From quantification to control: a population-based study to measure the secondary impact of ivermectin-based mass drug administration aimed to control onchocerciasis on the prevalence of scabies in northern Ethiopia

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Abstract

Scabies is a parasitic skin infestation endemic to both high-income and low-income settings but with a varying epidemiologic presentation. Despite its high burden and global distribution, it had been neglected as a public health problem and there is limited data about the nature of the disease in global health settings. In Ethiopia, a large-scale scabies outbreak was reported in 2015 mainly involving the northern part of the country. However, lack of data on the disease epidemiology and the effectiveness of a variety of control strategies was a barrier to the required swift response. This study aimed to determine scabies epidemiology and measure the secondary impact of ivermectin onchocerciasis Mass Drug Administration (MDA) on the prevalence of scabies in outbreak affected Ayu Guagusa district, Amhara regional state, northern Ethiopia. The study also aimed to synthesize the published knowledge of scabies in Ethiopia and measure the effect of the infestation on life quality of patients.

A systematic review was conducted targeting articles published on scabies in Ethiopia in the past 25 years. This provided the basis for the main study by identifying the local evidence gap in community-based scabies control interventions. A quasi-experimental approach was employed to measure the impact of ivermectin onchocerciasis MDA on the prevalence of scabies by conducting three successive surveys (baseline, 6-month, and 12-months) where the MDA was between the first two rounds. Randomly selected households (n=381) and the respective consenting members participated in the study. The impact of the MDA on scabies was determined by estimating the prevalence before and after the MDA. Multilevel logistic regression models were fitted to identify the determinants of scabies infestation in the study community. The effect of scabies on life quality of patients was measured using the Cardiff Dermatologic Life Quality Index (DLQI).

In the systematic review, high scabies prevalence and skewed geographic distribution of publications was identified. Scabies prevalence across the three surveys was high: baseline 13.4% (11.7%-15.2%), 6-month 11.7% (10.1%-13.2%), and 12-months 22.1% (20.1%-24.1%). Living in households of size $\geq$ 5 increased the odds of scabies infestation and female sex had lower odds. Scabies had moderate impact on life quality of patients and symptoms and feelings was the most affected life quality domain.

Onchocerciasis MDA did not impact scabies prevalence, at least in the study period. Increasing the number of doses in each round of MDA, distributing topical scabicides to people ineligible to take ivermectin can help optimize onchocerciasis MDA for the control of scabies. Demographic characteristics and host density were important determinants of scabies. Though these characteristics are not amenable for change, modifying circumstances associated with them may help reduce odds of the infestation.

Table of contents

List of tables

List of figures

Overview

In Ethiopia the latest scabies outbreak was reported in 2015 in northern part of the country. Since then, surveillance reports indicated that the outbreak has spread to the remaining parts of the country. Subsequently, the Ethiopian Ministry of Health (MoH) took control measures to abate the rapid transmission and effect eventual control. However, the limited local data on the epidemiology of scabies and patterns of the outbreak posed a challenge to control efforts.

The National Institute for Health Research (NIHR) funded a collaborative research project, on scabies and other Neglected Tropical Diseases (NTDs), between the Brighton and Sussex Medical School (BSMS), Addis Ababa University (AAU) and the MoH. The project was organized under seven work packages, which aimed to contribute to the evidence base for the control of three neglected tropical diseases: podoconiosis, mycetoma, and scabies. The study on scabies was categorised under work package seven and it aimed to generate evidence to support scabies outbreak control measures and improve patient care. The work package covered four research areas with the following objectives:

- Synthesizing the local knowledge about scabies in Ethiopia.
- Estimating the burden of scabies and identifying factors that increased the odds of acquiring scabies infestation.
- Determining the impact of scabies on life quality and psychosocial wellbeing of adult scabies patients.
- Measuring the secondary impact of ivermectin-based MDA aimed to control onchocerciasis on the prevalence of scabies.

This thesis describes my doctoral research project in the context of work package 7. My PhD research project primarily dealt with measuring the secondary impact of ivermectin-based onchocerciasis mass drug administration (MDA) on the prevalence of scabies. To get a complete picture of the disease, this thesis also illustrates the published knowledge of scabies based on data from publications on scabies in Ethiopia in the past decades. I also examined the epidemiology of scabies in terms of disease prevalence and determinants of scabies infestation in northern Ethiopia and investigate the impact of scabies infestation on the life quality of scabies

patients. The procedures followed in conducting these studies, and the findings thereof are organized into six chapters in this thesis.

Chapter-1-Introduction

The introductory chapter is organized into three subtopics: the background, problem statement, including research question and objectives. The background section covered biology of the scabies mite, pathogenesis of the disease, clinical presentation, and possible complications of scabies. The problem statement illustrates the ramifications of scabies in a spectrum ranging from individuals to society level. It also describes what is known about community-based scabies control interventions and the evidence gap in the international literature.

Chapter-2-Published knowledge of scabies in Ethiopia

This chapter illustrates findings of a systematic review of articles on scabies in Ethiopia that are published in the past 25 years. This chapter describes what is known about scabies in Ethiopia and determines the scabies research landscape, while describing the evidence gap in scabies research. Geographic distribution of the study settings, prevalence and determinants of scabies infestation and community-based scabies control strategies are covered under this chapter.

Chapter-3-The epidemiology of scabies in northern Ethiopia

We conducted three successive surveys (baseline, 6-months, and 12-months), with the aim of estimating the secondary impact of ivermectin onchocerciasis MDA on the prevalence of scabies. This chapter estimates scabies prevalence and identifies determinants of scabies infestation based on data from the baseline survey. Scabies prevalence estimates were generated for the entire district and separate study *kebeles*. Predictors of scabies infestation were determined by fitting a mixed effect logistic regression models that were aimed to adjust for confounders at the household and individual participant levels and account for household level clustering of the data.

Chapter-4-The impact of scabies on life quality of scabies patients

This chapter covers the impact of scabies on life quality of adult clinical scabies cases and addresses the community's knowledge and perception of scabies including health seeking for scabies suggestive symptoms. The Cardiff DLQI tool was used to collect data on life quality of scabies patients. The cumulative score of the impact of scabies on life quality patients is determined. The data is also recategorized to determine its impact on various life quality domains. Results on knowledge, perception, and health seeking for scabies is presented against each variable.

Chapter-5-The secondary impact of ivermectin onchocerciasis MDA for the control of scabies

It gives an account of the findings obtained by investigating the secondary impact of ivermectin-based MDA against onchocerciasis on the prevalence of scabies and it details the procedures followed in all three rounds of data collection. Background characteristics of people who participated in these rounds is described. The change in disease prevalence estimates at the three datapoints, one before and two after the MDA, was employed to measure the community level impact of the MDA.

Chapter-6- Summary of main findings, their implications on public health practice and policy

Chapter six summarises the findings from the preceding five chapters and puts the results into context with one another. Implications of the findings for policy and programmatic activities is indicated. Research questions that are not answered in this study are laid out in future research section of this chapter. My development as a PhD student and the progress to being an independent researcher is also described.

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Declaration

Declaration I declare that the research contained in this thesis, unless otherwise formally indicated within the text, is the original work of the author. The thesis has not been previously submitted to this or any other university for a degree, and does not incorporate any material already submitted for a degree.

Signature

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List of Acronyms and Abbreviations

ANOVA:	Analysis of Variance
ASAR:	Age Specific Attack Rate
BIT:	Burrow Ink Test
COVID-19:	Coronal Virus Disease 19
EDHS:	Ethiopian Demographic and Health Survey
ELM:	Epiluminiscence Microscopy
EOEEAC:	Ethiopian Onchocerciasis Elimination
EAC:	Expert Advisory Committee
GCP:	Good Clinical Practice
HDA:	Health Development Army
HEP:	Health Extension Program
IACS:	International Alliance for the Control of Scabies
ICC:	Intra-class Correlation Coefficient
Kms:	Kilometers
LF:	Lymphatic Filariasis
MDA:	Mass Drug Administration
NTD:	Neglected Tropical Diseases
ODK:	Open Data Kit
QOL:	Quality of Life
SD:	Standard Deviation
SPH:	School of Public Health
STH:	Soil Transmitted Helminths
VD:	Videodermatoscopy
WHO:	World Health Organization

Chapter One

Introduction

Chapter 1 : Introduction

1.1. Background

Scabies is an ancient skin infestation caused by the mite *Sarcoptes Scabiei* (1). The infestation establishes after the female mite burrows under the superficial layer of the skin (1, 2). A person with an average degree of infestation harbours ten to fifteen burrowing mites (3). However, severe infestations involve thousands of mites on a single host. This condition is referred to as crusted scabies where patients develop skin crusts filled with thousands of mites. Such patients have significant public health importance as they are highly contagious (2, 4).

Physical contact is the main route of scabies transmission. Because of this, it can easily transmit among household members and people in institutional settings (3). Outbreaks are also more common in refugee camps, residential care homes, and orphanages (5). As scabies is an obligate parasite, it does not last long once it is separated from the host. Therefore, transmission through fomites is not common except in cases of severe infestation. The large number of mites being shed, as in case of crusted scabies, enhances the risk of transmission through bedding and clothing even in the absence of a direct physical contact (1, 3, 6).

Typical manifestations of scabies infestation include multiple papules in the webs of the hands, the wrist, the axillary area, the lower abdomen, the lower portion of the gluteal area, the genitalia in men and the breasts in women (2). The rash is accompanied by an intense itch caused by the immune-mediated antigen-specific delayed hypersensitivity reaction of the human body against entry of the mite, its faeces, or eggs (2, 7). These symptoms guide clinical diagnosis, which is the mainstay diagnostic approach (8). However, when laboratory investigation is warranted, commonly microscopy of a superficial skin crust sample is examined under a light microscope (1, 9).

Secondary bacterial infection by Staphylococcus aureus or Group A streptococci is common among scabies patients (2, 4, 8). Compromised skin integrity due to scratching and temporary downregulation of the local immune response predisposes the host to secondary bacterial infection (10). If not treated timely, such secondary infections can cause an array of moderate local to severe systemic complications.

1.2. Problem statement

Scabies infestation affects physical, mental, and psychosocial wellbeing of people and has a range of socio-economic impact at a community level. Severe complications of scabies are associated with secondary bacterial infections. Impetigo, cellulitis and fasciitis are infections of the soft tissue which can accompany scabies infestation (1, 2), and the probable systemic complications include septicaemia, acute glomerulonephritis, and rheumatic heart disease (3-5).

Apart from its deleterious impact on physical wellbeing, scabies undermines the life quality of patients. The existing few studies on the subject indicated scabies has a moderate impact on life quality of patients (6). However, disaggregated scores indicate it has a severe effect on physical well-being and self-perception of patients due to symptoms such as constant itch, restlessness, and skin lesions (6). The impact of scabies on life quality and psychosocial wellbeing signifies the need for holistic care for patients. However, there is limited data to develop a holistic care package for scabies patients. In this study I measured the impact of scabies on life quality of patients and assessed the community's knowledge and perception of the disease.

Scabies has a global distribution, however, high prevalence and recurrent outbreaks are reported in under-resourced tropical countries (7). Considering this and a few more criteria, the World Health Organization (WHO) recently added scabies to the list of NTDs (8). Globally, the highest estimates are from countries in the southern pacific region, and the Aborginal communities living in Australia (2, 7, 9, 10). In Africa, although studies on scabies are limited, available evidence from studies conducted in most parts of the continent indicates hyperendemicity (2,15).

Ethiopia is one of the high scabies burden African countries and with an increasing trend of the disease prevalence. In the past, the few available studies on scabies epidemiology, estimated a prevalence of not more than five percent (11, 12). However, recent data indicated a significant increase in the past 5 to 10 years. This increase is primarily attributed to the latest scabies outbreaks (13-17). The highest prevalence estimate in recent population based studies is 33.7% in Amhara regional state, northern Ethiopia (13). The disease is pervasive in the central, southern, and southwestern parts of the country as well (16, 18-20). The latest increase in prevalence warranted community-based scabies control interventions that mainly rely on a robust population-

based data. However, local data on scabies epidemiology and the effectiveness of control interventions is limited. I conducted a systematic review of publications from studies in Ethiopia aiming to consolidate local knowledge and guide the desired control intervention by the MoH.

The global scabies research landscape has a distinction in the target study populations and settings. The research focus in high-income countries are facility settings such as elderly care homes, prisons, and health care facilities, where periodic outbreaks are reported from (21-23). Studies from low-income settings often target the general population, lacking focus to special population sub-groups and settings (7). In this study, I investigated the epidemiology of scabies in a special setting where ivermectin onchocerciasis MDA was underway since 2015 (24). Considering the probable secondary effect of ivermectin on scabies, its prevalence and predictors in such population may not be typical of communities where there are no similar interventions. This data will help to characterise scabies epidemiology in populations targeted by ivermectin MDA programs for the control other NTDs such as onchocerciasis and lymphatic filariasis in global health settings. This evidence is crucial as co-endemicity of the NTDs with scabies is common in high burden settings and MDA is at the core of NTD control strategies.

Ethiopia is undergoing ivermectin-based MDA against onchocerciasis in more than 184 hyper endemic districts. Other than onchocerciasis, ivermectin is active against several helminthic diseases and scabies (25, 26). Accordingly, MDA against onchocerciasis can have a spillover effect on scabies epidemiology. I hypothesized that, ivermectin onchocerciasis MDA impacts scabies incidence and prevalence in co-endemic areas. Therefore, this community-based study is intended to measure the off-target impact of onchocerciasis MDA on scabies. This data is vital to inform the shift in the global NTD control approach from vertical disease specific programs to integrated control interventions (27).

1.3. The nature of scabies infestation and public health control measures

1.3.1. The life cycle of the scabies mite

The scabies mite is an obligate parasite to humans, completing its entire lifecycle in one host (3, 28, 29). There are only very few studies concerning the biology and lifecycle of scabies and nearly all concluded that the lifecycle begins with the female mite laying eggs in the superficial skin. Thus far, the infestation is believed to be caused by adult female mites even though the theoretical possibility of the remaining stages (i.e. egg, larva or nymph) causing the infestation is still there (28, 30). The life cycle of a scabies mite involves four stages: egg, larva, protonymph and tritonymph and it takes 10 to 14 days to fully complete its lifecycle (31, 32). The infestation begins with the pregnant female mite entering the epidermis of a human skin (28). The mite burrows its way through the stratum corneum, to the upper most layer of the stratum granulosum, in less than one hour (31). The burrows are formed when the mite consumes epithelial cells by dissolving the tissue using enzymes (33). The mite stays in the burrow for the remainder of its adult life feeding on the epidermal tissue. Though this constantly elongates the burrows but it does not go much further as it loses its length when the epidermal tissue cells shade due to aging (28, 31).

Once it enters the skin the mite starts laying 2 to 3 eggs a day for 30 to 40 days (the span of its adult life) (28, 31, 34). At this rate, one mite lays an average of 90 eggs over a one-month period. For a parasitic infestation, this is a high reproduction rate. However, from the total number of eggs laid by a female mite, only 1% make it to adulthood (31). In 3 to 4 days' time the eggs hatch giving forth six-legged larvae. Each larva moults to an eight legged nymph which develops to an adult mite within three more days (31). It takes a total of two weeks to complete the life cycle, where the adult mite will eventually burrow its way out on to the surface of the skin (3). Then, female mites start digging a new burrow on the same host or infest a new one and the male mites search for and fertilize female mites on the skin surface (32, 34).

1.3.2. Manifestations of scabies infestation

Typical signs and symptoms of scabies include skin lesions, generalized itch and contact history with a person exhibiting signs and symptoms of scabies infestation (35). The primary skin lesion of scabies is a burrow right under the superficial layer of the skin (33). Scabietic burrows are serpiginous grey or whitish lines in the outermost lining of the epidermis measuring not more than 5 mms in length (32). Burrows follow typical

pattern of the remaining types of scabietic lesions and are commonly found in the webs of the finger, flexure side of the wrist, the elbows, the belt line, the axillary area, the peri-umbilical area, and in men the genitals (33). These primary lesions are pathognomonic, if identified, however, burrows are rarely identified because of the small size of the lesion, and is hidden by the accompanying excoriations, and crusts (34). The secondary lesions include papules, vesicles, excoriations, ulcers, bullae, and at times nodules. Scabies symptoms result from a mix of delayed hypersensitivity reaction and secondary bacterial infection. The pruritic papules that erupt in areas of predilection, which also includes body parts far from where the mites are, indicate systemic anaphylactic reaction to the mite, faecal pellets, its eggs, including the saliva and surface antigens of the mite (7, 35, 36). With time, some papules may turn into vesicles and less frequently into bullae. Secondary bacterial infections such as impetigo folliculitis, and fasciitis are responsible for a range of manifestations such as purulent vesicles, scabietic bullae, crusts, and ulcers (37, 38).

Similar to the burrows, the rash and related lesions typically involve crevices of the body including; the finger webs, the flexor side of the wrist, the extensor side of the elbow, the axillary area, the lower abdomen, the lower portion of the buttocks, the knees and the feet, the penis in men and the breasts in women (31, 32). In infants, it can atypically involve the head, neck, palms and soles (35). The rash is preceded by a generalised itch with nocturnal predominance. The increase in body temperature, when the host is in bed, causes discomfort to the mites, resulting in increased activity within their burrows increasing the intensity of the itch (28). However, the clinical picture varies depending on the duration of the infestation, the presence of secondary bacterial infection and sometimes the age of the patient (32).

In the elderly, the rash may be hidden, mainly involving body parts that are covered with clothing. Since the extent of the symptoms is determined by the strength of the host reaction, the limited range of manifestation in the elderly could be attributed to weakened immunity (22, 31, 39). Underlying disease conditions such as dementia and peripheral neuropathy, which are not uncommon among the elderly, can also contribute to atypical presentations. In addition, reduced sensation to stimuli from the skin renders patients non-responsive to itch (22, 32). These underlying disease conditions can at times predict severity of the infestation, including crusted scabies (7, 40). Crusted scabies presents with loose and flaky or thick and adherent hyperkeratotic skin lesions

and deep fissures involving the head, neck, palms, and soles are the possible presentations in such patients (32). However, cases of crusted scabies are generally less frequent than classical presentations, even among communities of high scabies burden (31, 32).

1.3.3. Modes of scabies transmission

Skin-to-skin contact is the main mode of scabies transmission. For this reason, circumstances that create opportunities for intimate physical contact, for instance bed sharing and sexual intercourse, creates an optimal environment for the transmission to take place. Because of this, scabies is at times regarded as a sexually transmitted infection (2, 41). Apart from the circumstances of physical contact, the number of mites on the host is an important predictor of effective transmission.

In a typical scabies infestation the average number of burrowing mites on a host, who has developed infestation for the first time, is around 12, this number decreases in cases of re-infestation (28). According to an experimental study by Mellanby casual physical contact risks transmission only if the number of mites in the index case is significantly higher than 50. If the number of mites is less than 5 it takes frequent and prolonged physical contact, for instance bed sharing, with the infected person for the transmission to take place (28). These findings have important public health implications where people with high parasite load can serve as core transmitters of the infestation, affecting many people in a short time (23, 28), and control interventions should target hosts with high parasite load, like cases of crusted scabies, to quell outbreaks (42).

Bedding and clothing can also transmit scabies. However, fomites are less effective in transmitting the mites. In one of the very few experimental studies healthy volunteers slept in beds that had been occupied by scabies patients in the past 24 hours. In this study the rate of transmission from typical scabies patients via bedding was only 1.3%, but the number increased to 15% when the bed had been occupied by a person with severe infestation (28, 31). Considering the rarity of people with severe infestation in the general population (often less than 10%), disinfecting bedding and clothing as a control intervention may not bring the desired result (31). Contrary to this, at times fomites are regarded as important modes of scabies transmission, as a result, promoting personal hygiene, disinfecting clothing and bedding take centre stage in scabies control interventions (43, 44).

This may divert the focus of control interventions to the less effective modes of transmission and undermine the effectiveness of the interventions. Therefore, scabies control measures should consider environmental, host, and agent related factors to effect a swift and lasting control (2).

1.3.4. Animal to human scabies transmission

The *Sarcoptes Scabiei* mite can also cause a cutaneous infestation called mange in domestic and wild animals (45). The infestation is commonly characterised by itch, patchy hair loss and scaling in the skin of the affected animal (46). So far, *Sarcoptes scabiei* were believed to be host specific (47), however, further study is needed to confirm host specificity of the different strains (45) as there are reports of atypical scabies manifestations in humans who were in contact with animals that had sarcoptic mange.

There are a few studies on the cross-infestation of scabies from domestic animals to humans, and nearly all were inspired by the occurrence of a small cluster of scabies cases at households (48-50). Studies that reported the possibility of the infestation passing on from domestic animals (mostly dogs) to humans, reported that the manifestations were mild and the infestation was self-limiting (45, 46). This is suggestive of the potential animal to human transmission of some variants of scabies mite but there is a lack of pathophysiologic mechanisms for the propagation of the infestation in a human host. Because of the limited replication, mainly causing localized lesions in human host, isolating the mites from the new host is difficult (49).

The disease presentation following the reported cross-infestations were also not typical. The time interval between the exposure and development of the symptoms were shorter (50). The distribution of skin lesions also substantially involved the chest, lower abdomen, fore- arm and thighs, body parts which often come in contact with infested pets (46).

1.3.5. Scabies diagnosis

Clinical diagnosis is commonly used to identify scabies patients. The signs and symptoms that clinicians use to base their diagnoses are intense generalised itch which worsens at night, papular rash with typical distribution, and contact history with a scabies patient (32, 34, 51). The clinical diagnosis approach has its strengths and draw backs over alternative approaches which most entail either dermoscopy or laboratory

investigation. The ease of employing the method in low-resource settings, ease of use by providers who have basic training in health care, convenience to reach many patients in a short time, and ability to use the method with no additional diagnostic equipment involved are some of the benefits. However, the clinical approach has low specificity in diagnosing scabies mainly because the usual signs and symptoms of scabies are shared with many other skin conditions such as folliculitis, contact dermatitis, insect bite, and allergy (30, 32). Furthermore, at an advanced stage of the disease, the manifestations that are regarded typical can change. In the presence of secondary bacterial infections, the lesion will be a mix of vesicles, pustules, and skin crusts, and it could expand beyond parts of the body the lesion typically involves. Other than secondary infections, atypical presentations could also result from characteristics of the host. For example, in young children, the scabietic lesions can involve the neck and the scalp. Among people with comorbidities such as leprosy, dementia or peripheral neuropathy, the sensations of itch may not be exhibited (3, 22, 39). Such conditions further undermine the diagnostic accuracy of the clinical approach (32). This signifies the need for alternative easy to use and more accurate diagnostic approaches.

Confirmatory scabies diagnosis is reached when the mite, the eggs, or the faecal pellets are visualized under a magnifying glass or a light microscope (32, 52). This should be done by taking skin scrapings from lesions containing the mite. Due to the low parasite load, taking a skin scraping containing the mite is not always straight forward. Skin lesions can sometimes help to narrow down to parts of the skin where one can find the mite. However, the generalized skin rash and range of lesions can still make locating the mites very difficult (31). Burrows under the superficial skin give a better lead to where the mites can be found, as the mites appear as a black or grey dot at the opposite end of a burrow from their point of entry (30).

A superficial skin shave biopsy is taken by scraping laterally over the skin by using an oil-covered scalpel blade (32, 44). The specimen will later be examined under a low power light microscope. Though this method has high specificity, getting negative results even with those who have typical scabies manifestations is common (3). To enhance the sensitivity of microscopy, the specimen collection and laboratory investigation should be handled by a trained and experienced person, and samples ought to be collected from multiple sites (32, 53). The need for trained health care providers and proper laboratory facilities indicates the resource implications of using this

method (53). For this reason, using laboratory diagnosis in high-scabies-burden, low-resource settings may not be economical or possible. In addition, the specimen collection procedure is sometimes regarded invasive and causes anxiety to patients. This signifies the need for a less-invasive and relatively easy to apply techniques which mainly involve equipment-aided visualizations of skin lesions.

Dermoscopy is one of the non-invasive techniques employed to diagnose scabies by visualizing the skin using a hand-held dermoscope. The fact that this is a manual technique with no digital assistance makes it easier to use both in clinics and in the field settings (54). The method entails direct visualization of the skin surface under a magnifying instrument. The dermoscopy technique is non-invasive, cheap and easy to use, but it has a magnifying power of not more than X10 (55).

With the growing need to increase in vivo detection of scabies mites different techniques are being tested (53). Epiluminiscence microscopy (ELM) is one of the methods promising an advanced magnifying power of structures under the superficial skin. This technique involves pressing a glass slide onto a lesion covered with oil immersion and visualizing it under a hand-held magnifying instrument. The oil immersion helps the light to be absorbed and reflected from structures beneath the superficial skin surface (56). In dermoscopy, the observer looks for a presentation resembling a jet with its contrail (53). A triangular dark spot at the tip represents the mite and the track is its burrow where the faeces and eggs can be found (39). In a validation study this method identified 93 percent of scabies patients which were first diagnosed with the standard microscopy technique (57).

Videodermatoscopy (VD) is another method that helps to visualize the mite while it is under the superficial skin. This method significantly surpasses the magnification of hand-held dermatoscopes (53, 58). VD involves the use of a video camera equipped with lenses having a high magnifying power, up to X1000 and connected to a computer (58). To further enhance the visualization of structures beneath the outer epidermal lining, VD can be coupled with the Epiluminescence Microscopy (ELM) technique (53). The larvae, eggs, and detailed anatomic structure of the mite which may be too small to be detected with the customary magnifying glasses are visible in VD (59). The fact that it is a non-invasive technique makes it easy to use with children and patients who detest skin scrapping. This technique fits the busy schedule of health care providers as they

can scan multiple parts of the body in a short period (60). Its possible application for follow-up patient examinations is the other value VD adds to scabies treatment (59). This technique also has high diagnostic accuracy. A validation study that compared the performance of VD against the microscopy technique reported a perfect match between the findings of the two methods. However, VD requires a high-power video camera imbedded with optical fibers and a computer to display the imaging. The total cost of the equipment and the expenses to set up the diagnostic equipment reaches $25,000 USD (53). This high equipment cost undermines its use in under-resourced settings (61).

Before the current advances in dermatoscopy, the Burrow Ink Test (BIT) was considered a highly accurate diagnostic technique. The technique involves rubbing papules which presumably harbour the mite with the under-side of a fountain pen (62). After a little while the ink is wiped off with alcohol swab, and the ink that entered the burrow marks a track under the superficial skin (62). The black or dark brown colour of the ink creates a clear contrast with the remaining parts of the skin. This distinction is more pronounced in light-skinned people. A study which compared the performance of BIT against a superficial skin shave biopsy found out all the twenty-five participants who were positive for the standard superficial skin shave test were also positive in the BIT. However, eleven of the 30 BIT negative individuals were positive for the standard test (62). The need for no special expertise to conduct the procedure and its non-invasive nature makes it fit for use in most settings globally. However, BIT has low sensitivity where only half of scabies patients diagnosed through microscopy were identified by this test and the difference may be even higher if the test is done among people with dark skin (63).

The universal use of most of the techniques I discussed above is challenged by their low accuracy or the need for advanced diagnostic facilities and specially trained health care providers (53). Nonetheless, growing interest to determine the burden of scabies and map its distribution in low-resource settings calls for inexpensive and easy to use diagnostic approaches (64). The Delphi consensus criteria were aimed to meet the need for easy-to-use diagnostic approach that can be applied to screen a large number of people in a short period with an acceptable level of accuracy. The criteria also help to maintain standard diagnostic procedures across providers with a varying clinical experience and expertise. It was first developed by a team of experts with International Alliance for the Control of Scabies (IACS) membership (52). It outlines major and minor

criteria which helps to make scabies diagnoses at three different levels of certainty (i.e., confirmed, clinical and suspected scabies). The levels vary in sensitivity and specificity making the tool adaptable to different objectives that aim for varying degrees of accuracy (52). The ability to discriminate between different clinical presentations of scabies is also important in enhancing accuracy. For instance, using dermoscope-aided examinations can increase accuracy in identifying burrows and isolating the mite, and the criteria have a room to account for the increase in accuracy by using aids instead of examinations with the naked eye (65). Though this approach addresses issues of resource constraints and is flexible for use by people with a range of clinical expertise, it still has multiple limitations. It requires validation to test its ability to discriminate between skin diseases with similar clinical presentations.

1.3.6. Complications of scabies infestation

Scabies primarily causes nocturnal itch and restlessness, but serious complications are associated with secondary bacterial infections. Impetigo, cellulitis and fasciitis are localized complications of scabies (1, 2), and the probable systemic complications include septicaemia, acute glomerulonephritis, and Rheumatic Heart Disease (RHD) (3-5). Impetigo, a skin infection commonly caused by *group A Streptococcus* and S*taphylococus aureus,* (66) is one of the most common complications of scabies (66). Its prevalence ranges between 50% and 87% among children in under-resourced communities (9, 66). Due to the pervasive prevalence and related complications, it has high public health significance specially in marginalized communities.

Though there are different causes of impetigo, in scabies endemic areas the occurrence of nearly 50% of the cases is associated with a preceding scabies infestation (9). According to epidemiologic studies impetigo partly mediates some of the scabies complications such as Streptococcal Glomerulonephritis (SGN) and RHD (67). A strong association was observed between scabies and acute Rheumatic Fever (RF) and chronic RHD (68). Though further studies are needed, scabies could be an important determinant of RHD and SGN, other than the known streptococcal throat infections (5, 68). Cognizant of the many fold increase in prevalence of scabies compared to throat infections, scabies control can have a substantial impact on reducing the incidence and prevalence of SGN and RHD.

The impact of scabies goes beyond affecting physical health. The pain and irritation caused by the lesions and its effect on self and community perception of the patients undermines life quality.

Skin diseases undermine the quality of life of patients (69). Measuring this impact is vital as skin diseases change physical appearance, limit bodily function, and undermine mental health of patients (70). They affect life quality through a range of mechanisms. Physical discomfort caused by the pain, itch, and irritation from the skin lesions; poor mental health secondary to distorted self-perception; limited social role and functioning due to stigma and social exclusion are some of the mechanisms (70-72). Numerous studies were conducted measuring the impact of a range of skin conditions on the life quality of patients (72-76). In most of these studies, the existence and severity of their impact is determined by the size of the lesion, the affected body part, severity of the symptoms, and the perceived and actual social support. Big lesions and lesions on exposed parts of the body or those that have severe manifestations cause a more serious impact on the life quality of patients (74, 77, 78).

Despite the evident association between other skin diseases and poor life quality, the impact of scabies on life quality of patients is not adequately investigated (6). In my literature search I have only identified three publications, which were conducted in China, Brazil, and Ethiopia (6, 11, 79). The first two involved adolescent and adult population while the study in Ethiopia only involved school children (11). In these studies, scabies had an overall moderate impact on life quality of patients (6, 79). However, disaggregated scores indicated a varying degree of impairment on a range of life quality domains. Severe degree of impairment was reported in physical well-being related domain. It includes impairments secondary to physical pain and discomfort that are caused by the lesions and the affective response associated with it (6). Self-perception, which has ramifications to mental health, is the other severely affected life quality domain (6). When we see the proportion of people by degrees of severity, scabies had a moderate to severe impact on the life quality of more than 50% of the participants (6, 79).

The constant severe itch, skin lesions on exposed parts of the body, and sleep disturbance can directly undermine life quality of patients (11, 79), or through social isolation, reducing work performance, and undermining social functioning of patients (79, 80). For this reason, scabies care should follow a holistic approach, that goes beyond ensuring physical wellbeing. However, thus far there were only few studies on the subject. This has limited the evidence base to develop a holistic scabies care package. One of the secondary objectives of this study is to generate data that helps to determine effective control strategy and improve scabies care for individual patients.

In this study I measured the impact of scabies on life quality of adult scabies patients using the Cardiff Dermatologic Life Quality Index (DLQI) tool (81). This tool is the most widely used dermatology specific instrument to measure quality of life. It is being used in 33 different skin conditions, and translated to 55 languages in 32 countries (82). The tool helps to generate data that measures the overall degree of impairment to life quality, and it also allows to qualify the impact by a range of life quality domains (72, 82). Such data helps to improve the overall life quality of patients and tailor the interventions to the most affected aspects of individuals' life quality domain.

1.3.7. The global burden and distribution of scabies

Scabies affects 100 million people globally at any one time and nearly 300 million people yearly (3, 7, 61). The global distribution of scabies is significantly skewed to under resourced tropical countries (61). However, there are reports of scabies in high-income countries as well but with a different epidemiologic presentation (2, 22). High scabies burden and frequent outbreaks are reported in under-resourced communities of low-income and middle-income countries and of few high-income countries (2, 83, 84). Globally, population-based estimates of scabies prevalence ranges between 5% and 50%(85, 86). The highest estimates come from countries of the southern pacific region, central America, and from under-resourced communities of Australia (10, 84, 87, 88). Though not as high as the reports from these regions significant prevalence is reported in South America, Asia, and Africa 9%(89), 4%-9% (90, 91), and 5%-9% (86, 92, 93), respectively. However, there is significant intra-region variation in the burden of scabies (61), and the patterns of outbreaks.

Historically, scabies outbreaks had a cyclic pattern repeating every 25 to 30 years (94). This pattern was at first attributed to the effect of herd immunity that delayed major outbreaks for 2 to 3 decades (28). However, this is only a hypothesis and there is no substantive evidence to back it. In addition to this, the outbreaks coincided with times of political instability and social unrest (95). This indicates the periodic increase in prevalence can be attributed to the deteriorating living condition secondary to the crises. It is known that natural disasters and social, political, and economic crises create a conducive environment for rapid transmission of scabies to take place (96, 97).

Most of the high scabies burden countries are found in the tropics. Even though climate is not an important predictor of scabies, settings with hot and humid climate have a higher scabies prevalence (7, 97). Despite the mounting evidence on the high burden of scabies in the tropics, the high prevalence has more to do with health service access and living condition than climate. However, to reach at a conclusion on the relationship between climate and scabies more epidemiologic data is needed from diverse settings and climatic zones but currently most of the existing publications are from areas where scabies is deemed a public health challenge (7). It includes the southern pacific region, Africa, Latin America, and southern Asian countries (7, 98, 99). This limits the availability of data from diverse settings. Even within these countries the studies are often either from times of outbreaks or among vulnerable population sub-groups such as in school children or people visiting out-patient departments at health care facilities (13, 14, 86). Scabies data in low-burden western countries is limited and population based studies are even fewer (7).

Most of the studies from high income settings are facility based in hospitals, care homes, and prisons (21-23, 100). In western and a few Far East countries outbreaks of scabies in care homes for the elderly showed an attack rate ranging from 15% to 93% (101). The rapid transmission in such settings is mainly attributed to increase in host density (21, 23, 102). However, the prevalence in the general population is low (7). In the United Kingdom, a mean prevalence of 2.81 per 1000 in females and 2.87 per 1000 in males, was estimated using data from a clinical practice records between 1997 and 2005 (103). A similar low proportion of scabies cases was reported among health care facility visits of other European countries. For instance, from a dermatology clinic in

Greece, 4.8% of visits were due to scabies (8) and an incidence rate of 28 per 100,000 inhabitants and a proportion of 1.7% of out-patient visits to a dermatology clinic were reported in Belgium (8, 104-106). Unlike most communities in high income countries, scabies prevalence in aboriginal communities in Australia is significantly high ranging between 16% and 30% (107, 108). However, as these estimates are from a specific community, it is not representative of the prevalence in the general Australian population (85, 107, 108).

