table 8 below shows that radios (47.2%), televisions (50.3%) and mobile telephones (80.4%) were common durable goods owned by the study households. Mobile telephones were particularly more common among the households and were owned by at least one person in 164 (86.8%), 134 (67.0%), and 174 (87.9%) households in Ashiabre, Keri and Sibi Hilltop respectively. Overall, ownership of refrigerator was observed in only 6.5% of the study households (Table 8).

Regarding ownership of means of transportation, bicycle ownership was the majority (74.8%). In the respective communities, 88.4%, 63.0%, and 73.7% of households in Ashiabre, Keri, and Sibi Hilltop owned at least one bicycle as a means of transportation (Table 8).

Ownership of agricultural land was observed in 72.7% of the households. In the study communities, agricultural land was owned by 69.3%, 58.5%, and 90.4% of households in Ashiabre, Keri, and Sibi Hilltop respectively (Table 8).

Farm animals were owned by 174 (92.1%) households in Ashiabre. In Keri and Sibi Hilltop, 126 (63.0%), and 167 (84.3%) households owned farm animals. Cumulatively, 79.6% of the study households owned at least one farm animal (Table 8).

Table 9 summarizes key characteristics of the 587 household heads. Majority (83%) of them were males. Most of them (73%) had no formal education. Regarding religion of the household heads, 11.1% indicated that they did not belong to any religion while the remaining were members of various religious groupings such as Catholics (16.5%), Protestants (9.5%), Pentecostals (21.5%), Moslems (3.9%), Traditional/Spiritualists (30.0%).

Although the heads of households interviewed belonged to different ethnic groups, it was noted that certain ethnic groups were more dominant in the respective study communities. In Ashiabre for instance, 81% of the household heads interviewed belonged to the Kokomba ethnic group while in Keri, the Achode ethnic group (62.0%) dominated. In Sibi Hilltop, it was observed that 92.9% of the household heads were members of the Kokomba ethnic group (Table 9).

Table 8: Summary of household possessions

Possession	Study Communities			Total n (%)
	Ashiabre n (%)	Keri n (%)	Sibi Hill Top n (%)	
Household effects				
Radio	100 (52.9)	88 (44.0)	89 (44.9)	277 (47.2)
Television	108 (57.1)	92 (46.0)	95 (48)	295 (50.3)
Mobile telephone	164 (86.8)	134 (67.0)	174 (87.9)	472 (80.4)
Non-mobile telephone	35 (18.5)	23 (11.5)	8 (4)	66 (11.2)
Refrigerator	17 (9)	6 (3.0)	15 (7.6)	38 (6.5)
Means of transport				
Bicycle	167 (88.4)	126 (63.0)	146 (73.7)	439 (74.8)
Animal drawn cart	23 (12.2)	33 (16.5)	33 (16.7)	89 (15.2)
Motorcycle/scooter	95 (50.3)	57 (28.5)	76 (38.4)	228 (38.8)
Car/truck	4 (2.1)	2 (1.0)	7 (3.5)	13 (2.2)
Boat with motor	3 (1.6)	1 (0.5)	5 (2.5)	9 (1.5)
Boat without motor	3 (1.6)	2 (1.0)	0 (0)	5 (0.9)
Ownership of agricultural land	131 (69.3)	117 (58.5)	179 (90.4)	427 (72.7)
Ownership of farm animals ¹	174 (92.1)	126 (63)	167 (84.3)	467 (79.6)
Number of households	189 (100)	200 (100)	198 (100)	587 (100)

¹ Cattle, milk cows, goats, sheep, chicken, ducks, other poultry

Table 9: Characteristics of the household heads

Household head characteristics	Categories	Study Communities			
		Ashiabre n (%)	Keri n (%)	Sibi Hill Top n (%)	Total n (%)
Household headship (Sex)	Male	164 (86.8)	158 (79.0)	164 (82.8)	486 (82.8)
	Female	25 (13.2)	42 (21.0)	34 (17.2)	101 (17.2)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Household head Level of education	No Formal Education	131 (69.3)	139 (69.5)	159 (80.3)	429 (73.1)
	Preschool	7 (3.7)	6 (3.0)	4 (2)	17 (2.9)
	Primary	14 (7.4)	22 (11.0)	8 (4)	44 (7.5)
	Junior High School	21 (11.1)	15 (7.5)	16 (8.1)	52 (8.9)
	Senior High School	13 (6.9)	15 (7.5)	9 (4.5)	37 (6.3)
	Tertiary	3 (1.6)	3 (1.5)	2 (1.0)	8 (1.4)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Household head religion	Catholic	16 (8.5)	76 (38)	5 (2.5)	97 (16.5)
	Protestant (Anglican, Presbyterian, Methodist, etc.)	14 (7.4)	10 (5.0)	32 (16.2)	56 (9.5)
	Pentecostal/Charismatic	61 (32.3)	33 (16.5)	32 (16.2)	126 (21.5)
	Other Christian	13 (6.9)	18 (9.0)	13 (6.6)	44 (7.5)
	Moslem	13 (6.9)	5 (2.5)	5(2.5)	23 (3.9)
	Traditional/Spiritualist	47 (24.9)	37 (18.5)	92 (46.5)	176 (30)
	No religion	25 (13.2)	21 (10.5)	19 (9.6)	65(11.1)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)
Household head ethnicity	Ewe	1 (0.5)	2 (1.0)	0 (0)	3 (0.5)
	Akan	1 (0.5)	12 (6.0)	0 (0)	13 (2.2)
	Mole-Dagbani	1 (0.5)	1 (0.5)	2 (1.0)	4 (0.7)
	Kokomba	153 (81.0)	27 (13.5)	184 (92.9)	364 (62.0)
	Grusi	0 (0)	2 (1.0)	3 (1.5)	5 (0.9)
	Achode	0 (0)	124 (62.0)	0 (0)	124 (21.1)
	Basare	19 (10.1)	1 (0.5)	6 (3.0)	26 (4.4)
	Challa	0 (0)	22 (11.0)	0 (0)	22 (3.7)
	Other	14 (7.4)	9 (4.5)	3 (1.5)	26 (4.4)
	Subtotal	189 (100)	200 (100)	198 (100)	587 (100)

4.1.3 Practices and behaviors during daily routine of study participants

Information regarding some specific routine practices and behaviors of study participants were obtained and classified as often (if it occurred at least once a week), sometimes (if it occurred at least once in three months), and never (if there had not been a previous experience).

A little over half of respondents (50.7%) had been at open field at dawn or sunset sometimes while 1323 (38.5) had been at open field at dawn or sunset often. This observation was similar in Ashiabre and Keri where 54.9% and 55.2% of respondents indicated that they had been at open field at dawn or sunset sometimes (Table 10).

In Sibi Hilltop however, majority of respondents (53.2%) had been at open field at dawn or sunset often compared with 43.5% who did same sometimes. The overall proportion of people who indicated that they never go to open field at dawn or sunset was 10.9% while 3.3%, 14.2%, and 17.1% of respondents at Sibi Hilltop, Ashiabre, and Keri respectively indicated that they had never been open fields at dawn or sunset (Table 10).

Regarding sleeping near forest or farm fields, 37.6% and 26.1% of respondents interviewed indicated that they had slept near forest and farms fields sometimes or often respectively. Overall, 36.3% of study participants interviewed never sleep near forest or farm fields. In the respective study communities, 42.5%, 38.9% and 28.6% of participants never sleep near forest or farm fields in Ashiabre, Keri, and Sibi hilltop (Table 10).

Cumulatively, 68.4% of participants reported that they slept in rooms or places without screen either sometimes or often. This proportion was 53.7% in Ashiabre, 71.3% in Keri, and 79.8% in Sibi Hilltop (Table 10).

Mosquito bites was reported in 98.9% of participants with 64.1% of respondents reporting that they experienced mosquito bites often. In the respective study communities, 68.8%, 55.7%, and 65.8% study participants reported that they experienced mosquito bites often in Ashiabre, Keri, and Sibi Hill top respectively (Table 10).

Apart from mosquito bites, 98.2% of participants reported that they experienced bites from other insects with 56.0% of respondents indicating that they experienced these bites often. In the individual study communities, 42.0%, 50.2%, and 73.1% of participants in Ashiabre, Keri, and Sibi Hilltop indicated that they experienced bites from other insects often (Table 10). Other insects indicated by study participants to have bitten them were ants, bees, blackflies, sand flies, tsetse flies, and some insects which were described as small insects.

Regarding contact with dogs, 2588 (74.2%) of study participants indicated that they had contact with dogs either often or sometimes. Specifically, 1091 (31.7%) of participants indicated that they have contact with dogs often. In Ashiabre, 68.5% of participants had some contact with dogs with 36.8% of them having dog contacts often. In Keri, 67.8% of participants had contact with dogs with 20.1% of participants having contact with dogs often. In Sibi Hilltop, 86.8% of participants had some contact with dogs while 35.5% of participants had contact with dogs often (Table 11).

Overall, 79.7% of participants had contact with goats, with 37.8% having contact with them often. In Ashiabre, 71.5% of participants had some contact with goats while 30.4% of them had contact with them often. In Keri, 77.2 of the respondents had some contact with goats while 30.4% of them had contact with goats often. In Sibi Hilltop, 89.1% of the participants had some contact with goats while 44.2% of them had contact with goats often (Table 11).

Apart from dogs and goats, 86.7% of study participants reported having contact with other domestic animals with 50.5% of participants having contact with at least one other domestic animal often. Contact with other domestic animals was reported among 80.7% of participants at Ashiabre with 45.0% of them indicating that such contact occurred often (Table 11). The other domestic animals that study participants had contact with included sheep, cattle, pigs, ducks, chicken, and other poultry such as guinea fowl and turkey.

In Keri, 83.6% of the participants reported having some contact with other domestic animals while 42.3% of them indicated that they had contact with other domestic animals often. In Sibi Hilltop, 61.5% of participants had contact with other domestic animals often although as many as 2980 (94.2%) of the participants indicated having some contact with other domestic animals (Table 11).

Concerning spraying of sleeping area with insecticides, 33.5% of participants indicated that they do, while 356 (10.3%) participants indicated that they spray their sleeping area with insecticides often. In Ashiabre, 3.9% of participants indicated that they sprayed their sleeping area with insecticides often while 12.3% and 14.8% of participants in Keri and Sibi Hilltop respectively, indicated that they used insecticides to spray their sleeping area often (Table 11).

The use of long sleeves was mentioned by 74.8% of study participants with 367 (10.7%) participants indicating that they use long sleeves often. In the study communities, long sleeves were used often by 10.3%, 9.2%, and 12.0% of participants in Ashiabre, Keri, and Sibi Hilltop respectively (Table 11).

Mosquito repellents such as mosquito coils were used by a total of 8.4% participants with 46 (1.3%) using them often. In the individual study communities, 2.4%, 1.5%, and 0.2% of participants in Ashiabre, Keri, and Sibi Hilltop used mosquito repellents often (Table 11).

Regarding sleeping in bed nets, 94.7% of study participants indicated that they slept in bed nets either sometimes or often. However, 69.0% of them reported that they slept in the bed nets often. In Ashiabre, 62.8% of the participants slept in bed nets often, while 59.9%, and 81.1% reported that they slept in bed nets often at Keri and Sibi Hilltop respectively (Table 11).

Table 10: Practices and behaviors during daily routine of study participants

Characteristics	Ashiabre		Keri		Sibi Hilltop		Total	
	no.	%	no.	%	no.	%	no.	%
Been at open field at dawn or sunset								
Often	368	30.8	261	27.7	694	53.2	1,323.00	38.5
Sometimes	656	54.9	519	55.2	568	43.5	1,743.00	50.7
Never	170	14.2	161	17.1	43	3.3	374	10.9
Sleep near forest or farm fields								
Often	219	18.3	253	26.9	427	32.7	899	26.1
Sometimes	467	39.1	322	34.2	505	38.7	1,294.00	37.6
Never	508	42.5	366	38.9	373	28.6	1,247.00	36.3
Sleep in rooms or places with open windows without screen								
Often	246	20.6	259	27.5	604	46.3	1,109.00	32.2
Sometimes	395	33.1	412	43.8	437	33.5	1,244.00	36.2
Never	553	46.3	270	28.7	264	20.2	1,087.00	31.6
Have mosquito bites								
Often	821	68.8	524	55.7	859	65.8	2,204.00	64.1
Sometimes	358	30	398	42.3	442	33.9	1,198.00	34.8
Never	15	1.3	19	2	4	0.3	38	1.1
Have bites from other insects								
Often	501	42.0	472	50.2	954	73.1	1,927.00	56.0
Sometimes	647	54.2	454	48.2	350	26.8	1,451.00	42.2
Never	46	3.9	15	1.6	1	0.1	62	1.8
Total	1,194.00	100	941	100	1,305.00	100	3,440.00	100

Table 11: Additional practices and behaviors during daily routine of study participants

Characteristics	Ashiabre		Keri		Sibi Hilltop		Total	
	No.	%	No.	%	No.	%	No.	%
Have contact with dogs								
Often	439	36.8	189	20.1	463	35.5	1,091.00	31.7
Sometimes	379	31.7	449	47.7	669	51.3	1,497.00	43.5
Never	376	31.5	303	32.2	173	13.3	852	24.8
Have contact with goats								
Often	438	36.7	286	30.4	577	44.2	1,301.00	37.8
Sometimes	415	34.8	440	46.8	586	44.9	1,441.00	41.9
Never	341	28.6	215	22.8	142	10.9	698	20.3
Have contact with other domestic animals								
Often	537	45.0	398	42.3	803	61.5	1,738.00	50.5
Sometimes	426	35.7	389	41.3	427	32.7	1,242.00	36.1
Never	231	19.3	154	16.4	75	5.7	460	13.4
Spray bedroom with insecticide in the last six months								
Often	47	3.9	116	12.3	193	14.8	356	10.3
Sometimes	268	22.4	246	26.1	283	21.7	797	23.2
Never	879	73.6	579	61.5	829	63.5	2,287.00	66.5
Use long sleeves								
Often	123	10.3	87	9.2	157	12	367	10.7
Sometimes	555	46.5	708	75.2	943	72.3	2,206.00	64.1
Never	516	43.2	146	15.5	205	15.7	867	25.2
Use mosquito repellents								
Often	29	2.4	14	1.5	3	0.2	46	1.3
Sometimes	110	9.2	54	5.7	79	6.1	243	7.1
Never	1,055.00	88.4	873	92.8	1,223.00	93.7	3,151.00	91.6
Sleep in bed nets								
Often	750	62.8	564	59.9	1,059.00	81.1	2,373.00	69.0
Sometimes	366	30.7	318	33.8	199	15.2	883	25.7
Never	78	6.5	59	6.3	47	3.6	184	5.3
Total	1,194.00	100	941	100	1,305.00	100	3,440.00	100

4.2 *Leishmania* Infection and Cutaneous Leishmaniasis among the Study Participants

4.2.1 *Leishmania* infection assessment by Leishmanin skin test (LST)

Of the 3440 enrolled study participants, 3173 (92.2%) were screened using the Leishmanin skin test (LST) procedure. Of the 3173, 3071(96.8%) comprising 1091, 848, 1132 participants from Ashiabre, Keri, and Sibi Hilltop returned within 48 to 72 hours to complete the test. Table 13 and Table 14 summarizes the prevalence of *Leishmania* infection by the LST procedure.

At Ashiabre and Keri, prevalence of 39.4% and 55.1% respectively was observed (Table 12). Prevalence among males at Ashiabre was 43.6% and 35.6% among females in the same community. In both males and females at Ashiabre, prevalence of *Leishmania* infection increased with age from 18.8% and 19.1% among males and females under five respectively to 67.4% and 59.5% among males and females greater than 45 years respectively. Cumulatively, prevalence of *Leishmania* infection at Ashiabre increased from 19.0% among children under five, to 63.8% among adults greater 45 years (Table 12).

At Keri, prevalence of *Leishmania* infection among males was 55.4% while a prevalence of 54.8% was observed among females. Among both males and females at Keri, prevalence of *Leishmania* infection increased with age from 24.4% and 22.2% among males and females under five respectively to 83.3% and 80.7% among males and females above 45 years respectively. Cumulatively, prevalence of *Leishmania* infection at Keri increased from 23.3% among children under five to 82.1% among adults aged above 45 years (Table 12)

Table 13 summarizes prevalence of *Leishmania* infection at Sibi Hilltop (34.2%) as well as the cumulative prevalence of *Leishmania* infection determined by the LST for all study sites (41.8%). At Sibi Hilltop, prevalence of *Leishmania* infection among males was 35.1% while it was 33.3% among females. Prevalence of infection increased from 28.8% and 30.2% among males and females under five respectively

to 47.4% and 48.0% among adult males and females above 45 years respectively. Cumulatively, Prevalence of infection determined by LST at Sibi Hilltop increased from 29.5% among children under five to 47.6% among adults above 45 years (Table 13)

In all the study communities, prevalence of *Leishmania* infection was observed to increase with age of study participants. While a cumulative prevalence of 41.8% was observed, prevalence among age groups was 23.3%, 47.1%, 70.0% and 82.1% among <5years, 5-15 years, 16-45 years, and >45 years respectively (Table 13). A summary of the prevalence of *Leishmania* infection across the study communities and cumulatively is presented in Figure 18 below.

LST positivity was associated with the study community, age of the study participants, and sex of the study participants. Compared to persons in Ashiabre, participants in Keri (AOR=1.83; 95% CI: 1.43, 2.34) had higher odds of being LST positive. Compared to children under 5 years, participants 5-15 years (AOR=1.49; 95% CI: 1.31, 1.98), those 16-45 years (AOR=3.31; 95% CI: 2.44, 4.47), and participants aged 45 years and above (AOR=4.85; 95% CI: 3.29, 7.15) had higher odds of being LST positive, with the odds increasing with age. Compared to females, males (AOR=1.27; 95% CI: 1.09, 1.49) had higher odds of being LST positive. Never using ITN or use of ITN sometimes was not significantly associated with being LST positive. Never using ITN or use of ITN sometimes was not significantly associated with being LST positive when compared with those who used ITN often (Table 14).