Scabies is endemic to Ethiopia (12, 97, 109) but a major outbreak, the first of its kind in the past decades, was reported in 2015 (13). The outbreak started in Amhara regional state, northern Ethiopia, and reached nearly all the 11 zones in the region (15). A population based survey conducted at the wake of the outbreak indicated a median prevalence of 33.5% (13). The study involved 68 districts, and the highest district level prevalence estimate was 67% (13). Another study in a traditional clergy school students, in the same region, estimated a 22.5% scabies prevalence (14). At the time this sharp rise in scabies prevalence was attributed to the El Nino event of 2015 and 2016 that severely impacted northern Ethiopia (110, 111). This hypothesis is based on the assumed but not yet proven association between limited access to water and the increased risk of scabies (13, 112). Because of the climatic factors and the findings of the early surveys, which only involved the Amhara region, at first the outbreak was assumed to be contained in northern Ethiopia. However, later studies reported a high scabies prevalence in southern and central Ethiopia ranging between 11% and 13.6% (19).

Most research in Ethiopia was conducted in the past few years, presumably due to a shift in attention following the outbreak, however, earlier studies also indicated its endemicity. A school-based study in Ilubabor Zone, western Ethiopia, revealed a staggering need for dermatologic care where 97% of the participants presented with at least one dermatologic disease (12). Scabies took a 6.5% share of these skin diseases (12). Another community-based study in the same part of the country also indicated a grave need for dermatologic care, with scabies being one of the leading dermatologic conditions once again. Though this study failed to distinguish between parasitic skin infestations; scabies, pediculosis, and onchocerciasis, altogether constituted 46% of the overall diagnoses (97).

Despite this longstanding need for evidence to guide scabies control interventions, data describing the epidemiology against key environmental and population characteristics is lacking.

1.3.8. Determinants of scabies infestation

The WHO has recently added scabies to the list of neglected tropical diseases (NTDs) (113). One of the rationales behind the decision was its skewed distribution to marginalised communities, where frequent social disruption and crowding is not uncommon (113). High crowding index (number of household members to living space ratio) is among key determinants of scabies transmission (28). A study in a small village in Egypt found a strong association between crowding index at night and the risk of scabies in the study households (86). Among others, this factor plays a significant role in mediating scabies outbreaks at times of social and political crises, natural disasters and in facility settings (96, 105).

Poor health-seeking due to sub-optimal economic or geographic access to health services hinders transmission interruption. The infestation will have time to spread among contacts if early treatment is not available (31). In addition, as the days go by, the number of mites on patients increase, making patients important sources of transmission (28).

Different studies have investigated the relationship between wealth and scabies. However, most of them measured wealth as a group factor, at the regional or country levels (7, 85). Though the existing evidence proves, beyond doubt, the effect of poverty and overcrowding on the transmission of scabies, evaluating the contribution of household wealth to the risk of acquiring scabies is vital. Community-level analysis of such factors is prone to confounding and its effect may not necessarily translate in the same way as the household level wealth status. In this study, I determined household wealth and examined its impact on the odds of scabies infestation among household members.

Poor hygiene and limited access to sufficient volume of water is regarded as one of the reasons for the endemicity of scabies in under-resourced communities (114-116). In relation to this, promoting personal hygiene has become one of the major control strategies (114, 117). The perceived association between hygiene and scabies mostly originated in earlier studies that were aimed to determine the impact of access to water

and personal hygiene on communicable diseases. One of the impactful publications on the subject was the book by White *et al*, a work that had substantive contribution to the WHO's classification of water related diseases (112). In this study scabies was classified as a water washed disease, a disease predicted by the volume of water people have access to (118). However, the publication did not include a mechanistic explanation how personal hygiene prevents scabies infestation. Furthermore, the reduction in morbidity of scabies that could be obtained by improving water supply was in the author's own words "guess work" that was mainly based on their observations and experience (118). Universally, personal hygiene prevents the spread of communicable diseases primarily by killing the pathogens on the body surface or by removing it through mechanical disturbance caused by the effect of the water and detergents. In the case of scabies, recent studies reported that neither soap nor antiseptic solutions can kill the mite (119), and even for topically applied acaricides it takes a prolonged exposure to kill these pathogens (88). The mechanical disruption on the mites caused by washing may not as well be significant since the pregnant female mite, which is responsible for the infestation, stay on the skin surface only for around 30 minutes, subsequently, the mite burrows under the superficial layer of the skin (120). Though vigorous scrapping may at times remove mites from their burrows this is not typical bathing and may sustain damage to the skin (121).

The lack of acaricidal effect of soaps that are commonly used for bathing and the mite staying hidden in its burrow undermines the effect of hygiene on individual's risk of infestation and subsequent transmission. However, there are several epidemiologic studies showing inverse association between hygiene or access to water and scabies infestation (19, 20, 32, 115). The indicators used to measure hygiene in some of these studies is access to clean water and the type of water source (110, 115). However, these indicators do not clarify whether improved access to water translates to better hygienic practices (122). A case control study from Ethiopia captured hygiene practices instead of only measuring access to water (20). However, the positive relationship between hygiene and scabies in this study is doubtful because contact history with a scabies patient, a well-established risk factor of scabies, was not found to be significantly associated (20). Furthermore, the frequent scabies outbreaks in institutional settings, where there is due attention to personal hygiene and access to the necessary facilities, challenges this hypothesis (21, 101, 114).

However, poor hygiene in scabies patients has evidently increased the risk of secondary bacterial infection (89, 94). The increase in size and change in appearance of the secondary lesions, following bacterial infection, may increase the chances of such cases to be identified in studies more than people who have a better access to water and where uncomplicated scabies is more common.

Age is the other determinant of scabies infestation. High scabies prevalence is observed in the extremes of age. High prevalence among children is reported in low- income settings while the elderly are more affected in high income settings (35, 51). Studies from hot and humid tropical countries indicated a disproportionately high prevalence of scabies among children (7, 10, 86, 107, 115). However, these studies used different age categories, ranging from 0 to 17 years, to define children. The inconsistency in operationalizing the age categories complicates the effort to attribute the infestation to a broad range of age-related determinants. For instance, at early ages (< 5 years), the source of the infestation could be household members. But during adolescence, sexual contact is among the factors which might increase the risk of transmission (2). Therefore, categorising the age into five-year intervals helps to identify age-related determinants with better accuracy. The increase in prevalence among the elderly in high income settings is partly due to the high number of publications from studies conducted in elderly care homes at times of scabies outbreaks (23, 123). The skewed distribution of research among the institutionalised elderly population, calls for further work to determine scabies epidemiology among the remaining groups of population.

Sex is an important sociodemographic determinant in infectious disease epidemiology (124). Women are at higher risk of developing NTDs but do not seek care as early. Gender roles are frequently used to explain the circumstances that expose people to the different sources of scabies infestation. With this consideration in mind, programs focusing on gender roles as a control strategy have been developed and carried out (125). Unlike other NTDs, the relationship between scabies and gender is not well studied. Most of the studies so far reported no difference in the distribution of scabies between genders (2, 21, 86, 115). In the developing world, women take the lead in nurturing the family and raising children. These responsibilities require them to stay in-doors for a prolonged period of time and invites frequent physical contact with household members (115).

Considering children are the most affected groups in the tropics and prolonged physical contact is the main mode of transmission, women are at a higher risk of developing the infestation (7, 35). Research that further investigate the association between gender dimensions and the risk of scabies are needed.

1.3.9. Public health control of scabies

There are five major NTD control strategies: MDA, control of zoonotic diseases, promoting water sanitation and hygiene, vector control, and intensified disease management (126). Based on disease epidemiology, availability of resources and the nature of the disease different control strategies are recommended for the range of NTDs (126). NTDs targeted by MDA for elimination, so far, are only five (i.e., onchocerciasis, lymphatic filariasis, soil transmitted helminths and schistosomiasis) and trachoma (127).

MDA is a large-scale delivery of therapeutic dose of a single or combination of drugs against target NTDs to communities living in hyperendemic areas where the disease prevalence crosses the recommended threshold to initiate community-based control measures (127, 128). MDA is guided by population-based data on disease prevalence and distribution. Post-intervention surveillance and follow up surveys are also necessary to measure its impact on the disease epidemiology and to eventually stop the intervention (126, 127). The disease prevalence threshold to initiate community-based intervention marks the level where standard care (treating individual patients) is no more an effective strategy to control the target NTD. By treating the whole population, it is possible to cure both symptomatic and asymptomatic patients and interrupt the transmission by preventing re-infection in endemic communities (84, 129). As MDA employs a community-based approach it also helps to shorten periods of transmission by providing treatment, early on, instead of waiting for patients to seek care. This is crucial as most communities targeted by MDAs live in low-income settings where infectious diseases are rampant but health care service access is limited (27).

Scabies ivermectin MDA also provides additional off-target benefit of controlling other infectious diseases and strengthening health systems. For instance, MDA against helminthic diseases can improve the effectiveness of malaria control interventions, reduce the risk of acquiring HIV and might delay the progress of HIV to AIDS (130-132).

Improved adherence to other health programs in areas where MDAs are underway is an ancillary benefit to health systems (133). This community directed approach helped to sustain a large population and geographic coverage for years as it reduces operational cost to health systems (127). Contrary to these advantages, MDA poses challenges to clinical services and has programmatic limitations.

Horizontal integration of MDAs is one of the recommended approaches to enhance cost effectiveness and achieve global targets (27). Co-administering different drugs against multiple NTDs, in co-endemic areas, is among the integration approaches (134). However, the safety of co-administering multiple drugs in MDAs is not fully understood and requires further study (135, 136). Lack of appropriate drug formulations that meet the needs of all groups of population entails operational challenge to the program and a safety issue to target populations (136). Potential drug resistance secondary to MDAs is the other challenge of MDA programs and a major threat to medical practice. Even though there are no reports of drug resistance secondary to MDAs, so far, administering small dose or sub optimal treatment schedule has the potential to cause a widespread drug resistance (137). For instance, in co-endemic areas of onchocerciasis and scabies, MDA against the former can theoretically risk resistance of scabies mites to ivermectin (138). This is so mainly due to the dose and treatment schedule for onchocerciasis MDA, which is lower than the recommended scabies treatment dose and schedule (139, 140). Therefore, optimizing onchocerciasis MDA for the control of scabies enables both integration and prevents the risk of scabies mite resistance to ivermectin.

MDA is getting a global acceptance and more programs implementing MDA against target NTDs are surfacing (128). In 2012 alone 800 million people were treated, and currently 700 million individual treatments are provided annually in MDA programs (141, 142). The success of MDA programs is the result of a global commitment to eliminate, control or eradicate NTDs by 2030 (27). Pharmaceutical companies pledged to donate free medicines for use in MDAs, NGOs committed to implement the WHO control strategies in endemic areas, bilateral and multilateral international organizations revitalized their commitment to put an end to NTDs (142). The 2012 London declaration, inspired by the WHO's NTD control road map, was instrumental in renewing the commitment to end NTDs (143).

NTD endemic countries, pharmaceutical companies, international organizations, and donors, were committed to eliminate, control or eradicate 10 NTDs by 2020 and to improve the living condition of people living with these ailments (143).

Scabies being one of the recently added ailments to the WHO's list of NTDs, the evidence base to determine efficacious control strategy is still evolving (1). Scabies control strategies that are currently in use can be broadly categorized as standard care and community-based interventions. The standard care involves providing a therapeutic dose of scabicidal drugs to patients and their close contacts in clinics or at outreach settings (144). The commonly used drugs against scabies include 5% permethrin cream, ivermectin tablets, bezyl benzoate creams, or sulfur creams (145). Standard care is a passive approach where patients are required to come to health care facilities or similar sources of care to get treatment. Compared to the community-based strategies standard care is the least effective in controlling scabies outbreaks. A reduction in scabies prevalence following optimally implemented standard care, as the only intervention, is not more than 50% (26, 129). This is mainly due to patient delay to health seeking, failing to treat contacts, poor treatment adherence, and fast transmission of the infestation (35). Standard care is better suited to settings where there is low disease burden, better access to health care services and optimal health care seeking behaviour (35, 146). Standard care combined with health education and environmental modifications helps to maintain the gains in scabies control obtained by community-based interventions (146).

Community based scabies control strategies include MDA, targeted MDA, and intensified disease management (IDM). The earliest community trial that evaluated the effectiveness of MDA for the control of scabies was conducted in Panama (88). Since then, additional trials were carried out to evaluate the effectiveness of MDA as a scabies control strategy and to measure the efficacy of alterative antiscabietic drugs in MDAs. Regardless of the differences in the design and duration of the studies, in nearly all these trials MDA against scabies was effective in significantly reducing the disease prevalence (26, 134, 135, 147). Secondary to intensive community-based interventions, a low disease prevalence that sustained for years was reported (148). Nonetheless, interruptions before the optimal threshold is reached could lead to a rebound (88). Though these findings are encouraging, MDA against scabies requires further studies in range of settings and administration modalities before universal use is recommended.

For instance, most community trials on scabies MDA were conducted in island communities of Fiji, Solomon Islands and Papua New Guinea (149). The islands created a natural barrier for the community not to mix easily with people from the mainland (88). This served as a natural barrier to prevent the reintroduction of scabies from neighbouring communities into the intervention population. However, the effectiveness of MDA against scabies in mainland population of a range of geographic settings and sociocultural backgrounds remains to be tested. This scepticism is not unfounded. A before and after study in an island community of Australia reported a lack of long-term impact of a scabies MDA, 12-months after the intervention (150). The authors attributed the surge in scabies prevalence in the 12-months survey, which was even higher than the baseline, to a re-introduction of scabies patients from the mainland population and inadequately treated crusted scabies patients circulating in the study community. Such operational challenges and cost effectiveness issues of the intervention are matters that require in-depth analysis and contextual understanding of target communities.

Targeted MDA, like the standard MDA, involves administering therapeutic dose of antiscabietic drugs to target population regardless of disease diagnosis. However, the focus of targeted MDA are population subgroups with high disease incidence instead of the entire community. This approach has been in use to control current and prevent future outbreaks in facility settings (21, 22, 106, 151). Mass treatments are crucial in such settings as scabies outbreaks are not uncommon. With the majority of evidence originating from high-income western countries reports of targeted MDA from low-income settings are rare (22), though the need for targeted interventions in low-income settings is as high (14, 98). This strategy is important to control outbreaks in special groups of population and prevent the spread to wider communities. In Ethiopia, for instance, evidence indicated high scabies prevalence among traditional religious school students (14) and in anecdotal field discussions these institutions are regarded as important sources of scabies outbreak for the wider community. The WHO informal consultation on scabies control observes this strategy as a possible scabies control approach (144). Nonetheless, its efficacy in community settings and contributions to overall control remains to be tested.

The WHO recommends innovative and intensified disease management (IDM) for NTDs where diagnostic and treatment facilities are limited or unavailable and diseases with complicated treatment approaches (152, 153).

IDM centers active case finding, providing appropriate treatment and subsequent follow up. Strong surveillance defines the success of this strategy and to follow post-intervention change in disease pattern. This approach was originally intended for five NTDs buruli ulcer, chagas disease, human African trypanosomiasis, leishmaniasis, and yaws (152, 153). However, in the current NTD roadmap IDM is recommended to complement the remaining NTD control strategies for all NTDs including scabies (144, 153).

Scabies MDA is effective in decreasing the disease prevalence in high burden settings. Studies showed successfully executed MDA can have a long-term impact. Strong post-MDA disease surveillance and case finding is key for the success of scabies MDA. One of the pioneering research works on scabies control in Panama showed a dramatic reduction in scabies prevalence following permethrin scabies MDA. The single MDA managed to decrease scabies prevalence from 33% to 2.5% (88). Three case finding and treatment surveys were conducted between the MDA and the endline survey, which reported a 1.5% scabies prevalence, and all the identified cases were fully treated (88). The program came to a stop in 1989 due to American invasion of Panama and a year after the program termination resurgence of scabies to 12% was reported (88). Similar studies, which combined IDM with MDA, managed to sustain low scabies prevalence for a longer period. Marks *et.al.,* reported a persistent low scabies prevalence fifteen years after the end of scabies ivermectin MDA in island populations (148). This long-term impact is mainly attributed to the effective administration of the MDA, which involved treating the whole community and all the returnees to the islands, and the follow up surveillance. Active case finding surveys were carried out three times a year throughout the intervention period (87). Cases identified in the surveys were treated right away and this helped to significantly decrease the risk of transmission and sustain low disease prevalence. This evidence supports the importance of IDM to maintain the low prevalence attained through MDAs. Nonetheless, the scale up of such approach should be taken with cautious optimism. As these studies were conducted in island communities monitoring newcomers and preventing reintroduction of scabies is more manageable than mainland communities. Therefore, the effectiveness of this approach should be tested in non-island communities. The reported effectiveness of IDM to sustain control has resulted from the low starting prevalence before the intervention.

Therefore, the threshold to initiate IDM both as a follow up to MDAs or as an independent intervention needs further study. Such evidence is vital as IDM is among the recommended scabies control approaches in the WHO's framework for scabies control (144). MDA is proven effective in controlling scabies in high burden settings, at least among secluded communities with limited interaction with people from the mainland (149). However, there is limited evidence on the appropriate strategy for scabies control in low-prevalence settings (1).

Ivermectin is a semi-synthetic macrocytic lactone effective against a range of parasitic diseases caused by nematodes and arthropods (35, 154). Its earliest application was in veterinary medicine to treat endo and ectoparasites in pets and cattle (155). It was first tested in humans in 1982 to treat onchocerciasis and was proven to be effective against microfilaria of the nematode *Onchocerca volvulus* (156). Its use against scabies was approved later, in 2001, in France (154).

Ivermectin is the drug of choice for use in onchocerciasis and scabies MDAs (144). Its high efficacy, wide safety margin and broad spectrum activities were among the criteria that led to its use in MDAs (157, 158). Ivermectin is proven to be superior to the commonly used topical scabies treatment, 5% permethrin cream (26). Apart from the difference in the acaricidal effect of the two drugs, ease of administration and convenience to treat contacts made ivermectin fit for use in MDAs. Treatment with permethrin requires applying the cream on the entire body, including the genitals, more than once. For many patients and their contacts adhering to this treatment protocol is not a simple task (1, 145) not to mention the logistic challenges of distributing the drug to thousands of people in remote areas. Though ivermectin decreases the challenges associated with drug administration and logistics, a drug with even longer plasma half-life is needed to reduce the number of doses per treatment round to one (135). Since ivermectin does not sterilize eggs, two doses separated by one to two weeks period is required to cure a scabies patient (3). The second dose is intended to clear the larvae hatched after the first dose is administered. For this reason, ideally ivermectin scabies MDA should involve two doses per round of MDA (135). However, administering two doses of ivermectin in a single round of MDA is still problematic and one dose ivermectin MDAs have also considerably reduced scabies prevalence in previous studies (26, 147). To ascertain the effectiveness of a single dose ivermectin MDA in controlling scabies a cluster randomised non-inferiority trial is underway (159).

Repurposing other acaricidal drugs that have a longer plasma half-life is the other way to enhance feasibility and cost effectiveness of scabies MDA. Moxidectin is a drug used in veterinary practice to treat sarcoptic mange and it is under trial for use in humans (160). If proven safe, the longer plasma half-life can make it more efficacious than ivermectin, the only systemic drug for scabies, and make scabies MDAs more feasible (145).

The WHO informal consultation on a framework for scabies control recommends annual MDA using two doses of ivermectin in communities where scabies prevalence exceeds 10% (144). The MDA is recommended to continue until the prevalence decreases below 2% (144). However, the framework is mainly based on previous experience in the control of other NTDs and expert opinion (135). Determining a more objective cut off to start and stop scabies MDA requires further study including empirical data based mathematical models. In addition to addressing these technical issues, strategies to enhance feasibility and efficacy of scabies MDAs should be sought. Feasibility is key to promote program ownership by local actors. For the past two decades MDAs for NTDs is mainly supported by pharmaceutical companies (145, 161). However, it is unclear whether this support is sufficient to meet the global health target and whether it will be lasting (162). For this reason, local governments should be able to own and fund NTD control programs (27). However, the programmatic cost that can be high to most low-income countries and extensive nature of MDAs delay the transition to ownership by local actors.

Integrating control interventions for different NTDs is one of the approaches that help enhance the feasibility and cost effectiveness of community-based control measures. This is in line with the WHO's renewed approach that moved NTD control from disease specific programs to integrated interventions to control, eliminate and eradicate NTDs by 2030 (27, 141). Integrated control interventions help to optimize utilization of resources, minimizes frequent disruptions to the health system in organizing MDA campaigns and enhance coverage and uptake by the target community (147, 163-165). Thus far, WHO mainly targeted five NTDs for control and elimination through preventive chemotherapy: onchocerciasis, lymphatic filariasis, soil transmitted helminths, trachoma, and schistosomiasis (27, 141). Regardless of the difference in treatment regimen, ivermectin is used in MDAs against the first three parasitic diseases (27).

Therefore, it is theoretically possible that in co-endemic areas the MDA against one of these NTDs will have an off-target impact on others including scabies. This presents the opportunity to integrate MDA programs against these NTDs (164). However, efforts to integrate control interventions are still challenged with lack of data on the burden and distribution of candidate NTDs, the optimal dose and number of rounds of MDA needed for control or elimination, and the safety of co-administering multiple drugs (164).

Separate studies in Tanzania, Zanzibar city and Kongwa district, reported the impact of MDA against lymphatic filariasis on scabies (166, 167). The former study reported a five year steady decrease in the number of clinical visits for scabies at the nearby health centers due to repeated MDAs of ivermectin and albendazole for lymphatic filariasis (166). The second study also reported a significant decrease in scabies prevalence after a single dose ivermectin MDA, even though no further decrease was observed following subsequent MDAs in the same intervention (167). Unlike previous community trials that reported a dramatic decrease (26, 129), this study observed a modest decrease in scabies prevalence after the MDA. The authors explained that the marginal decrease has resulted from the fact that the study was conducted in non-island population (167). A similar conservative decrease was reported following a single dose ivermectin scabies MDA in Aboriginal communities. Though this was an island community it was highly mobile and had close interactions with people from the mainland (150). This facilitated the reintroduction of scabies cases from the mainland to the study community. Such findings indicate, despite the reported effectiveness of ivermectin scabies MDA in island communities it may not have the same impact in mainland communities (26, 167). However, there is limited evidence on the effectiveness and scalability of scabies MDA in non-island communities (147, 167). My study investigates the impact of a single dose ivermectin MDA against onchocerciasis on scabies prevalence in non-island communities.

Onchocerciasis is a debilitating NTD of the skin and the eye caused by a filarial worm called *Onchocerca volvulus* (168). It is a vector born disease transmitted through the bite of a black fly of the genus Simulium (169). The vector breeds in fast flowing streams, hence onchocerciasis is more common in communities living at the banks or close to rivers. Once it enters the body, the adult worms release millions of microfilarie that damage the eyes and skin tissue (168). For this reason, the main manifestations of onchocerciasis are cutaneous including itch, de-pigmentation, and thickening.

Chronic infections can also cause blindness (170), and this is how it earned the name, river blindness. Onchocerciasis has high socioeconomic and public health significance and control measures are being taken in endemic areas, globally (171). In Ethiopia out of the total 817 districts 188 were onchocerciasis endemic and ivermectin MDA against onchocerciasis was underway in 184 of these districts (172). Before the MDA onchocerciasis mapping was conducted and it mainly involved western half of the country and nearly all of the intervention districts are found in this part of the country (173). Eastern Ethiopia is excluded from onchocerciasis mapping for lack of historical data and unconducive environmental factors for the vector to breed (170, 172). Similarly, scabies mapping that involved only the Amhara regional state, north-western Ethiopia, indicated that scabies is endemic to all the 11 zones of the region (17). Unlike onchocerciasis, geographic factors are not barriers against scabies transmission, hence, national scabies mapping is mandatory. Nonetheless, the mapping exercises so far, which involved a limited geographic area, indicated an overlap in the distribution of the two diseases in multiple districts. Co-endemicity is one of the important leverages to integrate NTD control interventions (162). The overlap in the distribution of the two NTDs promises effective integration of control interventions enhancing efficacy and cost effectiveness (164).

Earlier onchocerciasis treatment involved the drugs suramin and diethylcarbamazine. However, they were later banned for use against onchocerciasis, suramin for toxicity to multiple body systems and diethylcarbamazine for accelerating onchocerciasis related blindness (174, 175). Ivermectin is the only drug currently in use both for individual patient onchocerciasis treatment and community based control interventions (140). The drug is an effective microfilaricide but its effect on adult worms is limited to undermining their reproductive capabilities (140, 168). It takes three to 6-months for adult female worms to re-start reproduction post-treatment. Therefore, effective onchocerciasis treatment in individual patients involves administering ivermectin 2 to 4 times a year for as long as cutaneous and ocular manifestations disappear, which may take 10 to 15 years, a life span of the adult worms (171, 174).

Onchocerciasis ivermectin MDA was initiated in 1990 and a considerable impact on disease prevalence and distribution was reported ever since (168). The MDA involves once a year or bi-annual community treatment (depending on country level guidelines) with single dose ivermectin (150 µg/kg) (24, 174, 176).

Due to lack of conclusive evidence on safety of ivermectin for pregnant women, lactating women in their first week post-partum, children under 90 cm in height, and the severely ill; these groups of population are ineligible for ivermectin MDA (176). Mathematical models indicated that with high coverage (80%) and more than a one-time MDA per annum onchocerciasis elimination can be achieved in 5 to 15 years period even in population having high community microfilaria load (30-80 microfilaria per skin snip) (177, 178).

Onchocerciasis MDA protocol and the provisional WHO scabies control approach has some differences and more similarities. The drug in use in the two MDAs and the community treatment mechanisms and target population coverage are similar (24, 144). The differences mainly pertain to the drug dose, the number of MDA rounds, and the eligible population to the MDAs. 200 µg/kg of ivermectin is recommended for use in scabies MDAs as compared to the 150 µg/kg in onchocerciasis control, resulting in a 50 µg/kg difference in drug dose (144, 176). The other difference between the two interventions that is amenable to adjustment is the number of annual treatment rounds. In both cases, the number of MDA rounds depends mainly on the currently available evidence of its impact on the disease distribution and local treatment protocols. The WHO recommends at least a one-time single dose ivermectin MDA for onchocerciasis (179) and based on country standards and the local disease epidemiology the number of annual MDA can go higher. For instance, the onchocerciasis control program in Ethiopia recommends semi-annual MDA (24). Annual ivermectin MDA is recommended for scabies control, however, the scabies control framework is flexible to accommodate more rounds if there is evidence supporting superior efficacy of a more frequent use (144). Though there is difference in the treatment rounds, the flexible annual treatment schedules provide space to align the MDAs against the two diseases, if optimizing onchocerciasis MDA for the control of scabies is intended. The more consequential difference is the one in the eligibility criteria of the target populations for the two MDAs. Onchocerciasis MDA excludes people who are ineligible to use ivermectin (i.e., pregnant women, lactating women in their first week post-partum, the severely ill and children under 90cm in height). The provisional scabies MDA protocol also recognizes these groups of population, however, topical scabicides are administered instead (180). Leaving children, who are important focus of scabies infestation, untreated can undermine the impact of onchocerciasis MDA on scabies.

In Ethiopia, standard care has been the main scabies control strategy. Patients sought care for scabies mainly from the nearest primary health care facilities. In the past two decades there was a significant expansion of primary health care services that promoted access to primary health care. However, poor health care seeking for scabies and the scarcity of scabies drugs, in most primary health care facilities, has limited its impact. The inefficacy of this approach to control scabies became clearer following the scabies outbreak in northern Ethiopia that has expanded its reach to the central and southern parts of the country (13). This signified the need for an alternative strategy to control the outbreak. In 2016 the Amhara regional health administration office carried out a community-based control intervention involving 3 out of the 11 zones in the region (15). The intervention strategy involved a mix of MDA and targeted chemotherapy. In communities where scabies prevalence was 15% or more MDA was carried out and where the prevalence was less than 15% treatment of cases and household contacts was conducted (15). Mainly ivermectin, two doses, were used in the MDA. The intervention was successful, and reduced scabies prevalence by half in the intervention communities. At the time, this was the biggest ever community-based scabies control intervention. Later, in 2018 MDA against scabies was carried out involving 9 million people in the entire Amhara regional state (17). Once again, the MDA and targeted chemotherapy were conducted in communities of scabies prevalence > 15% and <15%, respectively. Nearly 94% of the target population were treated with two doses of ivermectin and the rest used permethrin and precipitated sulfur (17). However, as the authors merely intended to describe the intervention, its later impact on scabies epidemiology is not documented.

My study aimed to evaluate the impact of a single dose ivermectin onchocerciasis MDA on scabies. Though this MDA originally targeted onchocerciasis, the treatment protocol is comparable to the intervention designs reported in previous scabies control trials among isolated population and island communities (26, 129). This presented an opportunity to evaluate the effectiveness of a single dose ivermectin MDA for the control of scabies in mainland communities of northern Ethiopia. This study produces a rare data on the impact of ivermectin MDA on scabies prevalence in mainland communities (167) while determining the off-target impact of onchocerciasis MDA on scabies in co-endemic areas. The findings will also inform horizontal integration efforts of different MDAs.

1.4. Research questions and objectives

This thesis reports findings from studies that aimed to improve scabies care and enhance the efficacy of community-based control measures, in outbreak affected northern Ethiopia, and identify the gaps in local evidence on scabies. In Ethiopia, the main scabies control strategy, so far, is standard care. However, this approach has low efficacy in high prevalence settings and to control scabies outbreaks. This necessitated seeking alternative intervention strategies to leverage the efficacy and coverage of the scabies control approach. Optimizing ivermectin onchocerciasis MDA for the control of scabies, in co-endemic areas, can help reduce the prevalence to a level that is amenable to standard care. To this end, I measured the off-target impact of a single dose ivermectin onchocerciasis MDA on the prevalence of scabies. Three successive surveys, one before and two after the MDA, were conducted on a panel of households. The impact was determined based on the change in scabies prevalence at the three surveys. A cohort was formed constituting a sub-sample of participants who participated across the three surveys, regardless of differences in background characteristics. Scabies incidence and disappearance rates were calculated using the cohort data. The baseline survey was used to characterize scabies epidemiology (estimate the disease prevalence and identify determinants of scabies infestation) and determine whether the WHO 10% threshold to initiate MDA against scabies is met. Using the same survey, I determined the impact of scabies on life quality of patients including community's knowledge and perception of the disease. This evidence is vital to provide a comprehensive scabies care to individual patients and address knowledge gap in designing community-based control interventions. A review of local literature is conducted to identify the gaps in local scabies data and to provide context to the remaining chapters of the thesis.

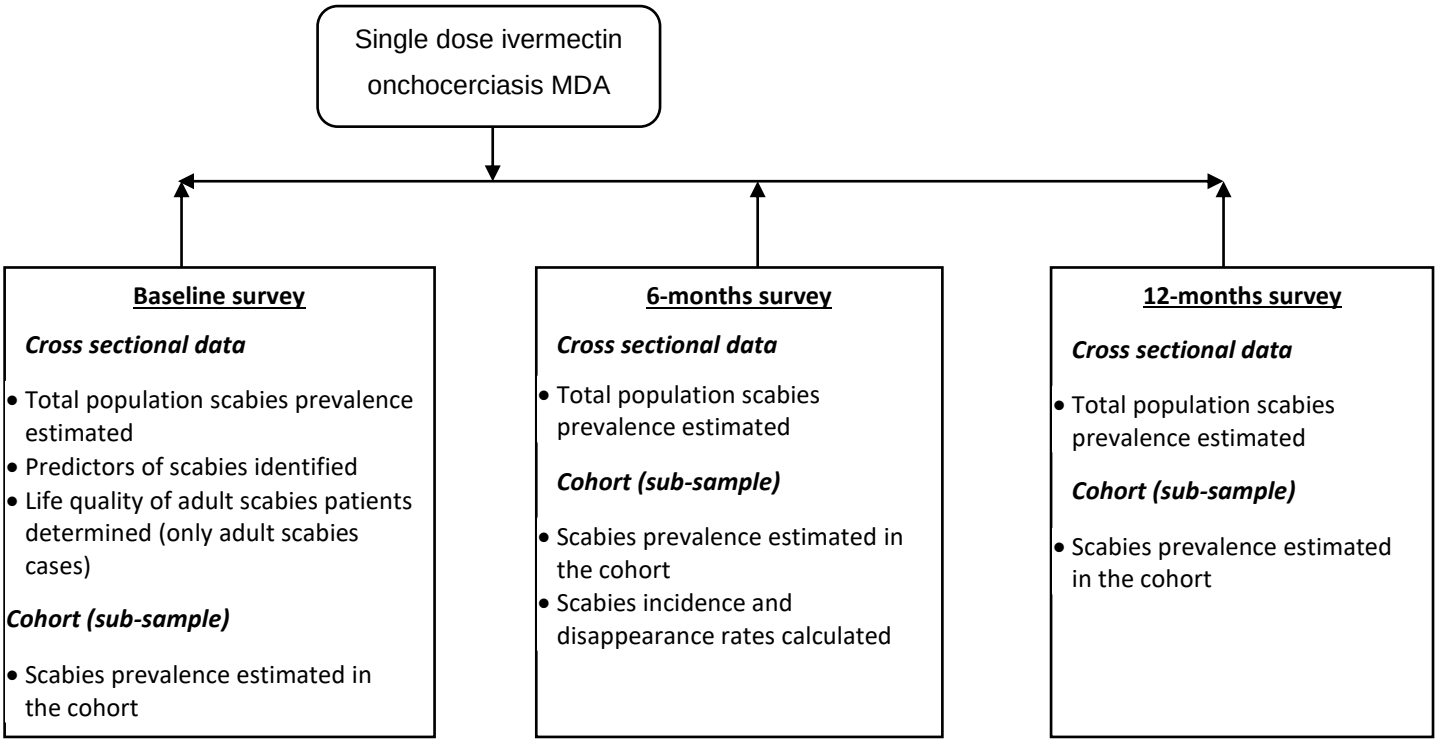

Figure 1.1 Survey rounds and respective study outcomes

1.4.1 Research questions

Ivermectin onchocerciasis MDA is hypothesized to have a spill over effect on scabies. This study is conducted to answer the question, ‘does ivermectin onchocerciasis MDA provide a secondary benefit of scabies control in co-endemic areas?’ The thesis summarizes international literature on the conduct and efficacy of MDA against scabies; and reports the findings of this evaluative research that measured the impact of a single dose ivermectin onchocerciasis MDA on the prevalence of scabies. A review of local literature on what is known, so far, about scabies in Ethiopia identifies the gap in local evidence on scabies and gave context to the cross-sectional study that aimed to answer the questions: ‘What is the epidemiology of scabies in northern Ethiopia?’ and ‘What is the impact of scabies on life quality of adult scabies patients?’. The former research question is set to describe scabies epidemiology and generate a baseline data for the related evaluative research. The later research question produces evidence to provide holistic care for scabies patients at the clinics and in community settings.