Table 12: LST prevalence by age and sex at Ashiabre and Keri

Community	Sex	Age	Number of household members screened	LST Prevalence		P value
				n (%)	95% CI	
Ashiabre	Males	< 5 years	69	13 (18.8)	(11.1, 30.1)	<0.001
		5-15 years	280	108 (38.6)	(33.0, 44.4)	
		16-45 years	131	78 (59.5)	(50.8, 67.7)	
		>45 years	43	29 (67.4)	51.6, 80.1)	
		Subtotal	523	228 (43.6)	(39.4, 47.9)	
	Females	< 5 years	68	13 (19.1)	(11.3, 30.5)	<0.001
		5-15 years	245	64 (26.1)	(21.0, 32.0)	
		16-45 years	218	103 (47.3)	(40.7, 53.9)	
		>45 years	37	22 (59.5)	(42.4, 74.5)	
		Subtotal	568	202 (35.6)	(31.7, 39.6)	
	Total	< 5 years	137	26 (19.0)	(13.2, 26.5)	<0.001
		5-15 years	525	172 (32.8)	(28.9, 36.9)	
		16-45 years	349	181 (51.9)	(46.6, 57.1)	
		>45 years	80	51 (63.8)	(52.5, 73.7)	
Total		1091	430 (39.4)	(36.5, 42.4)		
Keri	Males	< 5 years	41	10 (24.4)	(13.3, 40.4)	<0.001
		5-15 years	220	111 (50.5)	(43.8, 57.1)	
		16-45 years	84	60 (71.4)	(60.7, 80.2)	
		>45 years	36	30 (83.3)	(66.6, 92.6)	
		Subtotal	381	211 (55.4)	(50.3, 60.3)	
	Females	< 5 years	45	10 (22.2)	(12.1, 37.2)	<0.001
		5-15 years	192	83 (43.2)	(36.3, 50.4)	
		16-45 years	199	138 (69.4)	(62.5, 75.4)	
		>45 years	31	25 (80.7)	(61.9, 91.5)	
		Subtotal	467	256 (54.8)	(50.3, 59.3)	
	Total	< 5 years	86	20 (23.3)	(15.4, 33.5)	<0.001
		5-15 years	412	194 (47.1)	(42.3, 51.9)	
		16-45 years	283	198 (70.0)	(64.3, 75.1)	
		>45 years	67	55 (82.1)	(70.7, 89.7)	
Total		848	467 (55.1)	(51.7, 58.4)		

Table 13: LST prevalence by age and sex at Sibi Hilltop and cumulatively for all study sites

Community	Sex	Age	Number of household members screened	LST Prevalence		P value
				n (%)	95% CI	
Sibi Hilltop	Males	< 5 years	59	17 (28.8)	(18.5, 42.0)	0.022
		5-15 years	346	109 (31.5)	(26.8, 36.6)	
		16-45 years	136	59 (43.4)	(35.2, 51.9)	
		>45 years	38	18 (47.4)	(31.6, 63.7)	
		Subtotal	579	203 (35.1)	(31.3, 39.1)	
	Females	< 5 years	63	19 (30.2)	(19.9, 42.9)	0.002
		5-15 years	251	65 (25.9)	(20.8, 31.7)	
		16-45 years	214	88 (41.1)	(34.7, 47.9)	
		>45 years	25	12 (48.0)	(28.4, 68.2)	
		Subtotal	553	184 (33.3)	(29.5, 37.3)	
	Total	< 5 years	122	36 (29.5)	(22.0, 38.3)	<0.001
		5-15 years	597	174 (29.2)	(25.6, 32.9)	
		16-45 years	350	147 (42.0)	(36.9, 47.3)	
		>45 years	63	30 (47.6)	(35.4, 60.2)	
Total		1132	387 (34.2)	(31.5, 37.0)		
Total	Males	< 5 years	169	40 (23.7)	(17.8, 30.7)	<0.001
		5-15 years	846	328 (38.8)	(35.5, 42.1)	
		16-45 years	351	197 (56.1)	(50.9, 61.3)	
		>45 years	117	77 (65.8)	(56.6, 73.9)	
		Subtotal	1483	642 (43.3)	(40.8, 45.8)	
	Females	< 5 years	176	42 (23.9)	(18.1, 30.8)	<0.001
		5-15 years	688	212 (30.8)	(27.5, 34.4)	
		16-45 years	631	329 (52.1)	(48.2, 56.0)	
		>45 years	93	59 (63.4)	(53.0, 72.7)	
		Subtotal	1588	642 (40.4)	(38.0, 42.9)	
	Total	< 5 years	345	82 (23.8)	(19.6, 28.6)	<0.001
		5-15 years	1534	540 (35.2)	(32.8, 37.6)	
		16-45 years	982	526 (53.6)	(50.4, 56.7)	
		>45 years	210	136 (64.8)	(58.0, 71.0)	
Total		3071	1284 (41.8)	(40.1, 43.6)		

Table 14: Factors associated with LST positivity

Characteristics	Categories	Frequency	Number and proportion LST positive, n(%)	Crude OR (95% CI)	P value	AOR (95% CI)	P value
Study community							
	Ashiabre	1091	430 (39.4)	[Reference]		[Reference]	
	Keri	848	467 (55.1)	1.88 (1.57, 2.26)	<0.001	1.83 (1.43, 2.34)	<0.001*
	Sibi	1132	387 (34.2)	0.80 (0.67, 0.95)	0.011	0.65 (0.50, 0.85)	0.002
	Subtotal	3071	1284 (41.8)				
Person's age							
	< 5 years	336	86 (25.6)	[Reference]		[Reference]	
	5-15 years	1529	530 (34.7)	1.54 (1.18, 2.01)	0.001	1.49 (1.31, 1.98)	0.005*
	16-45 years	993	533 (53.7)	3.37 (2.56, 4.43)	<0.001	3.31 (2.44, 4.47)	<0.001*
	>45 years	213	135 (63.4)	5.03 (3.47, 7.29)	<0.001	4.85 (3.29, 7.15)	<0.001*
	Subtotal	3071	1284 (41.8)				
Person's sex							
	Female	1579	639 (40.5)	[Reference]		[Reference]	
	Male	1492	645 (43.2)	1.12 (0.97, 1.29)	0.121	1.27 (1.09, 1.49)	0.002*
	Subtotal	3071	1284 (41.8)				
Number of scars on skin							
	No scars	491	209 (42.6)	[Reference]		[Reference]	
	1-3 scars	680	248 (36.5)	0.77 (0.61, 0.98)	0.035	0.99 (0.76, 1.28)	0.923
	4-6 scars	582	226 (38.8)	0.86 (0.67, 1.09)	0.215	1.07 (0.80, 1.42)	0.665
	7-9 scars	482	193 (40.0)	0.90 (0.70, 1.16)	0.424	1.07 (0.78, 1.48)	0.674
	>=10 scars	836	408 (48.8)	1.29 (1.03, 1.61)	0.028	1.28 (0.97, 1.69)	0.084
	Subtotal	3071	1284 (41.8)				
Family CL history							
	No family history	825	341 (41.3)	[Reference]		[Reference]	
	1-3 persons with CL history	1874	772 (41.2)	0.99 (0.84, 1.17)	0.946	1.01 (0.83, 1.23)	0.946
	4-6 persons with CL history	307	139 (45.3)	1.17 (0.90, 1.53)	0.233	1.40 (0.94, 2.06)	0.094
	7-9 persons with CL history	25	13 (52.0)	1.54 (0.69, 3.41)	0.29	1.39 (0.66, 2.91)	0.382
	>=10 persons	40	19 (47.50)	1.28 (0.68, 2.43)	0.441	1.49 (0.84, 2.65)	0.170
	Subtotal	3071	1284 (41.8)				
Use of bed nets							
	Often	2129	887 (41.7)	[Reference]		[Reference]	
	Sometimes	677	304 (44.9)	1.14 (0.96, 1.36)	0.137	0.85 (0.68, 1.07)	0.163
	Never	162	63 (38.9)	0.89 (0.64, 1.24)	0.490	0.80 (0.55, 1.15)	0.227
	Subtotal	2968	1254 (42.3)				

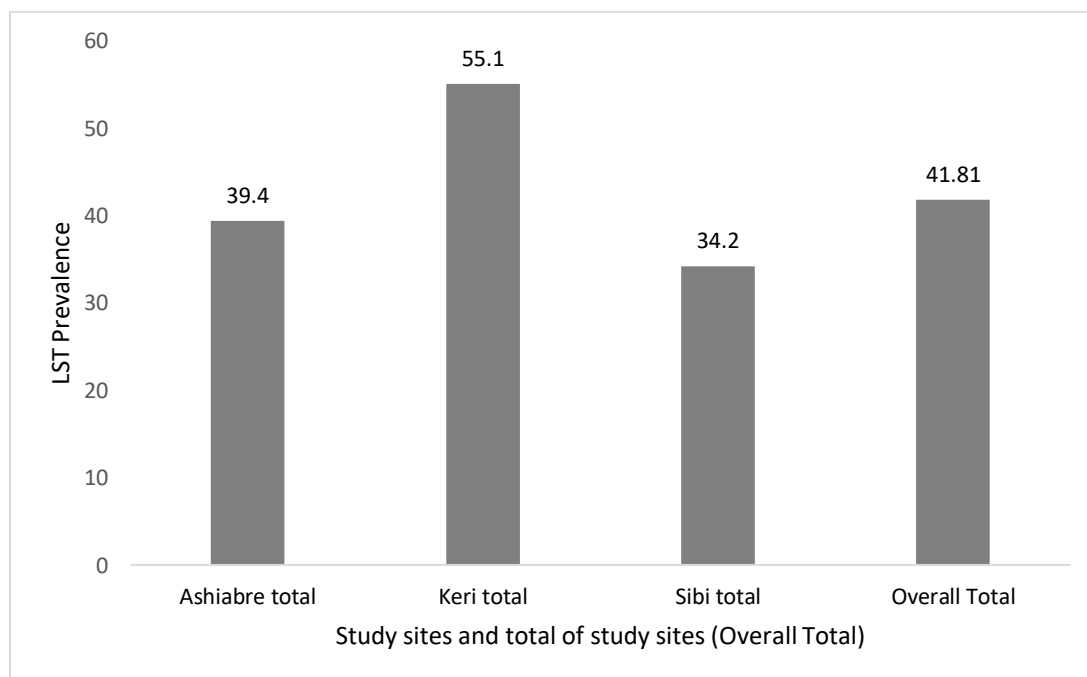


Figure 18: Prevalence of Leishmania infection at various study sites and cumulatively

4.2.2 Cutaneous leishmaniasis and ulcer treatment options among participants with skin ulcers

Out of 3440 persons who were physically examined for ulcers, a total of 595 skin ulcers were observed on 426 (12.4%) of them (Table 15). Of the 426 persons with skin ulcers, 73.7% were within the age group 5-15 years followed by children under five who constituted 13.6%. The number of skin ulcers observed on the participants ranged from 1 to 7 with those having one ulcer (47.1%) and two ulcers (27.6%) being in the majority. Although the skin ulcers were observed on various parts of the participants' body, majority occurred on the lower legs (71.3%) and feet (17.1%). In Ashiabre, Keri, and Sibi Hilltop, 65.2%, 70.1%, and 74.3% of persons with skin ulcers had the ulcer on their lower legs respectively (Table 15).

PCR test of the 595 ulcer samples indicated that 150 (25.2%) of them were *Leishmania* positive (Table 15). In the study communities, 14 (20.3%), 62 (22.1%), and 74 (30.2%) of skin ulcers tested from Ashiabre, Keri, and Sibi Hilltop were positive for *Leishmania*.

Of the 595 ulcer samples tested, 365 (61.3%) were obtained from males while 90 (60.0%) of the 150 *Leishmania* positive samples were also obtained from males. Also, 437 (73.4%) of the ulcer samples tested as well as 112 (74.7%) of the *Leishmania* positive ulcer samples were obtained from people within the age group 5-15 years (Table 16).

The 150 *Leishmania* positive ulcer samples were obtained from 136 study participants of which 123 (90.4%) had single *Leishmania* positive skin ulcer, 12 (8.8%) had two *Leishmania* positive skin ulcers and 1 person had three *Leishmania* positive skin ulcers (Table 16). Majority of individuals with *Leishmania* positive ulcers were within the age group of 5-15 years (73.5%) followed by children under five (14.0%) and persons aged 16-45 years (10.3%). Across the study sites and among males and females respectively, majority of persons with *Leishmania* positive skin ulcer(s) were within the age group 5-15 years (Table 17).

The overall prevalence of *Leishmania* infection (cutaneous leishmaniasis) observed among those with skin ulcers was 31.9% (136/426) with prevalence of 23.2% (13/56), 29.8% (56/188), and 36.8% (67/182) observed in Ashiabre, Keri and Sibi Hilltop respectively.

The average size of the skin ulcers was 10.2mm by 10.3mm with 573 (96.3%) of them reported to have started in the year 2018, 3 (0.5%) in 1990, 1 (0.2%) in 2007, 2 (0.3%) in 2010, 3 (0.5%) in 2011, 3 (0.5%) in 2012, 2 (0.3%) in 2015, 4 (0.7%) in 2016, and 4 (0.7%) in 2017. Among the ulcers which started in the year 2018, 17 (3.0%) of them were mentioned as having started between January to July 2018 while 13 (2.3%), 70 (12.2%), 346 (60.4%), 127 (22.2%) of them started in August, September, October and

November of the year 2018 respectively. Examples of *Leishmania* positive skin ulcers observed is captured as Figure 19.

Of the 426 individuals with skin ulcers observed, 419 (98.4%) indicated that they applied some form of treatment. Table 18 summarizes the type of treatments that the 419 participants used for their skin ulcers. Majority of them (67.5%) used herbs while 35.3%, and 14.2% of them used hot stone and hot water respectively for treatment of their skin ulcers.

Table 15: Individuals with skin ulcers, ulcers sampled and result of Leishmania PCR test

Characteristic	Category	Ashiabre		Keri		Sibi Hilltop		Total		P value
		n	%	n	%	n	%	n	%	
Age of individuals with skin ulcers										
	<5 years	12	21.4	22	11.7	24	13.2	58	13.6	0.141
	5-15 years	35	62.5	145	77.1	134	73.6	314	73.7	
	16-45 years	9	16.1	19	10.1	18	9.9	46	10.8	
	>45 years	0	0	2	1.1	6	3.3	8	1.9	
	Total	56	100	188	100	182	100	426	100	
Sex of individuals with skin ulcers										
	Male	36	64.3	109	58	110	60.4	255	59.9	0.684
	Female	20	35.7	79	42	72	39.6	171	40.1	
	Total	56	100	188	100	182	100	426	100	
Number of Skin ulcers tested										
	1	31	44.9	116	41.3	133	54.3	280	47.1	<0.001
	2	28	40.6	84	29.9	52	21.2	164	27.6	
	3	8	11.6	46	16.4	37	15.1	91	15.3	
	4	0	0	30	10.7	11	4.5	41	6.9	
	5	2	2.9	5	1.8	0	0	7	1.2	
	6	0	0	0	0	5	2	5	0.8	
	7	0	0	0	0	7	2.9	7	1.2	
	Total	69	100	281	100	245	100	595	100	
Skin ulcer locations										
	Face/Head	3	4.3	5	1.8	6	2.4	14	2.4	0.029
	Upper arm	0	0	2	0.7	0	0	2	0.3	
	Lower arm	1	1.4	13	4.6	11	4.5	25	4.2	
	Palm/Back of palm	0	0	2	0.7	3	1.2	5	0.8	
	Chest	0	0	1	0.4	0	0	1	0.2	
	Back (upper part below neck))	0	0	0	0	2	0.8	2	0.3	
	Stomach	2	2.9	0	0	0	0	2	0.3	
	Buttocks	1	1.4	0	0	2	0.8	3	0.5	
	Thighs	1	1.4	8	2.8	6	2.4	15	2.5	
	Lower legs(crus/cnemis)	45	65.2	197	70.1	182	74.3	424	71.3	
	Feet	16	23.2	53	18.9	33	13.5	102	17.1	
	Total	69	100	281	100	245	100	595	100	
<i>Leishmania</i> pcr result										
	Negative	55	79.7	219	77.9	171	69.8	445	74.8	0.061
	Positive	14	20.3	62	22.1	74	30.2	150	25.2	
	Total	69	100	281	100	245	100	595	100	

Table 16: Skin ulcers tested for *Leishmania* parasite using PCR by age and sex

Sex	Age	Number of skin ulcers tested	<i>Leishmania</i> Positive		P value
			n (%)	95% CI	
Males	< 5 years	48	8 (16.7)	(8.3, 30.5)	0.467
	5-15 years	276	70 (25.4)	(20.6, 30.9)	
	16-45 years	36	10 (27.8)	(15.2, 45.3)	
	>45 years	5	2 (40.0)	(3.8, 91.9)	
	Subtotal	365	90 (24.7)	(20.5, 29.4)	
Females	< 5 years	45	13 (28.9)	(17.2, 44.3)	0.912
	5-15 years	161	42 (26.1)	(19.8, 33.5)	
	16-45 years	19	4 (21.1)	(7.3, 47.3)	
	>45 years	5	1 (20.0)	(0.8, 88.9)	
	Subtotal	230	60 (26.1)	(20.8, 32.2)	
Total	< 5 years	93	21 (22.6)	(15.1, 32.4)	0.918
	5-15 years	437	112 (25.6)	(21.7, 29.9)	
	16-45 years	55	14 (25.5)	(15.4, 39.0)	
	>45 years	10	3 (30.0)	7.6, 69.0)	
	Total	595	150 (25.2)	(21.9, 28.9)	

Table 17: Distribution of individuals with *Leishmania* positive skin ulcers by age, sex, and community of residence

Characteristic	Category	Ashiabre		Keri		Sibi Hilltop		Total		Total
		Male (%)	Female (%)	Male	Female	Male	Female	Male	Female	
Individuals with one <i>Leishmania</i> positive skin ulcer										
	<5 years	1 (25.0)	1 (12.5)	3 (9.4)	5 (27.8)	4 (9.8)	3 (15.0)	8 (10.4)	9 (19.6)	17 (13.8)
	5-15 years	3 (75.0)	6 (75.0)	23 (71.9)	11 (61.1)	31 (75.6)	15 (75.0)	57 (74.0)	32 (69.6)	89 (72.4)
	16-45 years	0	1 (12.5)	6 (18.8)	1 (5.6)	4 (9.8)	2 (10.0)	10 (13.0)	4 (8.7)	14 (11.4)
	>45 years	0	0	0 (0)	1 (5.6)	2 (4.9)	0	2 (2.6)	1 (2.2)	3 (2.4)
	Sub total	4 (100)	8 (100)	32 (100)	18 (100)	41 (100)	20 (100)	77 (100)	46 (100)	123 (100)
Individuals with two <i>Leishmania</i> positive skin ulcers										
	<5 years	0	0	0	1 (33.3)	0	1 (25.0)	0	2 (28.6)	2 (16.7)
	5-15 years	1 (100)	0	3 (100)	2 (66.7)	1 (100)	3 (75.0)	5 (100)	5 (71.4)	10 (83.3)
	16-45 years	0	0	0	0	0	0	0	0	0
	>45 years	0	0	0	0	0	0	0	0	0
	Sub total	1 (100)	0	3 (100)	3 (100)	1 (100)	4 (100)	5 (100)	7 (100)	12 (100)
Individuals with three <i>Leishmania</i> positive skin ulcers										
	<5 years	0	0	0	0	0	0	0	0	0
	5-15 years	0	0	0	0	1 (100.0)	0	1 (100.0)	0	1 (100.0)
	16-45 years	0	0	0	0	0	0	0	0	0
	>45 years	0	0	0	0	0	0	0	0	0
	Sub total	0	0	0	0	1 (100)	0	1 (100)	0	1 (100)
Individuals with <i>Leishmania</i> positive skin ulcer(s)										
	<5 years	1 (20.0)	1 (12.5)	3 (8.6)	6 (28.6)	4 (9.3)	4 (16.7)	8 (9.6)	11 (20.8)	19 (14.0)
	5-15 years	4 (80.0)	6 (75.0)	26 (74.3)	13 (61.9)	33 (76.7)	18 (75.0)	63 (75.9)	37 (69.8)	100 (73.5)
	16-45 years	0	1 (12.5)	6 (17.1)	1 (4.8)	4 (9.3)	2 (8.3)	10 (12.0)	4 (7.5)	14 (10.3)
	>45 years	0	0	0 (0)	1 (4.8)	2 (4.7)	0	2 (2.4)	1 (1.9)	3 (2.2)
	Sub total	5 (100.0)	8 (100.0)	35 (100)	21 (100)	43 (100)	24 (100)	83 (100)	53 (100)	136 (100)

Table 18: Treatment practices for skin lesions observed

Treatment Options	Ashiabre		Keri		Sibi Hilltop		Total	
	No.	%	No.	%	No.	%	No.	%
Herbs	21	40.4	117	62.6	145	80.6	283	67.5
Hot stone	3	5.8	72	38.5	73	40.6	148	35.3
Dermacot	7	13.5	31	16.6	3	1.7	41	9.8
Penicillin	7	13.5	14	7.5	8	4.4	29	8.1
Amoxycillin	5	9.6	10	5.3	2	1.1	17	4.7
Hotwater	5	9.6	19	10.2	27	15	51	14.2
Other treatment	5	9.6	4	2.1	6	3.3	15	4.2
Total	52	100	187	100	180	100	419	100



Figure 19: Examples of skin ulcers which were *Leishmania* positive

4.2.3 Treponemal only and DPP RDT screening among selected persons with skin ulcers

A total of 46 study participants were screened using a treponemal specific rapid diagnostic test. Of the total, 13 (28.3%) tested positive (Table 20). The 13 treponemal positive persons were further screened using the DPP diagnostic RDT out of which 9 (69.2%) were observed to be positive (Table 19).

A total of 71 ulcer samples were obtained from the 46 people screened using the treponemal specific RDT; 18 (25.4%) from 13 persons who were RDT positive while 53 (74.6) were from 33 persons who were negative (Table 20).

Test for *Leishmania* parasite in the 71 ulcers indicated that 16 (22.5%) of the ulcers were *Leishmania* positive. Of the 16 ulcer samples that were *Leishmania* positive, 1 (6.3%) of them was obtained from a person who was positive to the treponemal specific RDT while the remaining 15 (93.8%) *Leishmania* positive ulcer samples were obtained from persons who were negative to the treponemal specific RDT (Table 20).

Eleven (61.1%) of the 18 ulcer samples from the 13 persons who tested positive to the treponemal specific RDT were obtained from persons who tested positive to the DPP RDT while 7 samples were from persons who tested negative to the DPP diagnostic RDT (Table 21).

It was also noted that none of the 11 samples obtained from persons who were DPP diagnostic RDT positive was also positive for *Leishmania* infection. One of the 7 samples obtained from persons who were DPP diagnostic RDT negative was *Leishmania* PCR positive (Table 21).

It was also observed that 5 of the 9 persons (55.6%) who were DPP diagnostic test positive were females. The ages and number of people per age of the 9 persons who were DPP diagnostic test positive were as follows: 10 years (1), 12 years (1), 14 years (2), 15 years (1), 16 years (1), 17 years (1), 55 years (1), and 65 years (1).