1.4.2. Research objectives

General objective: The general objective of the study is to identify gap in local scabies data, determine the effect of scabies on life quality of patients, describe scabies epidemiology and measure the secondary impact of onchocerciasis ivermectin MDA on the prevalence of scabies in northern Ethiopia.

Specific objectives:

I. To determine the published knowledge of scabies in Ethiopia in the past 25 years.

Sub-objectives:

a. To determine the prevalence of scabies in Ethiopia.
b. To identify important determinants of scabies infestation in Ethiopia.
c. To identify the type and assess the effectiveness of community-based scabies control interventions in Ethiopia.

II. To describe the epidemiology of scabies in Ayu Guagusa district, northern Ethiopia, a setting where there has been a bi-annual ivermectin onchocerciasis MDA.

Sub-objectives:

a. To determine the prevalence of scabies in northern Ethiopia.
b. To identify predictors of scabies infestation in northern Ethiopia.

III. To determine the effect of scabies on life quality of adult study participants.

Sub-objectives:

a. To measure the cumulative life quality score of adult scabies cases.
b. To identify the impact of scabies on a range of life quality domains.
c. To determine associated factors with severe life quality impairment.

IV. To measure the secondary impact of a single dose ivermectin onchocerciasis MDA on the prevalence of scabies.

Sub-objectives:

a. To determine the difference in scabies incidence before and after a single dose onchocerciasis ivermectin MDA.
b. To determine the difference in scabies prevalence before and after a single dose onchocerciasis ivermectin MDA.

Chapter Two

Published knowledge of scabies in Ethiopia, a systematic review

Chapter 2 : Published knowledge of scabies in Ethiopia, a systematic review

2.1. Introduction

Scabies is among the least studied skin diseases, globally, despite its endemicity to communities living both in high-income and low-income countries (2). Most of the existing publications, mainly related to community-based scabies prevalence, are from studies conducted in countries of the Pacific region and aboriginal communities in Australia (8). There are a few community-based studies from high-income western countries, with most publications coming from studies conducted in institutional settings including care homes, prisons, and hospitals, where scabies outbreaks are not uncommon (8). The studies from high scabies burden, under- resourced communities of Africa, Latin America, and Asia are either small scale or related to programmatic activities. However, in the past few years there is an improvement in the number of global research outputs surrounding scabies. This could have resulted from the fact that the WHO had included scabies among the list of NTDs in 2017 and targeted it for control by 2030 (95). Despite the change in the trajectory of scabies-related publications, designing meaningful control interventions and evaluating their effectiveness depends on sufficient evidence (95). Nonetheless, the existing evidence on most aspects of scabies is limited. To bridge the evidence gap, generating new data and synthesizing the existing knowledge is mandatory.

In Ethiopia there is unique demand for scabies data as control interventions against scabies and other NTDs are underway. The renewed national and global attention to NTDs has increased the demand for local data. The second reason is, by the time this study was conducted, a scabies outbreak had affected most parts of northern Ethiopia with possible expansion to the remaining regions (19). To understand the causes of the latest large-scale outbreak and design control interventions, epidemiologic and biomedical research is needed more than ever. However, due to the longstanding neglect, there is limited data surrounding scabies epidemiology in Ethiopia. In the past two decades, there have been fewer than 20 publications on the epidemiology of scabies and on the effectiveness of scabies control interventions in Ethiopia (96). Most of these studies were either school-based or healthcare-facility based, and the remaining few were secondary analyses of data collected during scabies outbreak control interventions.

This and factors such as the time the study was conducted, the scope of the study and the difference in the study population made the findings inconclusive.

This systematic review was aimed to pool the published knowledge on scabies in Ethiopia and give context to the conduct and findings reported in the upcoming chapters of this thesis.

Research question

What is the published knowledge about scabies in Ethiopia in the past 25 years?

2.2. Methods

2.2.1 Eligibility criteria

The aim of this review is to synthesize the existing knowledge about scabies in Ethiopia. Publications pertaining to the burden of scabies, determinants of scabies infestation, scabies control measures, knowledge of communities about scabies, and community's perception of the disease were the main topics covered by the review. Articles published in English, including publications in local journals, in the past 25 years were reviewed. Additional eligibility criteria were framed as per the attributes of the PICO (Population, Interventions, Comparison, and Outcome) criteria, which was used to develop the research question (181) (Table 2.1).

Table 2.1 Eligibility criteria for articles included in the review

Category	Criteria
Patients	Studies that involved all groups of population, regardless of sociodemographic backgrounds, were included.
Intervention	The presence of interventions was not part of the eligibility criteria.
Comparison	Studies were included regardless of the presence of a control group.
Outcome	Studies that reported on the epidemiology of scabies, including knowledge, and attitude of communities towards scabies were included.
Setting	Ethiopia

2.2.2 Exclusion criteria

Exclusion criteria were applied at two stages of the screening, when publications were screened by title and abstract and after reviewing articles by full text. After screening by title, studies that were not conducted in Ethiopia, that were not scabies studies, and non-human studies were excluded. Abstracts from the wider project on the epidemiology of scabies that were published in a conference booklet was also excluded. After reviewing articles by full text, research protocols, meeting abstracts and publications that were not about scabies were excluded.

2.2.3 Search strategy

Web of Science and MEDLINE (Medical Literature Analysis and Retrieval System Online), accessed through PubMed search engine electronic databases were searched. All local journals on biomedical sciences that have wide circulations were indexed in either of the databases. The following two strings were employed for the search.

- In Web of Sciences - Ethiopia* AND scabies
- In PubMedIused - (((scabies) OR (dermatology*)) OR ("skin disease*")) AND (Ethiopia*). The equivalent search strings of the database, Medical Subject Heading (MeSH) terms was: scabie "[All Fields] OR "scabies"[MeSH Terms] OR "scabies"[All Fields] OR "skin disease*"[All Fields] OR "dermatology*"[All Fields]) AND "ethiopia* "[All Fields]

The search strings were selected by considering their ability to identify the already available articles in my library. The level of agreement was determined by identifying how many of the articles in the personal library were identified by applying the different search strings. The level of agreement for each search string under the two databases was equivalent (Table 2.2). The above strings were selected as the publications identified by these strings had high levels of agreement with those found in the personal library. The strings identified 47 and 298 articles in the Web of Sciences and the MEDLINE databases, respectively (Table 2.2). After identifying the qualified articles on the basis of the eligibility criteria, I conducted forward search using the list of references in the bibliography of the articles identified in the preceding search.

Table 2.2 Search strings and the number of articles they identified from my personal library

Database	Search strings	Number of articles identified by the search strings	Level of agreement with the articles in the library
Web of Science	Ethiopia* AND scabies	47	83%
	(Scabies OR “skin disease*”) AND Ethiopia*	4196	83%
	(Scabies OR dermatology*) AND Ethiopia*	4183	83%
	(Scabies OR “skin disease*” OR dermatology*) AND Ethiopia*	317,293	
PubMed	(scabies) AND (Ethiopia*)	29	67%
	((scabies) OR ("skin disease*")) AND (Ethiopia*)	177	67%
	((scabies) OR (dermatology*)) AND (Ethiopia*)	180	67%
	(((scabies) OR (dermatology*)) OR ("skin disease*")) AND (Ethiopia*)	298	67%

2.2.4 Relevance screening of articles

The identified articles from both databases (Web of Sciences and MEDLINE) were exported to *EndNote X7* (Clarivate Analytics, London) reference management tool. Though *EndNote X7* was not originally designed to manage publications for systematic reviews, Mierden *et.al*., recommend its use if the review involves a limited number of articles (182). After the papers were identified from the two databases, the list of references was saved to *EndNote X7* forming separate libraries. Subsequently, the references from the two databases were exported from the *EndNote X7* reference manager to Microsoft Office Excel 2010 and were merged.

A total of 345 articles comprised the final list of articles from the two databases and 5 more publications, which were identified in the forward search, were later included.

The total list of articles was then organized in a hierarchical order, using the sort and filter function of the Excel Microsoft Office application. Once the references were sorted, I went line by line and checked for duplicate articles. In this way, 63 duplicates were identified and removed, leaving behind 287 articles to go to the next step of the screening process.

The list of 287 publications, after duplicates were removed, was further screened by title and abstract. Relevance of the articles to the review was checked by reading the title and the abstract and 249 publications were dropped at this stage since they did not fulfil the criteria, non-human research (n=35), studies that were not conducted in Ethiopia (n=15), and publications from studies that did not include scabies but other NTDs (n=199). The remaining 38 articles went into the next step that is screening by full text. After reviewing the full text of the 38 articles, 16 articles were excluded. One publication was a research protocol, others were not about scabies (n=4), were low quality publications (n=2), full text could not be found (n=2) and were meeting abstracts or short excerpts of conference proceedings with no viable scabies-related content (n=7). Eventually 22 articles were included in the review as they fulfilled all the eligibility and screening criteria (Figure 2.1).

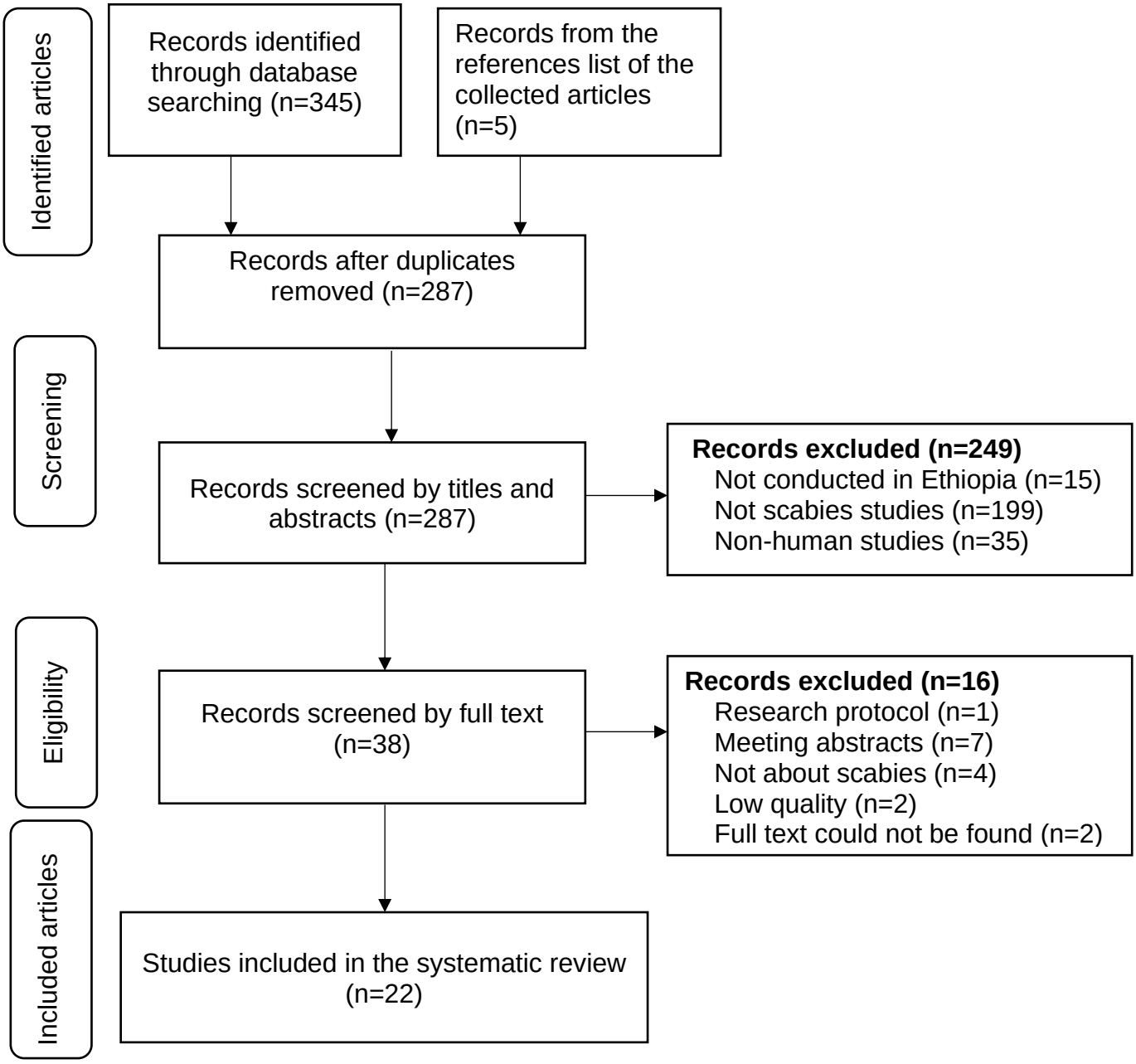

Figure 2.1 Flow diagram of the steps employed in the selection and screening of the review articles

2.3. Results

2.3.1 Description of reviewed publications

This review involved 22 articles published in local and international journals. Due to the broad search and screening criteria, outputs from research that employed both descriptive and analytic research objectives were included. Nearly two-thirds of the reviewed publications were cross sectional studies, and only two evaluated the effect of control interventions on the prevalence of scabies (one of these studies was a quasi-experimental study). The majority (77.3%) of the reviewed publications contained data on the estimated burden of the disease. The number of community-based and health care facility-based studies were comparable (36.4%) (Table 2.3).

Table 2.3 Study design and study setting of the reviewed publications (n=22)

Category	Sub category	Frequency	Percentage
Study design	Cross sectional	17	77.3
	Case control	4	18.2
	Before and after	1	4.5
Study type	Health care facility-based	8	36.4
	Community-based	8	36.4
	School-based	6	27.3
Intervention	No	21	95.5
	Yes	1	4.5

There were few publications on scabies in Ethiopia. From the reviewed articles, only six that met the eligibility criteria were published over a ten-year period, between 1996 and 2016. The number of publications showed a significant increase between 2017 and 2020 where the total number of publications in this period covered 72% of the total reviewed publications. The highest number of publications in one year was reported in 2020 with 8 articles published (Figure 2.2).

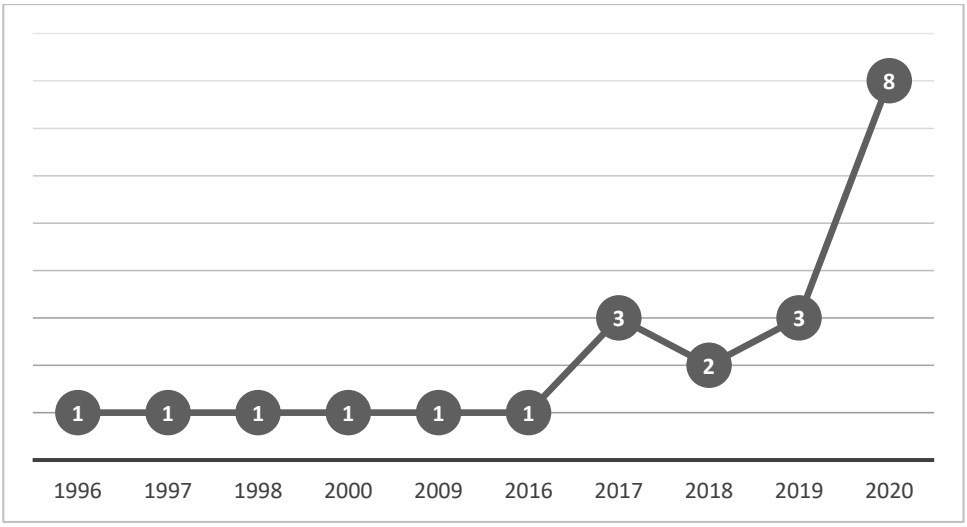

Figure 2.2 Number of articles by years of publication (n=22)

All the reviewed articles characterised the study areas except one, a systematic review, which included studies from different parts of the country. The study areas of the reviewed publications were further disaggregated by administrative regions of the country. From the ten regional states and two administrative city councils, totalling 12 administrative regions, I found publications from studies conducted in five regions. The highest number of publications were from Amhara regional state. The Oromiya regional state and the Southern Nations and Nationalities and Peoples Regions (SNNPR) had a comparable number of publications, and there were only two articles from facility-based studies in the capital, Addis Ababa (Figure 2.3).

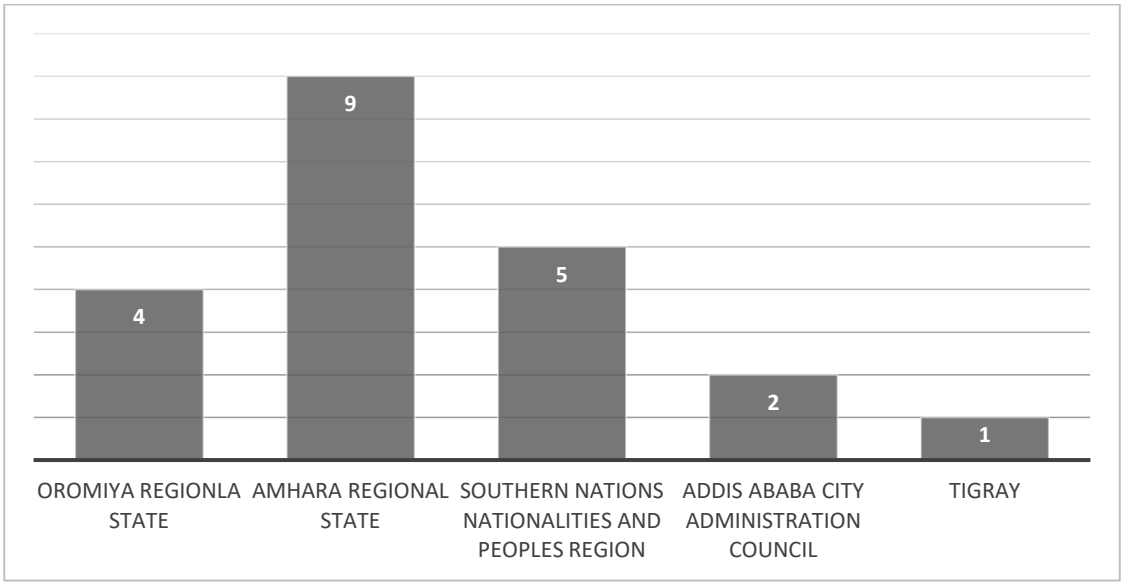

Figure 2.3 Number of articles by administrative regions of Ethiopia (n=22)

Figure 2.4 indicates the burden of scabies in different regional states of Ethiopia. The chart includes estimates reported in 21 studies as one of the 22 reviewed articles did not report the burden of scabies. These estimates were obtained from school, community, and facility-based studies. Though the graph does not distinguish between the sources of data for the estimates (i.e., proportions in facility-based studies or prevalence in population-based data) the magnitude of scabies ranges between 2.5% and 33.5% (13, 20). The highest prevalence estimate was reported in a community-based study from Amhara regional state and the lowest was in SNNPR (13). A meta-analysis reported 14% pooled national level estimate of scabies prevalence.

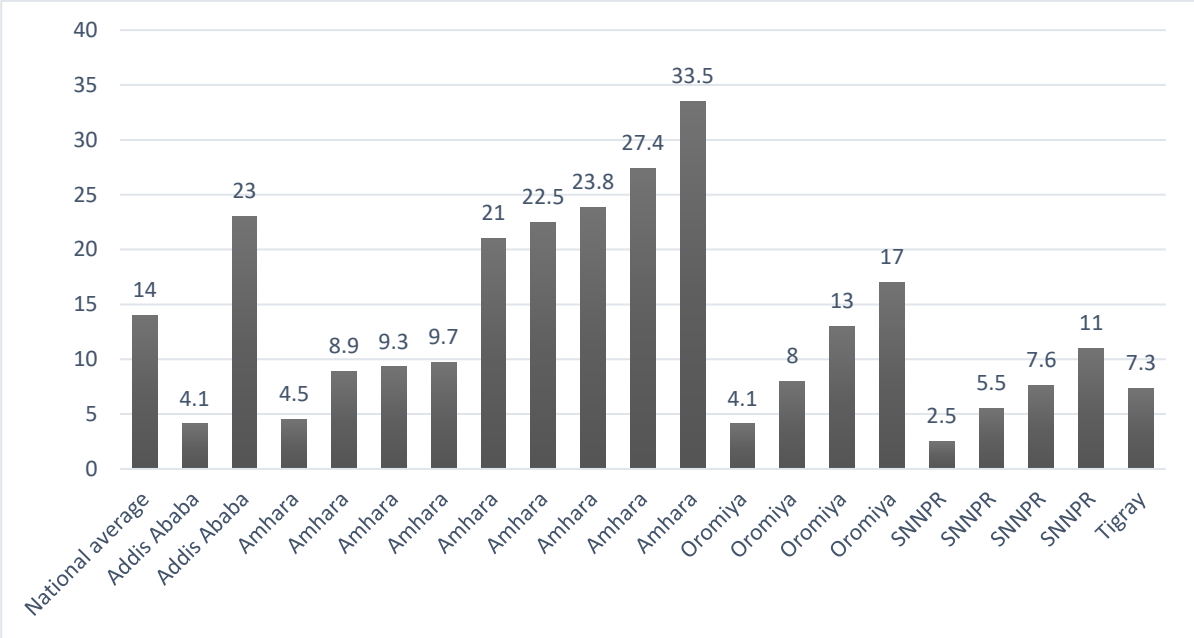

Figure 2.4 Scabies prevalence estimates by administrative region (n=21)

2.3.2. Quality assessment of reviewed articles

Six basic criteria were used to appraise quality of the reviewed articles, including eligibility criteria, sampling procedures, sampling techniques, sample size, response rate, and diagnostic criteria. The overall quality of publications included in the review was average. Only two papers fulfilled the six basic quality assessment criteria. Most of the papers with low quality grading failed to report the eligibility criteria, the response rate and did not indicate how the sample size was arrived at. Nine out of the 22 reviewed articles explicitly described the eligibility criteria they used to recruit study participants. Response rate was reported only in seven articles and only half of the reviewed publications described the assumptions considered and how the sample size was calculated.

Four articles did not describe how study participants were selected. The remaining 18 studies gave a varying level of detail concerning the sampling procedures. Eleven articles provided sufficient detail of the sampling process, regardless of the appropriateness of the sampling for the type of the study. None of the studies reported using a sampling frame to randomly select participants from. However, two studies used line lists, which were put together as part of preceding scabies control interventions, as sampling frames. One of these studies used the entire dataset of the line list to calculate attack rates of scabies infestation in the study district (19). This study used a mix of descriptive and analytic (case-control) designs where the authors used data from the line list for the descriptive analysis. However, the sample selection procedure for the case control component was not clearly stated (19). The second study that used a line list as a sampling frame was also a case-control study and reportedly selected the cases and the controls from the line list (183). Nonetheless, the steps followed to identify the cases and respective controls were not clearly described.

The level of detail in describing the sampling procedure was also dictated by the number of participants involved in the studies. Regardless of the type of data used in the studies, primary or secondary, studies involved either part of or the entire community. Among the community-based studies four involved all members of the study community (13, 15, 17, 97), and one article employed a multistage sampling technique to identify the study participants (184). Three of the five studies that employed multistage sampling approach clearly laid out the sampling procedure (11, 109, 185).

Of the four studies that obtained data by reviewing patient records, three used all records of the patients who visited the facility in the study period (16, 184, 186). However, Abdela SG *et al*., reported randomly selecting patient charts from a Health Management Information System (HMIS) database (187).

Only 6 publications reported response rate of participants (11, 97, 185, 188-190). These articles were facility-based (school and health care facility) studies that used primary data by interviewing pupils and patients. Most of the studies that used primary data but failed to report response rate were those that involved the entire study community (13, 15, 17, 19), or all patients who visited the health care facility in the study period (191). However, none of the publications from studies that used patient records reported response rates.

The other criteria used to appraise the quality of the reviewed papers was whether the assumptions and the steps involved in sample size calculation were reported. Half of the articles described the way in which the minimum sample size was arrived at, but in the remaining articles it was either totally ignored or was obscure.

Most of the publications described the diagnostic procedures employed to identify cases of scabies. Sixteen articles described the diagnostic procedures used to identify scabies cases. Twelve of these articles fully described the diagnostic procedure and four articles stated the case definition without giving the details including mere clinical diagnosis or laboratory-based investigations (13, 19, 184, 191). However, six articles did not report the diagnostic procedures used to identify scabies cases (16, 20, 183, 187, 189, 192).

2.3.3 Summary of the reviewed articles

Embiale et.al., conducted a community-based cross sectional screening of scabies infestation involving all the residents of 68 districts of Amhara region (13). This study was conducted to estimate the burden and map the distribution of scabies outbreak in Amhara region, northern Ethiopia, in a way that helped target an upcoming community-based scabies control intervention. More than one million people were screened by community health workers, community health workers, who had a one-day training on scabies diagnosis. They employed a clinical diagnosis approach based on a clinical case definition which included the symptoms, itchy rash on the areas of predilection and contact history with a person exhibiting symptoms of scabies.

The median scabies prevalence was 33.5% (IQR19-48%), however the prevalence in different districts ranged from 2% to 67% (13). In a quarter of the clinical scabies cases, the infestation was associated with a secondary bacterial infection and the median duration of the illness was 5 months (Table 2.4).

A cross sectional study that described a mass drug administration campaign for the control of scabies in Amhara region estimated a 9.7% scabies prevalence (17). The study involved 9 million people, disaggregated into the 13 zones of the Amhara regional state. The zone level estimates of scabies prevalence ranged between 0.2% and 39.2%. House to house scabies screening was conducted by HEWs applying a scabies case definition, that took into account typical scabies manifestation and contact history (17). Beyond the epidemiologic characterisation of scabies at baseline the study did also describe the MDA campaign. The campaign employed two intervention strategies. In communities where scabies prevalence was <15%, scabies cases and their contacts, and people without scabies symptoms but who had contact with a person exhibiting symptoms of scabies in the past two months, were treated. In communities where the prevalence was ≥15% MDA was conducted. Most of the community (94%) received ivermectin as a therapeutic agent, and for the remaining permethrin and sulfur was provided. There were two points which are distinctive of this campaign from the onchocerciasis MDA, which is more common in the area, the number of ivermectin doses and the target population. Both in the MDA and the selective chemotherapy, two doses of ivermectin were given in a week time. Contrary to the recommendations of MDA guidelines for onchocerciasis control, in this study children in the age range of 2 to 6 years received ivermectin chemotherapy (Table 2.4).

A study that investigated scabies outbreak among church school students indicated one of the highest scabies prevalence estimates (22.5%) where the highest age specific attack rate was among students aged younger than 18 years (14). Though the study employed a case control design, the prevalence estimates were based on data from all the students in the school (n=142). Having prolonged physical contact, sharing clothing with a scabies patient, travel history to areas where there was a scabies outbreak, and low frequency of bathing were associated with scabies. Unlike most studies included in the review, in this study, cases were identified by examining skin scrapings for the mite or eggs, under a microscope.

This diagnostic technique minimises misclassification bias as it increases specificity of the diagnostic test. On the contrary, its low sensitivity could undermine the prevalence estimate (Table 2.4).

Dagne H *et al*., estimated the prevalence and determinants of scabies among primary school children in Dabat district, north-western Ethiopia (185). The cross-sectional study involved 494 randomly selected students from 8 primary schools of the district. Clinical diagnosis, based on cutaneous presentation of scabies lesions was employed to diagnose scabies. The estimated scabies prevalence was 9.3%. Though the authors did not describe the measures of disease severity they employed, 65.22%, 28.26% and 6.52% of scabies patients reportedly had mild, moderate and severe lesions. Students from rural schools, participants who had illiterate fathers, pupils in grades 1 to 4, taking baths less frequently, not using soap when washing hands, physical contact with a person exhibiting symptoms of scabies and having family members complaining itch increased the odds of scabies infestation (Table 2.4).

The other school-based cross sectional study that was conducted in 2016, in Gedio zone, southern Ethiopia indicated a low scabies prevalence, relative to the other school-based studies (11). The study investigated the epidemiology of tungiasis and scabies among 1400 pupils in a primary school. They examined 210 randomly selected students. Scabies was diagnosed in pupils who presented itch and rash with a distribution typical of scabies. Visualizing the mite and eggs using a dermoscope was also applied. The team also applied the Children's Dermatologic Life Quality Index (CDLQI) to measure the impact of the two infestations on the quality of life of the patients. Scabies prevalence was estimated at 5.5%, where 0.6% were cases of crusted scabies. Scabies was not associated with school drop-out or the number of siblings scabies cases had. Urinalysis was conducted both for the cases of scabies and tungiasis and 13% had haematuria which was suggestive of acute glomerulonephritis. Though the investigators could not distinguish the impact of other dermatologic conditions on quality of life of students with scabies and tungiasis, the CDLQI score indicated that it had a moderate impact on quality of life of the study participants (Table 2.4).

A review of medical records of children referred form an orphanage to a tertiary hospital, in Addis Ababa, over the course of four years (2014-2018) indicated a high proportion of scabies (23%) and malnutrition. The estimates were disaggregated by year and the highest proportion of scabies patients (35%) was reported in 2016 (16). A quarter of these patients were recurring scabies cases. The report indicated that in a considerable number of cases either scabies was not the primary cause for the referral or was completely overlooked by the referring clinicians. Due to the limited data on background characteristics, predictors of scabies infestation were not investigated. However, prevalence of malnutrition among scabies patients was disproportionately high (85%) (Table 2.4).

Haile *et al*., estimated the prevalence and determined the associated factors of scabies among children of < 15 years of age and adolescents in Wadila district, northern Ethiopia (190). Scabies prevalence was 23.8%, and the characteristics that were associated with an increased odds of the infestation were, not cleaning the house daily, owning pets, lack of access to improved water source, sharing clothing with a person having scabies symptoms, travel history to areas where there was scabies outbreak, and not using detergents while taking showers (Table 2.4).

A cross sectional study aimed to determine the prevalence and distribution of skin diseases among children under five years of age who sought care in a rural hospital in West Arsi, south-western Ethiopia found that among those who visited the clinic 45% had skin disease (193). For 68% of the patients with cutaneous complaints, skin diseases were the primary reason for seeking care. However, for 31% of the cases skin diseases were the secondary diagnosis. The commonest dermatologic disease was scabies (13.6%) and 44% of scabies cases were complicated by secondary bacterial infection. There was no significant difference in the proportion of scabies patients across the different age groups (Table 2.4).

A review of more than 4000 medical records of patients who visited a specialized dermatologic clinic in Mekelle, Ethiopia, between 2005 and 2007 determined the pattern of skin diseases both among outpatient and inpatient departments (186). In this study scabies was the fourth commonest reason for outpatient visits covering 7.3% of all the diagnoses. However, it was the first indication for admission to the inpatient department. These findings were not consistent with findings from other facility-based studies. The

reason was that the facility was a specialized center so mild cases of dermatologic diseases were treated by general practitioners and only severe cases, including crusted scabies, visited the center. This could have contributed to the fewer number of scabies cases at the outpatient clinic and for the high burden among the inpatients (Table 2.4).

Abdela *et al*., investigated the burden of skin diseases and the comorbidity of different NTDs with cutaneous manifestations in a dermatologic clinic of Boru Meda hospital, north-western Ethiopia (187). Though the primary objective of the study was to assess the possibility of using dermatologic manifestations as an entry point to manage a range of NTDs, it also estimated the burden of scabies alongside other skin NTDs. Investigators reviewed records of 661 patients who were seen at the clinic between July 2017 and June 2018. Cutaneous leishmaniasis, leprosy, mycetoma, and scabies, were the leading skin NTDs identified from the records. Scabies was diagnosed in 4.7% of the patients who visited the facility in the study period, and it was the third most common skin NTD, making up 27.4% of all skin NTDs diagnosed at the hospital (Table 2.4).

One of the few hospital-based studies that used primary data to determine the prevalence and pattern of skin diseases at a specialized hospital in Addis Ababa found that the leading causes for seeking care were allergic skin diseases (191). The study involved children younger than 12 years of age who visited the facility between June 2015 and July 2017. Scabies was first among the infection and infestation category of skin diseases diagnosed at the hospital in the study period. It comprised 72.9% of the infection and infestations diagnosed at the facility. However, making comparisons of the proportion of scabies cases with other studies was not straight forward since the investigators used the different diagnoses, not the number of cases, in calculating the proportion of the different skin conditions. All the cases were reportedly seen by the author, who was also a clinician at the center, but his qualification and details of the diagnostic procedures were not documented (Table 2.4).

Figueroa JI *et al*., assessed the skin health needs of two communities in Illubabor zone, western Ethiopia, in 1998. A team of dermatologists examined 768 self-selected individuals from households in the study districts. In this cross-sectional study, data was obtained from a self-administered questionnaire and from clinical examinations by a team of dermatologists. The study signalled a high demand for dermatologic care 50% of the participants had dermatologic diseases.

In addition, from randomly selected households (n=30) that reported no dermatologic diseases in the baseline survey, 67% had at least one member of the household with dermatologic diseases. During the baseline point prevalence survey, parasitic skin infestations, scabies, pediculosis, and onchocerciasis, were the commonest complaints making up 46% of the diagnoses. From the two study communities 32% and 39% of the examined participants received treatments previously, however, the treatment was not effective in 74% and 63% of the cases respectively (Table 2.4).

A school-based study in southwestern Ethiopia estimated the prevalence of skin diseases. The study involved 219 randomly selected students from three junior schools, where two of the schools were in rural communities and one was urban (15). Clinical examination was employed to identify skin diseases. Nearly all (96.8%) pupils had at least one skin disease. Cutaneous infestations were the most common skin diseases and pediculosis capitis was found in 93% of the cases. Scabies was the third most common form of infestation with 4.1% prevalence. In this study, scabies infestation was associated with crowding, with the odds of infestation increasing among those who lived in small housing units. However, there was no difference by place of residence (urban or rural) access to health care facilities (Table 2.4).

A community-based unmatched case control study was conducted by Worku ED *et al*. The study was conducted in Takusa district, north-western Ethiopia from September to October 2015 aiming to identify the determinants of a scabies outbreak in the district. A total of 188 people (63 cases and 125 controls) participated in the study, with a 1:2 case to control ratio (183). Attack rates were calculated for different age groups based on screening the entire community. Accordingly, the highest attack rate was calculated for participants in the age range of >45 years, followed by children under five years of age. A logistic regression model was used to determine predictors of scabies infestation. Living in a household where there was a person complaining of itching, sleeping with a scabies patient, travel history to scabies outbreak areas in the last six weeks and not using detergents when taking baths were independently associated with scabies infestation (Table 2.4).

A school-based unmatched case control study that was conducted in Kembata Tembaro zone, southern Ethiopia, identified the determinant factors of scabies infestation among adolescents aged between 15 and 25 years (188).

The study was conducted from May 1 to 23, 2018. Clinical diagnosis, based on the WHO's standard case definition, was used to diagnose scabies by trained mid-level health care workers. A total of 725 pupils participated in the study with a 1:2 case to control ratio. A logistic regression model was fitted to determine factors that were independently associated with scabies. Low knowledge about scabies, male sex, parental illiteracy, sharing clothing or bedding were associated with scabies infestation. Of the household level characteristics, low household income, household size greater than five, limited access to a water source and poor personal hygiene increased the odds of developing scabies infestation (Table 2.4).

Sara J *et al*., conducted a community-based unmatched case control study in Bedewacho district southern Ethiopia in October 2016. The study employed both primary and secondary data. For the descriptive analysis, line listed data on 4532 members of the community was used. However, to identify determinants of scabies infestation, data from 162 participants (55 cases and 110 controls) was used. Data was collected by two nurses who had additional training on scabies diagnosis. The prevalence of scabies in the community was 11%, and the Age Specific Attack Rate (ASAR) was high (85 cases per 1000 people) among participants aged 5-14 years followed by children aged < 4 years (4 cases per 1000 people). Based on the anecdotal observation of the investigators, there was a high number of secondary bacterial infection cases among the scabies patients. Independent predictors of scabies that were identified by fitting a logistic regression model were age less than 15 years, household size greater than five, sharing bed with cases of scabies and being part of a household that was affected by flooding (Table 2.4).

Another study estimated scabies prevalence and identified its determinants in southern Ethiopia (20). The study used members of the community who were line listed during the response to the outbreak in the district. Though it was not clearly communicated, the scabies prevalence estimates were made based on the data captured in the line listing. One hundred and twenty-three study participants were included in the case-control analysis, with a 1 to 2 case to control ratio. The prevalence estimate for the district was among the lowest of all the studies I reviewed (2.5%). The sex-specific attack rate was comparable, however, the highest of the age specific attack rates (11/1000) was estimated for the group between the range 5 and 14 years.

The authors identified five variables that were independently associated with scabies infestation: taking a bath <2 times per week, sharing clothing with a person suspected of scabies, poor hand washing, household size of 6 people or more, and infrequent use of soap (Table 2.4).

Aynalem WS, involved 317 patients from a dermatologic clinic in a general hospital located in northern Ethiopia (189). The investigator aimed to determine the pattern of skin diseases at the dermatologic clinic among a sample of participants recruited purposively. Though the sampling approach undermined the generalizability of the findings, it captured the pattern of skin diseases among patients of cutaneous diseases at the hospital. Non-infectious dermatologic diseases, and primary seborrheic dermatitis made up the highest proportion of skin diseases seen during the study period. Skin infestations were the least frequently diagnosed skin conditions with scabies making up only 4.6% of the diseases diagnosed at the clinic (Table 2.4).

In a systematic review and meta-analysis, Azene GA *et al*., reviewed 12 articles on scabies in Ethiopia. They reviewed articles that came from studies conducted in different parts of the country and were published over a period of the past twenty years (between 2000 and 2020) (194). Among other criteria, the team considered publications which took scabies prevalence and determinants of scabies infestation as an outcome variable. They conducted both the narrative synthesis of the findings and meta-analysis of the prevalence estimates and measures of association. In the meta-analysis, the overall pooled prevalence estimate was 14.5%, and for Amhara regional state it was 19.6%. Being part of a large family and any contact with a scabies patient were significantly associated with scabies infestation. However, frequency of bathing and washing hands with soap did not affect the odds of developing scabies (Table 2.4).

Table 2.4 Evidence summary of the burden and determinants of scabies infestation in Ethiopia

no	Study area	Study design	Study population	Outcome measures	Results
1	Amhara region, northern Ethiopia (13)	Cross sectional	Study sample from the general population	Scabies prevalence	The median scabies prevalence was 33.5% (IQR 19% - 48%)
2	Amhara region, northern Ethiopia (15)	Cross sectional	Study sample from the general population	Scabies prevalence	Scabies prevalence was 9.7%, and the zonal level estimates ranged between 0.2% and 39.2%
3	Gondar, Amhara region, north-western Ethiopia (14)	Cross sectional study	Sampled students from a clergy school	Scabies attack rates and determinants of scabies infestation	Scabies prevalence was 22.5%. Skin contacts with a scabies patient, sharing clothing, travel to areas of scabies outbreak and taking bath seldom were associated with scabies
4	Dabat, Amhara region, north-western Ethiopia (185)	Cross sectional	Sampled students from primary schools	Scabies prevalence and factors associated with the infestation	Scabies prevalence was 9.3% 95% CI (5.66%, 12.94%). Studying at rural schools AOR = 2.99 (95% CI 1.33, 6.71); having an illiterate father AOR = 5.11 (95% CI 2.25, 11.58); being in grades 1–4 AOR = 3.91 (95% CI 1.69, 9.05); taking bath rarely AOR = 3.54 (95% CI 1.36, 9.25), skin contact with a person who showed scabies symptoms AOR = 2.66 (95% CI 1. 21, 5.83), not living with both parents AOR = 2.49 (95% CI 1.02, 6.06); and not using detergents when washing hands AOR = 4.38 (95% CI 1.78, 10.76) increased the odds of scabies infestation

no	Study area	Study design	Study population	Outcome measures	Results
5	Gedio zone, southern Ethiopia (11)	Cross sectional study	In school children	Scabies prevalence	Scabies prevalence was 5.5%, crusted scabies was 0.6% and non-crusted scabies was 5.0%
6	Addis Ababa, central Ethiopia (16)	Cross sectional study	Children under 5 years of age referred from an orphanage	Burden of skin NTDs	The four years average proportion patients diagnosed with scabies was 23.0%, and peaked in 2013 with 35%
7	Wadila district, northern Ethiopia (190)	Cross sectional study	Children and adolescents younger than 15 years	Prevalence and determinants of scabies	Scabies prevalence was 23.8%, 95%CI (20.1%-27.1%). Not using soap when taking shower AOR=2.93 (95% CI:1.72-5.00); using unimproved water source AOR=1.82 (95% CI:1.04-3.16); sharing clothes from scabies cases AOR=10.10 (95% CI: 3.37- 30.23); not cleaning the house every day AOR=2.28 (95% CI: 1.32-3.95); presence of pet animals at home AOR= 3.01(95% CI: 1.66-5.45) and went to scabies epidemic areas AOR= 4.09 (95% CI: 2.37-7.06).
8	West Arsi, southern Ethiopia (192)	Cross sectional study	Children aged < 5 years who sought care from the hospital in the study period	Patterns of skin diseases	The proportion of scabies patients was 13%
9	Tigray, northern Ethiopia (186)	Cross sectional study	Patients attending a specialized dermatologic center	Skin disease pattern	The proportion of scabies patients was 15.4%

no	Study area	Study design	Study population	Outcome measures	Results
10	North-eastern Ethiopia (187)	Cross sectional study	Patients of dermatologic diseases who visited the hospital in the study period	Prevalence of skin diseases	The proportion of scabies patients was 27.4%
11	Addis Ababa, central Ethiopia (191)	Cross sectional study	Children and adolescents who were younger than 12 years who visited the hospital in the study period	Prevalence of skin diseases	Proportion of scabies cases were 72.9% of patients
12	Jimma, south-western Ethiopia (109)	Cross sectional study	Children and adolescents in primary schools	Prevalence of skin diseases	Infestations were the most frequently reported diagnoses, and 17% of the diagnoses
13	Jimma, south-western Ethiopia (97)	Cross sectional study	Study sample from the general population	Prevalence of skin diseases	Parasitic infestations, scabies, pediculosis, and onchocerciasis all together accounted for 46% of the diagnoses
14	Jimma, south-western Ethiopia (11)	Cross sectional study	In school children	Burden of dermatologic diseases	The proportion of pupils with scabies was 4.1%
15	Takusa district, north-western Ethiopia (183)	Unmatched case control study	Study sample from the general population	Determinants of scabies outbreak	Complaining of itching AOR=7.7 (95%CI 1.9-30.5); sleeping with scabies patient AOR=3.99 (95%CI 1.37-11.7); not using detergents AOR=4.85 (95%CI 1.3-17.9); travel to scabies epidemic area AOR=3.79 (95%CI 1.28-11.1); history of scabies AOR=19.8 (95%CI 3.04-128.8)

no	Study area	Study design	Study population	Outcome measures	Results
16	Demboya district, north-western Ethiopia (188)	Unmatched case-control study	In school adolescents aged between 15 and 25 years	Determinants of scabies infestation	Poor knowledge about scabies AOR=4.32 (95% CI: 2.93, 6.36); male sex, AOR=2.69 (95% CI: 1.82, 3.96); parental illiteracy, AOR =3.49 (95% CI: 2.06, 5.94); sharing clothing and bedding AOR=3.12 (95% CI: 2.12, 4.59); low household income, AOR=2.13 (95% CI: 1.32, 3.44); family size greater than five AOR=1.77 (95% CI: 1.04, 3.01); limited access to water AOR=1.64 (95% CI: 1.12, 2.40); and poor personal hygiene AOR=1.69 (95% CI: 1.14, 2.51)
17	Bedewacho district, southern Ethiopia (19)	Un matched case control study	Study sample from the general population	Determinants of scabies infestation	Age less than 15 years AOR = 2.62, (95% CI: 1.31–5.22); family size > 5 AOR = 2.63 (95% CI: 1.10–6.27); bed sharing with scabies cases AOR = 12.47 (95% CI: 3.05–50.94); households affected by flooding AOR = 22.32 (95% CI: 8.46–58.90)
18	Kechabira district, southern Ethiopia (20)	Un matched case control study	Study sample from the general population	Determinants of scabies infestation	Sharing clothing with scabies patients AOR = 6.08 (95% CI: 1.54–23.92); households having > 6 family members AOR = 38.755 (95% CI 8.084–185.787).

no	Study area	Study design	Study population	Outcome measures	Results
19	West Gojam, northern Ethiopia (189)	Cross sectional study	Patients of dermatologic diseases who visited the hospital in the study period	Proportion of dermatologic diseases	Proportion of scabies patients who visited the hospital was 4.3%
20	Amhara and SNNP regions (194)	Systematic review and meta-analysis		Prevalence and determinants of scabies infestation	Pooled scabies prevalence was 14.5% (95%CI: 1.5-27.6%) and for Amhara region 9.6%. Large family size and bed sharing predicted scabies infestation

I found only two studies that described scabies control interventions and measured their effectiveness. Gezmu T. *et al.* studied the plausibility of decentralizing clinical management of scabies patients to primary health care facilities (184). This comparative study employed a before-and-after study design to measure whether training HEWs to care for scabies patients improves access to care and reduces the burden of scabies in the community. The study period was January 2018 to January 2019 in Arbaminch, southern Ethiopia. Two districts (an intervention and a control district) were selected for the study. In the intervention district, HEWs, received on the job training on scabies care. The impact of the study was estimated by determining the number of scabies patients that visited the health centers in the periods before and after the training. Consequently, there was a significant reduction in the number of scabies patients in the intervention district, from the baseline 7.6% to 1.6%, but in the control district the proportion of scabies patients rather increased from 1.3% to 2.4%. Though there is this change in proportion of scabies patients visiting the health care facilities before and after the intervention, adjusting for other confounders would have helped to measure the independent effect of the intervention on the disease burden (Table 2.5).

The other intervention study that evaluated the effectiveness of MDA against scabies was conducted in Amhara regional state involving all members of the intervention community. The study was conducted 15 months after the MDA, which involved more than 9 million people in three zones of northern Ethiopia (17).

The scabies control intervention followed two approaches, mass drug administration and selective chemotherapy. In communities where scabies prevalence was greater than or equal to 15%, MDA was carried out. However, in communities where the prevalence was ≤ 15% scabies cases and their contacts were treated. Scabies prevalence was 21%, and the highest was reported in North Gondar (46.1%), Wag Himra (15.3%) and East Gojam (3.2%). Nearly half (46%) of the participants reported previous infestation at the time of the MDA, 15 months back from the time of this study, where 86% of them were treated for scabies, 69.8% through the MDA and 30.2% at health care facilities. Of those who reported previous infestation and were treated, 91% were reportedly cured and there was no difference in cure rates between those who were treated with topical or systemic agents. Among those who reported treatment failure (7.8%), most had received care from health care facilities, not the MDA. Relapse of the infestation was reported among 14% of the cases and most of these cases were in North Gondar (Table 2.5).

Table 2.5 Summary of evidence on the impact of control intervention on scabies

no	Author	Study design	Intervention	Study population	Outcome measures	Result
1	Kamba district, southern Ethiopia (184)	Before-and-after study	Training health extension workers	Health extension workers and patients who came to health centers seeking care for dermatologic diseases	Proportion of scabies patients at the district health care facilities	Scabies cases declined in the intervention district from 7.6 to 1.6 per 1,000 population. However, in the control district it increased from 1.3 to 2.4 per 1000 population
2	Amhara region, northern Ethiopia (17)	Cross sectional study	MDA	Study samples from the general population	Scabies prevalence	15 months after MDA scabies prevalence was 21%. 46.3% of the participants had history of scabies

2.3.4 Narrative synthesis

Prevalence of scabies in Ethiopia

More than half of the reviewed articles reported the burden of scabies in different parts of the country. Community-based studies used prevalence estimates (11-13, 15, 17, 190, 194) and health care facility-based studies determined the proportion of scabies cases seen at clinics among other skin diseases (16, 186, 187, 189, 191, 192). Though in this review I covered articles from five regional states, population-based studies were only conducted in three regions, Amhara, Oromiya, and SNNPR. These regions cover the northern, southwestern, and southern parts of the country, respectively.

Estimates of scabies prevalence from the community-based studies ranged between 2.5 % and 33.5% (13, 20). However, these estimates varied between regions. Taking the WHO's consensus threshold for public health action against scabies, which is 10%, as a cut off to determine high prevalence, half of the publications with prevalence estimates crossing the threshold were from Amhara regional state (13, 15, 17, 190). The marginally lower prevalence estimates in this region were at 8.9% and 9.3% (183, 185). The estimates in most of the studies from the remaining regions were generally lower. There were only two articles from Oromiya (17%) and SNNP (11%) regions that reported a prevalence which exceeded 10% (12, 19). The national average pooled prevalence estimate of scabies from a meta-analysis was 14% and Amhara, the only region where estimates were pooled for, 19.6% (194).

Health care facility-based studies that determined the proportion of scabies among patients of cutaneous diseases indicated a comparable percentage of scabies patients among those who sought care from health care facilities in the study regions. The proportion of scabies cases among patients who visited health care facilities located in Amhara regional state ranged between 4.3% and 27.4% (187, 189). The upper limit marked the highest proportion of cases from all the facility-based studies included in this review. A study which involved children under five years of age in Oromiya region, reported that scabies cases made up 13% of the patients who sought care from the facility in the study period (192). I found another three publications from facility-based studies in Addis Ababa and Tigray regions that reported a varying proportion of scabies cases among the patients at the study facilities (16, 186, 191).

Two of the studies were from Addis Ababa, the first one investigated the pattern of NTDs among children referred to a hospital from an orphanage and the second one assessed skin diseases among all patients who visited a specialty clinic (16, 191). In the former study the four-year (2014-2018) average proportion of scabies patients among children referred to the hospital was 23.0% (16). The highest of the disaggregated yearly estimates reported the highest proportion (35%) for 2016 (16). The second facility-based study from Addis Ababa reported identifying 54 scabies cases from the 1000 patients (5.4%) who were seen at the center (191). The study from Tigray reported a modest proportion (7.3%) among patients who visited a care center for dermatologic diseases over a two-year period (186).

Determinants of scabies infestation

Half of the reviewed articles investigated determinants and associated factors of scabies infestation by employing various study designs. Four of the studies were case control studies (19, 20, 183, 188), and the rest were cross sectional studies using primary data or reviews of medical records. The commonly investigated characteristics were, sociodemographic markers, personal hygiene, contact history with a person exhibiting manifestations of scabies, sharing clothing and bedding with a person exhibiting manifestations of scabies, access to infrastructure, and access to health care facilities.

Sex was one of the sociodemographic variables whose effect on the odds of scabies infestation was investigated. Four articles reported their findings on the association between sex and scabies (13, 20, 97, 188), and sex was independently associated with scabies in only one of the reviewed articles (188). The authors fitted a logistic regression model to determine the independent effect of sex on the odds of scabies infestation. Male sex was associated with a two-fold increase in the odds of scabies infestation (AOR=2.69, 95%CI 1.82–3.96) compared with females (188).

The effect of age on the odds of scabies infestation was investigated in nearly all the reviewed articles, including 15 cross sectional studies and two case control studies (19, 188). Age was significantly associated with scabies in one of the two case control studies (19). Adolescents and children aged younger than 15 years showed a two-fold increase in the odds of scabies infestation than adolescents older than 15 years of age (AOR= 2.6, 95%CI 1.31–5.22).

From the 15 cross sectional studies that investigated the association between age and scabies there was a significant association in 6 of the studies. However, the age categories employed in the analysis and the measures of association used to determine the effect of the predictor on the probability of scabies infestation were different (i.e., age specific attack rates, age specific prevalence rates, and odds ratio). Regardless of these differences higher burden of scabies was reported among participants of age less than 18 years in two of the studies (13, 20). Wochebo W *et al*., estimated the age specific attack rate of scabies in different age categories, the highest being in the age range of 5 to 14 years (11/1000 population) (20). In another study age was classified into three categories (i.e., <2 years, 2-18, and >18 years) (13). Participants whose age fell in the first two categories had higher odds of scabies (COR = 2.5, P-value=0.01) and (COR = 2.4, P-value=0.01), respectively, than participants aged >18 years (13). Contrary to this, Aynalem WS, reported high prevalence of scabies among patients aged 21-30 years (32.5%), and second to the highest prevalence (21%) among those aged 11-20 years (189). In the remaining three articles there were no notable differences in the odds of scabies among people in different age groups (12, 186, 192).

Four articles reported the association between sharing clothing or bedding and scabies. In three of the four studies sharing clothing was positively associated, Wachebo W *et al*, Yassin ZJ, and Ejigu K found AORs of 6.083, 95% CI 1.546–23.927, 2.76, 95% CI 1.04-7.41, and 2.88, 95% CI 2.08–3.99, respectively (14, 20, 188). However, in one of the studies, sharing clothing, sharing a bed and having physical contact were put in one category and the effect of each individual variable on the odds of infestation was not reported (188).

Only two studies investigated the significance of sharing a bed or other sleeping space in determining scabies infestation. People who shared a sleeping space with a scabies patient had 12 times higher odds of developing scabies (AOR=12.4 95% CI 3.05–50.9) (19). Likewise, in the second study the odds of scabies was three times higher among people who shared sleeping space (AOR=3.99 95% CI 1.37-11.7) (183). In line with this, three studies, one case control and two cross sectional studies tested whether physical contact predicts scabies. The two cross sectional studies found a positive association between history of physical contact with a scabies patient and scabies. Dagne H *et al.* reported that people who ever had contact with a scabies patient had fourfold increase in the odds of scabies infestation as compared to those who did not (AOR=2.66, 95% CI

1.21 - 5.83) (185). A comparable increase in the odds of the infestation was reported in the study by Tariku B, and Dadi FA, (COR=2.76, 95% CI 1.04 - 7.41), but in this study, authors did not adjust for potential cofounders and the association was determined on the basis of crude odds ratios (14). Unlike the two cross sectional studies, having skin contact with a scabies patient had no association in a case control study. In this study, increased odds of scabies was observed in the bivariable analysis that later disappeared when confounders were adjusted for (20).

Five articles assessed the association between personal hygiene and scabies (14, 20, 183, 185, 188). In these articles authors used different approaches to measure personal hygiene. Frequency of bathing and whether detergents were used were the most frequently used approaches. In three of the papers (one case control and two cross sectional studies) where frequency of bathing was used to measure hygiene, a significant association with scabies infestation was shown (14, 20, 185). Bathing less than two times per week, not bathing in any given week, and bathing rarely were the categories used in these publications. The effect of the respective frequencies of bathing on the odds of developing the infestation were (AOR=9.77, 95% CI 2.44–39.09), (COR=3.22, 95% CI 1.22-8.5), and (AOR=3.54, 95% CI 1.36-9.25) (14, 20, 185). Bathing or washing hands without using soap was also reported to increase the odds of developing scabies in three publications (20, 183, 185). In two of the articles, both frequency of bathing and not using detergents were included in the same model but the effect of putting the two variables that potentially measure the same thing in one model was not discussed (20, 185). Worku DE *et al*, reported a fourfold increase in the odds of scabies infestation among participants who had not used detergents while bathing (AOR=4.85, 95% CI 1.3-17.9) (183). A similar increase in odds of scabies was reported by Dagne H *et al*., and Wochebo W et al., (AOR=4.38, 95% CI 1.78 - 10.76, and AOR=4.69, 95% CI 1.34, 16.36), respectively, among participants with poor hygiene. The odds in the former study pertained to the use of soap when washing hands and the latter considered the overall soap use for personal hygiene.

The association between host density and scabies was investigated in five studies. These studies used household size as a proxy to determine host density without considering the size of the residential units. All but one (183) of the articles reported a positive association between host density and scabies. Three of the studies fitted logistic regression models to determine the unconfounded effect of host density on the

odds of scabies infestation. Two of these studies used the cut off ≥5 household members to define crowding, and the independent effect of bigger households on the odds of scabies infestation were (AOR=1.59, 95% CI 1.14 – 2.22) and (AOR=2.63, 95% CI 1.10 – 6.27), respectively (19, 188). Wochebo W *et al.,* increased the cut off by one (>6 people) to define big households. Similar to the other two studies, in this study the odds of infestation among big households was considerably higher (AOR=38.21, 95% CI 7.72 - 189.08) (20). The last study that reported a positive association between host density and scabies did not use statistical tests to determine the statistical significance of the association. However, according to the descriptive analysis the number of cases among big households was high (14).

Poverty is among the strong predictors of scabies infestation. However, only one of the reviewed articles investigated the contribution of household wealth to scabies, where people from households with low income had two fold higher odds of scabies infestation (AOR=2.13, 95% CI 1.32 - 3.44) (188). Nonetheless, authors did not determine the range of household income they employed to assign households to different categories.

Scabies control interventions

I found only two publications on scabies control interventions. Embiale *et al*., determined the impact of MDA aimed to control a scabies outbreak (17). Scabies prevalence was measured 15 months after the intervention, and the estimated prevalence was 21%. The pre-intervention prevalence of scabies was determined by using patient reported history of scabies where 46% of the participants reported history of scabies infestation (17). However, details of the intervention and the temporal relationship between the MDA and the change in prevalence of scabies in the study community were not clearly presented.

The second intervention study assessed the impact of an education intervention on the prevalence of scabies (184). Community health care workers were trained to provide scabies care in their communities. In the intervention districts HEWs were trained to provide scabies care, hypothesizing that enhancing access to scabies care services would reduce scabies prevalence. In the intervention district scabies prevalence decreased from 7.6 per 1000 population to 1.6 per 1000 population. However, in the control district scabies prevalence increased from 1.3 per 1000 population to 2.4 per 1000 population (184).

2.4. Discussion

This review involved 22 articles published in peer reviewed journals. The publications were from five regions of Ethiopia and nearly half of the publications were from the Amhara regional state. Findings of the review are organized under three major areas, the burden of scabies in Ethiopia, determinants of scabies infestation, and scabies control interventions and their impact on the prevalence of scabies. The findings on the burden of scabies were prevalence estimates of community-based studies and the proportion of scabies cases among patients who sought care in different health care facilities.

The overall scabies prevalence estimates indicated a high scabies burden in Ethiopia and most of the high prevalence reports were from Amhara regional state. Sociodemographic characteristics such as age, household wealth, sharing clothing, and sleeping space with presumptive scabies patients, and personal hygiene showed significant associations with scabies in several publications. Two studies investigated the impact of community-based preventive chemotherapy and promoting access to scabies care on the prevalence of scabies. In both studies the interventions were linked to decreased burden of scabies in the study communities.

Half of the reviewed articles emanated from only one region, Amhara. The remaining half of the publications came from studies conducted in SNNP, Oromiya, Addis Ababa city administration, and Tigray regions. One of the major similarities between these five regions is that they were predominantly comprised of agrarian communities. In Ethiopia, agrarian communities live on or near their farmlands for generations, unlike pastoralist communities who are constantly on the move, looking for pasture for their cattle. These lifestyle differences determine health care service access, which is among the most important determinants of scabies burden in communities (195). As agrarian communities live in one area for a long-time availing health care infrastructure is relatively easier. However, pastoralist communities have limited access to community-based disease control interventions and health care services (195). Regardless of this difference and additional ecological factors which causes variation in disease burden and distribution, there were no publications on the epidemiology of scabies from the predominantly pastoralist regions that cover the eastern and western parts of the country. This lack of data from the regions with varying sociocultural backgrounds limits having a complete picture of scabies epidemiology in Ethiopia and undermines disease

control efforts. For instance, preventive chemotherapy, a likely intervention in high burden areas, requires disease distribution data before launching control interventions. For this reason, geospatial mapping of scabies covering all parts of the country vital.

Nearly all the reviewed articles had data related with the magnitude of scabies. However, I have found no national surveys or large-scale studies that generated regional or country level prevalence estimates. The only study that approximated the country level scabies prevalence (14.5%) was a meta-analysis by Azene GA *et.al* (194). However, in most of the small scale studies a high scabies prevalence was reported. The prevalence in nearly half of the publications crossed the WHO's cut-off to initiate community based control intervention (10%) (144).

Most of the articles that reported high prevalence were conducted after 2015, a time when the Ministry of Health declared a scabies outbreak (13, 15, 17, 187). The ministry renewed its attention on scabies following the unusual increase in the number of clinical reports. This change in pattern initiated further field investigations which led to the eventual declaration of the outbreak in Amhara region (196). However, our knowledge of the burden of scabies before 2015 is limited to the reported magnitude in the publications from small-scale studies as scabies was not under surveillance before the outbreak. Later it was included among the list of weekly reportable diseases under the national Integrated Disease Surveillance and Response (IDSR) system in the same year the outbreak was reported. In Amhara region, scabies prevalence estimates both from community-based and facility-based studies, ranged between 4.5% and 33.7% (13, 189). (13-15, 184, 187, 190)Studies conducted in the same period in Oromiya and SNNP regions (that cover the southern and south-western parts of the country), estimated prevalence of 13% and 2.5% - 11%, respectively (11, 19, 20, 184, 192). However, one of the two papers published on scabies in Addis Ababa reported a comparable proportion of scabies patients (23%) to studies conducted in Amhara. Nonetheless, this study was conducted using a four-year health service data on scabies in children referred from the nearby orphanage to a tertiary hospital (16). Nonetheless, interpreting the findings of this study requires caution since participants had high risk of developing scabies due to their background characteristics. One, institutional settings, such as orphanages, are known to facilitate rapid scabies transmission, and high prevalence of scabies in such institutions is common (151, 197). Two, the study only involved young children, an age group that is prone for scabies infestation. For this

reason, it is likely that the high proportion of scabies cases is not representative of the disease epidemiology in the general population.

Apart from the change in disease pattern, the study setting, and the design of some of studies could have contributed to the high prevalence estimates. Several publications were from studies that either aimed to identify areas of scabies outbreak, mainly in Amhara region, or address related health research needs of people living in already known high scabies burden settings (13, 17, 19, 187). This explains both the high prevalence and the increase in the number of publications on scabies in the past five years as investigators tried to determine the causes for the outbreak. More so, some studies were actual extensions of outbreak investigation activities aimed to generate baseline data for subsequent control interventions (14, 19, 20).

In some of the studies the nature of study participants and the study settings could have contributed to the high scabies prevalence. In settings that entail crowding such as schools, orphanages, prisons, and hospitals scabies outbreaks are not uncommon. In this review, articles from studies that were conducted in orphanages and primary schools were included (11, 12, 16, 109, 185). Apart from being institution-based these studies involved young children who are prone to scabies (198). The same is true for the study among traditional clergy school students (14). Though these students were all adults, they were boarding in the premises of the church compound and the dormitories were crowded with an average of five students per residential room. Dorm mates commonly shared bedding and clothing which facilitated further transmission (14).

Most of the reviewed articles tested whether there was an association between sociodemographic characteristics and scabies infestation. Sex was one of the factors under investigation, however, except in one article, sex was not associated with scabies. This was not unexpected as in several former studies the association between sex and scabies was either not significant or inconclusive (2, 21, 86, 115), and from the articles included in this review only Ejigu K, et.al, found a statistically significant association between sex and scabies (188). In this study, male participants had a two-fold higher odds of scabies infestation than their female counterparts. The school-based study attributed the increased odds of scabies among boys to an intimate physical contact which was more common among the boys than the girls. Though biological plausibility of

the association between sex and scabies including the role of gender as a predictor of the infestation are limited and it merits further study (199).

Age was the other demographic variable investigated as a predictor of scabies in most of the reviewed articles. The studies found an increased odds of scabies infestation among people aged 15 years and younger, which included both children and adolescents. This finding is consistent with studies in different parts of the world (7, 10, 107), that reported a disproportionally high odds of scabies among children, specially in marginalized communities (2, 7). Frequent physical contact among children in the house and outside is an important determinant of fast scabies transmission among young children.

Sharing clothing and bedding increased the odds of scabies infestation in three out of the four articles that assessed the association. Two of the studies sampled study participants from the community (20, 188) and the third study was from a traditional religious school (14). Sharing clothing is a possible mode of scabies transmission, especially when the index case has a high parasite load (31). However, there were limitations in two of the studies that could not establish an independent association between sharing clothing and scabies. The study from a clergy school determined the association based on crude odds ratio estimates, without adjusting for confounders (14). For instance, the authors reported crowding in the residential rooms of the students. This is a strong cluster level predictor that was not adjusted for in testing the association between sharing clothing and scabies. In the second article by Ejigu *et.al*., a logistic regression model was fitted to adjust for confounders and measure its independent effect on scabies. Nonetheless, in this study, sharing bedding or clothing and contact with scabies patients were grouped as one variable and determining the odds of transmission only through clothing or bedding is not possible.

Thus far, scabies control intervention strategies in Ethiopia have been focused on providing standard care to patients who sought care from health care facilities. Since scabies was not regarded as a public health threat, before the latest outbreak, community wide interventions were not considered. This could be one of the reasons for the limited publications on scabies control strategies in Ethiopia. I found only two publications on scabies control in Ethiopia. The first one measured the impact of a training intervention to community health workers on the prevalence of scabies (184)

and the second article reported results of an evaluation research of the impacts of a MDA on scabies prevalence (15). The training intervention was linked to a significant difference in scabies prevalence between the intervention and control districts. HEWs, who were community health workers comprising the lowest level in the health system, were the focus of the intervention. The observed effectiveness of this intervention might vary in different settings, based on disease endemicity, health service access and prior knowledge of health workers about scabies. However, the prominent difference in the prevalence of scabies between the intervention and control districts encourages considering decentralizing scabies care down to the fundamental units of a health system. Similarly, in the second article, the effect of the MDA was determined by measuring the prevalence of scabies at two time points that were interrupted by the intervention. Multiple anti-scabietic drugs were used in the MDA and the intervention decreased the prevalence of scabies. However, the study had multiple limitations that hindered attributing the change in prevalence to the MDA. The study had a quasi-experimental nature where description of the intervention lacked clarity and the data points, especially the baseline, were not discrete (history of scabies infestation was used to establish baseline estimate of scabies prevalence). Regardless of these limitations the MDA decreased the prevalence by half, comparing the estimate at baseline with the follow up data.

This review is not without limitations. I searched only two electronic databases and did not do review of unpublished documents. Though I have tried to account for this limitation by conducting forward literature search based on the bibliography of the articles identified in the two databases, it is still possible that I could have missed publications in journals that were indexed in other databases. Furthermore, I did not search for unpublished reports on scabies and these limitations could have narrowed the pool of publications for the review. However, aiming to compensate for this short coming, I used broad screening criteria (i.e., studies conducted in Ethiopia, involved human subjects, studies aimed to determine the burden and determinants of scabies, and studies that employed any of the epidemiologic study designs) so that as many articles as possible are included from the journals indexed in the databases I searched.

2.5. Conclusions and recommendations

2.5.1. Key findings

In the past 25 years there were only few publications on scabies in Ethiopia. However, the number have been increasing in the past years. Between 1996 and 2016 there were only 6 publications, and this increased to 16 publications only in five years' time, with the highest number of publications per annum reaching 8 articles in 2020. This increase in the number of publications coincided with the time when the scabies outbreak in northern Ethiopia was reported. Despite the increasing trend, and the total number of publications, the research questions they addressed, and the geographic areas covered by the studies were limited.

The overall research areas addressed by the studies so far can be grouped into two. Most reviewed publications from community-based and facility-based studies aimed to determine the prevalence and proportions of scabies patients, respectively. A significant number of publications also investigated the determinants of scabies infestation. It was only two of the reviewed 22 articles that measured the effectiveness of scabies control interventions. One of them was evaluative research measuring the effectiveness of a community-based scabies control intervention on the prevalence of scabies; and the second one was educational intervention to enhance the knowledge and skill of primary health care workers to give a better care for scabies patients.

Though the research agenda in the existing publications is limited to determining the burden and predictors of scabies, research areas such as care for scabies patients and public health control interventions need more data. For instance, the constant itch and sleep disturbance caused by scabies seriously undermines life quality of patients. However, in my review I haven't found any publication measuring the impact of scabies on life quality of patients.

Lack of data vital to design population-based interventions is the other gap I observed from the review. Articles reporting knowledge and perceptions of communities toward scabies were unavailable and studies measuring the effectiveness of alternative scabies control interventions were also limited.

The geographic distribution of where the studies were conducted was uneven. Half of the publications came from studies conducted in Amhara region, northern Ethiopia.

Once again, the outbreak that was first reported from this region could be the reason for most studies to emanate from the area. The remaining half of the publications were from studies conducted in other four regions whose communities are predominantly agrarian. However, there is no scabies study in the remaining seven regions of the country, and this includes all the regions where pastoralist communities are living. Ignoring this part of the population makes our understanding of the epidemiology of scabies in Ethiopia incomplete.

Like the skewed distribution of the number of publications to northern Ethiopia, high scabies prevalence is reported in most studies conducted in Amhara region. More than half of the studies reported an estimated prevalence exceeding the pooled national prevalence estimate. However, most publications from studies conducted in the remaining parts of the country were fewer in number, covered a small geographic area and reported low prevalence estimates. Since the remaining regions are not sufficiently represented by the existing publications, unlike Amhara region, our estimates of the disease burden at the national level are inconclusive. Other than higher number of publications coming from northern Ethiopia, most publications in these regions reported higher prevalence estimates than the publications on scabies in the remaining parts of the country. To be more specific, there were only two estimates from studies conducted in Addis Ababa and Oromiya regions that reported scabies prevalence comparable to the studies from Amhara region.

Determinants of scabies infestation were frequently being reported in most of the reviewed articles. Age, sex, sharing clothing and sleeping space, personal hygiene, and host density were some of the factors frequently being investigated. From the sociodemographic characteristics sex did not bear much weight as a predictor of scabies infestation, unlike age that had a significant association with scabies. In most of the articles young age increased the odds of scabies infestation. Though the intervals of age used in the different studies were different, in general children and adolescents in the age interval between 0 and 18 years were associated with higher odds of scabies.

Personal hygiene was investigated as a predictor of scabies in five of the articles. In these studies, poor personal hygiene was associated with higher odds of scabies.

However, the finding is not conclusive as the measures of hygiene used in these publications were inconsistent. Frequency of bathing, use of detergents and hand washing with and without soap were used as indicators hygienic practices.

Sharing clothing, bedding, and sleeping space with a person presenting scabies manifestations were associated with increased odds of scabies infestation. Similarly, four out of the five studies that investigated the association between host density and scabies found a positive association between the two variables. Interpreting this finding needs caution as host density was determined based on number of household members merely, without calculating the living space available for each household member.