Table 19: Treponemal specific and DPP diagnostic test screening of some persons with skin ulcers

Characteristics	Categories	Study communities							
		Ashiabre		Keri		Sibi Hilltop		Total	
		No.	%	No.	%	No.	%	No.	%
Treponemal specific RDT*	Positive	1	16.7	5	55.6	7	22.6	13	28.3
	Total	6	100	9	100	31	100	46	100
DPP RDT**	Positive	1	100	2	40	6	85.7	9	69.2
	Total	1	100	5	100	7	100	13	100

Table 20: Leishmania infection in skin ulcer samples obtained from persons screened with treponemal specific RDT

Study communities	Treponemal specific RDT result	<i>Leishmania</i> PCR test result					
		Negative		Positive		Total	
		No.	%	No.	%	No.	%
Ashiabre	Negative	5	83.3	1	100	6	85.7
	Positive	1	16.7	0	0	1	14.3
	Total	6	100	1	100	7	100
Keri	Negative	6	46.2	1	50	7	46.7
	Positive	7	53.8	1	50	8	53.3
	Total	13	100	2	100	15	100
Sibi Hilltop	Negative	27	75	13	100	40	81.6
	Positive	9	25	0	0	9	18.4
	Total	36	100	13	100	49	100
Total	Negative	38	69.1	15	93.8	53	74.6
	Positive	17	30.9	1	6.3	18	25.4
	Total	55	100	16	100	71	100

Table 21: Leishmania infection in skin ulcer samples obtained from individuals screened using DPP diagnostic RDT

Study communities	DPP RDT result	<i>Leishmania</i> PCR test result					
		Negative		Positive		Total	
		No.	%	No.	%	No.	%
Ashiabre	Negative	6	85.7	1	100	7	87.5
	Positive	1	14.3	0	0	1	12.5
	Total	7	100	1	100	8	100
Keri	Negative	6	75	1	100	7	77.8
	Positive	2	25	0	0	2	22.2
	Total	8	100	1	100	9	100
Sibi Hilltop	Negative	6	42.9	1	100	7	46.7
	Positive	8	57.1	0	0	8	53.3
	Total	14	100	1	100	15	100
Total	Negative	6	35.3	1	100	7	38.9
	Positive	11	64.7	0	0	11	61.1
	Total	17	100	1	100	18	100



Figure 20: Examples of skin ulcers which were *Leishmania* PCR negative and were observed on persons who were DPP RDT positive

4.3 Insecticide treated bed net ownership, access and use

Bed nets owned by the households ranged from 1 to 13 with majority of them owning 3 (35.9%) bed nets (Table 22). In the study communities, 59 (31.2%), 87 (43.5%), and 65 (32.8%) households owned 3 nets in Ashiabre, Keri, and Sibi Hilltop respectively. Cumulatively, the study households owned 2002 bed nets distributed as follows: 716 in Ashiabre, 542 in Keri, and 744 in Sibi Hilltop (Table 22).

Regarding cost of the bed nets, all respondents indicated that the bed nets were obtained free of charge. All respondents also indicated that they had heard about malaria.

Most (99.6%) of the bed nets owned by the study households were obtained from the public sector sources such as the Government hospital, health post/CHPS compound, and national ITN distribution campaigns (Table 23). Of the bed nets owned, 1253 (62.6%) and 1973 (98.6%) were obtained within 6 months and 12 months of this study initiation respectively (Table 23).

Of the bed nets owned, 1226 (61.2%) were observed hanging, 617 (30.8%) were either not hanging or packaged, while 159 (7.9%) of them were not observed. A similar trend was observed across the individual study communities (Table 23).

Within a period of 12 months prior to this study, respondents indicated that in 496 (84.6%) of the 587 interviewed households, at least one ITN had been disposed of using different methods. Across the study communities, the commonest methods of bed net disposal mentioned by household heads were garbage /refuse dump (45.2%) followed by burning (42.3%) (Table 24). Regarding duration of bed net use before disposal, majority of the household heads (69.4%) indicated that the nets had been used for a period of 2-4 years prior to disposal. This was followed by 121 (24.4%) household heads who indicated that their bed nets had been used for periods less than 2 years prior to disposal (Table 24).

Among the reasons for bed net disposal, 404 (81.5) household heads indicated that their nets were disposed of because they were torn. This was followed by 55 (11.1%) respondents who indicated that their bed nets were disposed of because they had obtained a new one (Table 24).

The proportion of households having a minimum of one ITN (this case the LLIN type) was 97.1% (95% CI: 95.4, 98.2). In both Keri and Sibi Hilltop, 97.0% of the households had at least one ITN with 97.4% in Ashiabre (Table 25).

Cumulatively, 386 (65.8%) households owned at least one ITN for every two household members. The proportion of households with at least one ITN for every two household members was 63.5%, 68.0%, and 65.7% in Ashiabre, Keri, and Sibi Hilltop respectively (Table 25).

Furthermore, the overall proportion of the individuals that could be potentially covered by the existing ITNs, if each ITN in the household could be used by two people (proportion of individuals with access to ITN within the households) was estimated as 86.8% (95% CI: 85.7, 87.9) with similar proportions observed in the individual study communities (87.3%, 87.9%, and 85.6% in Ashiabre, Keri, and Sibi Hilltop respectively) (Table 26).

The overall proportion of the study participants that used ITNs the night before the interview was 65.1% (95% CI: 63.6, 66.7). In the respective study communities, the proportions were 66.4% (95% CI: 63.7, 68.9), 65.1% (95% CI: 62.1, 68.0), and 64.0% (95% CI: 61.4, 66.5) in Ashiabre, Keri and Sibi Hilltop respectively. The overall ratio of ITN use to ITN access observed was 0.75 (Table 26).

In addition, it was observed among households having at least one ITN for every two family members that 1,581 (72.5%) of the household members slept in an ITN the previous night, with similar proportions of 73.5%, 71.1%, and 72.6 observed for same group in Ashiabre, Keri, and Sibi Hilltop respectively (Table 27).

A summary of the distribution of persons who used the ITN the night prior to this study by age, sex, and community of residence is presented in Table 22 below with 1197 (50.5%) of them being males. Majority of ITN users were within the age groups of 5-15 years (42.1%) and 16-45 years (35.6%) respectively.

In Ashiabre, 439 (51.7%) of those who slept in the ITN the night before the interview were males. Majority of ITN users in Ashiabre were within the age group 5-15 years (41.0%) followed by those within the age group 16-45 years (Table 28).

In Keri, 310 (48.4%) of the ITN users were males with majority of ITN users (38.9%) being within the age group 5-15 years followed by 38.3% of ITN users who were in the age group 16-45 years. In Sibi Hilltop, 448 (50.9%) of ITN users were males with majority of ITN users (45.5%) being 5-15 years old followed by 34.7% of ITN users who were 16-45 years old. Among females, majority of ITN users were 16-45 years old (42.4%) followed by those who were 5-15 years old (36.8%). Among males, majority of ITN users (47.3%) were 5-15 years old followed by those who were 16-45 years old (28.9%) (Table 28).

This study also observed significant associations between not sleeping under ITN the night before the household survey and the following factors using multiple logistic regression: family size and number of rooms used for sleeping (Table 29). Other factors associated with failure to sleep under ITN were number of screened windows in household, and household lacking access to ITN (Table 30).

Participants from households with size of 10 or more members (AOR = 2.53; 95% CI: 1.20, 4.24) were more likely not to use ITN than those from households with size less than 10.

Participants from households having >10 rooms for sleeping (AOR = 10.18; 95% CI: 1.28, 81.0) had greater odds of not using ITN than those from households having <10 rooms for sleeping. In addition, participants from households having 2-4 screened windows (AOR = 1.49; 95% CI: 1.00, 2.20), and 8-10

screened windows (AOR = 3.57; 95% CI: 1.25, 10.17) had higher likelihood of not using ITN compared with those

no screened windows the night before this survey.

Participants from households which did not have one ITN for every two household members (AOR = 1.80; 95% CI: 1.31, 2.47) had higher odds of failing to use ITN compared with participants from households

Bednet number	Ashiabre		Keri		Sibi Hilltop		Total	
	Households owning bednet, n(%)	Number of bednets owned	Households owning bednet, n(%)	Number of bednets owned	Households owning bednet, n(%)	Number of bednets owned	Households owning bednet, n(%)	Number of bednets owned
0	5 (2.6)	0	6 (3.0)	0	6 (3.0)	0	17 (2.9)	0
1	4 (2.1)	4	19 (9.5)	19	10 (5.1)	10	33 (5.6)	33
2	33 (17.5)	66	53 (26.5)	106	29 (14.6)	58	115 (19.6)	230
3	59 (31.2)	177	87 (43.5)	261	65 (32.8)	195	211 (35.9)	633

which had at least one ITN for every two household members.

Table 22: Number of bed nets owned by households

4	30 (15.9)	120	23 (11.5)	92	25 (12.6)	100	78 (13.3)	312
5	28 (14.8)	140	9 (4.5)	45	27 (13.6)	135	64 (10.9)	320
6	14 (7.4)	84	2 (1.0)	12	15 (7.6)	90	31 (5.3)	186
7	9 (4.8)	63	1 (0.5)	7	14 (7.1)	98	24 (4.1)	168
8	5 (2.6)	40	0 (0)	0	6 (3.0)	48	11 (1.9)	88
9	1 (0.5)	9	0 (0)	0	0 (0)	0	1 (0.2)	9
10	0 (0)	0	0 (0)	0	1 (0.5)	10	1 (0.2)	10
13	1 (0.5)	13	0 (0)	0	0 (0)	0	1 (0.2)	13
Total	189 (100)	716	200 (100)	542	198 (100)	744	587 (100)	2002

Table 23: Source, duration of ownership, and observation of bed nets owned by households

Characteristic	Category	Ashiabre		Keri		Sibi Hilltop		Total	
		no.	%	no.	%	no.	%	no.	%
Source of bed net									
	Public Sector	713	99.6	537	99.1	744	100	1994	99.6
	Other/Don't know	3	0.4	5	0.9	0	0	8	0.4
Duration of bed net ownership									
	0-6 months	430	60.1	450	83.0	373	50.1	1253	62.6
	7-12 months	279	39.0	85	15.7	356	47.8	720	36.0
	Not sure	7	0.9	7	1.3	15	2.0	29	1.4
Was bed net observed?									
	Observed Hanging	409	57.1	387	71.4	430	57.8	1226	61.2
	Observed Not Hanging or packaged	271	37.9	108	19.9	238	32	617	30.8
	Not observed	36	5.0	47	8.7	76	10.2	159	7.9

Total bed nets owned		716	100	542	100	744	100	2002	100
Characteristics	Category			Ashiabre		Keri		Sibi Hilltop	Total

Table 24: Methods of ITN disposal, duration of ITN use before disposal, and reason for ITN disposal

	no.	%	no.	%	no.	%	No.	%
Method of treated net disposal								
Burned	44	30.3	88	48.9	78	45.6	210	42.3
Buried	2	1.4	12	6.7	10	5.8	24	4.8
Garbage or refuse dump	87	60.0	69	38.3	68	39.8	224	45.2
Reused for other purpose	9	6.2	8	4.4	14	8.2	31	6.3
Other	3	2.1	3	1.7	1	0.6	7	1.4
How long was treated net used?								
Less than 2 years	27	18.6	43	23.9	51	29.8	121	24.4
2-4 years	102	70.3	134	74.4	108	63.2	344	69.4
More than 4 years	11	7.6	2	1.1	10	5.8	23	4.6
Don't know	5	3.4	1	0.6	2	1.2	8	1.6
What was the primary reason for treated net disposal?								
Torn	114	78.6	148	82.2	142	83	404	81.5
Could not repel mosquitoes anymore	6	4.1	17	9.4	9	5.3	32	6.5
Got a new one	22	15.2	14	7.8	19	11.1	55	11.1
Other/Don't Know	3	2.1	1	0.6	1	0.6	5	1.0
Households in which any treated net was disposed of in the past 12 months								
Total	145	100	180	100	171	100	496	100

Table 25: Ownership of ITNs by enrolled households in study community

Study Community	Households interviewed	Households with at least one LLIN, n(%)		Households with at least one LLIN for every two people	
		n(%)	95% CI	n(%)	95% CI
Ashiabre	189	184 (97.4)	(93.7, 98.9)	120 (63.5)	(56.3, 70.1)
Keri	200	194 (97.0)	(93.4, 98.7)	136 (68.0)	(61.2, 74.1)
Sibi Hilltop	198	192 (97.0)	(93.4, 98.6)	130 (65.7)	(58.7, 72.0)
Total	587	570 (97.1)	(95.4, 98.2)	386 (65.8)	(61.8, 69.5)

Table 26: Access to and use of LLINs by enrolled households in study communities

Study Community	Household Population (de facto)	Population with access to ITN		Population that slept in ITN the night prior to the study		Ratio of use to access
		n(%)	95% CI	n(%)	95% CI	
Ashiabre	1279	1116 (87.3)	(85.3, 89.0)	849(66.4)	(63.7, 68.9)	0.76
Keri	983	864 (87.9)	(85.7, 89.8)	640 (65.1)	(62.1, 68.0)	0.74
Sibi Hilltop	1377	1179 (85.6)	(83.7, 87.4)	881 (64.0)	(61.4, 66.5)	0.75
Total	3639	3159 (86.8)	(85.7, 87.9)	2370(65.1)	(63.6, 66.7)	0.75

Table 27: Use of ITNs by members of households having a minimum of one ITN for every two members

Study Community	Persons in Households with ITN access (de facto)	Persons that used ITN the night prior to the study among households with ITN access	
		n(%)	95% CI
Ashiabre	736	541(73.5)	(70.2, 76.6)
Keri	620	441 (71.1)	(67.4, 74.6)
Sibi Hilltop	825	599 (72.6)	(69.5, 75.5)
Total	2181	1581(72.5)	(70.6, 74.3)

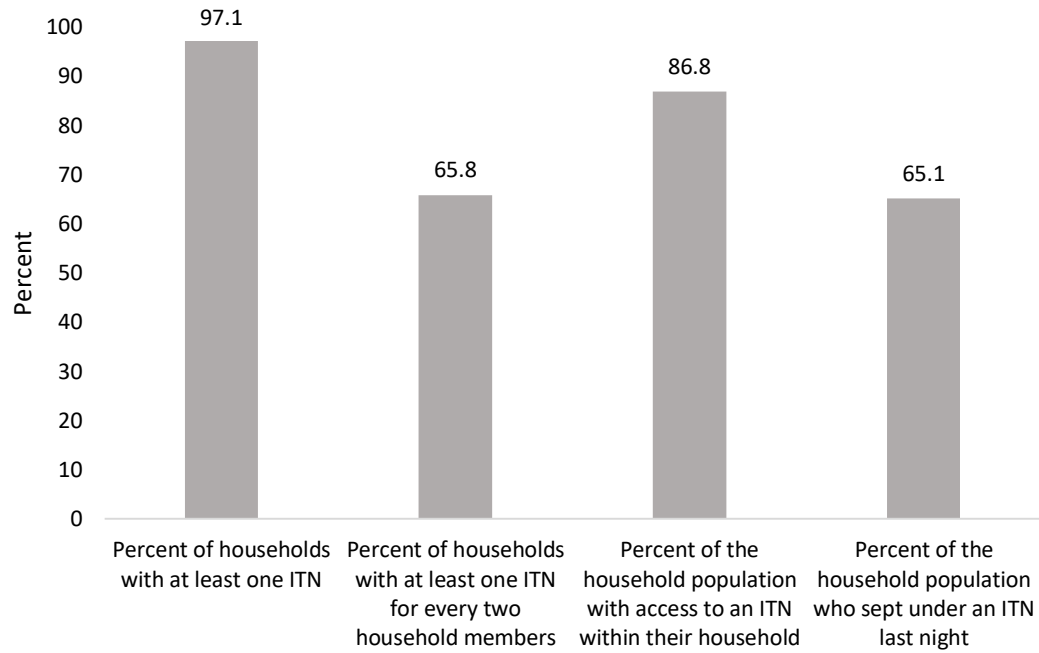


Figure 21: Summary of ITN ownership, access, and use in study communities (overall)

Table 28: Distribution of persons who used ITN the night before the interview by sex, age group and residence

Community	Age groups	Male	Female	Total	p-value
Ashiabre	< 5 years	65 (14.8)	65 (15.9)	130 (15.3)	0.002
	5-15 years	198 (45.1)	150 (36.6)	348 (41.0)	
	16-45 years	127 (28.9)	165 (40.2)	292 (34.4)	
	>45 years	49 (11.2)	30 (7.3)	79 (9.3)	
	Sub total	439 (100)	410 (100)	849 (100)	
Keri	< 5 years	38 (12.3)	37 (11.2)	75 (11.7)	0.002
	5-15 years	135 (43.5)	114 (34.5)	249 (38.9)	
	16-45 years	96 (31.0)	149 (45.2)	245 (38.3)	
	>45 years	41 (13.2)	30 (9.1)	71 (11.1)	
	Sub total	310 (100)	330 (100)	640 (100)	
Sibi Hilltop	< 5 years	52 (11.6)	59 (13.6)	111 (12.6)	<0.001
	5-15 years	233 (52.0)	168 (38.8)	401 (45.5)	
	16-45 years	123 (27.5)	183 (42.3)	306 (34.7)	
	>45 years	40 (8.9)	23 (5.3)	63 (7.2)	
	Sub total	448 (100)	433 (100)	881 (100)	
Total	< 5 years	155 (12.9)	161 (13.7)	316 (13.3)	<0.001
	5-15 years	566 (47.3)	432 (36.8)	998 (42.1)	
	16-45 years	346 (28.9)	497 (42.4)	843 (35.6)	
	>45 years	130 (10.9)	83 (7.1)	213 (9.0)	
	Total	1197 (100)	1173(100)	2370 (100)	

Table 29: Factors associated with non-use of ITN the night preceding the interview among de facto population of households having a minimum of one ITN

Characteristics	Categories	defacto population	People that did not sleep under ITN, n(%)	Crude OR (95% CI)	P value	*AOR (95% CI)	P value
Sex of Household head	Female	452	115 (25.4)	[Reference]		[Reference]	
	Male	3095	1062 (34.3)	1.53 (1.22, 1.92)	<0.001	1.45 (0.96, 2.20)	0.077
Household head age	<35 years	820	240 (29.3)	[Reference]		[Reference]	
	36-40 years	610	171 (28.0)	0.94 (0.75, 1.19)	0.610	0.98 (0.63,1.51)	0.910
	41-50 years	1226	443 (36.1)	1.37 (1.13, 1.65)	0.001	1.24 (0.84,1.84)	0.275
	>51 years	891	323 (36.3)	1.37 (1.12, 1.68)	0.002	1.15 (0.76, 1.73)	0.515
Family size	1-3 persons	157	33 (21.0)	[Reference]		[Reference]	
	4-6 persons	1380	374 (27.1)	1.40 (0.93, 2.09)	0.103	1.15 (0.81, 2.24)	0.249
	7-9 persons	1203	404 (33.6)	1.90 (1.27, 2.84)	0.002	1.34 (0.83, 2.65)	0.182
	>=10 persons	807	366 (45.4)	3.12 (2.07, 4.69)	<0.001	2.53 (1.20, 4.24)	0.011*
Main material in household roof	Metal	3234	1057 (32.7)	[Reference]		[Reference]	
	Thatch	313	120 (38.3)	1.28 (1.00, 1.63)	0.043	1.12 (0.70, 1.78)	0.643
Household socioeconomic status	Low	658	199 (30.2)	[Reference]		[Reference]	
	Second	735	237 (32.2)	1.10 (0.87, 1.38)	0.421	1.09 (0.65, 1.82)	0.755
	Middle	758	259 (34.2)	1.20 (0.96, 1.50)	0.115	1.22 (0.70, 2.10)	0.481
	Fourth	781	259 (33.2)	1.14 (0.92, 1.43)	0.236	1.15 (0.66, 2.02)	0.624
	Highest	615	223 (36.3)	1.31 (1.04, 1.66)	0.023	1.39 (0.85, 2.27)	0.188
Household number of rooms for sleeping	1 room	259	70 (27.0)	[Reference]		[Reference]	
	2-5 rooms	2553	802 (31.4)	1.23 (0.93, 1.65)	0.146	1.30 (0.35, 4.75)	0.693
	6-10 rooms	613	253 (41.3)	1.90 (1.38, 2.61)	<0.001	2.29 (0.60, 8.77)	0.225
	>10 rooms	122	52 (42.6)	2.01 (1.28, 3.15)	0.003	10.18 (1.28, 81.00)	0.028*

OR=Odds ratio, AOR= Adjusted odds ratio

Table 30: Additional Factors associated with non-use of ITN the night preceding the interview among de facto population of households having a minimum of one ITN

Characteristics	Categories	defacto population	People that did not sleep under ITN, n(%)	Crude OR (95% CI)	P value	AOR (95% CI)	P value
Number of windows in household							
	1 window	276	81 (29.4)	[Reference]		[Reference]	
	2-4 windows	2100	662 (31.5)	1.11 (0.84, 1.46)	0.464	0.74 (0.20, 2.79)	0.656
	5-7 windows	847	312 (36.8)	1.40 (1.05, 1.88)	0.024	0.66 (0.17, 2.47)	0.533
	8-10 windows	231	96 (41.6)	1.71 (1.18, 2.47)	0.004	0.41 (0.09, 1.77)	0.232
	>10 windows	93	26 (28.0)	0.93 (0.55, 1.57)	0.798	0.06 (0.01, 0.57)	0.015
Number of screened windows in household							
	No screened window	2476	765 (30.9)	[Reference]		[Reference]	
	1 screened window	223	59 (26.5)	0.80 (0.59, 1.10)	0.169	0.76 (0.41, 1.41)	0.387
	2-4 screened windows	557	208 (37.3)	1.33 (1.10, 1.61)	0.003	1.49 (1.00, 2.20)	0.047*
	5-7 screened windows	190	92 (48.4)	2.10 (1.56, 2.83)	<0.001	1.68 (0.85, 3.32)	0.136
	8-10 screened windows	96	53 (55.2)	2.76 (1.83, 4.16)	<0.001	3.57(1.25, 10.17)	0.017*
	>10 screened windows	5	0 (0)		1		1
Household head heard malaria message 6 months prior to interview							
	Heard malaria message	3468	1141 (32.9)	[Reference]		[Reference]	
	Did not hear malaria message	79	36 (45.6)	1.71 (1.09, 2.67)	0.019	2.01 (0.87, 4.64)	0.104
Household has ITN access (one ITN for every two household members)							
	Has access	2181	600 (27.5)	[Reference]		[Reference]	
	Lack access	1366	577 (42.2)	1.93 (1.67, 2.22)	<0.001	1.80 (1.31, 2.47)	<0.001*
Total defacto population with at least one ITN		3547	1177 (33.2)				

OR: Odds ratio; AOR: Adjusted odds ratio

* Statistically associated (AOR) with an increase in not using ITNs the night prior to the study

4.4 Cutaneous *Leishmaniasis* (CL) awareness, CL experience and CL related knowledge

When presented with pictures of skin lesions diagnosed as cutaneous *Leishmaniasis* from previous studies on cutaneous *Leishmaniasis* in the Volta Region of Ghana, 91.8% of the household heads interviewed admitted to having ever seen such lesions. Furthermore, 77.3% of them admitted to having ever heard about cutaneous *Leishmaniasis*. As a result, all household heads interviewed had either ever seen lesions of cutaneous *Leishmaniasis* or had heard about the disease (Table 31).