2.5.2 Policy recommendations

Scabies prevalence in Ethiopia is high with varying prevalence estimates for different parts of the country. The highest estimates were frequently reported in studies conducted in the past five years mainly in Amhara regional state. This can be a reflection of the outbreak reported in the same region in 2015 and still ongoing. This high magnitude of scabies indicates standard care alone is not enough to control the disease. The WHO informal consultation on the control of scabies recommends in communities where scabies prevalence is $\geq$10% preventive chemotherapy should be initiated using effective scabicides and the intervention should continue until the community-based prevalence decreases below 2% (144). MDA against scabies should be conducted in all communities in Ethiopia where the scabies prevalence is 10% or more.

Young people aged < 18 years had higher odds of scabies. This group of population can serve as core transmitters of the infestation to the wider community. In settings where MDA involving the entire community is unlikely, targeted preventive chemotherapy to this age group may help mitigate outbreaks.

Sharing clothing, bedding and physical contact with a person exhibiting symptoms of scabies was associated with increased odds of developing scabies in multiple publications. Future interventions aimed to control scabies need to include educational intervention component that helps to enhance awareness about scabies transmission and the importance of physical contact for the transmission to take place.

2.5.3 Further research

Though it is not unexpected, there is a wide evidence gap about the epidemiology of scabies in Ethiopia. Most of the available publications are from small scale studies involving only a small part of the intended study communities. These studies primarily dealt with scabies prevalence and its determinants and most of them were conducted in Amhara region. This has limited our understanding of the disease burden and distribution in the remaining parts of the country, and it hampered the effectiveness of control interventions. Future research should aim generating estimates for wider geographic areas so that it will be more appropriate to design targeted control interventions addressing all the affected population. Such studies should also go beyond geographic coverage and ensure representation of population groups from different socioeconomic background and lifestyle such as pastoralist communities in Ethiopia.

Future research agenda should also be diverse and address aspects vital to understand the extent of the effect of scabies on different aspects of individuals' life and the community at large. For instance, chapter three and chapter five of this thesis presents the findings of my study that investigated the impact of scabies on life quality of patients; and the secondary impact of onchocerciasis ivermectin MDA on the prevalence of scabies. So far, there are no studies on these two research agenda and though the studies answer some of the questions in relation to the impact of scabies on individuals' wellbeing and the effectiveness of integrated scabies control intervention.

Studies outside of Ethiopia found high odds of scabies among people from households with low socioeconomic status. This variable is an important confounder in the associations between other predictors under study and scabies. However, household wealth or income was not considered as a determinant of scabies infestation in nearly all the reviewed articles. Future studies need to factor in the effect of wealth while attempting to establish associations between exposure variables and scabies.

Despite the need for data to guide control interventions against the current scabies epidemic and potential future outbreaks, there were only one publication on community-based scabies control intervention. This lack of evidence about the effectiveness of alternative scabies control strategies, especially in the context of areas where there is an active scabies outbreak, inspired developing the main project that investigated the secondary impact of an ongoing ivermectin onchocerciasis MDA on scabies prevalence.

The result of the study is included in chapter five of this thesis, and it also explored the potential for future integration of control interventions for the two NTDs. However, this study covered only one district where there was an ongoing ivermectin-based MDA for onchocerciasis control. More research work in varying contexts is needed to guide future interventions and achieve control.

2.5.4. Doctoral candidate development

Conducting this systematic review gave me a comprehensive understanding of what is known so far about scabies in Ethiopia. The findings of the review made it easier for me to make regional and global comparisons in terms the disease epidemiology and put the contents of the upcoming chapters into perspective.

I have never conducted systematic reviews before and in developing this chapter I studied systematic review methods and familiarized myself with the techniques required to search different electronic databases. Each step of the process, from literature search to write up, needed different skill set that I managed to develop in conducting the review and through the regular discussions with supervisors.

I searched two of the largest electronic databases and supported this search by following any article on scabies in Ethiopia from the identified publications in the first search. Presumably, this approach granted me access to most of the existing publications surrounding the research question. However, it is possible that important pieces of grey literature that were not published in peer reviewed journals are still left out. In the future I intend to expand this work and involve a wider range of resources that will grant me access to both published papers and grey literature on scabies in Ethiopia.

Chapter Three

Epidemiology of scabies in Amhara region, northern Ethiopia

Chapter 3 : Epidemiology of scabies in Amhara region, northern Ethiopia

3.1. Introduction

Scabies is endemic to communities with a range of socioeconomic background. However, high disease burden and frequent outbreaks are often reported from marginalized communities with unconducive living condition and limited access to health care services (7, 115). Scabies is not a reportable disease in most countries of the world, our knowledge of its epidemiology comes predominantly from surveys in high burden settings, or from health care service records (200). Globally, the highest scabies prevalence from community-based studies is reported in countries of the South Pacific region, Central America, and the Aboriginal community in Australia (83, 88, 198, 201). Though the limited data in the remaining developing countries is a challenge to make regional estimates, reports from South Asia and Latin America indicated a prevalence estimate ranging between 3.8% and 17% (89, 96, 115). In sub-Saharan Africa where most studies are facility based, the existing few community-based studies indicated a prevalence estimate as high as 33.5% (13).

Ethiopia is among high scabies burden countries and the prevalence and distribution is seeing further increase in the recent years due to a scabies outbreak (194). However, data on scabies is limited and mainly comes from publications that used programmatic data aimed to guide control interventions (13, 15, 17). This study estimates scabies epidemiology in onchocerciasis endemic district in northern Ethiopia.

There is high burden of multiple NTDs in Ethiopia, which require intervention. The WHO promotes an integrated approach to achieve the ambitious NTD control targets (27, 164). Effective integration of control measures require knowledge of the burden and distribution of candidate NTDs for integration (1, 38). This study estimates scabies prevalence in onchocerciasis endemic district. Since there has not been a proper scabies mapping in Ethiopia, the findings of the study help to assess co-endemicity of the two diseases. This descriptive study is vital as median prevalence estimates from previous surveys (13) cannot accurately describe scabies epidemiology in the study district. In Ayu Guagusa district bi-annual ivermectin onchocerciasis MDA has been underway since 2015. Ivermectin, being a systemic scabies drug, can supress scabies prevalence. For this reason, the disease epidemiology may not be typical of the remaining districts of the region.

This is the first study in Ethiopia that determined the epidemiology of scabies in a setting where there is a longstanding history of ivermectin MDA. The findings of this study help to characterize scabies epidemiology in areas where there is ivermectin MDA against other NTDs such as onchocerciasis and lymphatic filariasis (1). It also provides the basis for further study on the collective gains of MDA programs other than their impact on the target NTDs. Secondary objective of this survey is to produce a counterfactual for the evaluative study that measured the off-target impact of the MDA against onchocerciasis on scabies. Chapter five of this thesis reports the methods and findings of the study thereof.

Most determinants of scabies infestation surround circumstances that promote physical contact among people. High host density, at households and institutional settings such as prisons, elderly care homes, hospitals, and schools facilitate rapid transmission causing outbreaks (23, 202, 203). Age is the other strong risk predictor and in low resource settings scabies is common among the young demographics (9, 115, 198). However, in societies of the developed world the disease epidemiology takes sporadic pattern and adolescents, and the elderly are the most affected (7, 33). Poverty mediated trough poor living condition and limited access to health care services increase the risk of infestation (161). The association between hygiene and scabies infestation is not conclusive (89). However, control interventions consider promoting personal hygiene as one of the main scabies control strategies (114, 116). Studying predictors of scabies infestation was intended to identify individual, household and health service-related factors that contributed to the latest increase in prevalence. Identifying the factors amenable for control interventions enhances effectiveness of the response against the current and future scabies outbreaks.

Research questions

- What is the prevalence of scabies in ivermectin onchocerciasis MDA targeted population of Amhara regional state, northern Ethiopia?
- What are the determinants of scabies infestation in a district where there is a bi-annual ivermectin onchocerciasis MDA?

3.2. Methods

3.2.1. Study design

This cross-sectional study was conducted in December 2018. The survey was a baseline for a longitudinal study that aimed to measure the secondary impact of ivermectin-based MDA for the control of onchocerciasis on the prevalence of scabies. Though there were two subsequent surveys, this chapter only addresses the epidemiology of scabies by using a point-in-time data from the baseline survey.

3.2.2. Study setting

Ethiopia is an East-African country found in the sub-Saharan region. This landlocked country shares borders with six other countries that comprise a region commonly referred to as the “horn of Africa”. These borders are to the West with Sudan, to the Southwest with South Sudan, and to the South with Kenya. The longest international border of the country is the Ethio-Somalia border which is an estimated 1019 miles. It forms the southern, south-eastern, and part of the eastern borders. The Ethio-Eritirean border forms the entire northern boundary and stretches halfway into its eastern border giving way to the Ethio-Djibouti corridor, which is the shortest of all of Ethiopia’s international borders, but this corridor has a high economic significance as Ethiopia uses the Djibouti port, located at the entrance to the Red Sea, to manage the majority of its international trade logistics.

The Federal Democratic Republic of Ethiopia came to power after the fall of the socialist Derg regime in 1991 (204). Subsequently, the government adopted ethnic-based federalism and gave partial autonomy to regional states that were formed on the basis of the ethnic groups that that are vastly found in the regions. This coalition of regional states forms the federal government which has a limited administrative role within the regions. Accordingly, ten regional states (including the newly formed Sidama region) and two city administration councils comprise the federal system (i.e., Amhara, Oromiya, Tigray, Southern Nations Nationalities and Peoples Region, Afar, Harari, Somali, Benishangul Gumuz, Gambella, Sidama regions, and Addis Ababa and Dire Dawa administrative city councils) (205). Except for the two city councils and Harari region, the administrative structure of all the regional states is similar. Regions are sub divided into zones, considering the number of population and their geographic distribution.

Due to the significant variation in the population of each region, the total number of people in the respective zones varies from around 35,000 to nearly 3 million (205). Zones are sub- divided into districts, bringing the administration closer to the community. Districts are the front-line implementers and regulators of government policies (204). Though the number of administrative districts is on the rise due to political and service-related factors, in 2010, there were 817 districts in all ten regions (206). The biggest districts have as many as 250,000 people (205). The *Kebele* is a sub-district structure and the smallest administrative unit, comprising 500 households on average (206). *Kebeles* use auxiliary unofficial structures called *Gote* to reach the population at the grassroots. This structure helps to bridge the kebele administration with the local community. *Gotes* are instrumental to mobilize communities for developmental activities that often required considerable community engagement. To this end, volunteers are recruited in each *Gote* and are tasked with coordinating and leading community mobilization activities.

Ethiopia is located in the tropics (i.e. 9.145 latitude and 40.489 longitude) and has four major seasons (207, 208). *Kiremt* (Summer) season (June to August) see heavy rainfall accompanied by intermittent sunshine. *Belg* (Autumn), also called a harvesting season, is a time when the heavy rains are replaced by predominant sunshine and intermittent showers. The dry season, *Bega* (Winter), spans three months (December to February). This is the coldest season with the annual average temperature (25°C), dropping to 8 °C or even lower. Tsedey (Spring) is the hottest season of the year averaging around 25 °C. However, due to the considerable difference in altitude, ranging from -116 meters below sea level to more than 4000 meters above sea level, there is considerable variation in temperature, humidity, and rainfall in different parts of the country (209, 210).

Ethiopia is the second most populous country in Africa. According to the population projection of 2021 the total population count is 115 million (211). The demographic distribution is dominated by young people. Children and adolescents aged younger than 15 years comprised 41% of the total population (205). Though there is a progressive increase in the elderly population, people of 60 years and older made up less than 4% of the total population (205). The high Total Fertility Rate (TFR), which is 4.6 children per woman, regardless of its progressive decline, has contributed to the rapidly growing population (212).

Ethiopia has substantially expanded its primary health care service in the past few decades. This was aimed to promote access to basic health care services, improve health literacy and enhance health care seeking (213). The primary health care expansion program helped improve maternal and child health and has contributed to the control of the targeted communicable diseases (214).

The health care delivery system of Ethiopia is organized into three tiers (i.e., primary, secondary, and tertiary). The primary level is comprised of a constellation of five satellite health posts, one health center and a primary hospital. These facilities are collectively referred to as the primary health care unit. General hospitals occupy the secondary level, with specialized and teaching hospitals rendering tertiary level health care services (206). Regardless of the ongoing efforts to promote access to health care services the population to health care facility ratio is sub-optimal. By the time this report was prepared, one primary hospital served a maximum of 100, 000 people, while general and specialized hospitals were for 1.5 and 5 million people, respectively. Health centers and their five satellite health posts were positioned to provide primary health care services to 15,000 to 25,000 people (206).

The primary health care expansion program has boosted access to primary health care services. However, millions who need advanced medical attention are still out of reach. In 2010 the population to physician ratio was 1 to 40,000 and almost all physicians worked in hospitals (206). Most general practitioners serve in primary and general hospitals, and specialist physicians mainly work in tertiary level care facilities. Though a few health centers, in particular those located in urban areas, are staffed by physicians, typical health centers are staffed by mid-level health workers (health officers, nurses, midwives, environmental health professionals and laboratory technologists) (206). Mid-level health care workers have 3 to 4 years of training, and they provide primary health care services, and see patients of diseases mild to moderate severity. Nurses are not new to most health systems; however, health officers are trained to provide clinical care to patients at primary health care facilities and play administrative role in the institutions they work for, commonly health centers and health administration offices.

Each *kebele* has one health post staffed by two Health Extension Workers (HEWs) (213). HEWs are community health workers with a one-year training in the basics of disease prevention and health promotion services. They serve as community-level agents for health education, disease prevention, and community-to-facility patient referral and linkage (213). To provide these services, HEWs, spend two-thirds of their working hours in the field conducting house-to-house visits with families in their respective kebeles. The two HEWs adjust their field visit schedule to ensure that both the outreach and the services at the health post continuous uninterrupted.

3.2.3. Study area

This study was conducted in Ayu Guagusa district, Agew Awi zone, Amhara Regional State. Amhara region is found in north-western Ethiopia, covering a total area of 170, 000 square kilometers. The adjoining regions include Benishangul Gumuz to the Southwest, Afar to the East, Oromiya to the South, and Tigray to the North. Amhara, shares its western border with Sudan (215). The region is divided into eleven zones and 140 districts (205).

Amhara is a predominantly highland region at an altitude ranging between 1500 and 2300 meters above sea level. The differences in altitude create a gradient of three main climatic zones. *Dega*, a cold climatic zone covers areas above 2300 meters above sea level. The semi-highland areas are found between1500 meters and 2300 meters above sea level. The climatic conditions in areas found at this elevation are named "*Woina Dega"* and are characterised by a predominantly warm and wet climate. Limited "*Kola*" lowland areas are found below 1500 meters above sea level, and these mainly have a dry and warm climate (216). Despite the difference in climatic conditions most parts of the region were conducive for agriculture, with 850 mm average annual rainfall and 22°C temperature. Agriculture is the mainstay of economic activity in the region, and more than 87% of the population draw their livelihoods from this sector. However, due to traditional and rain-dependent agricultural practices, a notable number of the community are subsistence farmers, and productivity is low (217).

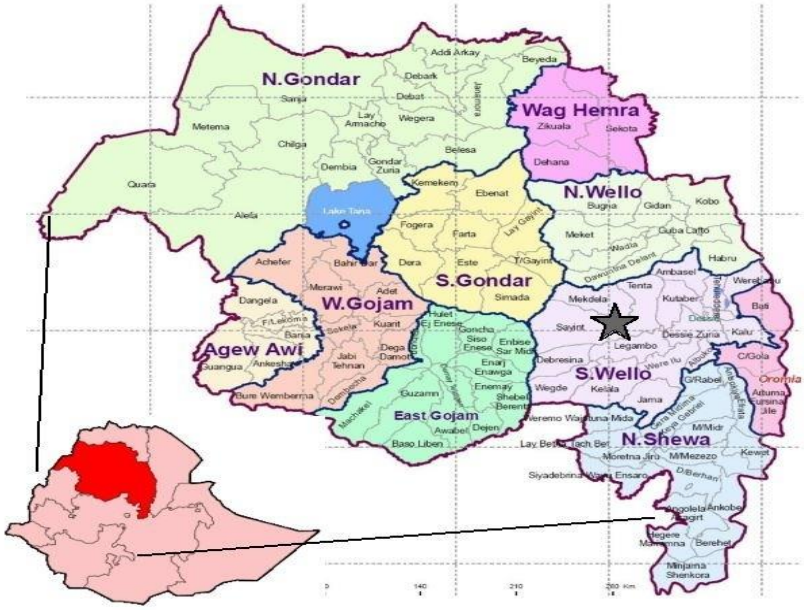

Figure 3.1 Map of Agew Awi zone, Amhara Regional State (Source: Rikoon,JS.(2017)).

3.2.4. Sample size

The sample size was calculated based on the median population prevalence of scabies in Amhara region (35%) (13). A 5% precision for two tailed tests (confidence interval ranging between -5% and 5% for population parameters) was considered. To calculate the design effect, 5% community level correlation coefficient (218) and an average cluster size (size of the study *Gotes*) of 50 was considered. With these assumptions, the minimum sample size, which is adequate to estimate scabies prevalence, is 1206. I subsequently added 10% of the calculated sample size to account for possible non-response, making the total sample size 1326. This final sample size was divided by 3.5, a number close to the national average household size for rural areas (205), to determine the number of households to be involved in the survey (n=379).

3.2.5. Source population

According to the 2007 national census, Amhara was the second largest region in Ethiopia, with 17 million people (205). The male to female ratio was similar to the distribution at the national level, and majority of the population were young. Children and adolescents aged younger than 19 years constituted 54% of the population. The elderly, who were 65 years and older, made up only 3.6% of the population (205). In 2017, in Ethiopia the estimated national adult literacy rate was 51.8% (219).

However, recent developments promise future change, since the national net primary school enrolment ratio has increased to 95% and that of the Amhara regional state, to 86% (220).

3.2.6. Study population

The study population was all consenting members of the study households.

3.2.7. Eligibility criteria

The eligibility criteria were applied to both study households and individual participants. The eligibility criteria for households primarily considered whether they had plans to move from the study area in the coming one year, counting from when the baseline survey was conducted. This way I checked the availability of the households for the planned three successive surveys over a one-year period. None of the households reported they had plans to move in the coming year.

The eligibility criteria for individual study participants were household membership of the participants. Household members were those who regularly lived with the family or guests who had stayed in the household for the two weeks prior to the day of data collection.

3.2.8. Sampling procedure

Onchocerciasis mapping conducted between the years 2000 and 2001 identified 188 onchocerciasis endemic districts in Ethiopia. Nineteen of these districts were found in Amhara regional state (24). Subsequently, ivermectin-based MDA was carried out to eliminate onchocerciasis from hyperendemic districts at different times. I purposively selected Ayu Guagusa district from the seven districts of Agew Awi zone, as it was the only district where MDA for onchocerciasis elimination was underway. There were 21 *kebeles* in the district, and six (Dekuna Dereb, Arbit, Degera, Ambera, Enavara, and Chibachibasa) were randomly selected. The total population of the study kebele vary where Dekuna Dereb had 8573 residents, Arbit 4527, Degera 5138, Ambera 5025, Enavara 2636, and Chibachibasa 8721. Each of the selected *kebele* was comprised of a varying number of *Gotes* and one *Gote* was randomly selected from each *kebele*. A census of all the households in the selected *Gote* was conducted and a sampling frame was prepared. I randomly selected 381 households from the frame and all 1437 consenting members of the selected households participated in the study (Figure 3.2.).

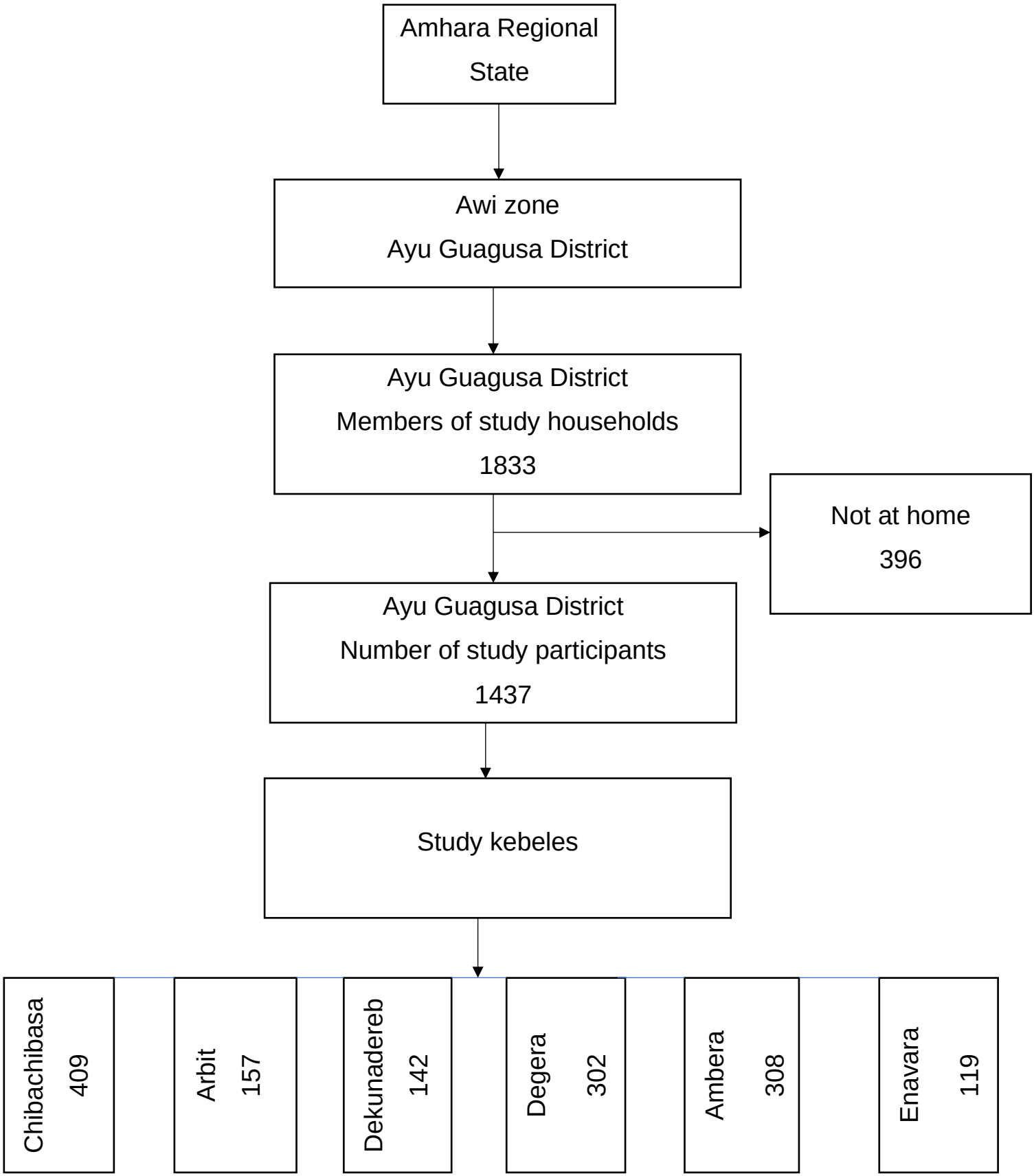

Figure 3.2 Steps involved in the study participant selection

3.2.9. Variables

Dependent variables

Scabies diagnosis was the dependent variable. Health care providers that I recruited from the nearby health care facilities diagnosed scabies cases employing clinical diagnosis. A method that is commonly in use to identify scabies cases both in the clinic and field settings (35).

Independent variables

Hierarchical data was generated at the household and individual participant levels. Household characteristics such as number of household members, ownership of durable assets, access to infrastructure, and access to health care facilities were included. Variables that pertained to individual participants were sociodemographic characteristics, personal hygiene, participation in the last MDA. Detailed list of variables and their respective operational definition is indicated in annex A.

3.2.10. Data collector recruitment and engaging health system administrators

Before commencing data collection, a team comprising myself, a co-investigator from the in-country research team, and the scabies control program focal person from the MoH visited the study area to discuss with local health office heads and administrators. I involved the heads of the Neglected Tropical Disease (NTD) Control Program of the Amhara Regional Health Bureau, the Amhara Regional Public Health Emergency Management and Response (PHEM) office, the Agew Awi zonal health office and the Ayu Guagusa District health office in the discussion. These meetings were aimed to introduce both the research team and the project to the local health office administrators. The discussions primarily addressed the epidemiology of scabies in the locality, the ongoing response to the scabies outbreak, and an overview of the former and planned MDA against onchocerciasis. Furthermore, recruiting data collectors for this study was covered in our discussion with the zonal health office head. Their involvement in the recruitment was vital since they have knowledge of the health workers' experience in giving care to scabies patients. It also helped to get permission for the staff to participate in the data collection putting on hold their clinical roles at the hospital for the period of the field work.

Four nurses and one health officer were recruited from the nearby Gimja Bet hospital, a primary hospital located nearly 30 Kms away from the study area. All had five years or more experience giving clinical care to patients, including scabies patients and had 3 to 4 years of training in their respective fields.

3.2.11. Data collectors' training

After recruitment, the data collectors attended a three-day refresher training (from December 01 to 03,2018) in Injibara town, the capital of Agew Awi Zone.

The aim of the data collectors training was to introduce the team to the project and refresh their existing knowledge about scabies, with due focus on scabies diagnosis.

The topics we covered in the training were:

- Project overview.
- Pathogenesis, clinical presentation, and differential diagnosis of scabies.
- Global and regional epidemiology of scabies.
- Overview of the questionnaire and interview skills exercise.
- Ethics of human subject research.

The training was facilitated by Dr Wondimagegnehu Embiale, a senior dermatologist from Bahirdar University, and me. Topics related to clinical aspects of scabies including the clinical demonstration sessions were covered by the dermatologist. I facilitated the sessions on the remaining four topics. I have received a certificate after attending a training on Good Clinical Practice (GCP) and the training qualified me to facilitate the session, ethics of human subject research.

The sessions were interactive with a mix of approaches including lecture and one-on-one discussions with each other and the facilitators. To standardise characterisation of clinical presentations, across the field team, pictorial slide presentations were used.

The interview skills of each participant were assessed and improved by conducting demonstration interviews where the trainees took turns as interviewers and respondents. The group and facilitators observed each interview and gave feedback to the pair of participants considering qualities of a good interview that is presented at the beginning of the session.

All the five data collectors conducted pilot interviews. Each of them interviewed five people, residents of a mix of urban and semi-urban kebeles, in the neighbouring community to the study district. The tools pertaining both to household level and individual participants were piloted. The data collectors checked wording of each question and whether it is consistent with the local dialect. Consistency and logical flow of the questions from the first through the last section was checked. Option choices under each variable was also checked for clarity, logical ordering, and comprehensiveness. Simultaneously, the interview process and convenience of the data collection procedures were assessed to plan the field work for the actual data collection.

Up on their return from the half-day field visit, we discussed their field experience and gathered feedback on the questionnaire and the interview process. All data collectors took turns and gave their feedback on the tools (household and individual participant level questionnaires). I documented their input under the topics: language clarity of variables, consistency of the questions, logical flow of variables and sections of the questionnaires and interview procedures.

I subsequently improved the tools based on the feedback. The input was mainly vital to improve wording of some of the variables, to capture the local dialect in the translation, and reorder sections of the questionnaire to maintain logical flow of questions. Using any adult member of the household, instead of household heads only, as an informant to collect household level data was a change made on the interview procedure following the pilot.

After finalizing the improvements to the tool, the latest tool was shared with the data collectors and checked if the improvements captured the desired modifications.

3.2.12. Data collection tool

Data was collected using an interview questionnaire that was originally prepared in English and later translated to the local Amharic language. The questionnaire contained ten sub-sections organized under two major sections. The first section dealt with household level characteristics and the second was about individual participant level variables.

Sub-section one contained sociodemographic characteristics, household asset ownership and housing condition related variables.

Sub-section two was designed to capture scabies manifestations in individual participants. Variables which were aimed to identify the potential source of the infestation and modes of transmission were grouped under sub-sections three and four. Sub-section five contained items from the Delphi consensus criteria which was completed both through interview and using physical examination. This sub-section summarised the data obtained from patient report and data collector's inspection of the participant's skin. Sub-section six contained variables which pertain to scabies cases and describes health service utilization by participants including the drivers and barriers of health service utilization.

The DLQI tool was used to determine the impact of scabies infestation on the life quality of scabies patients. Variables from this tool constituted sub-section seven of the questionnaire. However, details of the variables comprising the DLQI tool and the findings from the dataset are covered in section 4.2.8.

Knowledge about scabies was included in sub-section eight and participants' perception of the infestation was in sub-section nine. Lastly, questions pertaining to the past MDA for onchocerciasis were organised under sub-section ten.

3.2.13. Data collection procedures and field activities

The data collection took place from December 05 to 23, 2018. Before commencing field work administrative heads of the district and the study *Kebeles* were informed about our field teams' presence in the area, and we sought support on facilitating collaborations with HEWs in the respective districts. *Gotes* and study households were identified with the help of HEWs and local village guides. Their support was also instrumental in delineating boundaries of the study *Gotes* and identifying the study households after being selected from the sampling frame.

Household level data was collected from household heads. At times when household heads were not available, adult members of the household were interviewed. Once household level data was collected, available members of the same households were individually interviewed. For children aged younger than 15 years parents or guardians were interviewed on their behalf.

Households and individuals were reported unavailable if no one was at home during two successive visits in two consecutive days.

3.2.14. Data quality control

Sociodemographic characteristics were measured using standard variables adopted from the Ethiopian Demographic and Health Survey (EDHS) (212). However, the section which contained variables related to clinical presentations of scabies were not validated. To decrease the risk of bias, content and face validity was conducted by three people, who were members of the team and had years of experience in research surrounding NTDs. Subsequently, the translated version of the questionnaire was reviewed by health care workers from the study area who were familiar with the local dialect. The revised tool was piloted in a locality close to the study area, and relevant feedback from the pilot was incorporated.

Aiming to minimise intra-observer variability in the first three days of the field work each data collector sent every other participant who was identified as a scabies patient to the dermatologist. At times when there were disagreements in diagnosis, the dermatologist discussed the case with the data collector. A short debrief session was held at the end of the first few days of the field work to assess challenges associated with the field work and enhance accuracy of the data collectors in identifying scabies cases.

During data collection, I closely monitored the process, staying in the field with the data collectors. In each kebele I re-visited ten percent of the study households and checked whether the reported household level characteristics were valid.

Field data cleaning was conducted in the evenings and incomplete questionnaires and questionnaires with inconsistent entries were discussed with data collectors for further clarification and correction.

3.2.15. Data processing and analysis

Data processing

A data entry template was prepared using *Epidata version 3.1.* (EpiData Association, Odense) statistical software, and all the fields were programmed to minimize error during data entry. The data type, and the range of values the field was supposed to accommodate were pre-determined, field skip patterns were also programmed mirroring the paper-based questionnaire.

After data entry was completed, it was exported to S*tata-14* (StataCorp LLC, Texas) statistical software for further data cleaning and analysis. The data cleaning identified incomplete, inconsistent, and outlying values. The electronic records were continuously compared with the values in the questionnaire and corrections were made whenever disparities were detected between the two records. This was done through descriptive analysis of household and individual participant level variables.

Scabies prevalence was estimated by dividing the number of cases to the total study population per 100 people with a 95% Confidence Interval (CI). Summary measures, frequency and percentages were calculated for categorical variables. Due to the skewed distribution of the data from most of the continuous variables, median values were used to summarise continuous data.

Principal component analysis

Socioeconomic status is among important predictors of health outcomes both at individual and household levels. Estimating the household income and expenditure is one approach to determining socioeconomic status. However, these indicators may not determine the true socioeconomic status of households for different reasons. Getting accurate data on income is difficult as people may have various sources, and the attempt to address all sources complicates the indicator. Getting income in kind instead of cash, and irregularities in the amount and the times when the household gets income are some of the difficulties associated with using the income indicator (221). Expenditure data is relatively reliable but covering an array of possible household expenditures is a complex process and is challenging to undertake in large scale studies (222).

To circumvent these challenges, large-scale population-based surveys are using Principal Component Analysis (PCA) instead. PCA determines the socioeconomic status and living standards of households based on data concerning ownership of durable assets, access to infrastructure, and the condition of residential structures (222). It is a dimension reduction technique where principal components are generated as a linear combination of asset variables. Multiple components are generated based on a given set of asset data.

Each component captures a different degree of variability among the households, and Eigen values determine the level of variability explained by the respective principal components. The higher the Eigen value the more variability among households explained by the component.

In our analysis employed twenty-six binary household asset variables. Fifteen pertained to durable assets, one variable related to ownership of cattle and the remaining ten were about access to infrastructure like water source and electricity. As part of the data cleaning, data pertaining to the selected asset variables were checked for completeness. Aiming to generate robust principal components missing data were replaced by “0” according to the data management recommendations in wealth index analysis (223). Since all variables were dichotomous, I did not need to standardize the data for the analysis.

Covariance matrix was used to check for correlation among the covariates, but no significant correlation was reported among the asset variables. Varimax rotation was used to generate 22 principal components. Of all the components the first one had the highest *Eigen value*. For this reason, it was taken as a wealth index to explain the difference in property ownership between the study households. Eventually, the score in the component were sorted in ascending order and subsequently grouped into quintiles ranking the households they are associated, accordingly.

Multi-level logistic regression models

The aim of the multivariable logistic regression analysis was to determine the independent association of predictor variables with scabies infestation. However, variables which determine the risk of scabies infestation may stem from a collective characteristic of the household or personal attributes of the individual household members.

The dataset was hierarchical at household and household member levels. Due to the high transmission of scabies infestation, which was the dependent variable, among household members it is likely that the observation among individuals from the same household is correlated.

The Intra-class Correlation Coefficient (ICC) was used to determine the cluster effect (correlation) on observations from the same group.

$$\rho_1 = \frac{\sigma_r^{\ 2}}{\sigma_r^{\ 2} + \sigma_v^{\ 2}} \qquad (224, 225)$$

Where: ρ_1 is the intraclass correlation coefficient of the source population.

- σ_r^2 is the variance of the observed value between clusters.
- σ_v^2 is the variance of the observed value among individuals within clusters.

ICC values range from 0 to 1, a value different from 0 indicates the presence of a cluster effect, and those close to 1 signify a strong correlation (226). In our data the ICC was 0.88 (95% CI 0.79–0.94), indicating a strong correlation among observations from members of the same study households.

Fitting single level regression models in the presence of a significant cluster effect is not advised as it affects the accuracy of the model outputs. Applying the conventional single level regression analysis to clustered data underestimates the standard error as it fails to account for potential cluster level similarities between individual observations, and masking the effect of individual level variabilities on the outcome of interest (225). Furthermore, cluster level attributes that can modify characteristics at the primary level are not considered in a single level regression analysis (227). For instance, in this study individual participants are nested within their respective households, and household level attributes can affect the individuals' risk of developing scabies. In addition, single level regression analysis is conducted assuming independence between observations, which is not true for my data. I fitted a ***multi-level logistic regression model*** to calculate the independent effect of individual and household level predictors on the odds of developing scabies. The first model (Model-1) captured the within group regression determining intercepts of the variables pertaining to individual study participants:

Logit (*Odds*) = $\beta_0 + \beta_1 AGE_i + \beta_2 SEX_i + \beta_3 MAR_i + \beta_4 EDU_i + \beta_5 OCC_i + \beta_6 CONT_i + \beta_7 BATH_i + \beta_8 MDA + e_i$

The second model (Model-2) included five household level variables to the first model.