When asked about other community specific names used to describe cutaneous *Leishmaniasis*, either based on pictures of CL seen or based on the name of CL known in the study community, some names appeared dominant in some of the study communities. For instance, in Ashiabre, most household heads (82.0%) referred to CL as “Nato” while in Keri, 57% of them referred to CL as “Doti”. In Sibi Hilltop on the other hand, 52% of them referred to CL as “Mgbangba” with 35% of them calling it “Nato”. Across the study communities, 13% of the household heads referred to CL as “Mbuu” which is a Kokomba word for sore because to those household heads, CL was just sore which took a long time to heal. When asked whether CL was a problem in the study communities, 80% indicated that CL was a problem in their community (Table 31).

When asked five questions regarding CL related knowledge: cause of CL, how CL is transmitted, symptoms of CL, whether CL is preventable, and whether CL is treatable, 45% of the respondents indicated that CL is preventable while 80% indicated that CL is treatable. All respondents knew at least one symptom of CL. Regarding the cause of CL and how CL is transmitted, none of the household heads interviewed was able to provide a correct answer. A household head scored ‘good knowledge about CL’ when he/she correctly answered three or more of the five questions asked. Overall, 41% of the household heads scored ‘good knowledge about CL’ (Table 32).

Regarding CL experience, 48% of the household heads admitted to having previous personal history of the disease. Furthermore, 53% of them (64% in Ashiabre, 45% in Keri and 51% in Sibi Hilltop) indicated that they have had household members (excluding the household heads) with previous history of cutaneous leishmaniasis (Table 33).

Regarding number of household members (including the head of household) who had previous history of cutaneous leishmaniasis, a range of 1 to 10 was reported with 34% of the households reporting one person with a history of CL followed by 20% of households having two people with a history of CL. In all, 419 (71.4%) households reported at least one person including the household head with a previous history of CL (Table 33).

In the past two years preceding this study, 45.3% of household heads indicated that at least one member of their respective households (including the household head) had experienced CL. This proportion was 57.1%, 35.0%, and 44.4% in Ashiabre, Keri, and Sibi Hilltop respectively. A range of 1 to 8 household members were reported as having experienced CL in the past two years preceding this study initiation, in the households with a history of at least one case of CL (Table 33).

Beyond the respective households interviewed, 69% of the household heads indicated that they knew people in their community (outside of their households) who have had a history of cutaneous leishmaniasis (Table 3). Household heads were also interviewed regarding the months of the year, age groups, and occupational groups of people in their respective communities that they see with CL. According to them, cases of CL were seen in the various months of the year but majority of them indicated the following months across the study communities: June (16%), July (17%), August (14%), and November (15%) (Table 34).

Regarding age groups of people seen with CL in the study communities, majority of household heads (67%) indicated people within the age group 5-17 years. This was followed by 40.5%, 30.0%, 21.0%, and 1.9% of respondents who indicated persons <5 years, 18-35 years, 36-60 years, and persons above 60 years respectively (Table 34). Household heads were then asked about occupational groups of people they saw with CL and majority of them (61%) mentioned farmers whilst 47% of them mentioned children/students (Table 34).

Table 31: Awareness of cutaneous leishmaniasis among household heads

CL Awareness	Category	Study communities			Total, n(%)
		Ashiabre, n(%)	Keri, n (%)	Sibi Hilltop, n(%)	
Ever seen CL lesions as presented in picture		170 (89.9)	182 (91.0)	187 (94.4)	539 (91.8)
Ever heard about cutaneous leishmaniasis		153 (81.0)	156 (78.0)	145 (73.2)	454 (77.3)
Ever seen CL lesions or heard about CL		189 (100)	200 (100.0)	198 (100.0)	587 (100.0)
Names used to describe cutaneous leishmaniasis in community:					
	Doti	0 (0)	114 (57.0)	1 (0.5)	115 (19.6)
	Kpakpai	15 (7.9)	2 (1.0)	6 (3.0)	23 (3.9)
	Mbuu	22 (11.6)	4 (2.0)	49 (24.7)	75 (12.8)
	Mgbangba	1 (0.5)	0 (0)	103 (52.0)	104 (17.7)
	Nato	155 (82.0)	9 (4.5)	69 (34.8)	233 (39.7)
CL is a problem in this community		170 (90.0)	158 (79.0)	141 (71.2)	469 (79.9)
Total		189 (100)	200 (100.0)	198 (100.0)	587 (100.0)

Table 32: Cutaneous leishmaniasis related knowledge among household heads across study communities

	Study communities			Total, n(%)
	Ashiabre, n(%)	Keri, n (%)	Sibi Hilltop, n(%)	
Know the cause of CL	0 (0)	0 (0)	0 (0)	0 (0)
Know how CL is transmitted to people	0 (0)	0 (0)	0 (0)	0 (0)
Know CL symptoms	189 (100.0)	200 (100.0)	198 (100.0)	587 (100.0)
Know that CL is preventable	93 (49.2)	90 (45.0)	82 (41.4)	265 (45.1)
Know that CL is treatable	160 (84.7)	159 (79.5)	152 (76.8)	471 (80.2)
Overall good knowledge about CL	92 (48.7)	79 (39.5)	72 (36.4)	243 (41.4)
Total	189 (100.0)	200 (100.0)	198 (100.0)	587 (100.0)

Table 33: Household head report of CL experience at personal, household and community level

CL Experience	Study communities			Total, n(%)
	Ashiabre, n(%)	Keri, n (%)	Sibi Hilltop, n(%)	
Household head history of personal CL experience	78(41.3)	95 (47.5)	106 (53.5)	279 (47.5)
Household member (excluding household head) history of CL experience	120(63.5)	89 (44.5)	100 (50.5)	309 (52.6)
Households with various numbers of household members (including household head) with a history of CL experience:				
1	72 (38.10)	69 (34.5)	56 (28.3)	197 (33.6)
2	22 (11.6)	56 (28.0)	39 (19.7)	117 (19.9)
3	23 (12.2)	10 (5.0)	25 (12.6)	58 (9.9)
4	13 (6.9)	3 (1.5)	13 (6.6)	29 (4.9)
5	6 (3.2)	0 (0)	4 (2.0)	10 (1.7)
>5	6 (3.2)	0 (0)	2 (1.0)	8(1.4)
Maximum	10	4	6	10
Awareness of people in the community (outside personal household) with a history of CL experience	149(78.8)	132 (66.0)	126 (63.6)	407 (69.3)
Any household member (including household head) with CL experience within the past 2 years:	108(57.1)	70 (35.0)	88 (44.4)	266 (45.3)
Number of household members (including household head) with CL experience CL within past two years:				
1	55 (29.1)	35 (17.5)	31 (15.7)	121 (20.6)
2	20 (10.6)	23 (11.5)	26 (13.1)	69 (11.8)
3	17 (9.0)	11 (5.5)	17 (8.6)	45 (7.7)
4	9 (4.8)	1 (0.5)	8 (4.0)	18 (3.1)
5	3 (1.6)	0 (0)	4 (2.0)	7 (1.2)
>5	4 (2.1)	0 (0)	2 (1.0)	6 (1.0)
Maximum	8	4	6	8
Number of households interviewed	189 (100)	200 (100.0)	198 (100.0)	587 (100.0)

Table 34: Months of year, age groups, and occupational groups seen with CL in study communities

Characteristic	Categories	Study communities			
		Ashiabre, n(%)	Keri, n (%)	Sibi Hilltop, n(%)	Total, n(%)
Months of the year cases of CL are seen in this community:					
	January	10 (5.3)	10 (5.0)	13 (6.6)	33 (5.6)
	February	2 (1.1)	3 (1.5)	5 (2.5)	10 (1.7)
	March	5 (2.6)	6 (3.0)	9 (4.5)	20 (3.4)
	April	5 (2.6)	3 (1.5)	7 (3.5)	15 (2.6)
	May	10 (5.3)	8 (4.0)	3 (1.5)	21 (3.6)
	June	22 (11.6)	41 (20.5)	33 (16.7)	96 (16.4)
	July	36 (19.0)	24 (12.0)	40 (20.2)	100 (17.0)
	August	30 (15.9)	25 (12.5)	26 (13.1)	81 (13.8)
	September	15 (7.9)	18 (9.0)	20 (10.1)	53 (9.0)
	October	24 (12.7)	9 (4.5)	5 (2.5)	38 (6.5)
	November	34 (18.0)	26 (13.0)	30 (15.2)	90 (15.3)
	December	32 (16.9)	7 (3.5)	12 (6.1)	51 (8.7)
	All months	3 (1.6)	6 (3.0)	15 (7.6)	24 (4.1)
Age groups of people seen with CL in this community:					
	<5 years	64 (33.9)	98 (49.0)	76 (38.4)	238 (40.5)
	5-17 years	135 (71.4)	124 (62.0)	136 (68.7)	395 (67.3)
	18-35 years	53 (28.0)	52 (26.0)	71 (35.9)	176 (30.0)
	36-60 years	32 (16.9)	43 (21.5)	50 (25.3)	125 (21.3)
	>60 years	1 (0.5)	5 (2.5)	5 (2.5)	11 (1.9)
Occupational groups seen with CL in this community:					
	Farmers	103 (54.5)	119 (59.5)	133 (67.2)	355 (60.5)
	Hunters	30 (15.9)	46 (23.0)	47 (23.7)	123 (21.0)
	Traders	31 (16.4)	36 (18.0)	51 (25.8)	118 (20.1)
	Children/Students	93 (49.2)	95 (47.5)	87 (43.9)	275 (46.8)
	Civil Servants	5 (2.6)	13 (6.5)	16 (8.1)	34 (5.4)
	Total respondents	189 (100.0)	200 (100.0)	198 (100.0)	587 (100.0)

4.5 Presence of Sand Flies in Study Communities

A total of 218 sand flies comprising of 25 males and 193 females were trapped using both the CDC light trap and indoor aspiration methods. Sand flies were caught in all of the following locations; household compound, household sleeping area, church compound, inside church building, mosque compound, school compound, school KG classroom, school primary classroom, and school Junior high class room (Table 35).

Of the 193 female sand flies, 165 were trapped using the CDC light trap while 28 were trapped using the indoor aspiration method. Of the 165 female sand flies trapped using the CDC light traps, 131 (79.4%) were trapped from household compounds. In addition, 7 (4.2%), 25 (15.2%), and 2 (1.2%) were trapped from church compound, school compound, and mosque compound respectively (Table 35).

Of the 28 female sand flies caught using indoor aspiration, 9(32.1%), 2(7.1%), 3(10.7%), 3(10.7%), and 11(39.3%) were collected from Junior High School classroom, KG classroom, primary classroom, inside church, and household sleeping area respectively (Table 35).

Table 35: Summary of sandflies caught in study communities by sex, place of collection, and collection methods

Study Community	Outdoor/indoor collection	Place of collection	Sample collection Method	Sex of sand flies	No. of Flies
Ashiabre	Outdoor	Household Compound	CDC Light Trap	Female	77
Ashiabre	Outdoor	Church compound	CDC Light Trap	Female	2
Ashiabre	Outdoor	School compound	CDC Light Trap	Female	9
Ashiabre	Outdoor	Household Compound	CDC Light Trap	Male	14
Ashiabre	Indoor	School Junior High Classroom	Aspiration	Female	9
Ashiabre	Indoor	School KG Classroom	Aspiration	Female	2
Ashiabre	Indoor	School Primary Classroom	Aspiration	Female	3
Ashiabre	Indoor	Inside church	Aspiration	Female	3
Keri	Outdoor	Household compound	CDC Light Trap	Female	50
Keri	Outdoor	Church compound	CDC Light Trap	Female	3
Keri	Outdoor	Mosque compound	CDC Light Trap	Female	2
Keri	Outdoor	School compound	CDC Light Trap	Female	8
Keri	Outdoor	Mosque compound	CDC Light Trap	Male	1
Keri	Outdoor	Household compound	CDC Light Trap	Male	7
Keri	Indoor	Household sleeping area*	Aspiration	Female	10
Keri	Indoor	Household sleeping area**	Aspiration	Female	1
Keri	Indoor	Household sleeping area*	Aspiration	Male	2
Sibi Hilltop	Outdoor	Household compound	CDC Light Trap	Female	4
Sibi Hilltop	Outdoor	Church compound	CDC Light Trap	Female	2
Sibi Hilltop	Outdoor	School compound	CDC Light Trap	Female	8
Sibi Hilltop	Outdoor	Household compound	CDC Light Trap	Male	1
Total					218

*Room without bednet

** Room with old bednet (>6 years)

4.6 Malaria and *Leishmania* Infection among Participants with Temperature $\geq 38.0^{\circ}\text{C}$

Nine (0.3%) out of the 3440 individuals screened recorded an axillary temperature greater or equal to 38.0°C and were tested for malaria infection using malaria rapid test kit. All of the 9 persons reporting fever were positive.

Of the 9 persons, 4 (44.4%) were from Ashiabre while 5 (55.6%) were from Keri. Seven (77.8%) of the 9 persons were males while two of them were females.

Of the 4 malaria positive persons from Ashiabre, one was female. The ages of the malaria positive persons from Ashiabre were 4, 5 and 8 years with two of them being 5 years old.

Of the 5 malaria positive persons from Keri, one was female. The ages of the 5 malaria positive persons from Keri were 2, 4, 5 and 12 years old with two of them being 4 years old. As a result 7 out of the 9 malaria positive persons were 5 years old or younger.

All persons with fever were also tested for exposure to *Leishmania* parasite using the LST. Of these, two persons comprising a 4 year old male from Ashiabre and a 5 year old female from Keri were positive to the LST test.

Three persons comprising the 4 year old male from Ashiabre who was LST positive, a 5 years old male from Ashiabre, and a 12 years old male from Keri, had current skin ulcers among those reporting with fever. None of the samples of the skin ulcers obtained from the persons with fever were positive for *Leishmania* parasite.

CHAPTER FIVE

DISCUSSION

5.1 *Leishmania* infection and cutaneous leishmaniasis among study participants

Cutaneous leishmaniasis (CL) remains an important neglected tropical skin disease (Skin NTD) of public health importance and is the commonest form of leishmaniasis, characterized by skin lesions (mainly ulcers) which may result in scars, disability and stigma (Gabriel et al., 2019; Hay & Asiedu, 2018; World Health Organization, 2019c, 2019b).

The control of CL requires an understanding of the disease epidemiology including knowledge of the vectors, reservoirs and potential interventions (González et al., 2008, 2015). In the context of this study, confirmation of exposure to *Leishmania* infection using the Leishmanin skin test as well as detection of *Leishmania* infection in skin ulcers observed in communities without a previous documentation of *Leishmania* infection, is an important step towards understanding the epidemiology of the disease.

5.1.1 *Leishmania* infection using leishmanin skin test (LST) among study participants

Using the LST, an overall prevalence of 41.8% was determined for *Leishmania* infection, with individual community *Leishmania* prevalence of 39.4%, 55.1%, and 34.2% observed in Ashiabre, Keri, and Sibi Hill top respectively. This result therefore confirmed earlier suspicion of *Leishmania* infection in the study communities upon observation of skin ulcers which fit the clinical presentation of cutaneous leishmaniasis.

Data on LST positivity obtained from this study compares with that observed in some other African countries such as Mali where community based studies using LST observed *Leishmania* prevalence as high as 49.9% in certain communities with increase of prevalence associated with age groups such that in a certain community (Diema), *Leishmania* prevalence increased from 13.8% to 88% for age groups of 2-5 years and 41-56 years respectfully (Oliveira et al., 2009).

Systematic review of some studies conducted in Mali has further observed an overall prevalence of *Leishmania* infection using LST to be 22.1% while prevalence of CL among suspect cases was determined to be 40.3% (Kone et al., 2016).

In Tunisia, a cross-sectional survey for *Leishmania* infection among some households using the LST detected an overall prevalence of 57%, with age, personal or family history of cutaneous leishmaniasis, and whether the study community was an emerging or old focus of CL identified as determinants of *Leishmania* infection using the LST (Bettaieb et al., 2014)

Country wide estimates for *Leishmania* infection in Ghana is currently not available. Data obtained from this study on *Leishmania* infection therefore augments existing data on leishmaniasis in Ghana and Africa as a whole where a general paucity of data on leishmaniasis exists (Jorge Alvar et al., 2012).

As has been observed in other studies, this study detected significant association between increase in the prevalence of LST positivity and increase in age across the study communities (Bettaieb et al., 2014; Traore et al., 2016).

The observation of a significant association between increase in LST positivity and increasing age suggests a need to put in interventions to protect children in particular from exposure to *Leishmania* infection while additional studies are carried out to understand the reasons for the

increased prevalence observed among the older segments of the study population (Bettaieb et al., 2014; Traore et al., 2016).

Although *Leishmania* infection was observed in all three study communities, being a resident of study community Keri was significantly associated with increase in the likelihood of being exposed to the infection, while staying in Sibi Hill top was significantly associated with a less likelihood of being exposed to the infection, compared with being a resident of Ashiabre. This calls for more studies to better understand the characteristics of the study communities particularly with regards to determining how long members of the study communities may have been living with the health challenge of CL. This is important because of findings from other studies which observed higher prevalence of *Leishmania* infection in communities considered to be older/endemic foci for CL compared with those considered to be emerging foci (Oliveira et al., 2009; Traore et al., 2016).

Furthermore, observation of a significant association between being male and increased prevalence of *Leishmania* infection in the study communities calls for more studies to understand the daily activities of males in the study communities in order to develop appropriate measures to protect them from *Leishmania* infections. These findings corroborates Custodio et al., (2012) who found that sleeping outside, being male, and increasing age were associated with LST positivity in the highlands of northern Ethiopia.

Although in the present study, 89.2% of participants had been on open field either sometimes or often and 63.7% of study participants slept near forest or farm fields, their proximity to these areas being at open field or sleeping near forest was not significantly associated with LST

positivity. The factors associated with LST positivity in this study should therefore be taken into consideration in the development of CL control strategies in the study area.

5.1.2 Cutaneous leishmaniasis among study participants with skin ulcers

This study confirmed *Leishmania* infection in 150 (25.2%) out of 595 ulcer biopsies tested by PCR. This result therefore confirmed the existence of cutaneous leishmaniasis in the study communities. The overall prevalence of cutaneous leishmaniasis among those with skin ulcers was 31.9% (136/426) with prevalence of 23.2% (13/56), 29.8% (56/188), and 36.8% (67/182) observed in Ashiabre, Keri and Sibi Hilltop respectively. In Mali, a systematic review reported a prevalence of 40.3% for cutaneous leishmaniasis among suspected CL cases (Kone et al., 2016).

Majority of the persons with CL in this study (73.5%) were in the age group of 5-15 years, with males in this age group constituting majority of those infected among persons with skin ulcers. A study in Mali which conducted both LST for exposure to *Leishmania* parasites and also screened study participants with skin lesions for CL using PCR, confirmed *Leishmania* infection in skin ulcer samples from 8 persons who were all under 18 years (Traore et al., 2016).

In a study that evaluated CL in Afghanistan, the mean age of persons with the disease was 15 years with CL being significantly associated with persons' age, household prevalence and type of wall of houses (Reithinger et al., 2010).

A review of CL suggest that although *Leishmania* infection and subsequent leishmaniasis disease generally tends to be influenced by factors associated with the host, the parasite, as well as the disease vectors, the prevalence of CL usually increases with age till about 15 years. It is assumed that the prevalence of CL levels of at about 15 years because persons exposed early on in life to

Leishmania infection may have acquired some level of immunity to the infection by then (Reithinger, et al., 2007).