Logit (*Odds*) = $\beta_0 + \beta_1 AGE_i + \beta_2 SEX_i + \beta_3 MAR_i + \beta_4 EDU_i + \beta_5 OCC_i + \beta_6 CONT_i + \beta_7 BATH_i + \beta_8 MDA + \gamma_1 DISH_h + \gamma_2 DISW_h + \gamma_3 DOMA_h + \gamma_4 WEAL_h + \gamma_5 HHSI_h + e_i + r_h$

Where: β_i (i=1, 2, . . . 7) were regression coefficients for individual level variables, γ_i (i=1, 2, 3, 4, 5) were regression coefficients of household level variables, and e_i and r_h were residuals of model 1 & 2, respectively.

We applied the ***melogit*** stata command to fit the models and calculate Adjusted Odds Ratio (AOR), with 95%CI to determine the strength and direction of association between the dependent and predictor variables.

In all the three models I checked for multicollinearity, which is a significant correlation among predictor variables. Such correlation undermines the measures of association between the predictor and dependent variables (228). Variance Inflation Factor (VIF) estimates were used to determine the presence of multicollinearity among the predictor variables. Though a VIF value exceeding 5 indicates a significant correlation, it is a cause for concern if it is greater than 10 (228). I used the *regress* and *vif* Stata commands to determine VIF value of all the variables included in the model. However, the VIF value for all variables was less than 5 and I did not need to make additional adjustments before fitting the model.

3.2.16. Ethical consideration

Addis Ababa University (AAU) Institutional Review Board (IRB) and the Brighton and Sussex Medical School (BSMS) Research Governance and Ethics Committee (RGEC) granted ethical clearance to the entire project. Before commencing data collection, permission was sought from local administrative heads.

Children and adolescents aged younger than 18 years participated in the study. Assent was requested and received from participants between 15 and 17 years of age, and their parents gave consent before they participated in the study. For those younger than 15 years, written informed consent were obtained from parents or guardians.

The data did not contain household or individual level identifiers. Household and study participant identifiers were recorded in a separate codebook.

Data collectors documented identifiers against codes given to the study households and the individual participants during data collection. The codebook was kept in a separate location from where the database was stored.

During interview and physical examination scabies and other skin diseases including cutaneous infestations, bacterial and fungal infections were identified. After the interviews those affected were issued with a referral slip to the nearby health center to ensure they received proper medical attention.

3.3. Results

A total of 1437 people living in 381 households participated in the study. This number of participants exceeded the calculated minimum sample size (n=1171). However, at the time of the survey, the total number of people living in the selected study households was 1833, and 396 members of the study households were missing because they were not available at the time of the survey.

The median age of participants was 19 and those aged ≥41 years made up only 20% of the participants. Most of the participants did not have formal education (59%) and only 7% of the participants had above secondary level education. Farming employed half of the participants. The national average household size is five, in this study half of the households were equal to or greater than the national average household size. However, the distribution of households across wealth quintiles was comparable (Table 3.1).

Table 3.1 Socioeconomic characteristics of the study sample (n=1437)

Variables	Categories	Overall (n=1437)	Scabies diagnosis	
			No scabies (n=1245)	Clinical scabies (n=192)
Sex	Male	640 (44.5)	539 (43.3)	101 (52.6)
	Female	797 (55.5)	706 (56.7)	91 (47.4)
Age in years	≤10	365 (25.4)	316 (25.4)	49 (25.5)
	11 – 18	346 (24.1)	287 (23.1)	59 (30.7)
	19 – 40	435 (30.3)	387 (31.1)	48 (25.0)
	≥41[π]	291 (20.3)	255 (20.5)	36 (18.8)
	Median age IQR (Q1-Q3)	19 (10-37)	20 (10-38)	16 (10-30)
Level of education (n=1422)	No formal education*	849 (59.7)	745 (60.6)	104 (54.2)
	Primary education	474 (33.3)	401 (32.6)	73 (38.0)
	Secondary and higher	99 (7.0)	84 (6.8)	15 (7.8)
Occupation (n=1412)	Farmer	737 (52.2)	650 (53.3)	87 (45.3)
	Student	675 (47.8)	570 (46.7)	105 (54.7)
Marital tatus	Not married	228 (15.9)	204 (16.4)	24 (12.5)
	Married	558 (38.8)	487 (39.1)	71 (37.0)
	Young to be married[#]	651 (45.3)	554 (44.5)	97 (50.5)
Household size	< 5 people	707 (49.2)	637 (51.2)	70 (36.5)
	≥5 people	730 (50.8)	608 (48.8)	122 (63.5)

Variables	Categories	Overall (n=1437)	Scabies diagnosis	
			No scabies (n=1245)	Clinical scabies (n=192)
Contact history with scabies symptomatic person	No	947 (65.9)	939 (75.4)	8 (4.2)
	Yes	490 (34.1)	306 (24.6)	184 (95.8)
Participated in the last MDA	No	338 (23.5)	274 (22.0)	64 (33.3)
	Yes	1099 (76.5)	971 (78.0)	128 (66.7)
Domestic animals kept in the homestead	No	202 (14.1)	171 (13.7)	31 (16.2)
	Yes	1235 (85.9)	1,074 (86.3)	161 (83.9)
Household wealth	Lowest	291 (20.3)	266 (21.4)	25 (13.0)
	Second	277 (19.3)	240 (19.3)	37 (19.3)
	Middle	293 (20.4)	255 (20.5)	38 (19.8)
	Fourth	293 (20.4)	261 (20.9)	32 (16.7)
	Highest	283 (19.7)	223 (17.9)	60 (31.3)

[π] In Ethiopia people older than 40 years of age comprise only 16 percent of the total population.

*This category comprises children younger than school age.

[#] Participants younger than 16 years of age.

The prevalence of scabies among the sample population was estimated at 13.6%, 95%CI (11.8, 15.5), and there was a significant difference in prevalence between the six study kebeles of Ayu Guagusa district. However, as the sample size was calculated aiming to generate district level prevalence estimates, the kebele level estimates may not be as precise. The prevalence estimate for Chibachibasa was at 8.3%, 95%CI (5.6%, 10.0%), Arbit 12.1%, 95%CI (6.9%, 17.3%), Dekuna Dereb 9.2%, 95%CI (4.4%, 13.9%), Degera 16.2 %, 95%CI (12.0%, 20.4%), Ambera 16.6%, 95%CI (12.4%, 20.7%), and Enavara 21.8%, 95%CI (14.3%, 29.4%) (Figure 3.3).

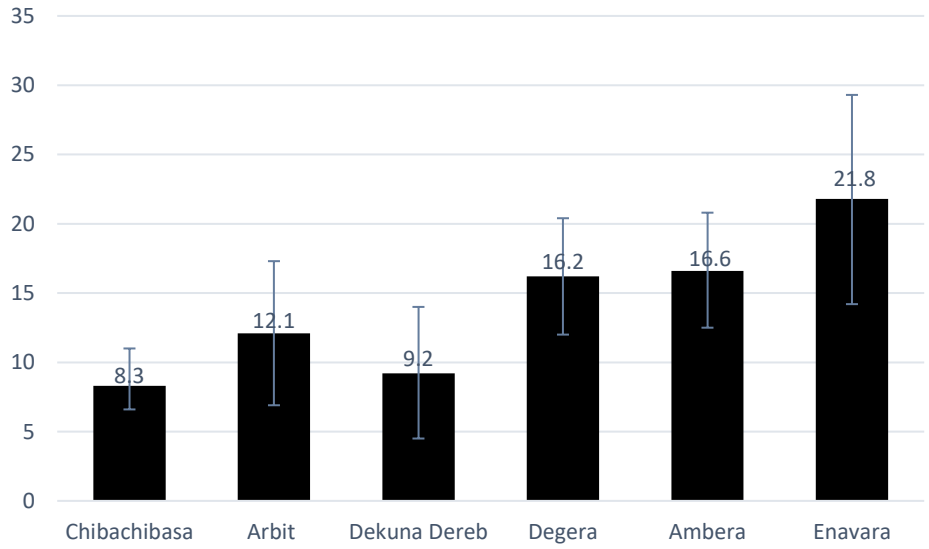

Figure 3.3. Prevalence of scabies by study *Kebeles*

Scabies prevalence was calculated for men and women and different age groups. Though it was not statistically significant, scabies prevalence was slightly higher among males 15.8%, 95%CI (12.9, 18.6) than women. The highest prevalence was reported among people in the age range of 11 to 18 years 17.1%, 95%CI (13.1, 21.0) and the lowest was reported among middle aged people (between 31 and 40 years) 6.7%, 95%CI (2.9, 10.6). Unlike most studies the prevalence among older people aged greater than 41 years was high 12.4%, 95%CI (8.6, 16.2) (Table 3.2).

Table 3.2 Scabies prevalence by socio-demographic characteristics (n=1437)

Variables	**Sample**	**Participants with scabies**	**Scabies prevalence**	
			%	**95%CI**
Sex				
Male	640	101	15.8	12.9 – 18.6
Female	797	91	11.4	9.2 – 13.6
Age				
< 10 yrs	365	49	13.4	9.9 – 16.9
11 to 18 yrs	346	59	17.1	13.1 – 21.0
19 to 30 yrs	272	37	13.6	9.5 – 17.7
31 to 40 yrs	163	11	6.7	2.9 – 10.6
>41 yrs	291	36	12.4	8.6 – 16.2

Vesicles were the most frequently reported (67.7%) clinical signs among the clinically diagnosed scabies cases. The trunk and head were the most (62.0%) and least (3.6%) frequently involved parts of the body. Nearly all the participants (95.8%) reported itch and a considerable number reported contact history with presumptive scabies cases (Table 3.3).

Table 3.3 Scabies manifestations among clinically diagnosed cases (n=192)

Variable	Categories	n (%) *
Skin lesions	Vesicle	130 (67.7)
	Scratch marks	117 (60.9)
	Papules	99 (51.6)
	Skin crust	78 (40.6)
	Pustule	52 (27.1)
	Burrows	8 (4.2)
Skin rash distribution on the body	Trunk	119 (62.0)
	Elbow	99 (51.6)
	Finger webs	98 (51.0)
	Wrist	81 (42.2)
	Knee	38 (19.8)
	Neck	25 (13.0)
	Ankle	12 (6.3)
	Head	7 (3.6)
History features	Itch	184 (95.8)
	Contact history with a presumed scabies patient	490 (34.1)
Relationship of the participant with participant presumed source of infestation (n=165) #	Household members	146 (76.0)
	Neighbour**	20 (10.4)
	Friend	15 (7.8)

*Total scores exceeded 100% as one participant could select more than one response category.

#This was calculated only from those who admitted having contact with a person exhibiting manifestations of scabies.

**Neighbour is the household right next to the study household

Most study participants (75.5%) used surface water for any purpose. The median time for a round trip from the household to the most frequently used water source was 20 minutes. Most of the participants (54.9%) reported bathing one to two times per week (Table 3.4).

Table 3.4 Hygiene practices of study participants and access to water source (n=1437)

Variables	Categories	Overall (n=1437)	Scabies diagnosis	
			No scabies (n=1245)	Clinical scabies (n=192)
Main source of water for any purpose	Public tap	181 (12.6)	139 (11.3)	42 (21.9)
	Dug well	405 (28.2)	355 (28.5)	50 (26.0)
	Spring water	850 (59.2)	746 (59.9)	104 (54.2)
	Surface water	1014 (70.6)	869 (69.8)	145 (75.5)
Frequency of bathing per week	<1 time	382 (26.6)	326 (26.2)	56 (29.2)
	1-2 times	789 (54.9)	688 (55.3)	101 (52.6)
	≥3 times	266 (18.5)	231 (18.6)	35 (18.2)
Frequency of washing clothing per week	<1 time	199 (13.9)	174 (13.9)	25 (13.0)
	1-2 times	1116 (77.7)	967 (77.7)	149 (77.6)
	≥3 times	122 (8.5)	104 (8.4)	18 (9.4)
Time for a round trip to a water source	< 5 minutes	393 (27.4)	354 (28.4)	39 (20.3)
	6-30 minutes	814 (56.7)	689 (55.3)	125 (65.1)
	>30 minutes	230 (16.0)	202 (16.2)	28 (14.6)
	Median time IQR(Q1-Q3)	20 (5-30)	20 (5-30)	20 (10-30)

The multi-level data showed strong cluster effect with Intracluster Correlation Coefficient (ICC=0.88,95%CI 0.79-0.94). In model-1 there was one variable that showed a statistically significant association with scabies: sex, where females had low odds of scabies (AOR= 0.5, 95%CI 0.3 – 0.9). Model-2 (the final model) adjusted for household level characteristics (i.e., household size, household wealth, and keeping domestic animals in the homestead). In this model, female sex decreased odds of developing scabies (AOR=0.5, 95%CI 0.3 – 0.9), and living in households of size greater than or equal to five increased odds of scabies (AOR= 3.8, 95%CI 1.2 – 11.5) (Table 3.5).

Table 3.5 Multilevel logistic regression analysis result of the determinants of scabies infestation

Variable	aOR	95%CI
Sex		
Male (ref)		
Female	0.5	0.3 – 0.9
Age	1.1	1.0 – 1.2
Occupation		
Farmer (ref)		
Student	1.0	0.4 – 2.6
Level of education		
No formal education (ref)		
Primary education	1.2	0.6 – 2.3
Secondary and higher	2.4	0.8 – 7.4
Marital status		
Not married (ref)		
Married	0.7	0.2 – 2.2
Young to be married	1.0	0.2 – 4.5
Frequency of bathing per week		
< Once (ref)		
1-2 times	0.7	0.2 – 2.2
>3 times	1.0	0.2 – 4.5
Took ivermectin tablets during the last MDA		
No (ref)		
Yes	0.5	0.2 – 1.1

Variable	aOR	95%CI
Household size		
< 5 people (ref)		
≥ 5 people	3.8	1.2 – 11.5
Domestic animals kept in the homestead		
No (ref)		
Yes	0.8	0.2 – 3.4
Household wealth		
Lowest (ref)		
Second	0.5	0.1 – 2.6
Middle	0.8	0.1 – 3.9
Fourth	0.9	0.2 – 4.3
Highest	3.7	0.8 – 16.7
Intra-cluster correlation coefficient (ICC, 95%CI)	0.89	0.79 – 0.95

AOR - Adjusted odds ratio

3.4. Discussion

The prevalence of scabies in northern Ethiopia was estimated at 13.6%, 95%CI (11.8%, 15.5%). However, there was considerable difference in prevalence between the study kebeles ranging between 8.3%,95%CI (5.6%, 10.0%) in Chibachibasa, and 21.8%, 95%CI (14.3%, 29.4%) in Enavara. Vesicles, excoriations, and papules were the most observed scabietic lesions. The lesions often involved the lower trunk followed by the elbow area, finger webs and wrists. The multilevel logistic regression models adjusted for individual and household level confounding variables to identify important predictors of scabies infestation. In model one of the multivariable analyses, the odds of scabies was lower for females. When I adjusted for household level characteristics in the final model (model-II) female sex and living in households of size greater than or equal to five were associated with scabies where the former decreased and the latter increased the odds of scabies.

In this study, scabies prevalence in Ayu Guagusa district was estimated at 13.6%, 95%CI (11.8, 15.5). This finding was half that of the estimate in the survey conducted in the wake of the outbreak in 2015 (13). The latest community-based studies that estimated scabies prevalence in northern Ethiopia were conducted in 2017 and 2018 with estimates of 21% and 9.7% scabies prevalence, respectively (15, 17). Including our finding the estimates in all four studies indicated high scabies prevalence in northern Ethiopia. Considering all the studies were conducted after the outbreak and in the same region this high prevalence may not accurately reflect the disease burden in the remaining parts of the country. This being the case, regardless of the high scabies prevalence in all these studies, there is a considerable difference in the estimates ranging between 9.7% and 33.5% (13, 17). The highest estimate was from the study that was conducted in 2015, when the outbreak was first identified, presumably indicating the height of the epidemic. The prevalence estimate for Agew Awi zone (where our study district is located) in the study by Embiale *et al*., was 0.5% (17). This is a significant difference in prevalence estimates. The difference in the scale of our study and the reference study including the time when the two studies were conducted can partly explain the wide difference in the scabies prevalence estimates for the zone. This study involved only one district out of the 11 districts found in Agew Awi zone and I could not confirm whether my study district (Ayu Guagusa) was part of the sample in the reference study.

In addition, the study by Embiale et.al. was conducted after MDA that involved most part of the Amhara region but not our study district. At the time Ayu Guagusa district was excluded from the MDA for low prevalence of scabies. The MDA that presumably involved much of the remaining districts in the zone could have reduced the prevalence estimates at the zonal level while the disease pattern in our study district remains unaffected.

The overall scabies prevalence estimates for Ayu Guagusa district was high and met the WHO criteria to initiate community-based intervention. However, there is a significant difference in the kebele level prevalence estimates. Degera, Ambera, and Enavara had the highest prevalence estimates and Chibachibasa had the lowest. This stark variability can be explained by the difference in health service access and remoteness of the kebeles. Of all the kebeles, Enavara was the remotest with the least geographic access to the available health centers in the district. The remoteness did not only affect utilization of standard care but also undermined MDA coverage. Furthermore, the districts with high prevalence estimates are closer to the border that adjoins the Amhara regional state with the neighbouring Benishangul Gumuz region. Due to their location, the remote kebeles faced sporadic ethnic conflict between the neighbouring communities of the two regions. This had its negative impact on the availability and success of clinical services for scabies patients, including effective implementation of onchocerciasis MDA. Social instability and political conflict are among the anticipated challenges of NTD control in general (27), but it has a unique importance in scabies control. Unlike other NTDs, scabies is highly contagious and any untreated foci or interruptions in control measures, has the potential to start an outbreak in a short time (88). In scabies control intervention areas this could mean reversing the gains obtained from years of effort (88, 150, 229). Therefore, optimizing coverage of MDAs and promoting access to standard care by all members of a population, including people in conflict areas, is essential to ensure lasting scabies control.

Types of skin lesions and the acral distribution was typical of scabies infestation where papules, vesicles, excoriations were frequently observed but burrows (3). Though these skin manifestations are descriptive, the primary lesions of scabies are dry lesions. The reported high proportion of vesicles, pustules and skin crusts can be suggestive a chronic infestation and secondary lesions due to bacterial infections (146).

In resource-poor communities in the tropics the prevalence of skin infestations parallel related skin infections (66, 83). Even though I did not investigate the prevalence of impetigo and related bacterial infections among scabies patients, the high proportion of wet lesions suggest the prevalence of bacterial skin infections in the community can also be high and future research work in the region should consider measuring the burden of bacterial skin infections.

Scabies lesions were evenly distributed in the hands, the finger webs, the wrist, the arm, and the trunk with a lower involvement of the legs. This distribution is typical of classical scabies among adults (9, 35). Though it was observed among few patients, the neck and head were also involved. These body parts were not commonly involved in adults; however, it is not uncommon to see the lesion involving head, neck, palms, and soles in infants (3, 230). However, even though scabies lesions also involve breasts, genital area and buttocks (35) these body parts were not examined during the data collection since the examinations were conducted in the houses of the respective households and we believed participants may not be comfortable to have their private parts examined in such settings.

Scabies is a skin infestation that affects all groups of population (83). However, there are important sociodemographic characteristics that increase odds of the infestation. Age is one of the important predictors of scabies infestation. So far, the relationship between age and the risk of scabies infestation is inconclusive. However, most studies from high scabies burden settings reported increased risk of infestation among younger population groups (7) contrary to low scabies burden settings that either show no significant difference among the different age groups or a higher prevalence among adolescents and the elderly (55, 115). I calculated the proportion of scabies cases in different age categories to determine which age group contributed the most to the increased odds of developing the infestation. The disaggregated data indicated that more than half of the scabies patients were younger than 18 years. This finding is consistent with a report from a meta-analysis on publications from Ethiopia where the pooled prevalence estimate among participants aged $\leq$ 15 years is significantly higher than their counterparts (194). Considering that physical contact is the mainstay of scabies transmission, the increased odds of scabies infestation among children is attributed to their frequent physical contact with their peers.

The school environment also creates conducive circumstances for transmission among in-school adolescents, as classrooms in most public schools are crowded with high number of students often exceeding the average classroom size. On the opposing extreme to adolescents and young children the prevalence estimates of scabies for people aged >41 years was high. This finding may not be striking for studies in high income and low scabies burden settings where scabies distribution among the elderly could show an increase (7, 115). However, the typical distribution in high burden settings is skewed to children and adolescents (9, 129, 146). This finding could be explained by the role of older people in rural families which is taking care of the young children in the family. This might have predisposed them to the infestation as children are core transmitters in high scabies burden settings (146). Though the impact of the immune response on the risk of acquiring scabies is still unclear and the role of heard immunity for the cyclic pattern of scabies outbreaks has not been ruled out (31, 95). However, the increase in the odds of acquiring scabies alongside the increase in age of the participants challenges the heard immunity hypothesis as older people are likely to be exposed to the infestation at some point in their lifetime particularly in high scabies burden settings (83).

The disaggregated scabies prevalence estimates by age of participants indicated a high prevalence among adolescents. The expanding social circle of adolescents and growing intimacy with their peers enhances the chances of physical contact. During adolescence, social connectivity increases, the games played become more physical, sleepovers at friends' houses are common and many have their first sexual encounter (231, 232). Intimate physical contact during sexual intercourse creates an environment for effective scabies transmission. For this reason, scabies is also regarded as a sexually transmitted infection (233). In Ethiopia, the median age of first sexual encounter is 16 years (212), and among in-school adolescents as high as 24% reported sexual debut (234-236), and a considerable proportion of sexually active in-school adolescents reported a history of multiple sexual partners (236). This local data indicates sex is a possible contributor for the increase in prevalence of scabies among adolescents, though in this study people were not explicitly asked about their sexual life.

Household size was the only household level variable that significantly increased the participants' odds of developing scabies infestation.

People living in households of five people and more had a significantly high odds of developing the infestation than their counterparts. Physical contact is the most important mode of scabies transmission and circumstances that favour prolonged physical contact increases the risk of transmission (28). This finding is consistent with similar studies that considered the contribution of household size to the risk of scabies infestation (9, 19, 20, 86, 188) in these references and in my study the number of people in study households is used to determine host density. However, a more accurate estimate of host density requires determining the size of the living space (in square meters) available per household member. In this study we did not measure the size of the living space, so it is not possible to determine host density in terms of the space available for household members. To overcome this limitation, I took the national average household size as a cut-off, and households above the average, 4.6 household members (rounded up to 5), were considered crowded. This cut-off also facilitated comparability of the findings with previous local studies that used a household size exceeding 5 or 6 people to approximate crowding (19, 20, 188). Regardless of the accuracy of using the number of people per household to determine host density, the mere household size can give us important information about the risk of infestation. In most Ethiopian communities, it is not uncommon for family members to share sleeping space, and bed sharing is a key determinant of scabies transmission (28, 232). Young children often sleep with their parents and older children share bed with their siblings or other members of the family. This could explain why bigger households have a high risk of transmission, regardless of the size of the dwelling unit.

After adjusting for household and individual level variables, in the final model, I observed that personal hygiene and access to a water source did not affect participants' odds of developing scabies. The effect of hygiene on the odds of scabies is unclear with multiple publications reporting the decreased odds of the infestation among people who had better hygienic practices (14, 20) and others reported hygiene had no impact on scabies (146, 194). The principal mechanisms how personal hygiene reduces the risk of contracting infections or infestations is by killing pathogens or removing it from the body. However, scabies mite is not susceptible to the effects of regular soap and water (146). Removing the agent through the mechanical effects of water and soap is also unlikely as it only takes the mite 30 minutes to 1 hour to submerge under the superficial layer of the skin (33, 146).

These factors prohibit bathing from impacting individuals' risk of acquiring scabies. However, personal hygiene decreases the risk of bacterial infections of the skin associated with scabies infestation (115). As impetigo causes prominent skin lesions, scabies patients with secondary bacterial infection might have higher chance of getting identified, than cases of uncomplicated scabies. Considering the significant proportion of impetigo among scabies patients ranging between 20% and 41% (9, 115) and the low diagnostic accuracy of the clinical approach, the spurious relationship between hygiene and scabies could be partly explained by the averted bacterial infections among scabies patients (83, 237, 238).

This study is not without limitations. The main limitations emanate from the study design and the approach I followed to identify scabies cases. A clinical approach was the most common approach used to diagnose scabies, both in clinical and field settings. However, this approach is based on scabies manifestations, which are not apparent in the preclinical stages of the disease, and the results of this study should be viewed in the light of the probable misclassification of preclinical cases. Possible intra-observer variability among the data collectors and their clinical acumen was the other limitation. To minimise its effect, on the study findings a three-day refresher training, which was aimed to optimize scabies diagnosis, was given for the five health care workers who participated in identifying scabies cases, and experience of the health workers in caring for scabies patients was considered when they were recruited as data collectors. Nonetheless, I cannot completely avoid intra observer variabilities that could have impacted the diagnosis, however, since clinical approach is the most commonly used approach in surveys on scabies (32, 89) and our findings are comparable to prevalence reports of similar studies in the region (17, 184). For this reason, supposedly using this approach may not have a significant impact on the validity of the study outcome.

3.5. Conclusions and recommendations

3.5.1. Key findings

Scabies prevalence in Ayu Guagusa district was high. The disaggregated *kebele* level prevalence estimates were different, but this difference was not statistically significant. Similarly, the prevalence estimates were disaggregated by age and sex. However, the difference in prevalence between people in different age groups and among male and female participants was not significant.

Types of lesions and its distribution observed on clinical scabies patients including history features were typical of scabies. Nearly all cases reported that they had generalized itch and upon physical examination vesicles, papules, and excoriations were the most frequently observed lesions mainly involving the trunk, the elbows, the finger webs, and the wrists.

Household members are important sources of scabies infestation, and most participants reported that they believe the infestation passed to them from other members of their household.

To determine factors independently associated with scabies a multilevel model was fitted. From the model female sex and high host density were associated with low and high odds of scabies infestation.

3.5.2. Policy recommendations

The thirteen percent scabies prevalence in Ayu Guagusa district is high and it requires an immediate MDA involving all community members. The MDA should be in line with the recommendations of the WHO informal consultation on the control of scabies in communities where scabies prevalence reaches 10% and more (144). Because of the ease of administration and the high effectiveness of the drug, ivermectin-based MDA is recommended, and permethrin cream should cover people to whom ivermectin is contraindicated. This intervention should continue until the community-basedprevalence of scabies decreases below 2% (144).

Side by side undertaking the MDA, standard care should be strengthened by promoting access to scabies care. Currently the closest health facilities to the community that are mandated to provide scabies care are health centers.

However, from our field observation and discussions with health workers there is recurrent stockout of scabicides and effective drugs such as ivermectin and permethrin are only provided through the public health care facilities. This limits access to the drugs since those who afford to buy from private drug vendors cannot do so because of this policy. From these two drugs only ivermectin is included in the essential drug list for health centers for the treatment of lymphatic filariasis. This is partly affecting drug availability even in public health care facilities, and future revisions to the essential drug list should consider the change in the epidemiology of scabies and the need for constant supply of scabicides to health centers.

Access to scabies care can be further promoted by providing the service at the level of health posts. Though HEWs, who staff health posts, were trained to provide health promotion related services, in the past few years they have participated in providing curative care for diseases of high public health importance and that has a validated diagnostic algorithms and drugs of wide safety margins. Given the current epidemiology, high prevalence, and the involvement of remote communities, in Ethiopia effective control requires improving access to scabies care. For this reason, availing drugs in primary health care facilities, validating diagnostic algorithms and training HEWs in providing care for scabies patients will help promote access to care and subsequently reduce the prevalence.

3.5.3. Future research

This study was conducted in an area where there was an ongoing ivermectin-based MDA to control onchocerciasis. It is likely that the MDA had suppressed scabies transmission and the estimated scabies prevalence may not be typical of communities living outside of the study district where there was no intervention. Future research should cover wider geographic area and generate regional and national prevalence estimates with the respective geospatial disease distribution. This way data representative of all communities and various contexts can be generated. Such data is also vital to tailor control interventions and monitor its impact on the disease burden and distribution.

In this study the effect of household level host density on the odds of developing scabies was modelled. Host density was estimated by taking the number of household members as a proxy indicator of density.

However, a more accurate representation of host density requires determining the living space available for household members per capita. Future research should measure the total living space of the household and approximate how much space is available for each household member. This way we can better quantify crowding by adjusting for variabilities in the size of the housing unit.

The other missed opportunity in this study and can be included in future research is measuring the degree of severity of the infestation and looking for the presence of common scabies related complications. At first, I tried to measure severity by using the number of lesions as indicators of disease severity. However, after starting the field work using this approach was difficult as we did not examine private body parts and the lesions in those parts of the body could not be accounted for. Impetigo is one of the commonest complications associated with scabies and quantifying it helps to determine the comprehensive skin health needs of the affected community and gives us a clearer understanding of the level of impact of scabies on health and wellbeing of the affected community (239). Such complications are also markers of the subsequent development of a more severe sequelae such as rheumatic fever and post streptococcal glomerulonephritis (67, 240).

3.5.4. Doctoral candidate development

This was the first survey I led which involved clinical examination of participants by clinicians in a field setting. Recruiting health care workers who were experienced in giving care for scabies patients, who were willing to work in field settings for weeks and who could get permission from their employers for the period of the field work was a challenge. The existing good relationship between my home university and the zonal health office administrators when collaborating in former and ongoing projects was helpful to get the type of health workers I wanted for the project. Furthermore, I engaged the leadership from regional health office to the district level long before the field work was planned. As an extension of the stakeholder engagement activity, I discussed the objectives of the study and the activities that would be carried out by the field team with local gate keepers as well. In addition, the dermatovenerologist who trained our field team appeared in an orientation session for HEWs who were preparing for the onchocerciasis MDA campaign and gave an hour-long seminar about scabies. The session and subsequent discussions helped us create a strong connection with front-line health workers of each kebele in the entire study district.

This facilitated the field activity for the team and eased getting support from gate keepers. From these exercises I learned the importance of engaging local health system actors and the community, early on, to facilitate research operations and improve the uptake of the research findings.

During data collection I closely supervised the process and provided assistance tailored to the needs of the individual members of the field team. My close involvement in the field work and the frequent one-on-one discussions with the field team helped me address new questions that arose when the filed team interviewed actual participants. Considering the high level of involvement required of us to support the field team at the start of the field work, it is important that in similar future research investigators consider the first few days of data collection critical to ensure data quality. By staying in the field, during the data collection, I also had the opportunity to experience the lifestyle and living condition of the study community, first-hand. I also had side discussions with members of the community and front-line health workers of the respective *kebeles*. The anecdotal information obtained from the discussions were vital for me to understand the sociocultural context and helped me to interpret the study findings. Furthermore, I have identified research grey areas that invite follow up qualitative studies in relation to operations of the health system in relation to scabies care and the community's knowledge and perception of scabies.

The main challenge I faced in this study was the prolonged time it took to finalize data management. The data was collected using paper-based survey questionnaire and I had to develop electronic data entry template to enter data. Due to the large number of items per questionnaire and the high number of participants, the data entry took a long time. For the same reason, the data cleaning was also a challenge. Learning from my experience in this baseline survey I employed electronic data collection for the subsequent survey rounds. This way I managed to reduce the workload related with data collection and data cleaning. Details of the process of developing the electronic forms and the data collection process is described in chapter five.

Chapter Four

Impact of scabies on life quality of patients; and community's knowledge, and perception of scabies

Chapter 4 : Impact of scabies on life quality of patients; and community's knowledge, and perception of scabies

4.1. Introduction

The inconsistent interpretation of life quality in varying disciplines has challenged developing a standard definition. The World Health Organization defines quality of life as "An individual's perception of their position in life in the context of the culture and the value systems in which they live and in relation to their goals, expectations, standards and concerns" (69). However, empirical definitions of Quality of Life (QOL) in health sciences further modify this definition in a way that accounts for the impact of diseases and treatment on health outcomes including physical, mental and emotional wellbeing (241). Measuring QOL has gained popularity in biomedical fields in the past few decades (242). The increase in prevalence of chronic diseases where clinical interventions have managed to prolong life, without effecting cure, has increased the need to consider life quality as one of the treatment outcomes (243). To this end, QOL scores are used to assess the effectiveness and prospects of favourable outcome of therapeutic interventions (243).

Most dermatologic diseases may not pose an imminent threat to the lives of patients, however, they disfigure the body (244). The alterations to the skin are accompanied by symptoms such as irritation, pain, soreness, and itch. These symptoms take physical and affective toll on patients, undermining their life quality (245). Factors such as size of the lesion, body parts affected by the lesion, and the community's knowledge and perception of the disease determines the severity of its impact on the life quality of patients. Given the need to measure dermatologic life quality both as a treatment outcome or predictor of disease sequelae, standard measurement tools have been developed in the past few decades (245).

In this study I used the DLQI tool to measure the impact of scabies on life quality of patients. The DLQI tool was developed in 1994 building on previous disease specific disability measures (245). This tool is applicable to clinical and field settings and to multiple skin diseases, facilitating comparison between different skin conditions and their impact on life quality (72).

Scabies, a skin infestation characterized by a range of skin lesions, from papular lesions of different sizes to major skin crusts and a constant generalized itch, undermines the quality of life of patients (6, 79). However, despite the high prevalence and the nearly global distribution of scabies, there are only a few studies that have investigated its impact on life quality of patients (6). The level of impact of skin diseases on the life quality of patients depends on multiple factors including community perception of the disease. Stigma, self-isolation, and related impacts on mental health are results of inadequate understanding of the community about the disease (80). Therefore, local data in different cultures is mandatory to address the context-specific impact of scabies on life quality of patients. However, to the best of my knowledge, globally there are only a few studies on the impact of scabies on life quality of patients (6, 79) and in Ethiopia, there has been no study on the topic. Community perception and knowledge about scabies are the other areas that received no attention so far in any of the previous studies on scabies. In this study I measured the impact of scabies on life quality of patients, assessed knowledge and community's perception of scabies and determined health seeking for scabies. This data is vital to develop a holistic and context-oriented care package for scabies patients and provides a baseline for future studies that aim to evaluate the impact of individual scabies treatment and MDAs on improving life quality.

Research questions

- What is the impact of scabies on life quality of adult scabies cases in Amhara region, northern Ethiopia?
- What is the knowledge and perception of the study community towards scabies in Amhara region, northern Ethiopia?

4.2. Methods

4.2.1 Study area

The study was conducted in Ayu Guagusa district, Agew Awi zone, northern Ethiopia. This study is part of the wider project and details of the study area are indicated in sections 3.2.2 and 3.2.3.

4.2.2 Source population

Ayu Guagusa district is among the newly formed districts after the last national census which took place in 2007 (205). For this reason, data characterizing the district population is available only from documents used for routine administrative purposes in the administrative offices of the district. The estimated total population is 136,510 and children under 5 years of age, who are prone to scabies, constitute 14% of the total population.

4.2.3 Study population

All consenting members of the selected study households aged $\geq$ 18 years were involved in the study. This chapter only involved adult study participants as it dealt with their personal experience and their understanding of the community's perception of the disease. Participants who were diagnosed with scabies in the baseline survey were asked the life quality-related questions, while the 'knowledge about scabies' section included all adult study participants regardless of their diagnosis. However, since the 'perception towards scabies' questions included peoples' personal views towards scabies patients, I only included scabies-free adult study participants in this part of the study.