Detection of increased odds of exposure to *Leishmania* infection using LST among children 5-15 years in this study and subsequently observing the highest prevalence of CL in this age group suggest a need to prioritize this group in future CL control planning in the study area.

5.1.3 Treatment of persons with cutaneous leishmaniasis

An important aspect of disease control is treatment of affected people. The data on treatment of skin lesions by study participants indicate that majority of them use herbs (67.5%) followed by those who use hot stone (33.5%) and hot water (14.2%) respectively (Table 19).

In the case of cutaneous leishmaniasis, the first choice of treatment is pentavalent antimonials with its attendant cost and possible adverse effects (Aronson et al., 2010; Asilian et al., 2004; Berbert et al., 2018; Haldar et al., 2011; Hodiament et al., 2014).

However, the evidence for what can be described as optimal treatment for CL has been described as patchy and generally weak. There is therefore a need for the development of improved guidelines for management of CL in addition to the conduct of more robust studies to improve the existing body of evidence for treatment of CL (Berbert et al., 2018; Olliaro et al., 2013; Palumbo, 2009; Uribe-Restrepo et al., 2018).

Furthermore, although efforts are ongoing to develop a vaccine against leishmaniasis, there is currently no vaccine licensed for use against leishmaniasis (Whyte, et al., 2017; De Luca & Macedo, 2016).

Given the gaps in the treatment of leishmaniasis and ongoing global efforts to develop vaccines, there is a need to develop measures in the local Ghanaian context, to protect people who are affected by leishmaniasis while research continues to provide data on critical aspects of the disease such as the vectors and reservoirs.

5.1.4 Need for investigation of skin ulcers which were negative for *Leishmania* infection

Given that not all skin ulcers observed in the study communities were infected with *Leishmania* parasites, there is a need for continuous diagnoses of skin ulcers observed in the study communities in order to identify the ulcers infected by *Leishmania* parasite for the appropriate treatment to be applied (Cruz, et al., 2013; Foulet, et al., 2007; Goto & Lindoso, 2010b).

It was observed that 9 (69.2%) of 13 persons who tested positive to the treponemal only RDT were also positive to the DPP test (Tables 26-28). Interestingly, 11 ulcers obtained from the 9 persons who tested positive to the DPP RDT were all negative to the *Leishmania* PCR test. Examples of the ulcers observed on the 9 persons who were DPP RDT positive but whose ulcers were *Leishmania* test negative is presented in Figure 19.

The treponemal only as well as the DPP RDT which were designed for screening for syphilis have also been used in field studies in areas known to have cases of Yaws as a first line screening test. This has been possible because the causative agent for Yaws, *Treponema pallidum pertenue*, is a bacterium which closely resembles the causative agent of syphilis, *Treponema pallidum pallidum*, with the key difference being the fact that while syphilis is a venereal disease, Yaws is transmitted by skin-to-skin contact in warm and humid environments, usually among children (Oriol Mitjà, Kingsley Asiedu, 2013).

Although the treponemal only test has a limitation of not being able to differentiate between past and current treponemal infection, the DPP is able to differentiate between past and current infection and its widespread use in areas known to be endemic with Yaws has been suggested to improve understanding of worldwide Yaws case reporting (Marks et al., 2014, 2020).

A previous pilot study aimed at using azithromycin as treatment for Yaws in some communities of the West Akim district of Ghana also used sero-positivity based on a point of care dual treponemal and non-treponemal test as the primary outcome in addition to presentation with clinically active Yaws like lesions (as secondary outcome) to select Yaws cases (Abdulai et al., 2018).

As a result, future studies aimed at screening a larger sample of persons in the study area for Yaws and other skin ulcer causing diseases such as buruli ulcer, incorporating more sophisticated laboratory diagnostic approaches may help to better characterize the etiologies of the ulcers.

5.2 Insecticide Treated Bed Net Ownership, Access and Use

5.2.1 Insecticide treated bed net Ownership and access

Results from this study indicate that 570 households, representing 97.1% (95% CI: 95.4, 98.2) of the total owned at least one ITN. Similar proportions of ITN ownership was observed across the study communities with all the ITNs being the long lasting insecticidal net (LLIN) type. In addition, 86.8% (95% CI: 85.7, 87.9) of the population in the enrolled study households had access to ITN.

ITNs have been one of the main interventions for malaria control (World Health Organization, 2017a). In addition, it has been suggested that insecticide treated materials (ITMs) may be effective in the control of other vector borne diseases including CL, in areas where CL is co-endemic with malaria (Moosa-Kazemi, et al., 2007; WHO/Department of Communicable Disease Prevention, 1997; Wilson et al., 2014).

Between 2016-2018, Ghana was one of a total of 8 countries that received 50% of the global distribution of ITNs hence evaluation of ITN indicators in communities with suspected CL cases is an implementation research which provides feedback to inform future improvements of the intervention delivery (World Health Organization, 2019a)

Although documentation of previous studies on ITN in the study communities was not found, a study conducted in the year 2010 in the Hohoe municipality of the Volta region of Ghana among mothers/caregivers of children under five observed ITN ownership of 81.3% while another study conducted in the same municipality in the year 2016 among the same target group observed ITN ownership of 88.1% (Amedo, 2016; Nyavor, et al., 2017).

According to the 2014 Ghana demographic and health survey (DHS), 80.1% of households in the Volta Region (made up of the current Volta and Oti Regions) owned a bed net with 75.3% of households in the region owning bed nets of the LLIN type. In that survey, 70% of the de facto population of the then Volta region had access to an ITN (Ghana Statistical Service, 2015).

Furthermore, the 2014 Ghana DHS also observed that 59.8% of households in the Volta region had one bed net for every two household members with 54.0% of households in the region having one bed net of the LLIN type for every two household members (Ghana Statistical Service, 2015). On average, 65.8% of the households in this study had one ITN for every two household members .

Over the years, several countries including Ghana have made significant strides in increasing the number of households that own ITNs through the adoption of several ITN (intervention) delivery strategies such as mass ITN distribution campaigns (Baume & Franca-koh, 2011).

The observations made regarding bed net ownership and household population with access to ITN in this study were improvements over what was observed in the Volta region during the 2014 Ghana DHS as well as the individual studies in the Volta Region cited above. Current regional level estimates of the Oti Region for the ITN indicators discussed above will be helpful in comparing the observations in the study communities.

Evaluating access to ITN at both the household and individual levels is important in explaining the ITN use observed in a given setting. The fact that a household has at least one ITN may not mean that the household has enough ITNs such that every two household members could use one ITN if they decide to use the ITN (access). Given that 86.8% of study population and 65.8% of

study households had access to ITN suggests a need to improve the existing strategies of delivering ITNs to the study communities to ensure that all households have at least one ITN for every two household members (Seyoum et al., 2017).

5.2.2 Insecticide treated bed net use

Across the study communities, an average of 65.1% of the study population used the ITN the night prior to the interview (Figure 28). Among households having least one ITN for every two household members (access), 72.5% of their household population used ITN the night prior to the interview.

According to the 2014 DHS, only 36% of the household population in Ghana slept under an ITN. In that survey, the then Volta region recorded the highest proportions of household population using the ITN compared to other regions such that 53.7% of the household population in the region was reported to have slept under an ITN while 64.9% of the household population in households having at least one ITN slept under an ITN the night before the survey in the Volta region of Ghana (Ghana Statistical Service, 2015).

As a result, while data obtained from this study indicate a need to improve household access to ITN, it also suggests a need to put in measures to understand why some people in households with household access to ITN still fail to use the ITN. This may call for the development of context specific change communications strategy to promote ITN use among the general study population (Kilian et al., 2016; Pulford et al., 2011).

As a result, universal coverage, defined as all households having at least one ITN and at least 80% of household population using the ITN was not attained in any of the study communities (Larsen et al., 2010; Roll Back Malaria, 2009).

The fact that universal coverage of ITN was not achieved in the study communities suggests a need to review the current ITN delivery strategies to ensure that all households in these malaria endemic communities of Ghana attain universal coverage of ITN. This is important because of documented benefits of community wide high coverage of ITN on reduction of malaria morbidity and mortality as well as the anticipated benefits of this intervention against vectors of leishmaniasis, particularly in communities with malaria and leishmaniasis co-morbidity (Kilian, et al, 2009).

Furthermore, there may be a need to investigate what other uses the bed nets may be put to in the study communities which may reduce the number of bed nets available for the household use. This is because 496 (84.5%) of household heads indicated that at least one ITN had been disposed of from their households in the past 12 months prior to this study. Among the methods for net disposal indicated, 6.3% of household heads mentioned that they had reused the bed nets for other purposes.



Figure 22: Bed net observed hanging in sleeping area of a household

Across the study communities, it was observed that the use of ITNs cut across the age groups with the majority of users being in the 5-15 years group (42.1%) followed by those in the age group of 16-45 years (35.6%). Children under 5 years accounted for 13.3% of the ITN users. When ITN users were stratified by sex, it was observed that females of 16-45 years were the majority of net users (42.4%) while males of 5-15 years (47.3%) were the majority net users among the males. Regardless of sex, children under 5 constituted between 12.9%-13.7% of the ITN users among males and females respectively .

Considering the breakdown of household population by age group, children under 5 constitute 13.4% (12.8% of males and 13.4% of females) of household population among the study households. As a result, efforts should be made to encourage and possibly increase ITN use by

people of all age groups in the malaria endemic communities to ensure community wide benefits from the improvements in ongoing malaria control efforts which may be of benefit to the control of leishmaniasis, as has been observed in other countries such as India and Nepal (Maxwell et al., 2002; Picado, et al., 2010).

5.2.3 Factors associated with failure to use ITN

This study explored associations between the non-use of ITN and the socio-demographic variables. The lack of household access to ITN (AOR=1.80; CI: 1.31, 2.47), having family size of more than 10 members (AOR=2.53; CI: 1.20, 4.24), having more than 10 rooms for sleeping in a household (AOR=10.18; CI: 1.28, 81.00), having 2-4 screened windows (AOR=1.49; CI: 1.00, 2.20), and having 8-10 screened windows (AOR=3.57; CI: 1.25, 10.17) were found to be significantly associated with non-use of ITNs.

In a cross-sectional study conducted in south west Ethiopia, household having decreased access to ITN, and having household size of 4-6 members were significantly associated with failure to use ITN (Seyoum et al., 2017). Another cross-sectional survey conducted in Yemen found having three or more damaged LLINs in the house, individuals aged 16 years and above, and living in huts to be significantly associated with failure to use ITN (Al-Eryani et al., 2017).

Given that in this study, lack of household access to ITN was significantly associated with failure to use it, the national malaria control program should review its delivery mechanisms to ensure that all households own an ITN and at least 80% of all households in the study communities have a minimum of one ITN for every two members in order to achieve universal coverage (WHO Global Malaria Programme, 2014b; World Health Organization, 2017a).

Having increased family size (>10 members) and more than two screened windows were also observed to be associated with failure to use the ITN in this study. As a result, further studies on sleeping arrangements, housing conditions as well as reasons for non-use of ITN by larger families and households having at least two screened windows will help to develop strategies to improve use of ITNs in the study communities (Seyoum et al., 2017).

Factors associated with use of ITNs therefore tend to be context specific and varied. Identifying such factors and the people not using the ITNs presents an opportunity to both explore and understand their reasons for non-use in order to develop and adapt implementation strategies to encourage an increased use of the ITNs among community members (Baume & Franca-koh, 2011; Biadgilign et al., 2012; Fokam et al., 2017; Kimbi et al., 2014; Moon et al., 2016).

5.2.4 Insecticide treated bed net disposal in study communities

It was observed that various methods of net disposal were used by the 496 (84.5%) households which disposed of at least one ITN in the 12 months preceding this study. The commonest bed net disposal methods indicated was garbage or refuse dump, followed by burning. The mode of disposal of the ITNs and their non-biodegradable packaging materials is of concern due to its potential for environmental and human health harm. Efforts towards recycling these used bed nets should be explored to reduce their potential for human and environmental harm (Ghana Statistical Service, 2015).

In addition, majority (81.5%) of those who disposed of at least one bed net indicated that the nets were torn. This observation was similar to what was observed in the 2014 Ghana demographic

and health survey in which 82.9% of households surveyed in Ghana indicated that their main reason for treated bed net disposal was because the nets were torn (Ghana Statistical Service, 2015).

It was also observed in this study that 69.4% of the respondents disposed of their nets after using them for 2-4 years while 24.4% of the respondents disposed of nets which were less than 2 years old. While these results suggest a need to intensify campaigns about maintenance and retention of the ITNs to ensure that they are used longer without compromising their effectiveness, these findings also support the three-year serviceable life span recommendation of WHO for LLINs and which has been confirmed by other studies (De Sousa et al., 2019; Hakizimana et al., 2014)

5.2.5 ITN use and *Leishmania* infection in study communities

The Ghana national malaria control program distributes free insecticide treated bed nets to Ghanaian households through various channels such as free bed net distribution campaigns, and antenatal clinics. This distribution of insecticide treated bed nets is therefore encouraged as a preventive measure not only against vectors of malaria but against vectors of cutaneous leishmaniasis as well (González et al., 2015; Wilson et al., 2014).

The use of insecticide treated materials has been recommended to reduce the numbers of phlebotomine sand flies which may eventually lead to a reduction in the incidence of leishmaniasis (González et al., 2015).

However, this study did not observe a significant association between the non-use of insecticide treated bed net and *Leishmania* infection. Although systematic reviews have suggested that the use of insecticides including ITNs can be effective against sand fly vectors and thereby result in

a reduction in the incidence of leishmaniasis, other studies have also failed to establish any association between the ownership, use or non-use of insecticides including ITN and leishmaniasis (Reithinger et al., 2010).

This is an a example of a case where an evidence based intervention, in this case the ITN has been found to be effective, yet it does not appear to have the same effect in a real setting (Moosa-Kazemi, et al., 2007; Yaghoobi et al., 2006).

5.3 Cutaneous *Leishmaniasis* awareness, experience and knowledge

Measuring awareness about different aspects of cutaneous leishmaniasis is helpful in planning CL disease control programs (Sarkari et al., 2014). This study obtained information on household heads awareness of cutaneous leishmaniasis by asking whether they had seen people with CL (using pictures of CL lesions) or heard about CL using the context specific local name. All household heads had either seen or heard of CL which suggests a high level of awareness of the disease by its name and appearance. However, only some 77.3% of them were aware of the local name(s) used to describe CL.

This suggests that although the CL or CL like lesions was familiar to most household heads as evidenced by their response when the CL pictures were shown to them, some of them were not familiar with the local name used to describe CL. Recognition of the picture of CL lesions presented in itself may not necessarily indicate awareness of the CL lesion but suggests familiarity with such skin lesions. This is because there are several skin NTDS which share similar characteristics with CL. Some of these skin NTDs include Buruli ulcer, Yaws, leprosy,

cutaneous and muco-cutaneous ulcers, and this has resulted in a call for an integrated approach to tackling skin NTDs (Barogui et al., 2018; Yotsu, 2018).

Previous studies on CL in the Volta Region noted that CL was commonly referred to as ‘agbamekanu’ meaning gift from someone who has returned from a journey in the local Ewe language (Boakye et al., 2005; Doe, et al., 2019; Kwakye-Nuako et al., 2015; Kweku et al., 2011).

In this study, it was detected that household heads belonging to the Ewe ethnic group constituted only 0.5% of the household heads. Majority (62%) of the household heads in this study belonged to the Kokomba ethnic group followed by the Achode (21%) ethnic group, and others.

The diverse ethnic groups in the study communities also reflected in different local names used to describe CL. In Ashiabre, CL was predominantly referred to as “Nato” by 82% of household heads while in Keri and Sibi Hilltop, it was mainly called “Doti” and “Mgbangba” by 57% and 52% respectively. Across the study communities, 12.8% of the interviewed household heads used a local Kokomba name, “Mbuu”, which means sore, to describe CL. This is because to them, the CL lesion is a sore which is difficult to treat and takes a long time to heal.

The fact that 80% of respondents admit that CL was a problem in their community may also be of importance to future control efforts in terms of getting the buy-in of community stakeholders such as the household heads (Kebede et al., 2016).

Any future CL control program in this study area needs to take into account the different ethnic groups, particularly the different names used to refer to CL, in order to develop an appropriate control measure.

Results on CL related knowledge of household heads in this study suggest a gap in the knowledge of the causes and transmission of CL as none of the interviewees was able to correctly indicate the cause of CL or how CL is transmitted. There is therefore a need for increased awareness building activities about CL in the study areas in order to sensitize the community members about key aspects of the disease such as cause, mode of transmission, treatment and prevention (Akram et al., 2015; Ruoti et al., 2013).

A study in the Ho municipality of the Volta Region reported that community members had a reasonable knowledge of CL but lacked sufficient knowledge of the vector (Doe et al., 2019). Although household heads in this study exhibited high awareness about CL, 58.6% did not demonstrate good knowledge about key aspects of the disease. As a result, innovative approaches including direct, in-person training on CL for key stakeholders in the community such as the household heads may also help in improving preventative practices and attitudes towards CL (Kebede et al., 2016; Saberi et al., 2012). Future CL health education and awareness campaign activities should also focus on the vector of the disease to promote CL preventive behavior on the part of community members.

Regarding CL experience, the data summarized in Table 34 suggests that CL was quite common in the study communities as 69% of the interviewed household heads knew at least one person within their community (outside their home) who had a history of CL. Within the study households, a history of CL was reported for at least one person in 71.4% of the households while a history at least one person with CL in the past two years preceding the study was reported in 45.3% of the study households. The months of June, July, August, and November were mentioned by majority of the respondents as the months in which majority of the skin ulcers reported as CL were observed in the study communities.

Furthermore, in descending order, cases of CL were reported in the following age groups 5-17 years, < 5 years, 18-35 years, and 36-60 years. In terms of occupational groups observed with CL in the study communities, farmers were the majority (61%) followed by children/students (47%).

This information can be helpful for conducting follow-up investigations in the study area to better understand the epidemiology of the reported CL by taking into account the data provided regarding months of the year with most CL cases observed, occupational groups affected as well as age groups of people affected by CL.

The experience of CL may lead to social and mental dimensions for the affected people considering that the disease can be disfiguring and may also result in stigma. As a result, these reports of CL by the household heads require the attention of the Ghana health authorities as well as other stakeholders such as researchers to better understand and address the situation of skin ulcers in the communities (Bilgic-Temel et al., 2019; Khatami et al., 2018).

Although this study had no way of verifying that each number of persons reported in the respective households as having a history of CL within the past two years or earlier, actually had CL, the reports of CL obtained from the household heads interviewed is important because there are many NTDs that have major skin manifestations including ulceration. As a result, an unknown proportion of the reported history of CL may or may not actually be CL (Chandler & Fuller, 2018) .

However, what is not in doubt is the fact that the heads of households reported skin ulcers which to their understanding fits the clinical description of CL. An integrated skin NTD study in this area will therefore be very useful in determining what proportions of the reported skin ulcers

may not be CL and to determine which other skin NTD etiologies could be circulating in the study area (Chandler & Fuller, 2018; World Health Organization, 2019c; Yotsu, 2018).

5.4 Presence of sand flies within study communities

Using indoor aspiration and CDC light traps, 218 sand flies (25 males and 193 females) were trapped from various locations of the study communities where humans could be found such as household compounds, household sleeping areas, church compounds, inside church buildings, mosque compounds, school compounds, school KG classrooms, school primary classrooms, and school Junior high class rooms.

It is also important to indicate that, even among the vectors of *Leishmaniasis* in the Old World, some phlebotomine sand fly species have been more associated with certain species of the *Leishmania* parasite which has more than twenty parasite species known to infect humans. Of about 500 known phlebotomine sand fly species, only about 30 of them are known to transmit *Leishmania* parasites (Claborn, 2010; WHO, 2016a).

There is a need to confirm the presence of sand flies in a given setting in order to proceed with the next steps of investigating the sand fly species as well as determining whether or not the sand flies observed are infected with *Leishmania* parasites. Identification of sand flies in the communities investigated in this study presents an opportunity for the next steps of sand fly species identification and investigation of *Leishmania* infection to be carried out.

It is also worth noting that, out of the sleeping areas of thirty households (10 in each community) in which indoor aspiration was carried out, sand flies were trapped in only one household. All the other 29 households had ITN which was obtained within the past one year. The sand flies were

trapped in two rooms in a household and these rooms had peculiarities. One of the rooms had no bed net at all while the other room had an old bed net (more than 6 years old). All other rooms with ITN in this study recorded no sand flies. It is therefore important for future studies to be carried out to investigate the role of the ITN roll out in these study communities on the absence of sand flies observed in majority of the household sleeping rooms having ITN which were selected for indoor aspiration.

Furthermore, detection of sand flies in areas outside the household sleeping areas but with close proximity to human activities such as the household compounds, school compounds and classroom calls for a more integrated vector control approach to ensure a reduced contact with the sand flies as further studies are conducted to describe species and vector competence of sand flies in the study communities to transmit leishmaniasis (Claborn, 2010; Dostálová & Volf, 2012; WHO, 2016a).

5.4.1 Need for identification of vectors and reservoirs of *Leishmania* infection in Volta and Oti regions of Ghana

Previous vector studies in Ghana have confirmed DNA of *Leishmania* parasites such as *Leishmania tropica* and *Leishmania major* in sand flies belonging to the genus *Sergentomyia* (Nzeli et al., 2014a). Sand flies belonging to the genus *Sergentomyia* have not been confirmed as vectors of human *Leishmaniasis*. However, detecting species of *Leishmania* known to cause human *Leishmaniasis* in the Volta region calls for more studies to identify the likely putative vectors of those parasites (Maia & Depaquit, 2016).

It is also of interest to point out that several previous vector studies in Ghana aimed at identifying phlebotomine sand flies belonging to the order Diptera in the family Psychodidae (known vectors of leishmaniasis in the Old World) have resulted in identifying many species of sand flies mostly belonging to the genus *Sergentomyia* with only two species belonging to the genera *Phlebotomus* (*P. duboscqi* and *P. rodhaini*) detected in such low numbers that their vectorial role in Ghana is currently uncertain (Boakye et al., 2005).

Dogs, fox, rodents, and humans are among the documented reservoirs for CL in west Africa (Alemayehu & Alemayehu, 2017). The reservoir of cutaneous leishmaniasis in the Volta region of Ghana is currently uncertain. Previous attempts at identifying the potential reservoirs of leishmaniasis in the Volta region of Ghana were unsuccessful due to various reasons such as difficulty in trapping animals.

In the areas of the Volta region with reported CL cases during a suspected CL outbreak in the year 1999 in Ghana, keeping dogs was considered a taboo. As a result, although dogs have been documented as a reservoir for CL, they have not yet been investigated for *Leishmania* infection in Ghana. Goats were among the suspected reservoirs for leishmaniasis in the Volta region of Ghana. However, previous attempts to investigate *Leishmania* infection in goats suspected to have *Leishmania* infection did not find any such infection (Raczniak, et al., 2008).

In this current study, dogs were among the livestock owned by households and no taboos prevented dog ownership in this study area. In this study, 75.2% of study participants had some contact with dogs with 31.7% of participants having such contacts often. Furthermore, 79.7% of the study participants also indicated having some contact with goats (Table 11). As a result, new studies targeted at identifying reservoir of cutaneous leishmaniasis are needed to inform CL

control approaches in the Oti and Volta regions of Ghana (Alemayehu & Alemayehu, 2017; Boakye et al., 2005).

Despite the gaps mentioned above which calls for more studies on the different aspects of CL in the Volta region including the recently carved out Oti region, this study provides critical data on the epidemiology of *Leishmania* infections in the Oti region including age groups previously and currently exposed to *Leishmania* infection, which is important for guiding implementation of future CL control measures.

5.5 Fever among study participants

Fever has been documented as one of the human body's mechanisms for responding to various infections (Plaza, et al., 2016). All 9 persons reporting with axillary body temperature of 38°C or more during this study were positive for malaria infection using malaria RDT. As a result, while a more integrated approach for sand fly vector control approach is advocated, the continuation of insecticide treated bed net distribution program of the Ghana Health service is encouraged to ensure that the gains made on the malaria control front in the study area are not eroded.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study has demonstrated exposure to *Leishmania* infection in three communities of the Oti region of Ghana using the LST. Prevalence of *Leishmania* infection observed was 39.4%, 55.1%, and 34.2% in Ashiabre, Keri, and Sibi Hilltop respectively. Being male, living in Keri and being five years or older were associated with an increase in the odds of exposure to *Leishmania* infection using LST.

Out of 426 individuals observed with various numbers of skin ulcers in the study communities, majority (73.7%) were within the ages of 5-15 years. Of 136 individuals with various numbers of confirmed *Leishmania* positive skin ulcers, 100 (73.5%) were children within the ages of 5-15 years. The data obtained on exposure to *Leishmania* infection as well as actual *Leishmania* positive skin ulcers in the study area suggest an active cycle of transmission of *Leishmania* infection with children of the ages 5-15 years having the highest numbers of cases of cutaneous leishmaniasis.

This study also confirmed the presence of sand flies in the study communities in areas where people could easily be found such as household compounds, school compounds and classrooms, as well as church and mosque compounds.

In addition, this study evaluated the following indicators of insecticide treated bed net distribution program of the Ghana malaria control program: household ownership of at least one ITN (97.1%), households with at least one ITN for every two household members (65.8%),

population with access to ITN (86.8%), and population that slept in ITN the night prior to this study (65.1%). Household ITN access of 65.8% and use of ITN by 65.1% of the study population suggests room for implementation strategies to improve both access to ITN and use of ITN in the study communities in order to achieve universal coverage of ITN. However, no association was observed between non-use of ITN and Leishmania infection.

This study also identified the following factors as being significantly associated with non-use of ITN across the study communities: Lack of household access to ITN, having family size of more than 10 members, having more than 10 rooms for sleeping in a household, having 2-4 screened windows, and having 8-10 screened windows.

Because factors associated with using or not using ITNs tend to be context specific, identification of these factors is an opportunity for further studies to understand reasons for non-use in order to develop and adapt implementation strategies to encourage an increased use of the ITNs among community members (Baume & Franca-koh, 2011; Biadgilign et al., 2012; Fokam et al., 2017; Kimbi et al., 2014; Moon et al., 2016)

All household heads either knew a local name for CL or recognized the CL lesion as being familiar. Thus, the household heads had high awareness of CL based on the two criteria above. In addition, this study concluded that different local names were used to refer to CL in the respective communities and as such any future control intervention in the study area will have to take these different names into consideration.

Household heads confirmed that CL was common in their communities and indicated previous and recent (within two years prior to the start of the study) cases in the respective study communities. The reported experience of CL in the study communities suggested that cases of

CL were seen in all months of the year with majority of cases seen in the months of June, July and November of the year.

In descending order, the following age groups were reported as having experienced CL: 5-17 years, < 5 years, 18-35 years, and 36-60 years. Farmers and children were mentioned by 61% and 47% of household heads as occupational groups commonly seen affected by CL. Results of PCR test confirm that majority of those with CL in the study community were within the ages 5-15 as was reported by the household heads.

Less than half of the interviewed household heads (41.4%) demonstrated overall good knowledge about cutaneous leishmaniasis. This calls for strategies to improve overall awareness of the various aspects of cutaneous leishmaniasis disease in order to ensure improvements in future interventions for disease control.

6.2 Public health importance of the findings from this study

This study has demonstrated exposure to *Leishmania* infection and cutaneous *Leishmaniasis* (CL) in three communities of the Oti region of Ghana which had no previous documentation of *Leishmania* infection. Identification of cases of cutaneous *Leishmaniasis* in such communities forms a basis for future studies to investigate key aspects of the disease such as vectors and reservoirs.

Furthermore, identification of these CL cases calls for measures to provide appropriate CL treatment for affected people who otherwise may have been treated as having other types of ulcers.

This study also investigated and demonstrated gaps in CL related knowledge of interviewed household heads. This information can form a basis for future interventions such as behaviour

change communication approaches to improve community awareness about key aspects of CL such as mode of transmission and CL preventive measures.

Documentation of key indicators of ITN in the study communities and observation of gaps in the household access and use of ITN provides a basis for implementation strategies to improve household access to as well as use of ITNs in the study communities.

6.3 Contribution to knowledge

This study described prevalence of exposure to *Leishmania* infection and also confirmed *Leishmania* infection in skin ulcers obtained from three communities of the Oti region of Ghana without a previous documentation of *Leishmania* infection.

Although experimental studies and systemic reviews have suggested an effect of insecticide use on reducing the incidence of leishmaniasis, no association was observed between non-use of ITNs and exposure to *Leishmania* infection in this study which was conducted in a real-world setting.

This study confirmed the possibility of multiple aetiologies of skin ulcer in the study community and calls for an integrated skin NTD approach.

This study further investigated and confirmed the presence of sand flies in three communities of the Oti region which had cases of cutaneous leishmaniasis.

Although household heads demonstrated high awareness about CL, this study identified gaps in their knowledge about CL.

6.4 Limitations of the study

- This study was a community based cross-sectional study which only used quantitative research methods. A better understanding of some aspects of the study such as reasons for non-use of ITN could have been achieved if qualitative methods were included.
- Also, a longitudinal study of both sand flies and human *Leishmania* infection would have enriched the data.

6.5 Recommendations

6.5.1 Research

1. Studies to investigate species of *Leishmania* parasites causing human cutaneous leishmaniasis in the study communities.
2. Research to characterize species of sand flies in the study communities.
3. Investigation of *Leishmania* infection in sand flies in the study communities.
4. Research to investigate reservoirs of *Leishmania* infection in the study communities.
5. Investigation of additional aetiologies of skin diseases (Skin NTDS) in the study area

6.5.2 Ghana Health Service

1. Identification of cases of cutaneous leishmaniasis calls for treatment of the affected people. The Ghana Health service should therefore develop and put in place measures to treat the affected people.
2. The service should also develop and put in place community sensitization programmes.

6.5.3 World Health Organization

1. The assistance of WHO with the development of clinical guidelines for CL case identification and management in Ghana.

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Appendix 1: ETHICAL CLEARANCE FOR THE STUDY

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.



Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com
2nd October, 2018

MyRef. GHS/RDD/ERC/Admin/App 18/412

Your Ref. No.

Richard Adjei Akuffo
University of Ghana
School of Public Health
Legon, Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	GHS-ERC006/08/18
Project Title	Leishmania Infection and Use of Insecticide Treated Bed Net (ITN) in Selected Communities of Volta Region, Ghana – An Implementation Research
Approval Date	2 nd October, 2018
Expiry Date	1 st October, 2019
GHS-ERC Decision	Approved

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report **after completion** of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
PROFESSOR. MOSES AIKINS
(GHS-ERC VICE- CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

Appendix 2: Consent Form

TITLE: *Leishmania* infection and use of insecticide treated bed net in selected communities of Volta region, Ghana –An implementation research

Principal Investigator: Mr. Richard Akuffo

School of Public Health, University of Ghana

Introduction: This consent form contains information about the research named above. In order to be sure that you are informed about being in this research, please take the time to read this consent form. You will also be asked to sign it or make your mark in front of a witness. A copy of the completed consent form will be given to you. This consent form might contain some words that are unfamiliar to you. Please ask for explanation of anything you may not understand.

General Information about the Research:

You are invited to participate in this research study titled, “Leishmania infection and use of insecticide treated bed net (ITN) in selected communities of Volta region, Ghana –An implementation research”. This study is part of a PhD research at the School of Public Health, University of Ghana and is sponsored by the Special Programme for Research and Training in Tropical Diseases (TDR) at the World Health Organization. Participation in this study is entirely voluntary. Before you decide to participate in this study, please take as much time as you need to read this information sheet and to ask any questions you may have about the study.

In the year 1999, there were some people from the Ho municipality who developed skin lesions (sores) suspected to be cutaneous leishmaniasis. Samples from a few of the people who had developed such lesions have been taken to identify the cause of the lesions. However, the magnitude of the lesions in the municipality has not yet been well studied. As a result, this study is being conducted to investigate the magnitude, distribution, as well as knowledge, attitudes and practices related to cutaneous leishmaniasis in your community. Knowledge of this information will provide opportunity for us to investigate factors which expose people to the infections which cause the lesions in your community. Subsequently, this information will help health authorities in Ghana to protect people in the municipality against the organism that causes the lesions.

Study Participants

You may participate in this study if you are between the ages of 2-65 years old, a permanent resident of your community (resident for at least the past 12 months).

Study Procedures

If you agree to participate, we will ask of your age, ethnicity, profession and other basic questions about your life and record your home location. We will perform a physical exam and take a brief medical history.

If upon physical examination, we notice a lesion (sore), we will take a photograph of the sore. Afterwards, we will take small skin sample from your sore. This will be done by scraping the sore and using a thin needle to remove any fluid in the sore. This sample will be used for standard tests to find the germ causing the sore. We will also perform a skin test called Leishmanin Skin Test or LST which

involves injection of the skin of your arm. Two days later, we will look for a bump at the injection site to see if the skin reacts to the LST.

If your skin reacts to the LST, called LST positive, it means that you have already been naturally exposed to the organism that causes the lesion. If your skin does not react to this test (called LST negative), it means that you may have not been infected with the organism in the past.

Sand fly collection from homes

As part of this study, a random sample of households within your community shall be selected for sand fly collections. If your household is selected, we shall place sand fly traps in your house including where you sleep for 3 consecutive nights each month for 3 months. The traps do not contain any chemicals or substances that could harm you. These traps use a small light to attract the sand flies. We may also put traps near your animals if you have animals within your household. The sand flies will be trapped in a container and held until our study team comes to remove the trap.

Risks/Discomforts: Performance of LST is associated with minimal discomfort. Although we will use new needles that are very small to perform the skin test, this procedure may be slightly uncomfortable or result in local skin irritation. In addition, fine needle aspirates (FNA) or skin scrapings of suspected CL lesions may cause some discomfort and bleeding. After scraping, the small wound area will be covered with an antiseptic ointment to avoid any risk of bacterial infection.

Potential Benefits: You may receive no direct benefit from participating in this study, but we may gain knowledge about the distribution of cutaneous leishmaniasis (CL) in the Ho municipality which can help Ghanaian health authorities to plan preventive measures against exposure to the organism that cause it.. Furthermore, if you are suspected to have CL upon screening, you will be directed to the nearest health center for medical attention.

Alternatives to Participation: Participation in this study is completely voluntary, meaning you are free to participate or not.

Confidentiality: Information provided by you or obtained from the LST will be strictly confidential. To guard your identity, names will not be used on the data collection forms; only a research identification number will be used. Findings from this study may be published, but we will never use your name or identification information in any publication. The study staff and the ethics review committee may look at your records obtained from this study. By agreeing to enroll in this study you give these people the right to check your study records. However, they are required to keep any information provided by you or others in this study private. Mr. Richard Akuffo from the School of Public Health, University of Ghana is responsible for the long-term storage of the research records related to your participation in this study.

Compensation: There will be no compensation to you for being a part of this study.

Additional Cost: There will be no additional cost to you for participating in this study.

Future Use of Biological Materials: You will be asked if you will allow us to use any leftover specimens for future testing or studies. Your/your child's name will not be recorded on the sample and nobody will know if it is yours/your child's. If you do not want us to use these samples in the future you are free tell us that you do not want any additional testing done. You/Your child may still participate in the study even if you do not want any future testing on the samples you provide.

If You Have a Problem or Have Other Questions: You are encouraged to ask questions at any time before and during the study. If you/your child have/has questions about this study, please contact Mr. Richard Akuffo at +233-243834945 or richard.akuffo@gmail.com.

You may also contact Ghana Health Service Ethics Review Committee Administrator, Hannah Frimpong, 233 (0) 243235225 or 0507041223, Hannah.Frimpong@ghsmai.org

Participation Agreement: I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any question I have asked have been answered to my satisfaction. I consent voluntarily to participate in this study and understand that I have the right to withdraw from the study at any time.

Signature (or Thumbprint) of Participant (Parent or Legal Guardian)

Date (DD/MM/YY)

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

Printed Name and Signature of Person Who Obtained Consent

Date (DD/MM/YY)

**If consent WAS provided, the patient will be enrolled in the study.*

** If the patient did NOT consent to participate in the study, all study procedures must stop at this time.*

Statement Regarding the Disposition of Biological Specimens: If you agree to participate in this study and you have a skin lesion, we will take some specimen from your skin lesion. These samples will be tested in Ghana at the Noguchi memorial institute for medical research (NMIMR) for the possible cause of the lesions. The samples may be stored up to 10 years. If any sample remains after that time, it will be destroyed. We are asking you to allow us to use any leftover specimens that we obtain today for other laboratory tests in the future. Testing may be done to evaluate new ways to diagnose the skin lesions. Before any future tests are carried out on any left-over samples, clearance will be obtained from a recognized institutional review committee such as the Ghana Health Service (GHS) Ethical Review Committee. We will not use these samples to perform any genetic testing. Your name will not be recorded on the sample and nobody will know it is yours or your child's. Because a name will not be recorded we cannot provide you with the results of any future tests. If you do not want us to use these samples in the future you are free to say that you do not want any additional testing done. You/your child may still participate in the study even if you do not want any future testing done on the samples you provide.

Agreement Regarding the Disposition of Biological Specimens: I agree to allow NMIMR to store and use any leftover samples taken today for laboratory tests in the future. I understand that no information will be recorded that will identify those samples as belonging to me and I will not be notified of the results of any future tests on these samples.

I wish I do not wish (to approve the storage of my sample for future research)

* If the patient does NOT authorize the use of biological material in future studies, the patient ID must be recorded and all samples discarded after protocol procedures are complete.

Statement Regarding Child Assent:

For participants under the age of 18 years but greater than or equal to 5 years.

By making a mark or thumb printing below, it means that you understand and know the issues concerning this research study. If you do not want to participate in this study, please do not sign this assent form. You and your parents will be given a copy of this form after you have signed it.

This assent form which described the benefits, risks and procedures for the research titled "*Leishmania* infection and use of insecticide treated bed net in selected communities of the Volta region, Ghana" has been read and or explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate.

Age: Is the child between 5 and 18 years old? Yes No

Child's Response to Participation: Yes No

Note: Any child whose age is greater than or equal to 5 years AND less than 18 years must sign/thumbprint the space provided below.

Child's Signature/Thumbprint _____ Date _____

** If child assent WAS provided, the child will be enrolled in the study.*

** If the child did NOT provide assent to participate in the study, all study procedures must stop at this time.*

Appendix 3: Individual case report

INDIVIDUAL CASE REPORT

HOUSEHOLD INFORMATION PANEL		HH
HH1A. Cluster number: ___ ___ ___	HH2. Household number: ___ ___ ___ ___	
HH1B. Community name: _____		
HH3. Interviewer name and number: Name _____	HH4. Supervisor name and number: Name _____	
HH5. Day / Month / Year of interview: ___ / ___ / _____		Study ID: _____ HH Line# ___
HH6. Area: Urban 1 Rural 2	HH7. District: Nkwanta South 1 Nkwanta North 2 Ho 3 Other Specify 4	

DOB (dd/mm/yyyy): ___ / ___ / ___ Age: ___ Gender: 1. Male 2. Female

Occupation: 1. Farmer 4. Trader 7. Military
 2. Logger 5. Student 8. Hunter
 3. Teacher 6. Civil Servant 88. Other (specify): _____

1. Have you ever had any skin lesions?
 0. No → **GO TO 9**
 1. Yes → When? (mm/yyyy) ___/___

2. Did any of your previous skin lesions result in scars?
 0. No
 1. Yes

3. Do you think any of your skin lesions was due to cutaneous leishmaniasis?
 0. No
 1. Yes
 99. Don't know

4. Do you currently have any skin lesions?
 0. No → **GO TO 6**
 1. Yes

5. When did this current skin lesion start? (mm/yyyy) ___/___

6. How many scars do you have currently?
 ___ scars. 3. None

7. Have you ever treated any of your skin lesion(s)?
 0. No
 1. Yes

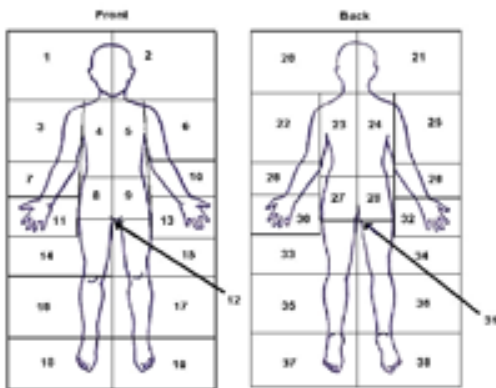
8a. Where did you go for treatment? (Multiple answers)
 0. Nowhere (self-treatment)
 1. Hospital
 2. Traditional healer (self treatment)
 3. Pharmacy
 4. Other (Specify).....

8b. What did you use for treatment? **READ EACH RESPONSE AND MARK ALL THAT APPLY:**
 1. Herbs
 2. Hot stone
 3. Dermacort Hydrocortisone cream (Observed)

7. No idea
 7. Other (Specify).....
 8c. How many days did the treatment last? _____ days
 8d. Did you complete the treatment?
 0. No → Specify why not? _____
 1. Yes
 8e. What was the outcome?
 1. Cured
 2. Treatment failure
 3. Relapsing

PHYSICAL EXAMINATION

9. Height: _____ cm 10. Weight: _____ kg
 11. Temperature: _____ °C 1. Orally 2. Axillary
 12. Total number of suspected active lesions: _____ lesion(s)
 13. Complete the table with all the information from each



lesion. Use the figure to localize the lesions on the patient's body.