4.2.4 Data collection

Dermatologic life quality data

The Likert scale constituting the Cardiff DLQI too to collect life quality data was relatively more difficult to administer than the remaining sections of the interview questionnaire (72). The challenge originated in the difficulty for some participants to rank their experience against the continuous scale where categories were too close to tell apart. I employed different techniques to create a better understanding of the scales and make it easier for participants to comprehend.

Data collectors thoroughly explained the scale and how their responses were ranked before starting to ask the questions. After questions were asked, longer time is given to participants to mentally process the question and rank their experience in accordance with the scale before responding to the question. This way I minimised the bias that could have been introduced due to the difficulty to rank their responses.

Knowledge, perception, and health seeking data

Unlike the items about life quality, knowledge and perception related variables had categorical responses for participants to choose from with no order applied to the responses. Participants were asked about their knowledge pertaining to the different aspects of scabies as indicated in the questions. Data collectors did not read out loud the list of possible responses, rather they probed participants so that they list out all the possible correct responses based on their knowledge and perception of scabies.

4.2.5 Sample size

In the baseline survey, sample size was calculated aiming to estimate 35% scabies prevalence (13) at 95% level of confidence (5% margin of error for prevalence estimates on either side of two tailed tests) and a community level correlation of 5% (218). With these parameters into consideration and after adding a 10% for non-response, the minimum sample size is 1326.

However, in this chapter the median value of the effect of scabies on life quality of patients was to be determined. For this reason, I tested adequacy of the estimated sample size of the prevalence survey for the life quality analysis. I employed the sample size calculation formula for continuous outcome variable in single group studies (246). The sample size was aimed to identify life quality mean score $\bar{x}$=10 and the different with the hypothesized mean score being 2, with a standard deviation σ=5.9 (6) and a 5% precision for two tailed tests. The minimum sample size (the number of scabies patients) needed for this analysis is 69.

4.2.6 Eligibility criteria

Eligibility criteria were applied at two levels, the household and individual participants. Households that didn’t have plans to move for at least the coming year, counting from the time when the baseline survey was conducted, were recruited.

This helped to assure availability of the household members for the planned three surveys over the study period. However, none of the households reported plans to change their place of residence in the coming year.

All consenting members of the selected study households aged older than 18 years were recruited to participate in the study. A household member was defined as a person who regularly lived with household members or people who had stayed with the family for the week prior to data collection.

Additional filter was applied to those who would participate in the life quality, knowledge, and perception studies. Only adults participated in all these three sections. Since the items related with community perception included hypothetical questions that apply to a person who is free of scabies, for this part of the study I involved adult study participants who were scabies free at the time of the study.

4.2.7 Sampling procedure

Agew Awi zone was purposively selected due to two main reasons. One, the wider project was aimed to assess the epidemiology of scabies and evaluate alternative control interventions in Amhara regional state, where Agew Awi zone is found. Two, CDT-Africa, under the College of Health Sciences, Addis Ababa University, had additional work packages on NTDs underway in the zone, and the already established work relationship with local authorities was believed to contribute to the effectiveness of the field operations. Similarly, the study district, Ayu Guagusa district, was also selected purposively from seven other districts of the zone. Ayu Guagusa was the only district where MDA for onchocerciasis elimination was underway. Considering the wider project aimed to evaluate the secondary impact of the MDA for onchocerciasis on scabies prevalence, selecting a district where MDA was carried out was mandatory. The district was comprised of 21 *kebeles*, and six of them (Dekuna Dereb, Arbit, Degera, Ambera, Enavara, and Chibachibasa) were randomly selected for this study. Each of the selected *kebele* was comprised of a varying number of *Gotes* and one *Gote* each was randomly selected from the study *kebele*. Subsequently, a census of all the households in the selected *Gote* was conducted and a sampling frame was prepared using the census data. From the frame 381 households were selected and all consenting adult members of the selected households participated in the study. Additional details of the sampling procedure are indicated in chapter 3 (Figure 3.2).

4.2.8 Variables

Dermatologic life quality variables

The standard DLQI tool was used to collect data on quality of life of scabies patients (72). The DLQI tool has been used to measure the effect of more than 36 skin conditions including scabies (72). Since its first development, the tool was used in more than 20 countries, including Ethiopia, and translated to 55 different languages (82, 247, 248).

The tool has a total of 10 items that pertain to different aspects of life quality impairment including the impact on physical wellbeing secondary to disease sequelae, and the psychosocial impact secondary to changes in life style and social functions (72). Each item has four ordinal response categories with their respective scores (i.e. Not at all=0, a little=1, a lot=2, and very much=3) (72). The highest cumulative score for a participant is 30 and remaining scores parallel the degree and number of impairments on life quality by the skin condition.

Knowledge, perception, and health seeking variables

The knowledge, perception and health seeking related variables were adapted from a standard survey tool in the WHO's guide to develop knowledge, attitude, and practice surveys for Tuberculosis (TB) (249). Since both TB and scabies are communicable diseases the knowledge and attitude domains and wording of the variables were coherent. This tool was pre-tested in Ethiopia before it was used in multiple small scale and nationwide TB surveys (250, 251). The process of adapting the tool started by reviewing the questionnaire and checking whether the variables included were able to answer my research question. The next step was language assessment and making changes to the wordings so that they pertain to scabies instead of TB. Then this tool was made part of the subsequent translation to the local language and piloting as part of the whole tool. All variables under this section were categorical with a mix of single and multi-select items. The only continuous variable used was under the health seeking for scabies sub-section and it measured distance of households to the nearest health care facility.

4.2.8 Data analysis

Dermatologic life quality data analysis

The ten items included in the Cardiff DLQI tool are supposed to capture six life quality domains (i.e., symptoms and feelings, daily activities, work and school, leisure, personal relationship, and treatment) and the level of impairment related to each one of them. Items 1 & 2 were grouped to indicate impact on symptoms and feelings; 3 & 4 on daily activities; 5 & 6 on leisure activities; item 7 on schooling and work; 8 & 9 on personal relationship & 10 treatment (72).

However, in our study I dropped items 6 (sport) and 10 (treatment) from the original list of questions for lack of relevance to our study community. Due to the physically demanding and around the clock daily chores, both domestic and in the field, engaging in sports is uncommon and regarded as superfluous by most communities in rural Ethiopia. A validation study of the DLQI tool in Ethiopia by Henok and Davey also found marginal contribution of this item to the overall life quality score (248). The last item (item-10) was also excluded as the question was relevant only to clinical settings where patients would record their experience with treatment being used against scabies. This study being a house-to-house survey, the question about treatment was not relatable to most of the participants since most wouldn't have sought care.

To measure reliability of the items in the translated version of the tool I used the scale reliability coefficient. The Cronbach's alpha value for the eight DLQI items was 0.93 and the average inter-item correlation score was 0.63. Both measures were higher than the commonly used cut-offs to determine reliability of items, which are 0.7 and 0.2, respectively (252).

It should be noted that in calculating the cumulative and individual life quality domains, excluding the two items from the standard tool has an effect. The highest cumulative score for a participant can only add up to "24", instead of "30" that I would get if all the ten items were applied. From the individual lifestyle domains, "leisure activity" and "treatment" were affected by the change. The treatment domain was fully omitted and the score of the leisure activities domain only contained the score for item "5", rather than for "5" and "6". This modification also affected the cumulative life quality impairment score of individual participants and the average scores of participants.

The mean DLQI score (mDLQI) for the eight items involved in the analysis and the score for separate domains were calculated with their respective standard deviations. The grand mean was calculated by dividing the total score by the number of participants, and the mean values of the life quality domains were similarly calculated by adding the scores of items under the respective categories and dividing the total score by the number of participants.

I tested whether the sociodemographic background of the participants or the duration of scabies symptoms were associated with life quality impairment. To this end, one way Analysis of Variance (ANOVA) was used in the analysis and the statistical significance of the difference in mDLQI scores of participants with different sociodemographic backgrounds was tested using the F-statistic (253). Only two of the eight independent variables involved in this analysis were continuous and the rest were categorical. The independent continuous variables (age and duration of the infestation) were recoded into discrete categories to meet one of the important assumptions of ANOVA, which is the independent variable should be a dummy variable.

The severity of impairment on life quality was determined based on the categories recommended by Hongbo *et.al.,* where the total score is sorted into five degree of severity categories: no effect (0-1), small effect (2-5), moderate effect (6-10), very large effect (11-20), and extremely large effect (21-30) (254). Scores from individual participants were added and the result was referenced to the degree of severity intervals.

Knowledge, perception, and health seeking data analysis

Participants' knowledge about scabies was measured using seven questions that pertained to their source of information about scabies, their knowledge about the manifestations of scabies, its mode of transmission, and the treatment for scabies. The proportion of participants who gave different answers to each question were separately calculated for those who had the infestation (n=70) and those who did not (n=431). The analysis on knowledge of participants about scabies involved adult study participants who heard about scabies at least once before. Participants who reported they heard about scabies at least one time before the survey were 501 and the analysis in this section involved these participants.

Perception of scabies was measured using five items. The number and proportion of responses to each response categories of the respective items were calculated. Since this sub-section only involved participants without scabies infestations, the analysis was conducted among scabies-free adult study participants.

Four questions were asked to measure access to health care services and health seeking for scabies suggestive symptoms. Three of the variables were single select categorical variables and only one was a continuous variable. Like in the preceding sections, frequency and percentage of the categorical variables were calculated. The median value and its interquartile range were calculated to determine distance of households from nearest health care facilities.

4.3. Results

The results of the study are organized into two sub-sections: the impact of scabies on life quality of patients, and the knowledge, perception and health seeing for scabies sub-sections. Tables 4.1, 4.2 and, 4.3 included data on sociodemographic characteristics of the study participants, the distribution of life quality related items and the results of ANOVA test that sought the association between background characteristics of participants and quality of life, respectively. Knowledge about scabies, community perception of the infestation and health seeking for scabies related data are included in the last three tables under this section. Graphs 4.1 and 4.2 described the impact of scabies on different life quality domains and the distribution of the degrees of severity among the study participants, respectively.

Study participants profile

This study, which investigated the impact of scabies on the life quality of scabies patients involved adults (aged $\geq$ 18 years) who were diagnosed with scabies in the baseline survey (n=91). The sex ratio of study participants was comparable, and the median age was 34 and most were between the ages 18 and 30 years. Nearly three quarters of the participants did not have formal education, and only 13.2% had secondary and above level of education. Most participants were married. Unmarried, divorced, and widowed participants were grouped under the category “single”, and it comprised only 21.9% of the participants. The main stay of occupation was farming (86.7%) and 4.4% of the participants were unemployed.

There was a comparable distribution of households across wealth quintiles with a slight increase in the number of households categorised under the highest wealth quintile (Table 4.1).

Table 4.1 Sociodemographic characteristics of adult study participants who were involved in dermatologic life quality index analysis (n=91)

Variables	Categories	n (%)
Sex	Female	47 (48.4)
	Male	44 (51.7)
Age	18 – 30	44 (48.4)
	31 – 40	11 (12.1)
	>41π	36 (39.6)
	Median age IQR (Q1-Q3)	33 (25-53)
Level of education	No formal education	66 (72.5)
	Primary education	13 (14.3)
	Secondary and above	12 (13.2)
Occupation	Farmer	78 (86.7)
	Student	8 (8.9)
	Unemployed	4 (4.4)
Marital status	Married	71 (78.0)
	Single	20 (21.9)
Household size	< 5 people	38 (41.8)
	≥5 people	53 (58.2)
Household wealth	Lowest	14 (15.4)
	Second	18 (19.8)
	Middle	15 (16.5)
	Fourth	15 (16.5)
	Highest	29 (31.9)

4.3.1 Impact of scabies on dermatologic life quality

Table 4.2. describes mean scores of the individual items and presents the number of participants who gave the respective responses. Of the 91 adult participants with scabies, 86 gave responses to the DLQI items and this was the denominator for the analysis in this section. Eight of the ten standard DLQI questions were used to measure the effect of scabies infestation on life quality of scabies patients who were identified during the house-to-house survey. The DLQI questions assessed the experience of participants in the past one week from the time of the data collection. The cumulative mean DLQI (mDLQI) score for the sample population was 7.2 (SD =7.6); and the mean values of the scores for individual questions ranged between 0.5 (SD=0.9) and 2.3 (SD=0.9). Questions about symptoms of scabies, embarrassment and self-consciousness, and interference of the symptoms with outdoor activities contributed the most to the overall score, whereas the effect of scabies on the sexual life of the participants contributed the least with a cumulative mean score of 0.5 (Table 4.2).

Table 4.2 Distribution of dermatologic life quality index items and their respective mean scores among adult clinical scabies cases (n=86)

Variable	Categories	Overall n (%)	Mean item score±SD
Over the last week, how itchy, sore, painful or stinging has your skin been (symptoms)	Very much	43 (50.0)	2.3±0.9
	A lot	31 (36.1)	
	A little	7 (8.1)	
	Not at all	5 (5.8)	
Over the last week, how embarrassed or self-conscious have you been because of your skin (feelings)	Very much	29 (33.7)	1.4 ±1.3
	A lot	13 (15.1)	
	A little	7 (8.1)	
	Not at all	37 (43.0)	
Over the last week, how much has your skin interfered with you going shopping or looking after your home or garden (work or study)	Very much	20 (23.3)	1.1±1.3
	A lot	14 (16.3)	
	A little	7 (8.1)	
	Not at all	45 (52.3)	
Over the last week, how much has your skin influenced the clothes you wear (clothes choice)	Very much	24 (27.9)	1.0 ±1.3
	A lot	7 (8.1)	
	A little	4 (4.6)	
	Not at all	51 (59.3)	
Over the last week, how much has your skin affected any social or leisure activities (daily activities)	Very much	13 (15.9)	0.8±1.1
	A lot	11 (13.4)	
	A little	12 (14.6)	
	Not at all	46 (56.1)	
Over the last week how much has your skin been a problem at work or studying (work or study)	Very much	20 (23.5)	0.9±1.3
	A lot	10 (11.8)	
	A little	3 (3.5)	
	Not at all	52 (61.2)	
Over the last week, how much has your skin created problems with your partner or any of your close friends or relatives (personal relationships)	Very much	15 (17.4)	0.9±1.1
	A lot	10 (11.6)	
	A little	13 (15.1)	
	Not at all	48 (55.8)	
Over the last week, how much has your skin caused any sexual difficulties (sexual difficulties)	Very much	7 (8.2)	0.5±0.9
	A lot	5 (5.9)	
	A little	8 (9.4)	
	Not at all	65 (76.5)	

Table 4.3 presents outputs from the ANOVA to explore whether there is a difference in mDLQI scores by different sociodemographic characteristics. No statistically significant differences in mDLQI scores were noted between participants with different sociodemographic characteristics or symptom durations.

Table 4.3 Demographic characteristics associated with DLQI scores (n=86)

Variables	Categories	n (%)	Mean ± SD	P-value
Sex	Female	47 (51.7)	9.2 ± 7.9	0.9
	Male	44 (48.4)	9.0 ± 7.8	
Age (years)	18 – 30	44 (48.4)	6.7 ± 7.0	0.4
	31 – 40	11 (12.1)	8.4 ± 7.7	
	>41	36 (39.6)	10.5 ± 7.9	
	Median age IQR (Q1-Q3)	35 (26-50)		
Level of education	No formal education	66 (72.5)	8.9 ± 7.8	0.9
	Primary education	13 (14.3)	9.9 ± 7.6	
	Secondary and above	12 (13.2)	9.6 ± 8.3	
Occupation	Farmer	83 (91.2)	9.1 ± 7.7	0.9
	Student	8 (8.8)	9.3 ± 8.9	
Marital status	Married	70 (81.4)	9.4 ± 8.0	0.5
	Single	16 (18.6)	7.9 ± 6.5	
Symptom duration	≤ 60 days	64 (70.3)	8.3 ± 7.7	0.1
	>60 days	27 (29.7)	11.0 ± 7.8	
Household size	< 5 people	38 (41.8)	8.5 ± 7.1	0.5
	≥5 people	53 (58.2)	9.6 ± 8.2	
Household wealth	Lowest	13 (15.1)	12.2 ± 8.0	0.6
	Second	18 (20.9)	7.4 ± 6.4	
	Middle	13 (15.1)	9.2 ± 7.4	
	Fourth	14 (16.3)	8.9 ± 8.7	
	Highest	28 (32.6)	8.8 ± 8.2	

The six quality of life domains; symptoms and feelings, daily activity, leisure, work and school, personal relationships, and treatment are presented in Figure 4.1 (81). However, since items 5 and 10 were excluded, the treatment domain was omitted, and the graph shows the remaining 5 domains. The mean scores for the respective domains are indicated in the figure, where symptoms and feelings had the highest ($\bar{x}$=3.7) and the leisure domain had the lowest scores ($\bar{x}$=0.8). The standard deviations for each of the domains vary; symptoms and feelings ($\bar{x}$=1.9), daily activity ($\bar{x}$=2.5), leisure ($\bar{x}$=1.1), work and school ($\bar{x}$=1.3), personal relationships ($\bar{x}$=1.8) (Figure 4.1).

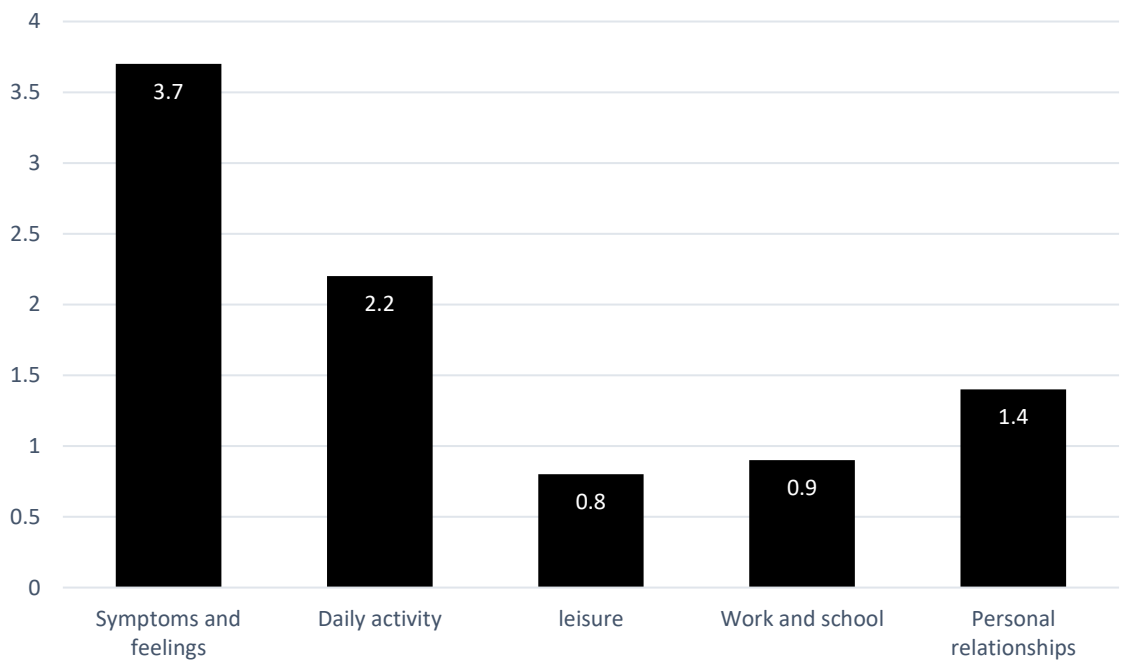

Figure 4.1 Mean scores of the five quality of life dimensions (n=86)

Cumulative scores of the DLQI were divided into six categories to assist interpretation of the data and guide clinical decision making as per the degree of severity of its effect on life quality of patients (254). Category-I (0-1) means there is no effect on the life quality of patients; category-II (2-5) small effect on the life quality of patients; category-III (6-10) moderate effect; category-IV (11-20) means very large effect, and lastly category-V (21-30) extremely large effect on the life quality of the patients (6).

In 11(12%) of participants with clinically confirmed scabies, the manifestations had an extremely large effect on their life quality. On the opposite extreme, 10 (11.6%) reported the infestation had no effect on life quality of patients and it had had a small effect on the quality of life of most of the participants 28 (32.6%). In 17 (19.8%) patients, scabies had a moderate effect and in 19 (22.1%) large effect (Figure 4.2).

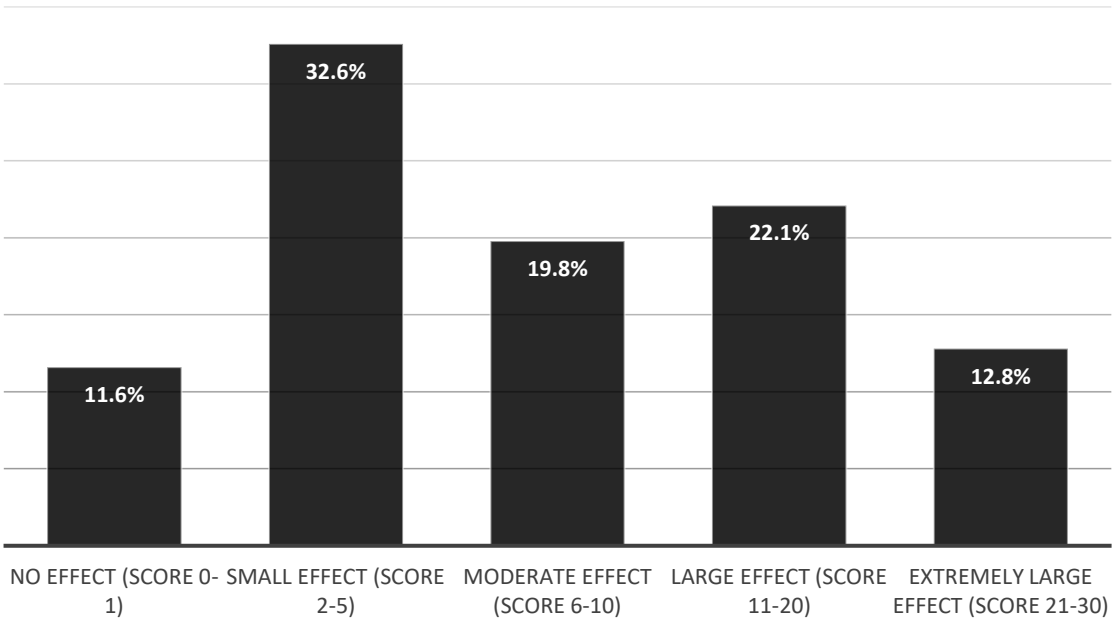

Figure 4.2 Dermatologic life quality index scores of scabies patients with intervals indicating degree of severity of effect on life quality (n=86)

4.3.2. Results of the analysis on the knowledge, perception and health seeking for scabies

Two-thirds of the adult study participants (n=501) reported that they had heard of scabies. Table 4.4 contained the responses of the 501 participants, who reported to have heard of scabies, to the items that assessed the knowledge of the participants. All but one variable (scabies treatment) under this section were multi select and the total score of the responses for the different categories can be greater than the number of participants. Physical contact was mentioned as a mode of transmission by 57.2% of the participants, and only 2.8% believed scabies to be acquired from the soil. Most of the participants in both groups (clinical scabies cases and their counterparts) believed that scabies could be treated with drugs. However, more of the clinical scabies cases wanted to know more about scabies than the apparently healthy. Though body creams and anti-scabies tablets were believed to treat scabies, 3.5% regarded traditional treatment (home remedies and traditional herbs) as a treatment for scabies (Table 4.4).

Table 4.4 Knowledge of adult study participants about scabies (n=501)

Variable	Overall n (%)*	Scabies diagnosis	
		No scabies (n=431)	Clinical scabies (n=70)
Have you heard about scabies?			
Yes	501 (69.1)	431 (67.9)	70 (76.9)
No	224 (30.9)	203 (32.0)	21 (23.1)
Where did you hear about scabies for the first-time?			
Family and friends	320 (64.0)	269 (62.6)	51 (72.9)
Health care providers	71 (14.2)	65 (15.1)	6 (8.6)
Health extension workers	48 (9.6)	9 (2.9)	39 (55.7)
Mass media	44 (8.8)	33 (7.7)	11 (15.7)
Religious leaders	18 (3.6)	18 (4.2)	0
Not collected	44 (8.8)	42 (9.8)	2 (2.9)
What are the manifestations of scabies?			
Itch	449 (89.9)	382 (88.8)	67 (95.7)
Rash	242 (48.4)	187 (43.5)	55 (78.6)
Skin crust	24 (4.8)	17 (3.9)	7 (10.0)
How is scabies transmitted?			
Physical contact with a scabies patient	288 (57.6)	245 (59.2)	43 (61.4)
Sharing clothing and bedding with a scabies patient	257 (51.4)	216 (50.2)	41 (58.6)
Sharing a sleeping space with a scabies patient	212 (42.4)	175 (40.7)	37 (52.9)
Through contaminated water	50 (10.0)	49 (11.4)	1 (1.4)
Blood contact with a scabies patient	20 (4.0)	18 (4.2)	2 (2.9)
From the soil	14 (2.8)	12 (2.8)	2 (2.9)
No response	58 (11.6)	49 (11.4)	9 (12.9)

Variable	Overall n (%)	Scabies diagnosis	
		No scabies manifestations (n=431)	Clinical scabies (n=70)
Is scabies treatable			
Yes	450 (90.0)	387 (90.0)	63 (90.0)
No	45 (9.0)	39 (9.1)	6 (8.6)
No response	5 (1.0)	4 (1.0)	1 (1.4)
What is the treatment for scabies			
Body creams and tablets	469 (93.8)	404 (93.9)	65 (92.8)
Holy water	22 (4.4)	21 (4.9)	1 (1.4)
Traditional treatment	17 (3.4)	16 (3.7)	1 (1.4)
Prayer	7 (1.4)	5 (1.2)	2 (2.8)
Who can catch scabies			
Any one	282 (56.3)	235 (54.5)	47 (67.1)
Poor people	53 (10.6)	42 (9.7)	11 (15.7)
Rich people	14 (2.8)	11 (2.6)	3 (4.3)
Homeless people	24 (4.8)	20 (4.6)	4 (5.7)
Urban people	14 (2.8)	12 (2.8)	2 (2.9)
Rural people	49 (11.1)	38 (10.1)	11 (16.9)
Commercial sex workers	22 (4.4)	19 (4.4)	3 (4.3)
Prisoners	22 (4.4)	18 (4.2)	4 (5.7)
No response	44 (8.8)	39 (9.1)	5 (7.1)
Do you wish to know more about scabies			
Yes	435 (87.0)	371 (86.3)	64 (91.4)
No	66 (13.0)	60 (13.7)	6 (8.6)

*Total scores may exceed 100% for some questions when individual participants could select more than one response categories.

Sixty-one percent of healthy participants perceived that any member of the community, including themselves, could acquire scabies. Slightly less than half (48.3%) of the participants reported that they would feel nothing, emotionally, if they developed scabies. However, 37.6% believed their community would prefer to avoid scabies patients. The items in this table were multiselect and participants could give more than one response to each variable, causing the total score to exceed 100% (Table 4.5).

Table 4.5 Attitudes of apparently healthy adult study participants towards scabies (n=441)

Variables	n (%)
Do you think you can acquire scabies?	
Yes	265 (61.0)
No	169 (38.3)
No response	7 (1.6)
What would you feel if you had developed scabies?	
Nothing	213 (48.3)
Shame	116 (26.3)
Fear	113 (25.6)
Disappointment	68 (15.4)
Surprise	16 (3.6)
No response	13 (2.9)
What would you do if you had developed scabies?	
Seek care from health care facilities	422 (95.7)
Use traditional medicine	2 (0.5)
Do nothing because it improves on its own	2 (0.5)
No response	16 (3.6)
What is your feeling towards scabies patients? (n=204) *	
I feel compassion and wish to help	115 (35.5)
I fear they may infect me	104 (32.3)
I do not feel anything	66 (20.0)
I feel compassion but prefer to stay away	40 (12.4)
Not collected	14 (4.1)
How does the community treat scabies patients? (n=204) *	
Most people prefer to avoid scabies patients	166 (37.6)
People help and support them	78 (17.7)
People appear friendly but they wish they avoided them	46 (10.4)
No response	25 (7.6)
Not collected	13 (3.9)

**Calculated out of 204 participants who have knowledge of a scabies patient.

Of the 192 scabies cases, 62 (32.3%) reported seeking care for the symptoms, where the median number of days to care seeking was 20 days. The most frequently mentioned reasons for delay were, assuming the symptoms would disappear on their own (21, 77.8%), lack of time to seek care (3, 11.1%), perceived high medical expenses (2, 7.1%), and mild symptoms (2, 7.1%). Among those who sought care, most (64.5%) reported seeking care from health care facilities, while only three reported using holy water as a remedy. The median number of days before treatment seeking was the cut off to determine care seeking delay (Table 4.6).

Table 4.6 Care-seeking for scabies suggestive symptoms by clinical scabies cases (n=62)

Variable	Categories	n (%)
Source of care	Health facility	40 (64.5)
	Self-treatment	14 (22.6)
	Holy water	3 (4.8)
	Prayer	1 (1.6)
	Missing data	4 (6.5)
Time to care seeking	Median number of days (IQR; Q1-Q3)	20 (7-30)

4.4. Discussion

The discussion addresses findings from the analysis concerning the effect of scabies on life quality of patients including knowledge, perception and health seeking for scabies. Scabies had a moderate impact on life quality of patients. Items that measured the impact of scabies symptoms on physical wellbeing, work and schooling, and self-perception (embarrassment) were the main contributors to the cumulative score. Of the six quality of life domains the symptoms and feelings domain was the most affected and the leisure activity domain had the lowest DLQI score. The mDLQI did not show a statistically significant difference among people with different sociodemographic characteristics. People who reported that scabies had either a large effect or an extremely large effect on their life quality accounted for 35% of the participants whose life quality had been affected.

Knowledge of the study participants about scabies and the community's perception of the infestation was assessed. More than two-thirds of adult study participants had heard about scabies and the main source of information surrounding scabies were friends and family. Most believed that scabies is transmitted through physical contact and sharing clothing with a scabies patient. Nine out of ten participants responded that scabies can be treated with tablets and creams. Slightly more than half of the participants had perceived susceptibility to scabies where 60% of the participants believed it is possible for them to acquire the infestation, and half of the sample participants reported they would feel nothing if they developed scabies. When participants were asked about their feeling toward scabies patients one-third of them reported that they wished to help them, however, a comparable proportion of participants reported that they fear they would infect them.

Concerning healthcare seeking for scabies, sixty-two of the 192 clinical scabies cases sought care for their symptoms, and the median number of days lapsed before seeking care was 20. The commonest sources of care were health care facilities followed by self-treatment. Reasons for the delay to care seeking were assessed among those who sought care beyond the median time to care seeking (20 days). The assumption that it would disappear on its own was the frequently mentioned reason for the delay and mild symptoms and perceived high medical expenses were the least frequently mentioned reasons.

4.4.1. Effect of scabies on life quality of patients

The cumulative mDLQI score was 7.2 (SD =7.6), indicating a moderate effect of scabies on the life quality of the patients. Though there are only few studies, globally, that have investigated the impact of scabies on the life quality of patients (6), these also reported a moderate impact (6, 79). The degree of impairment that skin diseases cause to life quality of patients depends on factors such as severity of alterations to the skin surface, type of lesion, and body parts affected by the lesion (255, 256). In cases of uncomplicated scabies, the primary lesions are papules involving caveats of the body on the hands, armpits, axillary area, the breast and gluteal areas (35). Small, closed lesions on parts of the body that can be covered with clothing, minimize the impact of uncomplicated scabies on life quality. Similarly, other parasitic skin infestations that cause limited alterations to the skin surface such as tungiasis and pediculosis also have a moderate impact on life quality of patients (11, 257). Apart from the extent of the lesion, these infestations also resemble scabies in the persistent itch they cause to patients (258). However, NTDs that cause major alterations to the skin surface and a notable impairment to bodily functions of patients such as podoconiosis, leprosy, and leishmaniasis have a high or very high effect on life quality of patients (74, 76, 259). In addition to the disease manifestation-based explanations of its moderate impact, the changes I made to the DLQI tool in adapting it to this study would also decrease the cumulative DLQI score. As detailed in section 4.2.8 of this chapter 1 dropped two items (item numbers 6 and 10) from the tool, due to lack of relevance of the items to this study (72, 248). Sports are not common in the study community and the population-based nature of the study invalidated asking about scabies treatment. However, dropping them can decrease the maximum possible cumulative DLQI score.

The sexual difficulties item had the least impact on life quality (6). Sexual difficulties or dysfunction in patients with skin diseases result from both psychosocial and physical factors. In diseases that cause prominent skin lesions, patients feel that they are sexually undesirable and this at times leads to low self-confidence, and depression causing sexual dysfunction, especially among men (260). Pain and discomfort from the lesions during sexual intercourse is the other link between skin diseases and sexual dysfunction (73). However, the small-sized lesions, in classical scabies, and the distribution, which spares the genital area, may minimise its impact on sexual functioning of scabies patients.

Minimal impairment to sexual health was also reported in other NTDs that cause large skin lesions but do not commonly involve the genital area, such as podoconiosis and leishmaniasis (74, 248). However, contrary to our findings, a study by Jin-gang et.al., reported that the sexual difficulties question was among the items that had the most impact on the life quality of the participants (6). This difference could have resulted from the difference in the study participants where the reference article involved people older than 16 years of age. This category includes adolescents, an age group where sexual experimentation is not uncommon and the impact of scabies on sexual life could have stronger effect in this age group than older adults. Contrary to this, our study only involved adults, and 80% of the participants were married, so, given the fast transmission of scabies it is likely that couples have the infestation, which might reduce refraining from sex in fear of transmitting it to their partner. In addition, in high scabies burden communities, the disease is normalized and tolerated (66) and made part of daily life to the extent that it does not stand in the way of sexual activities.

Of the five quality of life domains investigated in this study, the most affected was the symptoms and feelings domain, followed by the daily activity and personal relationship domains. The symptoms and feelings domain is comprised of items measuring the pain, itch, and physical discomfort secondary to the scabietic lesions, and the affective response to these manifestations. The largest impact was seen in the symptoms and feelings domain owing to the intense generalized itch (32), which worsens at night-time and caused sleep disturbance (185, 261). The reason for most participants to seek care is to stop the itch (80), which indicates that the symptoms, particularly the itch, may be the main cause of impairment to life quality of the patients. Additional sensations such as pain and soreness are also characteristic of scabies lesions, but these qualities are more apparent in the presence of secondary bacterial infections or in crusted scabies cases (34). However, in this study I did not measure either disease severity or the presence of secondary bacterial infections.

The second item within the symptoms and feelings domain is the item, feeling, which captures the emotional response of scabies patients to scabies symptoms. Skin lesions and related alterations of the skin surface affect the mental health of patients causing low self-esteem, social isolation and at times depression (79, 262, 263). These negative emotional responses become more intense when social stigma is attached to the disease or its symptoms (262).

In the case of scabies though the lesions are not highly disfiguring it involves the hands, and the wrist which are exposed parts of the body. Having lesions on exposed parts of the body have strong associations with negative emotional responses to one's health condition (264, 265).