#	Begin. Date (mm/yy)	Type	Localization (code)	Size (mm)	Sample taken (Y/N)
A				/	
B				/	
C				/	
D				/	
E				/	

Type

1. Ulcer
 2. Nodule
 3. Papule
 4. Plaque
 5. Scar

Sample taken

1. Tissue aspirate
 2. Lancing sampling
 3. Biopsy sampling
 4. Filter paper

III. EPIDEMIOLOGY

14. Places of residence in the last 5 years (stayed more than 1 month)

#	From (M/Y)	To (M/Y)	Region	District	Village	Occup.
A						
B						
C						

D					
E					
F					
G					

Occupation:

1. Farmer 2. Logger 3. Teacher
 4. Trader 5. Student 6. Civil Servant
 7. Military 8. Hunter
 88. Other (specify):

Please, answer the following questions about your practices and behaviors during your daily routine: MARK ONLY ONE ANSWER PER QUESTION:

1 2 3 4 5

 Never Rarely Sometimes Often Always

	Rating	Does not apply
15. Do you use mosquito repellent?		
16. Do you use long sleeves		
17. Have contact with dogs		
18. Have contact with goats?		
19. Do you have contact with other domestic animals		
20. Have you been at open field at dawn or sunset		
21. Do you sleep in bed nets		
22. Do you sleep in rooms or places with open windows without screen?		
23. Do you sleep in areas near to forest or farm fields?		
24. Did you spray your bedroom with insecticide in the last six months?		
25. Have you had mosquito bites		
26. Have you had bites from other insects?		

27. Specify any insects which has bitten you (other than mosquitoes) in the last six months?

.....
 Does not apply 3

IV. LABORATORY (Q29-33 ONLY FOR THOSE WITH SUSPECT CL LESION)

	Result	Result:
28. Malaria RDT		0. Negative
29. Direct observation		1. Positive
30. Culture		99. Not performed
31. LST		
32. Real time PCR		

33. *Leishmania* species causing the current episode:

1. *L. major*
 2. *L. tropica*
 3. *L. ethiopic*
 98. Unknown



HH14. Field edited by (name and number): _____

HH15.
Record the time.

Hours ____

Minutes ____

HOUSEHOLD LISTING FORM				HL
<p>FIRST, PLEASE TELL ME THE NAME OF EACH PERSON WHO USUALLY LIVES HERE, STARTING WITH THE HEAD OF THE HOUSEHOLD. <i>List the head of the household in line 01. List names of all household members (HL2), their relationship to the household head (HL3), and their sex (HL4)</i></p> <p>Then ask: ARE THERE ANY OTHERS WHO LIVE HERE, EVEN IF THEY ARE NOT AT HOME NOW? <i>If yes, complete listing for questions HL2-HL4. Then, ask questions starting with HL5 for each person at a time.</i></p>				
	For household members age 15 and above	Women age 15-49	For children under 5 years of age	For all household members

HL1 Line no.	HL2. Name	HL3. WHAT IS THE RELATIONSHIP OF (name) TO THE HEAD OF HOUSEHOLD?	HL4. IS (name) MALE OR FEMALE ?		HL5. WHAT IS (name)'s DATE OF BIRTH?		HL6. HOW OLD IS (name)?	HL7. WHAT IS (name)'s CURRENT MARITAL STATUS?	HL8.	HL9	HL10. WHAT IS (name)'s NATIONALITY?	HL11. WHERE WAS (name) BORN?		HL12. FOR HOW MANY YEARS HAS (name) LIVED IN THIS VILLAGE/ TOWN? <i>Record zero if less than one year</i>		
			M	F	MM	Year						IN THIS VILLAGE OR TOWN?	ELSEWHERE?			
Line	Name	Relation	M	F	MM	Year	Age	Marital status	15-49	Under 5	Nationality	Y	N	Village/Town	Code	Years
01		0 1	1	2	__	_____	__	1 2 3 4	01	01	--	1	2→	_____	__	__
02		__	1	2	__	_____	__	1 2 3 4	02	02	--	1	2→	_____	__	__
03		__	1	2	__	_____	__	1 2 3 4	03	03	--	1	2→	_____	__	__
04		__	1	2	__	_____	__	1 2 3 4	04	04	--	1	2→	_____	__	__
05		__	1	2	__	_____	__	1 2 3 4	05	05	--	1	2→	_____	__	__
06		__	1	2	__	_____	__	1 2 3 4	06	06	--	1	2→	_____	__	__
07		__	1	2	__	_____	__	1 2 3 4	07	07	--	1	2→	_____	__	__
08		__	1	2	__	_____	__	1 2 3 4	08	08	--	1	2→	_____	__	__

HL1 Line no.	HL2. Name	HL3. WHAT IS THE RELATIONSHIP OF (name) TO THE HEAD OF HOUSEHOLD?	HL4. IS (name) MALE OR FEMALE ?		HL5. WHAT IS (name)'s DATE OF BIRTH?		HL6. HOW OLD IS (name)? <i>Record in completed years. If age is 95 or above, record '95'</i>	HL7. WHAT IS (name)'s CURRENT MARITAL STATUS? 1 Married or living together 2 Divorced/ separated 3 Widowed 4 Never married or lived together	HL8. <i>Circle line number if woman is age 15-49</i>	HL9 <i>Circle line number if child is under 5 years of age</i>	HL10. WHAT IS (name)'s NATIONALITY? <i>Insert appropriate nationality code</i>	HL11. WHERE WAS (name) BORN?		HL12. FOR HOW MANY YEARS HAS (name) LIVED IN THIS VILLAGE/ TOWN? <i>Record zero if less than one year</i>		
			1 Male 2 Female	98 DK 9998 DK <i>Ensure that every person less than 6 years of age has a month and year of birth</i>	IN THIS VILLAGE OR TOWN?	ELSEWHERE? <i>Insert village or town name and appropriate birthplace code</i>						Y N	Village/Town Code		Years	
Line	Name	Relation	M	F	MM	Year	Age	Marital status	15-49	Under 5	Nationality	Y	N	Village/Town	Code	Years
09		__ __	1	2	__	__ __ __ __	__ __	1 2 3 4	09	09	__ __	1	2→	__ __	__ __	__ __
10		__ __	1	2	__	__ __ __ __	__ __	1 2 3 4	10	10	__ __	1	2→	__ __	__ __	__ __
11		__ __	1	2	__	__ __ __ __	__ __	1 2 3 4	11	11	__ __	1 2 3 8	__ __	1 2→	__ __	__ __
12		__ __	1	2	__	__ __ __ __	__ __	1 2 3 4	12	12	__ __	1 2 3 8	__ __	1 2→	__ __	__ __
13		__ __	1	2	__	__ __ __ __	__ __	1 2 3 4	13	13	__ __	1 2 3 8	__ __	1 2→	__ __	__ __
14		__ __	1	2	__	__ __ __ __	__ __	1 2 3 4	14	14	__ __	1 2 3 8	__ __	1 2→	__ __	__ __
15		__ __	1	2	__	__ __ __ __	__ __	1 2 3 4	15	15	__ __	1 2 3 8	__ __	1 2→	__ __	__ __

Tick here if additional questionnaire used

Probe for additional household members.
 Probe especially for any infants or small children not listed, and others who may not be members of the family (such as servants, friends) but who usually live in the household.

* Codes for HL3: Relationship to head of household:

Codes for HL10: Nationality

Codes for HL11: Birthplace

01 Head	09 Brother-In-Law / Sister-In-Law
02 Wife / Husband	10 Uncle / Aunt
03 Son / Daughter	11 Niece / Nephew
04 Son-In-Law / Daughter-In-Law	12 Other relative
05 Grandchild	13 Adopted / Foster / Stepchild
06 Parent	14 Not related
07 Parent-In-Law	98 Don't know
08 Brother / Sister	

01 Ghanaian by birth
02 Ghanaian by naturalisation
03 Dual nationality (Ghanaian & other)
04 African
05 European
06 American (North, South & Caribbean)
07 Asian & Oceanian (incl. Australia & New Zealand)
98 Don't know

01 Western region	09 Upper East
02 Central region	10 Upper West
03 Greater Accra	11 Africa
04 Volta region	12 Europe
05 Eastern region	13 Americas (North, South & Caribbean)
06 Ashanti region	14 Asia
07 Brong Ahafo region	15 Oceania
08 Northern region	98 Don't know

RESIDENCE AND EDUCATION **ED**

For all household members *For those 11 years of age and above* *For those 5 years of age and above*

ED1. <i>Line no.</i>	ED2. <i>Name and age</i> <i>Copy from Household Listing Form, HL2 and HL6</i>	ED3. <i>DID (name) STAY HERE LAST NIGHT?</i> 1 Yes 2 No	ED4. <i>DID (name) LIVE HERE MOST OF THE LAST 6 MONTHS?</i> 1 Yes 2 No	ED5. <i>DOES (name) EXPECT TO LIVE HERE FOR MOST OF THE NEXT 6 MONTHS?</i> 1 Yes 2 No 8 DK	ED6. <i>IN WHAT LANGUAGE CAN (name) READ AND WRITE?</i> <i>Code:</i> 1 None (not literate) 2 English only 3 Ghanaian only 4 English & Ghanaian 5 English & French 6 Other language than Ghanaian, English or French 8 DK	ED7. <i>HAS (name) EVER ATTENDED SCHOOL OR PRE-SCHOOL?</i> 1 Yes 2 No ⇨ <i>Next line</i>	ED8. <i>DURING THE PRESENT SCHOOL YEAR, DID (name) ATTEND SCHOOL OR PRESCHOOL AT ANY TIME?</i> 1 Yes ⇨ED10 2 No ⇨ED9	ED9. <i>WHAT IS THE HIGHEST LEVEL OF SCHOOL (name) ATTENDED? WHAT IS HIGHEST GRADE (name) COMPLETED AT THIS LEVEL?</i> Level: 0 Preschool 1 Primary 2 Junior HS 3 Senior HS 4 Higher 8 DK <i>If level=0, skip to next line</i> Grade: 98 DK <i>If less than 1 grade, enter 00.</i>		ED10. <i>DURING THIS SCHOOL YEAR, WHICH LEVEL AND GRADE IS (name) ATTENDING?</i> Level: 0 Preschool 1 Primary 2 Junior HS 3 Senior HS 4 Higher 8 DK <i>If level=0, skip to next line</i> Grade: 98 DK	
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Line	Name	Age	Yes	No	Yes	No	Yes	No	DK	Literacy code	Yes	No	Yes	No	Level	Grade	Level	Grade
01		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
02		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
03		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
04		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
05		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
06		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
07		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
08		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
09		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
10		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
11		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line
12		__	1	2	1	2	1	2	8	1 2 3 4 5 6 8	1	2	1⇨ED10	2	0 1 2 3 4 8	Next line	0 1 2 3 4 8	Next line

13		__	1 2	1 2	1 2 8	1 2 3 4 5 6 8	1 2	1⇒ED10 2	0 1 2 3 4 8	__	<i>Next line</i>	0 1 2 3 4 8	__	<i>Next line</i>
14		__	1 2	1 2	1 2 8	1 2 3 4 5 6 8	1 2	1⇒ED10 2	0 1 2 3 4 8	__	<i>Next line</i>	0 1 2 3 4 8	__	<i>Next line</i>

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
001	Does your household have any mosquito nets that can be used while sleeping?	YES 1.... NO 2....	136A
002	How many mosquito nets does your household have? IF 7 OR MORE NETS, RECORD '7'.	NUMBER OF NETS <input style="width: 30px; height: 20px;" type="text"/>	

		NET #1	NET #2	NET #3
003	ASK THE RESPONDENT TO SHOW YOU ALL THE NETS IN THE HOUSEHOLD IF MORE THAN 3 NETS, USE ADDITIONAL QUESTIONNAIRE(S).	OBSERVED HANGING 1 OBSERVED NOT HANGING OR PACKAGED ... 2 NOT OBSERVED .. 3	OBSERVED HANGING 1 OBSERVED NOT HANGING OR PACKAGED ... 2 NOT OBSERVED .. 3	OBSERVED HANGING 1 OBSERVED NOT HANGING OR PACKAGED 2 NOT OBSERVED . . . 3
004	How many months ago did your household get the mosquito net? IF LESS THAN ONE MONTH AGO, RECORD '00'.	MONTHS <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> AGO ... MORE THAN 36 MONTHS AGO . 95 NOT SURE 98	MONTHS <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> AGO ... MORE THAN 36 MONTHS AGO . 95 NOT SURE 98	MONTHS <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> AGO ... MORE THAN 36 MONTHS AGO .. 95 NOT SURE 98
005	Where did you get this net?	PUBLIC SECTOR GOVT. HOSPITAL/ POLYCLINIC ... 11	PUBLIC SECTOR GOVT. HOSPITAL/ POLYCLINIC ... 11	PUBLIC SECTOR GOVT. HOSPITAL/ POLYCLINIC 11

	<p>GOVT. HEALTH CENTE 12</p> <p>GOVT. HEALTH POST/CHPS . . . 13</p> <p>FIELDWORKER/ OUTREACH/ PEER EDUCATOR 14</p> <p>CAMPAIGN 15</p> <p>OTHER PUBLIC 16</p> <p>_____ (SPECIFY)</p> <p>PRIVATE MEDICAL SECTOR</p> <p>PRIVATE HOSPITAL/ CLINIC 21</p> <p>PHARMACY/CHEMICAL/ DRUG STORE . . . 22</p> <p>OTHER PRIVATE MEDICAL 26</p> <p>_____ (SPECIFY)</p> <p>OTHER SOURCE</p> <p>NGO/CBAs 31</p> <p>SHOP/MARKET . . . 32</p> <p>STREET VENDOR . 33</p> <p>PETROL STATION/ MOBILE MART . . . 34</p> <p>PRIMARY SCHOO . 35</p> <p>OTHER 36</p> <p>_____ (SPECIFY)</p> <p>DON'T KNOW . . . 98</p>	<p>GOVT. HEALTH CENTER 12</p> <p>GOVT. HEALTH POST/CHPS . . . 13</p> <p>FIELDWORKER/ OUTREACH/ PEER EDUCATOR 14</p> <p>CAMPAIGN 15</p> <p>OTHER PUBLIC 16</p> <p>_____ (SPECIFY)</p> <p>PRIVATE MEDICAL SECTOR</p> <p>PRIVATE HOSPITAL CLINIC 21</p> <p>PHARMACY/CHEMICAL/ DRUG STORE . . . 22</p> <p>OTHER PRIVATE MEDICAL 26</p> <p>_____ (SPECIFY)</p> <p>OTHER SOURCE</p> <p>NGO/CBAs 31</p> <p>SHOP/MARKET . . . 32</p> <p>STREET VENDOR . 33</p> <p>PETROL STATION/ MOBILE MART . . . 34</p> <p>PRIMARY SCHOO . 35</p> <p>OTHER 36</p> <p>_____ (SPECIFY)</p> <p>DON'T KNOW . . . 98</p>	<p>GOVT. HEALTH CENTE 12</p> <p>GOVT. HEALTH POST/CHPS 13</p> <p>FIELDWORKER/ OUTREACH/ PEER EDUCATOR 14</p> <p>CAMPAIGN 15</p> <p>OTHER PUBLIC 16</p> <p>_____ (SPECIFY)</p> <p>PRIVATE MEDICAL SECTOR</p> <p>PRIVATE HOSPITAL/ CLINIC 21</p> <p>PHARMACY/CHEMICAL/ DRUG STORE 22</p> <p>OTHER PRIVATE MEDICAL 26</p> <p>_____ (SPECIFY)</p> <p>OTHER SOURCE</p> <p>NGO/CBAs 31</p> <p>SHOP/MARKET 32</p> <p>STREET VENDOR . . 33</p> <p>PETROL STATION/ MOBILE MART 34</p> <p>PRIMARY SCHOOL . . 35</p> <p>OTHER 36</p> <p>_____ (SPECIFY)</p> <p>DON'T KNOW 98</p>
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		NET #1	NET #2	NET #3
006	How much did it cost you to obtain this net? RECORD '00.00' IF FREE OF CHARGE.	COST IN CEDIS <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> </div> DON'T KNOW . . . 9998	COST IN CEDIS <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> </div> DON'T KNOW . . . 9998	COST IN CEDIS <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> </div> DON'T KNOW . . . 9998
007	OBSERVE OR ASK THE BRAND/ TYPE OF MOSQUITO NET. IF BRAND IS UNKNOWN AND YOU CANNOT OBSERVE THE NET, SHOW PICTURES OF TYPICAL NET TYPES/BRANDS TO RESPONDENT.	LONG-LASTING INSECTICIDE-TREATED NET (LLIN) OLYSET 10 PERMANET ... 11 INTERCEPTOR . 12 NETPROTECT . 13 DURANET 14 LIFE NET 15 . DAWA PLUS ... 16 MAGNET 17 YORKKOL 18	LONG-LASTING INSECTICIDE-TREATED NET (LLIN) OLYSET 10 PERMANET ... 11 INTERCEPTOR . 12 NETPROTECT . 13 DURANET 14 LIFE NET 15 DAWA PLUS ... 16 MAGNET 17 YORKKOL 18	LONG-LASTING INSECTICIDE-TREATED NET (LLIN) OLYSET 10 PERMANET 11 INTERCEPTOR .. 12 NETPROTECT .. 13 DURANET 14 LIFE NET 15 DAWA PLUS ... 16 MAGNET 17 YORKKOL 18

		OTHER/ DK BRAND 19 (SKIP TO 134) 'PRETREATED' NET OTHER/ DK BRAND ... 26 (SKIP TO 134) OTHER LOCALLY SEWN NETS 31 OTHER BRAND ... 96 DK BRAND 98	OTHER/ DK BRAND 19 (SKIP TO 134) 'PRETREATED' NET OTHER/ DK BRAND ... 26 (SKIP TO 134) OTHER LOCALLY SEWN NETS 31 OTHER BRAND 96 DK BRAND 98	OTHER/ DK BRAND 19 (SKIP TO 134) 'PRETREATED' NET OTHER/ DK BRAND 26 (SKIP TO 134) OTHER LOCALLY SEWN NETS 31 OTHER BRAND 96 DK BRAND 98
008	When you got the net, was it already treated with an insecticide to kill or repel mosquitoes?	YES 1 NO 2 NOT SURE 8	YES 1 NO 2 NOT SURE 8	YES 1 NO 2 NOT SURE 8
009	Did anyone sleep under this mosquito net last night?	YES 1 NO 2 (SKIP TO 136) NOT SURE 8	YES 1 NO 2 (SKIP TO 136) NOT SURE 8	YES 1 NO 2 (SKIP TO 136) NOT SURE 8

		NET #1	NET #2	NET #3
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<p>010</p>	<p>Who slept under this mosquito net last night?</p> <p>RECORD THE PERSON'S NAME AND LINE NUMBER FROM THE HOUSEHOLD SCHEDULE.</p>	<p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p>	<p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p>	<p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p> <p>NAME _____</p> <p>LINE NO. <input type="text"/></p>
<p>011</p>		<p>GO BACK TO 010 FOR NEXT NET; OR, IF NO MORE NETS, GO TO 012A.</p>	<p>GO BACK TO 010 FOR NEXT NET; OR, IF NO MORE NETS, GO TO 012A.</p>	<p>GO TO 010 IN FIRST COLUMN OF A NEW QUESTIONNAIRE; OR, IF NO MORE NETS, GO TO 012A.</p>

012A During the last 12 months has any member of your household disposed of any treated net?

YES 1

NO 2

DON'T KNOW 3



(SKIP TO 136E)

012B How did you dispose of your last treated mosquito net?

BURNED 1

BURIED 2

GARBAGE OR REFUSE DUMP 3

REUSED FOR OTHER PURPOSE 4

OTHER 6

(SPECIFY)

DON'T KNOW 8

012C How long did you use the net before disposing of it?

LESS THAN 2 YEARS 1

2-4 YEARS 2

MORE THAN 4 YEARS 3

DON'T KNOW 8

012D What was the main reason for disposing of this net?

TORN 1

COULD NOT REPEL MOSQUITOS ANYMORE . 2

GOT A NEW ONE 3

OTHER (SPECIFY)6

DON'T KNOW 8

012A Have you ever heard about malaria? YES 1

NO 2
 DON'T KNOW 3

013 In the past 6 months, have you seen or heard any

messages about malaria:		YES	NO
a) On the television?	TELEVISION	1	2
b) On the radio?	RADIO	1	2
c) In a newspaper or magazine?	NEWSPAPER/ MAGAZINE	1	2
d) From a poster?	POSTER	1	2
e) From leaflets or brochures?	LEAFLET/BROCHURE	1	2
f) From a health worker?	HEALTH WORKER	1	2
g) From a Community volunteer/CHW/CBA?	VOLUNTEER	1	2
h) Anyone/anywhere else? Where/Whom?	OTHER	1	2

Awareness about cutaneous Leishmaniasis

NO. QUESTIONS AND FILTERS
 SKIP

CODING CATEGORIES

014 Have you ever seen lesions like what is the picture?
 YES 1
 NO 2
 DON'T KNOW 3

Please show the pictures of the lesions to the respondent

015 Have you ever heard about Cutaneous Leishmaniasis?
 YES 1
 NO 2 }
 DON'T KNOW 3 } ←

(SKIP TO 017)

016 In the past 6 months, have you seen or heard any

messages about Cutaneous Leishmaniasis?:		YES	NO
a) On the television?	TELEVISION	1	2
b) On the radio?	RADIO	1	2
c) In a newspaper or magazine?	NEWSPAPER/		
	MAGAZINE	1	2
d) From a poster?	POSTER	1	2
e) From leaflets or brochures?	LEAFLET/BROCHURE	1	2
f) From a health worker?	HEALTH WORKER	1	2
g) From a Community volunteer/CHW/CBA?			
	VOLUNTEER	1	2
h) Anyone/anywhere else? Where/Whom?	OTHER	1	2

017 List any names used to describe cutaneous leishmaniasis/

the lesions in the picture shown, in this community: NAME 1

**If 'NO' or 'DON'T KNOW' FOR 014 AND 015,
EXCLUDE FROM QUESTIONS UNDER CL
EXPERIENCE, AND CL KAP. THEY CAN
HOWEVER RESPOND TO QUESTIONS ON
SANDFLIES AND HOUSEHOLD**

NAME 2

NAME 3

OTHER.....

NO IDEA

CL Experience

018	Do you have a personal experience of cutaneous	YES	1
	leishmaniasis?	NO	2
019	Do you know anyone in this community (outside your	YES	1
	Household) who has had cutaneous leishmaniasis?	NO	2

		DON'T KNOW	3	
020	Has any member of your household other than yourself had a history of cutaneous leishmaniasis?	YES	1	
		NO	2	
		DON'T KNOW	3	
021	How many members of your household (including you)		
	Have experienced cutaneous leishmaniasis?	DON'T KNOW	3	
022	Has any member of your household (including you) experienced CL Within in the past two years?	YES	1	
		NO	2	
		DON'T KNOW	3	
023	How many members of your household (including you) experienced CL within the past two years?		
		DON'T KNOW	3	
024	Which month(s) of the year do you see cases of CL In this community?	JANUARY.....1 FEBRUARY..... 2 MARCH.....3 APRIL..... 4 MAY.....5 JUNE..... 6 JULY.....7 AUGUST..... 8 SEPTEMBER.....9 OCTOBER..... 10 NOVEMBER.....11 DECEMBER..... 12 ALL MONTHS..... 13 OTHER (SPECIFY)...14		
		DON'T KNOW ...	15	
025	Which age groups of people do you see with CL In this community?	Children (<5 years)	1	
		Children (5-17 years)	2	
		Young Adults (18 -35 years)	3	
		Older Adults (36-60 years).....	4	
		Aged (>60 years).....	5	
		DON'T KNOW	6	

026	Which occupational groups of people do see with CL in this community?	Farmers	1
		Hunters	2
		Traders.....	3
		Students/Pupils.....	4
		Civil servants.....	5
		Others (Specify).....	6
		DON'T KNOW	7

CL Knowledge

027	What is the cause of cutaneous leishmaniasis (CL)?		
	CL Cause		1
	DON'T KNOW		3

028	How is CL transmitted to people?		
	CL Transmission		1
	DON'T KNOW		3

029 What are the symptoms of cutaneous leishmaniasis?

CL Symptoms 1

.....

.....

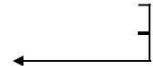
DON'T KNOW3

030 Is CL preventable?

YES 1

NO 2

DON'T KNOW 3



(SKIP TO 031)

031 How can CL be prevented?

CL Prevention methods1

.....

DON'T KNOW3

032 Is CL treatable?

YES 1

NO 2

DON'T KNOW3

Knowledge about Sand flies

033 Can you differentiate sandflies from mosquitoes? YES 1

NO, cannot tell the difference between them..... 2

NO, Can recognize mosquitoes but never heard about sand flies..3

NO, Can recognize mosquitoes but not sand flies.....4

Other(Specify)..... 5

034 Can sand flies transmit any disease(s)? YES 1

NO 2

DON'T KNOW3

(SKIP TO 036)

035 Name the disease(s) that sand flies can transmit? DISEASE 1..... 1

DISEASE 2..... 2

OTHER3

DON'T KNOW 4

036 Where do sand flies breed?

Sand fly breeding places 1

.....

DON'T KNOW3

037 What is the most active biting time of sand flies?

DURING DUSK AND DAWN. 1

DURING MID NIGHT 2

DURING DAY TIME.....3

AT ANY TIME.....4

OTHER (SPECIFY).....5

DON'T KNOW6

038 How can sand flies be controlled?

Sand fly control methods. 1

.....

DON'T KNOW3

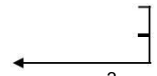
CL Related Attitude

039A Is CL a problem in this community?

YES 1

NO 2

DON'T KNOW 3



(SKIP TO 040)

039B How is CL a problem in this community?

How CL is a problem?..... 1

.....

DON'T KNOW3

040 What do you think the outcome of CL will be if not treated? **MULTIPLE RESPONSES ACCEPTED**

Death..... 1

Disability..... 2

Scar..... 3

Self heal.....4

Others (Specify).....6

DON'T KNOW 7

041 Compared with malaria, how serious do you
 Consider CL in this community? Malaria is more serious than CL. 1
 CL is more serious than malaria. 2
 Both malaria and CL are equally serious..... 3
 Others (Specify)..... 6
 DON'T KNOW 7

042A Do you think there is a role(s) members of this community YES 1
 Can play to prevent CL in this community? NO 2
 DON'T KNOW3

(SKIP TO 043A)

042B What role(s) can members of this community play to prevent CL?

Community members role in CL prevention? 1

 DON'T KNOW3

043A Do you think there is a role(s) you can play
 to prevent CL in your household? YES 1
 NO 2
 DON'T KNOW3

(SKIP TO 044)

043B What role(s) can you play to prevent CL in your household?
 Community members role in CL prevention? 1

.....

DON'T KNOW3

044	Which age groups of people do you think can get CL in this community?	Children (<5 years) 1 Children (5-17 years) 2 Young Adults (18 -35 years) 3 Older Adults (36-60 years).....4 Aged (>60 years).....5 DON'T KNOW 6
-----	------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

045	Which occupational groups of people do you consider Likely to get CL in this community?	Farmers 1 Hunters 2 Traders.....3 Students/Pupils.....4 Civil servants.....5 Others (Specify).....6 DON'T KNOW 7
-----	------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------

046	Where are you likely to go for treatment if you get CL?	No where (No treatment) 1 No where (self treatment) 2 Hospital 3 Pharmacy..... 4 Herbalist (Traditional healer)..... 5 Other (Specify).....6 DON'T KNOW 7
-----	----------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

047	Can someone have leishmaniasis and not show any	YES 1
-----	-------------------------------------------------	-----------------

symptoms?	NO2
	DON'T KNOW3

CL Related Practices

048	Where do you or members of your household go for treatment if you get CL?	No where (No treatment)	1
	MULTIPLE RESPONSES ACCEPTED	No where (self treatment)	2
		Hospital	3
		Pharmacy.....	4
		Herbalist (Traditional healer).....	5
		No one in my household ever had.....	6
		Other (Specify).....	7
		DON'T KNOW	8

049	What do you or members of your household do to prevent CL?		
	Household CL prevention method?		1
		
	Nothing		2
	Don't Know what to do to prevent CL.....		3

050	What is your preferred work time?	Day time when temperature is high	1
	Multiple answers accepted	Early morning	2
		In the evening	3
		At night).....	4
		Other (Specify).....	5

DON'T KNOW 6

051A Do you sleep outdoors in the evening after 5pm? Yes, Very often (At least once a week) 1

Multiple answers accepted

Yes, Often (At least once a month) 2

Yes, Sometimes (At least once in six months)..... 3

Yes, rarely (At least once in a year night)..... 4

No..... 5

Other (Specify)..... 6

(SKIP TO 052)

051B **If you sleep outdoors after 5pm:**

051B1 Do you sleep in insecticide treated bed net? YES 1

NO 2

OTHER 3

051B2 Do you use mosquito coil? YES 1

NO 2

OTHER 3

051B3 Do you use any insecticide other than YES 1

Mosquito coil and ITN? NO 2

OTHER 3

051B4 Do you sleep near vegetation? YES 1

NO 2

OTHER 3

WATER AND SANITATION		WS
<p>WS1. WHAT IS THE <u>MAIN</u> SOURCE OF DRINKING WATER FOR MEMBERS OF YOUR HOUSEHOLD?</p>	<p>Piped water Piped into dwelling 11 Piped into compound, yard or plot 12 Piped to neighbour 13 Public tap / standpipe 14 Tube Well, Borehole.....21 Dug well Protected well31 Unprotected well32 Water from spring Protected spring.....41 Unprotected spring.....42 Rainwater collection.....51 Tanker-truck61 Cart with small tank / drum71 Surface water (river, stream, dam, lake, pond, canal, irrigation channel).....81 Bottled water.....91 Other (<i>specify</i>) 96</p>	
<p>WS2. WHAT KIND OF TOILET FACILITY DO MEMBERS OF YOUR HOUSEHOLD USUALLY USE?</p> <p><i>If “flush” or “pour flush”, probe: WHERE DOES IT FLUSH TO?</i></p> <p><i>If necessary, ask permission to observe the facility.</i></p>	<p>Flush / Pour flush Flush to piped sewer system 11 Flush to septic tank 12 Flush to pit (latrine) 13 Flush to somewhere else..... 14 Flush to unknown place / Not sure / DK where 15 Pit latrine Ventilated Improved Pit latrine (VIP)21 Pit latrine with slab22 Pit latrine without slab / Open pit23 Composting toilet31 Bucket41 Hanging toilet, hanging latrine 51 No facility, bush, field95 Other (<i>specify</i>) 96</p>	<p>95⇒Next Module</p>

<p>WS3. DO YOU SHARE THIS FACILITY WITH OTHERS WHO ARE NOT MEMBERS OF YOUR HOUSEHOLD?</p>	<p>Yes1 No.....2</p>	<p>2⇒Next odule</p>
<p>WS4. HOW MANY HOUSEHOLDS IN TOTAL USE THIS TOILET FACILITY, INCLUDING YOUR OWN HOUSEHOLD?</p>	<p>Number of households (if less than 10) .. 0__ Ten or more households10 DK98</p>	

HOUSEHOLD CHARACTERISTICS		HC	
HC1A. WHAT IS THE RELIGION OF THE HEAD OF THIS HOUSEHOLD?	Catholic	11	
	Protestant (Anglican, Lutheran, Presbyterian, Methodist, etc.)	12	
	Pentecostal/Charismatic	13	
	Other Christian	14	
	Moslem	21	
	Traditional/Spiritualist	31	
	Other (<i>specify</i>) _____	96	
	No religion	41	
HC1B. TO WHAT ETHNIC GROUP DOES THE HEAD OF THIS HOUSEHOLD BELONG?	Ewe	11	
	Ga-Dangme	12	
	Akan	21	
	Mole-Dagbani	31	
	Kokomba	32	
	Grusi	41	
	Other (<i>specify</i>) _____	96	
HC1C. IN THE LAST 4 WEEKS DID THE HEAD OF THIS HOUSEHOLD DO ANY ACTIVITY OF AT LEAST ONE HOUR FOR PAY OR PROFIT OR FAMILY GAIN (IN CASH OR IN KIND)?	Yes.....	1	1⇒HC1E
	No	2	2⇒HC1D
HC1D. WHAT WAS THE HEAD OF HOUSEHOLD DOING?	Did not work but had job to go back to	1	1⇒HC1E
	Unemployed, worked before and available to work now	2	2⇒HC1E 3⇒HC2
	Unemployed, never worked before	3	4⇒HC2
	Did not work before and not seeking work now	4	8⇒HC2
	DK	8	

<p>HC1E. WHAT KIND OF WORK DID THE HEAD OF HOUSEHOLD DO?</p> <p><i>This refers to the type of work the head of household was doing. Use two or more words. For example, street trader, cattle farmer, primary schoolteacher, domestic worker, truck driver, filing clerk, etc.</i></p>	<p>Description of work:</p> <p>-----.</p> <p>-----.</p> <p>-----.</p>	
<p>HC1F. WHAT IS THE AVERAGE MONTHLY INCOME OF THIS HOUSEHOLD (GHS)?</p>	<p>Monthly income.....GHS</p>	
<p>HC2A. HOW MANY ROOMS IN THIS HOUSEHOLD ARE USED FOR SLEEPING?</p>	<p>Number of rooms..... __ __</p>	
<p>HC2B. HOW MANY WINDOWS ARE IN THIS HOUSEHOLD?</p>	<p>Number of windows __ __</p>	
<p>HC2C. HOW MANY WINDOWS IN THIS HOUSEHOLD HAVE SCREEN/NET?</p>	<p>Number of screened windows..... __ __</p>	
<p>HC3. <i>Main material of the dwelling floor.</i></p> <p><i>Record observation.</i></p>	<p>Natural floor</p> <p>Earth / Sand 11</p> <p>Dung 12</p> <p>Rudimentary floor</p> <p>Wood planks..... 21</p> <p>Palm / Bamboo 22</p> <p>Finished floor</p> <p>Parquet or polished wood 31</p> <p>Vinyl or asphalt strips..... 32</p> <p>Ceramic tiles..... 33</p> <p>Cement..... 34</p> <p>Carpet 35</p> <p>Other (<i>specify</i>) _____ 96</p>	

<p>HC4. <i>Main material of the roof.</i></p> <p><i>Record observation.</i></p>	<p>Natural roofing</p> <p>No Roof 11</p> <p>Thatch / Palm leaf 12</p> <p>Sod..... 13</p> <p>Rudimentary Roofing</p> <p>Rustic mat 21</p> <p>Palm / Bamboo 22</p> <p>Wood planks..... 23</p> <p>Cardboard 24</p> <p>Finished roofing</p> <p>Metal 31</p> <p>Wood..... 32</p> <p>Calamine / Cement fibre 33</p> <p>Ceramic tiles..... 34</p> <p>Cement..... 35</p> <p>Roofing shingles 36</p> <p>Other (<i>specify</i>) _____ 96</p>	
<p>HC5. <i>Main material of the exterior walls.</i></p> <p><i>Record observation.</i></p>	<p>Natural walls</p> <p>No walls..... 11</p> <p>Cane / Palm / Trunks 12</p> <p>Dirt 13</p> <p>Rudimentary walls</p> <p>Bamboo with mud 21</p> <p>Stone with mud..... 22</p> <p>Uncovered adobe 23</p> <p>Plywood..... 24</p> <p>Cardboard 25</p> <p>Reused wood..... 26</p> <p>Finished walls</p> <p>Cement..... 31</p> <p>Stone with lime / cement..... 32</p> <p>Bricks 33</p> <p>Cement blocks..... 34</p> <p>Covered adobe 35</p> <p>Wood planks / shingles 36</p> <p>Other (<i>specify</i>) _____ 96</p>	

<p>HC6. WHAT TYPE OF FUEL DOES YOUR HOUSEHOLD MAINLY USE FOR COOKING?</p>	<p>Electricity01 Liquefied Petroleum Gas (LPG).....02 Natural gas03 Biogas.....04 Kerosene05</p> <p>Coal / Lignite06 Charcoal07 Wood08 Straw / Shrubs / Grass09 Animal dung.....10 Agricultural crop residue.....11</p> <p>No food cooked in household95</p> <p>Other (<i>specify</i>) 96</p>	<p>01⇒HC8 02⇒HC8 03⇒HC8 04⇒HC8</p> <p>95⇒HC8</p>																																				
<p>HC7. IS THE COOKING USUALLY DONE IN THE HOUSE, IN A SEPARATE BUILDING, OR OUTDOORS?</p> <p>IF IN THE HOUSE PROBE IS IT DONE IN A SEPARATE ROOM USED AS A KITCHEN?</p>	<p>In the house In a separate room used as a kitchen1 Elsewhere in the house2</p> <p>In a separate building.....3 Outdoors 4</p> <p>Other (Specify) 6</p>																																					
<p>HCB. DOES YOUR HOUSEHOLD HAVE:</p> <p>[A] ELECTRICITY? [B] A RADIO? [C] A TELEVISION? [D] A NON-MOBILE TELEPHONE? [E] A REFRIGERATOR? [F] A GENERATOR [G] A COMPUTER [H] A SEWING MACHINE [I] A BED [J] A TABLE [K] A CUPBOARD /CABINET</p>	<table border="0"> <thead> <tr> <th></th> <th style="text-align: center;">Yes</th> <th style="text-align: center;">No</th> </tr> </thead> <tbody> <tr> <td>Electricity</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Radio</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Television</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Non-mobile telephone</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Refrigerator</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Generator</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Computer</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Computer</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Bed</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Table</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Cupboard /cabinet</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> </tbody> </table>		Yes	No	Electricity	1	2	Radio	1	2	Television	1	2	Non-mobile telephone	1	2	Refrigerator	1	2	Generator	1	2	Computer	1	2	Computer	1	2	Bed	1	2	Table	1	2	Cupboard /cabinet	1	2	
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<p>HC9. DOES ANY MEMBER OF YOUR HOUSEHOLD OWN:</p> <p>[A] A WATCH?</p> <p>[B] A MOBILE TELEPHONE</p> <p>[C] A BICYCLE</p> <p>[D] A MOTORCYCLE OR SCOOTER?</p> <p>[E] AN ANIMAL DRAWN CART?</p> <p>[F] A CAR OR TRUCK?</p> <p>[G] A TRACTOR?</p> <p>[H] A BOAT WITHOUT A MOTOR?</p> <p>[I] A BOAT WITH A MOTOR</p>	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 80%;"></th> <th style="width: 10%; text-align: center;">Yes</th> <th style="width: 10%; text-align: center;">No</th> </tr> </thead> <tbody> <tr> <td>Watch</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Mobile telephone</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Bicycle</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Motorcycle / Scooter</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Animal drawn -cart</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Car/ Truck</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Tractor</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Boat without motor</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> <tr> <td>Boat with motor</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> </tr> </tbody> </table>		Yes	No	Watch	1	2	Mobile telephone	1	2	Bicycle	1	2	Motorcycle / Scooter	1	2	Animal drawn -cart	1	2	Car/ Truck	1	2	Tractor	1	2	Boat without motor	1	2	Boat with motor	1	2	
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<p>HC10. DO YOU OR SOMEONE LIVING IN THIS HOUSEHOLD OWN THIS DWELLING?</p> <p>IF "NO THEN ASK: DO YOU RENT THIS DWELLING FROM SOMEONE NOT LIVING IN THIS HOUSEHOLD?</p> <p>IF "RENTED FROM SOMEONE ELSE", CIRCLE "2" FOR OTHER RESPONSE, CIRCLE "6"</p>	<p>Own1</p> <p>Rent2</p> <p>Other (Not owned / rented) (Specify)</p> <p>.....6</p>																															
<p>HC11. DOES ANY MEMBER OF THIS HOUSEHOLD OWN ANY LAND THAT CAN BE USED FOR AGRICULTURE?</p>	<p>Yes1</p> <p>No2</p>	2⇒HC13																														
<p>HC12. HOW MANY HECTARES, ACRES OR POLES OF AGRICULTURE LAND DO MEMBERS OF THIS HOUSEHOLD OWN?</p> <p>IF LESS THAN 1 RECORD "00" IF 95 OR MORE RECORD "95" IF UNKNOWN RECORD "98"</p>	<p>Hectares__ __</p> <p>Acres</p> <p>Poles__ __</p> <p>DK.....98</p>																															
<p>HC13. DOES THIS HOUSEHOLD OWN ANY LIVESTOCK, HERDS, OTHER FARMS ANIMALS OR POULTRY?</p>	<p>Yes.....1</p> <p>No.....2</p>	2⇒HC15																														
<p>HC 14. HOW MANY OF THE FOLLOWING ANIMALS</p>	<p>How Many?</p>																															

<p>DOES THIS HOUSEHOLD HAVE?</p> <p>[A] CATTLE, MILK COWS OR MULES?</p> <p>[B] HORSES, DONKEYS OR MULES?</p> <p>[C] GOATS</p> <p>[D] SHEEP?</p> <p>[E] PIGS</p> <p>[F] CHICKENS?</p> <p>[H] DUCKS?</p> <p>[I] OTHER POULTRY (TURKEYS OR OTHER)?</p> <p>[J] OTHER =1?</p> <p>[K] OTHER -2?</p> <p>IF NONE, RECORD "00"</p> <p>IF 95 OR MORE RECORD "95"</p> <p>IF UNKNOWN RECORD "98"</p>	<p>Cattle, milk cows, or bulls ____ ____</p> <p>Horses, donkeys or mules ____ ____</p> <p>Goats ____ ____</p> <p>Sheep ____ ____</p> <p>Pigs ____ ____</p> <p>Chickens ____ ____</p> <p>Dog ____ ____</p> <p>Ducks ____ ____</p> <p>Other poultry(Specify)</p> <p>..... ____ ____</p> <p>Other -1 (specify)</p> <p>..... ____ ____</p> <p>Other -2 (specify)</p> <p>..... ____ ____</p>	
<p>HC15. DOES ANY MEMBER OF THIS HOUSEHOLD HAVE A BANK ACCOUNT?</p>	<p>Yes1</p> <p>No.....2</p>	
<p>HC16. HOW MANY HOUSEHOLD MEMBERS ARE REGISTERED WITH THE NATIONAL HEALTH INSURANCE SCHEME?</p>	<p>Number of persons ____ ____</p> <p>DK98</p>	
<p>HC18. RECORD THE TIME.</p>	<p>Hours and Minutes ____ ____ ____</p>	

Interviewer's Observations

Field Editor's Observations

Supervisor's Observations