The personal relationship domain, which ranked the third highest domain, can be seen as an extension of the discussion in the preceding paragraph. Though the sexual difficulty item made only a small contribution to the cumulative score of this domain, the relationship with close friends and family question ranked relatively high. Relationship with family and friends can be affected when isolating oneself to prevent transmission or in the attempt to escape stigma. In many communities in both high-income and low-income countries scabies is perceived to be associated with unhealthy behaviours such as poor hygiene and unhealthy sexual behaviours (261, 266), and one of the major strategies used by patients to avoid stigma is to isolate themselves from family and friends until the manifestation subsides (266). In our study community, the perception of scabies is unfavourable where 37% of our participants reported members of the community would rather avoid scabies patients than engaging them. These circumstances may lead to self-isolation contributing to the high score under the personal relationship domain.

The daily activities domain is the second most affected domain. This domain involved the effect of the lesions on participants' choice of clothing and including their work and study. The impact of the infestation on patients' choices of clothing was also reported in a study by Worth et.al., where scabies patients living in the slums of northeast Brazil had to change their clothing because of scabies lesions (79). Due to the unappealing appearance of the lesions and to not risk stigma, patients hide the lesions by covering as much of the skin surface as possible. Wearing clothes with long sleeves, trousers, and long skirts instead of shorts and tank tops were preferred to cover much of the body (266). This may be more pronounced in areas of warm climate where clothes that cover less of the body are commonly used (79). The effect on work and study can be explained by the inconvenience caused by the lesions to physical activities. The sleep disturbance secondary to the itch, which worsens at night, also undermines productivity of the patients during daytime (35).

ANOVA was employed to determine whether there was a statistically significant difference in the mDLQI score by sociodemographic characteristics or duration of scabies symptoms, but none was found. Only a handful of publications have investigated sociodemographic variables as predictors of life quality of scabies patients. In one study in China, higher cumulative mDLQI score was reported among men than women (79) but feeling ashamed of one's skin was reported by more women than men in a study from Brazil (79). Only a few sociodemographic variables showed a significant association with a change in DLQI score (6, 75, 79, 265). However, in other skin NTDs such as leishmaniasis, differences in disease symptoms such as severity, long duration and extensive lesions were strong predictors of impairment on life quality of the patients (74, 75, 79).

4.4.2. Knowledge, perception, and health seeking for scabies

Only sixty-two (32.2%) of the 192 scabies cases sought care for scabies symptoms. A comparable delay to care seeking for scabies suggestive symptoms was reported in similar studies (266, 267). High risk perception, knowledge of available health care services are vital to healthcare seeking (268). In this study, the sample population had above average knowledge about treatment availability and a positive attitude towards seeking care for scabies. Regardless of these conducive circumstances, health seeking for scabies is low, and this requires alternative explanations. I did not assess determinants of healthcare seeking in this study, however, low perceived severity of the disease may have contributed to the delay (269). This is true in other studies where poor healthcare seeking was associated with low perceived severity. A study in Brazil, indicated that only half of the study participants actively sought care for complaints associated with scabies (267).

Healthcare service access is the other important determinant of optimal health care seeking behaviour. Over the past few decades access to health services has significantly improved in Ethiopia, mainly due to the government policy that aimed expanding primary health care (206). In most parts of the country, one health center serves 25,000 people; and each *kebele* (of approximately 5,000 people) has one health post (206). Nonetheless, scabies care has not had enough attention. This neglect is reflected in the limited availability of anti-scabietic drugs at health facilities and drug stores and the national essential drug list did not contain permethrin, the first line anti-scabietic cream (270, 271).

Ivermectin, a systemic drug for scabies and other NTDs, is part of the essential drug list, though was originally intended for use as an anti-filarial drug (271). Recurrent stock outs of scabicides from health care facilities, undermine the care for scabies patients. From our informal discussions with community members, I understand that the community believe scabies to be treatable but that unreliable access to anti-scabietic drugs hindered healthcare seeking.

More than two-thirds of the scabies patients who sought care for scabies symptoms went to health posts and health centers and only one-third sought care from traditional healers and sought self-treatment. With limited access to modern medicine, traditional treatment and home remedies have been the primary sources of medical care in most parts of Ethiopia (272). However, the past few decades have witnessed a rapid expansion of primary health care, improving health literacy and access to health care services in the predominantly rural Ethiopian communities (206, 213). The improving physical access to health care has been augmented by a community-based health insurance program aimed to address economic barriers (273). The collective impact of these initiatives may have increased use of formal health care facilities. However, I cannot rule out that social desirability bias that lies behind the relatively high levels of respondents seeking care from health care facilities (274). The data collectors had introduced themselves as health care providers from the nearest hospital before each interview and clinical examination. Though they tried to dissociate their positions as clinicians from their roles as investigators, it is possible that participants may not share answers they thought medical personnel would not approve.

Of the participants who were diagnosed with clinical scabies and had sought care, nearly 40% either treated themselves using traditional home remedies or used holy water. In most developing countries, where there is limited access to health care services, traditional treatment is the primary source of care for classic scabies (261, 266), and chronic scabies or secondary bacterial infections are the common reasons to consider seeking care from modern health care facilities (261). In a study on health seeking for cutaneous leishmaniasis in northern Ethiopia, participants reported they would use traditional medicine if they developed the skin disease (275). This speculative health seeking is comparable to our actual health care seeking practices for scabies symptoms. In Ethiopia, only people living in a few urban areas were privileged to access modern medical care until the past couple of decades (272).

Because of this, the majority of the population had to rely on traditional medicine for their medical needs. Still, despite the ongoing expansion of modern primary health care services significant number of the population use traditional medicine (276, 277). People use traditional medicine or home remedies (from my anecdotal field observation, people applied a local herb named "*Etse fares*" on the lesions and in some cases, garlic) because it is cheap, accessible, and is socially acceptable specially in rural communities (266, 275, 276).

Nearly all (96%) respondents indicated they would seek care from health care facilities if they developed scabies. This estimate is considerably higher than the estimates from other studies in the same area (275). Considering these studies were conducted in the same regional state (Amhara regional state), the difference in speculative health seeking behaviour is significant. This higher preference for modern health care services could be partly explained by the scabies outbreak response related activities that were ongoing since the outbreak was reported in 2015. The control activities involved health education about the infestation and the possible control measures including treatment. It is possible that these interventions could have increased the overall awareness of the community about the disease and influenced their preferred sources of scabies care.

The scarce evidence on healthcare seeking behaviour for skin diseases in general and scabies in particular has limited our understanding of the care-seeking patterns of scabies patients (267). In the future, large scale studies involving a diverse population group will give a more complete understanding of health care seeking behaviour and its drivers. Though our finding is from a small sample, the low care seeking prevalence and the delay in those who eventually sought care, affect the effectiveness of current scabies control strategies. Providing standard care to scabies patients who visit health care facilities, and empirically treating their contacts was the primary strategy employed in Ethiopia to control scabies. This approach works best in settings where there is low scabies prevalence and optimal access to health care services including above average health care seeking behaviour. Therefore, the low care seeking prevalence and the significant delay to care seeking, underscores the need to consider community-based preventive chemotherapy alongside the standard care to effect scabies control.

Understanding a community's knowledge of and attitude towards a disease condition may help determine disease transmission and the effectiveness of control interventions.

However, due to the lack of research on the subject, our understanding of the perceptions of the different communities towards scabies is limited (80, 261). In this study, nearly two thirds of the sample had heard about scabies. This finding is comparable to the estimate from studies in Indonesia and Guinea Bissau where 60% and 96% of the study population, respectively, had heard about scabies (266, 278). Scabies has been endemic to most developing and developed countries for centuries, and its occurrence is not determined by geographic and climatic circumstances (279).

In assessing the level of knowledge, they had about scabies, participants were asked whether they know about its manifestations, modes of transmission, treatment, sources of scabies-related information and whether they wished to know more about scabies in the future. Respondents that mentioned itch and skin lesions as symptoms of scabies were 96% and 52%, respectively, and only 5% knew that skin crust was among the manifestations of scabies. In similar studies, itch was the most commonly mentioned scabies symptom followed by skin lesions (266, 278). The other possible signs of scabies include burrows, excoriation, and skin crust. Though scabietic burrows are pathognomonic for scabies, they are not often recognised due to their microscopic size and scarcity. As skin crusts are associated with secondary bacterial infection or more severe forms of scabies, people have little chance of observing them among cases of the most common form of scabies, classical scabies (31).

Physical contact with a scabies patient was the most frequently reported mode of transmission. Sharing bedding and clothing and sharing sleeping space with a person exhibiting scabies symptoms were mentioned by 50% and 61% of the responses, respectively. I intentionally used the phrase, sleeping space, instead of bed. In some households, built up parts of the floor are used to sleep on. Furthermore, this response category does not imply sexual encounters, though I could not rule it out, but sleeping in close physical proximity with one another. In studies from Fiji and Guinea, sharing bedding and clothing was the most frequently mentioned mode of transmission over physical contact (261, 266). Though transmission through fomites is possible, it is not the most important mode of transmission specially for cases of classical scabies (31), and educational interventions aimed to promote knowledge about scabies and its prevention should focus on the importance of circumstances that create physical contact and crowding.

Three quarters of the participants first heard about scabies from family members or friends, and only 15% were told about the disease by health care providers. The limited role of the health system in health information dissemination was also reported in related studies (266, 275). Since scabies has been neglected for so long this finding is not unexpected (280). This limits effectiveness of scabies control interventions as optimal awareness of communities about a disease is key to achieving control. Therefore, the health system should engage the community in health information dissemination activities to increase awareness about its transmission and prevention; as information through social network cannot be free of misconceptions and inaccurate information (266). The Ethiopian health system has a structure that allows reaching the grass roots and disseminating health information. The Health Extension Program (HEP) and the Health Development Army (HDA) are community-based structures, where the HDA is a para-health system social structure that organized women in 1-to-5 units and regularly meet and discuss different health agendas (213, 281). Like other health agendas such as maternal and child health, environmental health, and infectious diseases, scabies could be one of the discussion topics in the house-to-house health information dissemination sessions of HEWs or an agenda in the discussion sessions by the HDA. There was high demand for information about scabies, with 86% of the sample population saying they wanted to know more about scabies. However, to standardise education intervention programs and refresh health care workers knowledge about scabies on-job training is recommended as generic training of health care workers with different training backgrounds lacked focus on NTDs (282, 283).

The Amharic word for scabies is *ekek* and in some localities the term, *foket*, is used, and both words are derivatives used to describe itch in the Amharic language. At times, these words are used as derogatory terms to refer to people who are either poor or unhygienic. This sentiment is rooted in the frequently observed association between scabies and households of low socioeconomic status having crowded living conditions (7, 86). These circumstances are indicative of the unwelcoming attitude and a degree of stigma against scabies patients. Only half of the participants reported perceived susceptibility to the infestation. Even though the majority reported that anybody could catch scabies. Given this study was conducted in an area where there was a scabies outbreak, I expected high perceived susceptibility among the study community.

This discordance could have resulted from ascribing the infestation to circumstances or backgrounds that participants did not want to associate themselves with. For the hypothetical question which asked what they would feel if they developed the infestation, the majority reported that they would feel shame, fear, disappointment, or surprise. These negative affective responses were also reported in other studies that involved scabies patients (6, 80, 266). Misconceptions surrounding the causes or modes of transmission of scabies could have caused the unfavourable emotional responses. Poor personal hygiene, living in unsanitary environments, poverty and the possibility of sexual transmission are perceived and valid yet unpopular circumstances associated with scabies (80, 266). By extension, these perceptions and fear of transmission might explain why 50% of the participants reported they would prefer to avoid scabies patients whenever possible.

This study is not without limitations. The analysis that sought the effect of scabies on life quality of patients involved all the identified participants who had scabies. However, their number is smaller than the total study sample and this could have affected the power of the study. The standard Cardiff DLQI tool has a total of 10 items that best fit studies in clinical settings. However, in this study two of the items, the effect of scabies on sporting activities and convenience of using scabies treatment, were excluded for lack of relevance to my study. This change could have decreased the cumulative score of the effect of scabies on life quality of participants and might have affected comparability of the findings of this study with similar studies on scabies.

I used quantitative methods to measure the knowledge and attitude of the sample population towards scabies. This approach is in use to answer similar research questions in numerous studies. However, the method has limited ability to give a deeper understanding of social phenomenon. The reported current community perception of scabies is shaped by numerous factors that has evolved for years. The point in time quantitative data cannot capture these background drivers of the manifested perception (284). To address this gap, a follow up qualitative research is important to capture the community's knowledge and perceptions towards this stigmatizing skin condition. Such approach is also vital to explain the social constructs that led to the existing attitude towards scabies.

4.5. Conclusions and recommendations

4.5.1. Key findings

The cumulative impact of scabies on life quality of clinical scabies cases was moderate. I used the Cardiff DLQI tool translated to the local Amharic language. In adapting the tool to the local context, I excluded two items from the original tool and used the remaining eight items and each item pertains to different aspects of life and each one of these questions had varying scores. The item about the impact of symptoms of scabies on life quality of patients had the highest mean score, followed by the item which asked the impact of scabies on affective factors such as self-consciousness and embarrassment. For a considerable proportion of participants scabies was a barrier for people to undergo their day-to-day activities such as shopping or looking after their garden. From the list of items, the one that refers to the effect of scabies on sexuality of participants had the least contribution to the overall effect of scabies on life quality of patients. This difference in contribution of the different items to the overall score is also reflected in the life quality domains where the ‘symptoms and feelings’ domain, which comprises the first two items, discussed above, had the highest mean score followed by the ‘daily activity’ domain. The least affected life quality domain was the ‘leisure’ domain that comprises items measuring the effect of scabies on social activities and sporting.

I tested whether the impact of scabies on life quality of patients vary by sociodemographic characteristics of participants. However, regardless of the differences in background characteristics and symptom duration between participants, the effect of scabies on life quality was not significantly different between these groups of people.

Severity of effect on life quality of patients was ranked on a range of no effect to extremely large effect. Scabies had small effect on life quality of one third of the study participants. The proportion of participants on whose life quality scabies had moderate and large effect were comparable to each other (~20%). The extremes of effect (no effect and extremely large effect) were also comparable to each other affecting 11% and 12% of the participants respectively.

Nearly three quarters of the participants had heard about scabies. For most of the participants the sources of scabies related information were family and friends. Itch was the most frequently reported scabies manifestation.

Physical contact with a scabies patient, sharing clothing with a scabies patient and sleeping together with a scabies patient were the most frequently given responses, to the question, what is the mode of scabies transmission? Nearly all participants believed that scabies is treatable, and they would seek care from health care facilities if they had the infestation. Tablets or creams were the possible treatments participants presumed could be used to cure scabies. Most participants reported that they would feel nothing emotionally if they had scabies. However, unfavourable perceptions such as feelings of shame and fear were associated with acquiring scabies. Though compassion and willingness to help scabies patients is mentioned, fear of possible transmission from scabies patients was observed. In relation to this, one in ten of the participants reported they would rather avoid scabies patients than risk acquiring the infestation.

4.5.2. Policy recommendations

Scabies impacts physical wellbeing, self-perception, and social functioning of patients. Promoting access to scabies care may help avert its impact on life quality of patients before it causes a significant damage to one's wellbeing. The toll of scabies on life quality of patients also signifies the need to include improving the life quality of patients among the main treatment objectives in scabies care.

The main source of scabies related information for most participants were family and friends. Though getting information about scabies is important, to avoid misconceptions the source of information had better be from trained health care providers and community health workers. The high demand for more scabies related information is a good opportunity to communicate health messages from formal sources.

Educational interventions may help enhance the awareness of the community about the cause, mode of transmission and treatment of scabies may help reduce stigma caused by lack of accurate information about scabies and the misconceptions associated with it.

4.5.3. Future research

This analysis was based on a limited number of scabies patients who were identified during fieldwork. Future research should consider involving high numbers of scabies cases that are identified in clinical settings to investigate the effect of scabies on life quality.

Scabies moderately impacted the feeling and self-perception of patients and covert stigma is associated with it. These circumstances can affect mental health of the patients and future research should investigate the impact of scabies on psychosocial wellbeing of patients.

In this study I excluded the item that pertained to the effect of scabies on sporting activities and treatment from the standard DLQI tool for lack of relevance to the study. Future research may consider adapting and testing the DLQI tool for use in similar community-based global health settings.

The analysis on the knowledge and perception of the community toward scabies indicated subtle stigma. A follow-up ethnographic research may help further elaborate the effect of scabies on the social role and functioning of patients.

4.5.4. Doctoral candidate development

This is the first study that I have conducted which measured the impact of a disease condition on life quality of people. Since the study involved participants where nearly half could not read and write, the ordinal scale was somehow difficult for participants to understand. Observing this difficulty in the first few interviews, I discussed with participants and sought a better way to administer the questions. Assessing the participants understanding surrounding each question and how it should be administered is important instead of relying on my personal understanding of the questions and how they should be conveyed. Techniques such as thoroughly explaining the scales under each item and giving enough time for participants to process the questions before giving responses and reassessing whether the responses were what they wanted to say were some of the techniques I devised in the field to minimise bias during data collection.

Chapter Five

The secondary impact of ivermectin onchocerciasis MDA on the prevalence of scabies

Chapter 5 : The secondary impact of ivermectin onchocerciasis MDA on the prevalence of scabies

5.1. Introduction

The five main NTD control strategies are: preventive chemotherapy, intensified case management, vector control, improving access to water and sanitation, and veterinary public health for zoonotic NTDs (126). These strategies are meant to be used separately or in concert depending on the epidemiology of the target disease. Intensified case management is a cross cutting strategy can be used against nearly all NTDs (153). The remaining strategies target specific diseases, vector control is applied against vector-transmitted NTDs such as human African trypanosomiasis, leishmaniasis, and rabies (27). Water sanitation and hygiene related interventions help control water-borne and water-washed NTDs such as schistosomiasis, soil transmitted helminths and trachoma (27). In recent years MDA has become the main NTD control strategy against selected NTDs (285).

MDA is a form of preventive chemotherapy where the therapeutic dose of a drug against an infectious agent is administered to the entire target population regardless of infection status or the presence of disease manifestations (286). Unlike interventions in clinical settings, MDAs take place depending on the findings of community-based surveys on disease epidemiology. Drug administration is often carried out by lay personnel and frequency of MDAs can be once a year or more, depending on the nature of the disease (287). This strategy is proven effective in controlling NTDs in different parts of the world. However, its impact in combating NTDs relies mainly on the availability and accuracy of data about the disease epidemiology both before and after the intervention. Data on disease distribution helps to tailor interventions to endemic areas, guide NTD control program integration efforts, and inform the planning of routine health care services in a way that creates synergy with the interventions (288).

NTDs targeted for elimination with MDA are onchocerciasis, lymphatic filariasis (LF), schistosomiasis, soil transmitted helminths (STH), and trachoma (289). These diseases were deemed eligible for MDA considering their potential to involve people from a range of demographic groups, their high prevalence in target populations, and high likelihood of interrupting transmission through MDA (287).

The first four are parasitic diseases and trachoma is a bacterial infection (162). Ivermectin is the first line drug for use in MDAs against onchocerciasis and LF, and praziquantel for schistosomiasis and STHs (126).

However, the list of NTDs eligible for MDA is not final. With increasing evidence on the epidemiology of NTDs and the inclusion of new diseases to the list of NTDs, it is possible that the NTDs targeted with MDAs will increase. Scabies is added to the WHO list of NTDs only in 2017 (113) and it fulfills most criteria used to target NTDs with MDA. Furthermore, existing evidence unequivocally indicated successful control through ivermectin-based MDA against scabies (129).

As a control intervention MDA resource intensive and puts pressure on the health system (22). To ensure sustainability of this important intervention enhancing its cost effectiveness and ease of implementation is vital (287). Integrating disease-specific MDA programs is one approach which may help to reduce cost associated with the implementation and enhance the effectiveness of control interventions. However, evidence about efficacy of integrated MDA is limited (26). This study investigated the secondary effect of single dose ivermectin-based MDA against onchocerciasis on the prevalence of scabies. The finding helps to assess the potential to integrate community-based control interventions against onchocerciasis and scabies.

Research question

- Does single dose ivermectin onchocerciasis MDA impact scabies epidemiology in Amhara region, northern Ethiopia?

5.2. Methods

5.2.1. Study design

A longitudinal study was conducted to measure the secondary impact of ivermectin-based MDA aimed to eliminate onchocerciasis on the prevalence of scabies. Three consecutive surveys were carried out on a panel of households in Northern Ethiopia. The study was conducted over the course of a twelve-month period, from December 2018 to February 2020. The baseline survey was conducted in December 2018, which was followed by the MDA that took place three to seven days (depending on the remoteness of the study *kebeles*) after the baseline survey. The 6-months survey was conducted in June 2019, and the 12-months survey (the third-round survey) was conducted in February 2020, 12-months after the baseline survey was conducted.

5.2.2. Study area

The study was conducted in Ayu Guagusa district, Agew Awi zone, Amhara regional state, northern Ethiopia. Amhara region is one of the ten regional states and two city councils comprising the Ethiopian Federal system. It is in the north-western part of the country sharing borders with Tigray, Benishangul, Oromiya and Afar regions and shares an international border with Sudan. Agew Awi zone is one of the 11 zones in the region, which is located in the south-western part of the region (205). Ethiopia has 839 districts, Ayu Guagusa district was the only district in Agew Awi zone where ivermectin-based bi-annual preventive chemotherapy has been undertaken since 2015 (172, 173). The district has 21 *kebeles* (the lowest administrative unit) and each *kebele* is further sub-divided into a varying number of *Gotes.* As *Gotes* are random villages within *kebeles*, their number and the number of households comprising each *kebele* varies.

There are three health centers in the district and the *kebeles* have one health post each. The nearest hospital, Gimja Bet Primary Hospital, is located approximately 30 to 40 Kms away from the district. This hospital mainly provided primary level curative health care services for patients referred from satellite health centers.

5.2.3. MDA for onchocerciasis

Onchocerciasis is one of the eight priority NTDs that the Ethiopian MoH targeted for elimination. According to a rapid assessment of the disease distribution conducted by the Ethiopian Onchocerciasis Elimination Expert Advisory Committee (EOEEAC), onchocerciasis is hyper endemic in multiple woredas in western Ethiopia. This includes districts in parts of Oromiya, Amhara, Southern Nations Nationalities and Peoples (SNNP) and Gambella regions and all the districts in Benishangul Gumuz region. This was later corroborated by onchocerciasis mapping conducted in 2015. However, neither the rapid assessment nor the mapping covered eastern Ethiopia, due to the absence of historical data indicating endemicity of the disease and the unfavourable environmental circumstances for the vector to breed (172).

Though the onchocerciasis control program started in 2001 in selected endemic districts of SNNP region, an onchocerciasis elimination strategy was implemented in 2012 aiming to interrupt onchocerciasis transmission by 2020 (173). The strategy centered on ivermectin-based preventive chemotherapy plus health education and advocacy to increase public awareness about the disease (172). Out of the 188 onchocerciasis-endemic districts, the EOEEAC regarded 184 eligible for MDA, and the majority of these were in western-Ethiopia. The criteria used to select eligible districts for the MDA were: (1) skin-snip positive rate among adults in any community was >2%; or (2) OV16 rates in adults exceeding 10%; or (3) any skin snip positive children <10 years of age in any community; or (4) Ov16 rates in children <10 years exceed >0.1%; or (5) PCR infectivity in flies exceeds >1/2000; or (6) seasonal transmission potential (as calculated by PoolScreen) exceeds 20 L3/person/year.

MDA was previously conducted in a few districts of SNNP region, but the program picked up pace after 2015 where MDA was carried out, bi-annually, in most of the eligible districts (173). During the MDA campaigns, the drug distribution was carried out by community volunteers named the health development army (172). Before the field operation commenced, people from the zonal health office, who would take part in managing and coordinating the MDA, received training. The training was later cascaded to district-level actors including health extension workers and the health development army (24).

Though the health development army carried out the actual distribution of ivermectin tablets, the community mobilization, heath education, and supervision of the MDA operations was led by health extension workers, health care workers from the nearby health centers and NTD program experts from district level health offices (24).

In the intervention districts, ivermectin was given at a dose of 200µg/kg to all members of the community aiming a 90% population coverage (173). However, pregnant women and lactating women in the first week post-partum, children younger than five years of age, and the severely ill were ineligible to take ivermectin (176).

5.2.4. Sampling procedure

I purposively selected Amhara regional state as the reason for the inception of this study was a call from the Ethiopian MoH to investigate the reason for the scabies outbreak in the region and to seek alternative control interventions. Ayu Guagusa district, which was one of the 11 districts in Agew Awi Zone, was again purposively selected due to two main reasons. One, Ayu Guagusa district was the only district in Agew Awi zone where MDA for onchocerciasis elimination was underway and I aimed to measure its secondary impact on the prevalence of scabies. The other reason is that there were other NTD-focused collaborative research projects conducted in the area. This existing collaboration with the local administration and health offices was instrumental for the successful roll out, conduct, and completion of the project.

Ayu Guagusa district comprised 21 *kebeles* with an average 3000 to 5000 people. Six *kebeles* (Dekuna Dereb, Arbit, Degera, Ambera, Enavara, and Chibachibasa) were randomly selected. Each *kebele* contained a varying number of *Gotes* and one *Gote* was randomly selected from each study *kebele*. Then a census of all the households in the selected *Gote* was conducted to prepare a sampling frame. The census involved house-to-house listing and numbering of all households. Households were randomly selected from the frame and all members of the selected households were invited to participate in the study (Figure 3.2).

5.2.5. Study population

The sampling unit being households, all members of the sampled households, who were available at the time of the survey were invited to participate in the study.

5.2.6. Eligibility criteria

All consenting members of the study households, including infants and children, were eligible to participate in the study. Due to the planned repeated measurements I proposed to consider the participants' plan to stay in the study area for the coming year, from the time when the baseline survey was conducted, as an eligibility criterion. However, during the baseline survey nearly all participants reported that they did not have plans to change place of residence at least for the coming one year.

5.2.7. Sample size

For the baseline survey the minimum sample size was 1326, which was calculated to estimate a 35% scabies prevalence, with 5% precision, and community level correlation coefficient of 5% (13). However, I had to check whether this sample size is adequate to detect a difference in scabies prevalence before and after the MDA. The sample size formula for test of equivalence between two independent proportions was employed (290, 291). I used the 35% scabies prevalence at baseline considering the estimate from a region wide survey (13), and assumed a 70% relative reduction in scabies prevalence, from 35% to 11%, secondary to the onchocerciasis MDA. This estimate is based on previous community trials that reported near 90% relative reduction in prevalence secondary to ivermectin scabies MDA (147). Once again, a 5% community level correlation (218) and average cluster size of 50 was used to calculate the design effect. A sample size of (n=448) has 80% power to detect a 28% effect size with a 5% precision (i.e., 5% margin of error on the opposing extremes for the two tailed statistical tests). Adding 10% for non-response the final sample size is 492. Therefore, sample size calculated at baseline to estimate scabies prevalence (n=1326) is adequate to detect the estimated effect size of the MDA.

5.2.8. Data collection tool

Data was collected using an interview questionnaire which was first developed in English and translated to the local Amharic language. The questionnaire had sections which helped generate multilevel data at the household and individual study participant levels. However, there were changes to the sections of the questionnaire used in the three surveys. The first section contained a household roster (a register for household members and their respective sociodemographic characteristics), living arrangements and housing condition-related questions.

Except for the variables which pertained to the manifestations of scabies, which I developed based on previous publications, the standard sociodemographic variables were adopted from the Ethiopian Demographic and Health Survey (212). Most of sociodemographic questions were available across the three rounds of surveys. The major change to this section was in the 12-months survey where only household members who had either left or had newly arrived were registered. This included the housing condition subsection, which was aimed to collect data on household density. In the 12-months survey I only asked these questions to households who had made structural modifications to their house including demolishing it or building a new one. Maintaining residential houses, demolishing old houses, and constructing new ones is not uncommon in rural communities in relation to weather change. For instance, during the rainy season old houses are maintained to withstand heavy rain shower and during the harvesting season new rooms could be built to serve as grain stores.

Section two was about characterizing scabies and other co-morbid conditions. Here circumstances such as contact with a presumed scabies patient were included. The remaining sections included standard questionnaires to measure the quality of life of scabies patients and its effect on the physical ability of people with scabies infestation.

The standard DLQI tool was included in the baseline and the first follow-up surveys. This tool has been used in more than 30 different settings and was validated for use in Ethiopia (248).

5.2.9. Data collection using electronic forms

In the baseline survey, data collection was conducted using a paper-based interview questionnaire and the data processing took more time than anticipated. Drawing lesson from our experience in the first survey, electronic data collection was used in the subsequent two surveys. This approach was employed to shorten the turn-around time between data collection and analysis and to enhance data quality. To this end, I used Open Data Kit (ODK)-enabled android smart phones. ODK is an open-source android application designed to replace paper-based questionnaires. The application can support different layouts of survey variables and a range of response categories (292). This application has been used by a range of regional and international organizations, including the WHO, for programmatic and research purposes.

ODK has three main tools namely ODK build, ODK collect and ODK aggregate. ODK build is a web-based tool used to develop electronic forms replicating the paper-based questionnaire. ODK collect is a front-end system that users employ to fill in data and upload to a server which is developed using ODK aggregate (293). The application was installed on android smart phones and the electronic forms (developed both in English and Amharic) were downloaded from the server to the application.

The electronic form development process was iterative with the ODK-form programmer successively developing updated versions of the form depending on comments from the team. Though the first few versions were developed before the training, the final version was developed based on data collectors' feedback after piloting the tool in the field. Even though electronic data collection is vital to improving data quality, the process of developing the form requires rigorous review.

The back-end system was set-up in a password-protected server based at Addis Ababa University. Like the front-end system, the back-end system required rigorous testing to check whether the data structure fitted the data analysis plan. In the form development process, more attention was given to the front-end system but not as much to the back-end system, particularly to the data structure once it was uploaded to the server. I had household and individual household member level data. To capture these levels, two types of ODK-form were required. The first was the 'parent' form that captured household level data and the second was the 'child' form which pertained to individual participants. These two electronic forms had to be linked in a way that allowed the application of household level data, measured once, to all household members. However, in the 12-months survey I faced technical difficulty with the data collection form as the parent form auto linked only with the individual participant who was interviewed first from the household. Therefore, to make the data fit for the plan of analysis I had to restructure the dataset using *Stata.14.* software and it took more time than I originally planned for data management.

5.2.10. Variables

Background variables of the study participants, housing condition, and living arrangement-related variables were kept the same across the three rounds (please see chapter one). The new additions to the 6- and 12-months surveys measured each participant's involvement in the MDA, which followed the baseline survey (Annex A).

5.2.11. Data collectors

In each survey round, the data collection was conducted by five data collectors who were recruited from the nearby hospital. All the data collectors were mid-level health workers, four with a first degree in the field of nursing and one a health officer.

Due to the dire shortage of health care workers in Ethiopia, and the plan to promote access to health care services, the national human resource for health development program expanded training of mid-level health workers and they were given the responsibility of seeing patients. The aim was to ramp-up the availability of adequate human resources that can provide health care services through shorter training periods than the conventional training for medical doctors. Health officers and nurses took a four-year training and were positioned to treat patients in primary health care facilities. They diagnose and treat patients in out-patient departments. They also play a vital role in identifying patients who need advanced care and referring them to the nearest hospital. Though all the data collectors in this study had the responsibility of seeing patients in outpatient departments, their experience in caring for scabies patients was a major recruitment criterion. This group of data collectors collected data during the baseline and 6-months surveys.

Although this team conducted the baseline and the first follow-up survey, I couldn't use the same team for the third-round survey because the zonal health bureau had recruited them for a diarrheal disease outbreak response campaign. Therefore, I had to recruit five other data collectors to conduct the 12-months survey. This team was comprised of health care providers with similar training backgrounds to the previous team, three health officers and two nurses. The only difference was that this team was recruited from the health centers in the district, unlike the previous team that was recruited from a primary hospital. Experience in treating scabies patients was the main recruitment criterion. Due to the scabies outbreak in the area and the fact that scabies cases were first seen at health centers, finding health care providers with the required clinical acumen was not difficult.

5.2.12. Data collector training

The data collectors received training before all the three survey rounds. The content of the training was broadly the same across the three rounds except for minor changes. For instance, electronic data collection was introduced in the second-round survey.

Therefore, I had to include a section on introduction to electronic data collection in survey rounds two and three to familiarize data collectors with the android application and the electronic data collection forms. Clinical demonstrations on actual scabies patients at the outpatient clinic of Gimjabet hospital was included during the training for the 12-months survey. However, in the baseline survey the dermatologist accompanied the field team for the first few days of the data collection and practical demonstrations were carried out in the field.

A dermatovenerologist, Dr.Selamawit Girma, from Addis Ababa University College of Health Sciences facilitated the training for the 12-months survey. She covered the topics which pertained to the clinical aspects of scabies, including the clinical demonstration sessions. I facilitated the sessions concerning project overview, epidemiology of scabies, contents of the questionnaire, interview techniques, and research ethics.

Apart from the project overview, most training sessions were interactive, and participants played an active role in the training. The wealth of their clinical and public health experience was pivotal in tailoring the contents of the training to the local context. Visual aids were used to demonstrate cutaneous presentations of scabies, and role plays were used to assess and comment on their interview skills.

The session on how to use the ODK application mainly employed hands-on exercises after giving an overview on the different features of the application and how the system operates. The afternoon of the last day of the training was saved to conduct pilot interviews and identify whether there were difficulties in using the application in field setting. This exercise was helpful to identify technical issues with the electronic form that were communicated to the ODK developer for further improvement. Alongside field testing the forms I assessed the data collectors' interview skills. Four of the data collectors were proficient, but one required support, so I spent extra hours helping him improve his skills.

5.2.13. Data collection procedures and field activities

The three rounds of data collection were carried out from 05 to 23 December 2018; May 17 to June 1, 2019; and from February 04 to 18, 2020. Each round started off by contacting the local administrative heads and receiving permission to work in the study area. I had no administrative challenges during the arrangement or conduct of the first two rounds of data collection. However, at the time of the field work for the 12-months

survey there was a conflict at the outskirts of the study district. Before commencing the field work, I assessed the level of security risk to the team by discussing with the local administrative officials. Starting the data collection from the *kebele* closest to the nearest town and progressively advancing into the remote *kebeles* was recommended by security officials. This way we got time to check on the developments of the conflict before going close to the borders. In addition, we took contacts of the security office of the district and the team kept in touch with the security officials throughout the data collection period.

Before data collection started, the team, with the help of HEWs and village guides, delineated the boundary of the selected study *Gotes* of the respective *kebeles*. Each *Gote* was delineated by walking the boundaries and identifying its landmarks. Distinguishing the study *Gotes* was not difficult as most were clusters of households in isolation from the households belonging to the next *Gote*. After the delineation was completed, all households of each *Gote* were listed against unique identifiers.

For household level data, household heads were the primary informants. When household heads were not available, another adult member of the household was interviewed. In households where there was no one at home data collectors made three visits before reporting the household as unavailable. To minimise non-response, religious holidays observed by the local community and weekends were used for repeat visits. Household member level data was obtained by interviewing individual members of the study households. For children aged younger than 15 years, parents or guardians were interviewed on their behalf.

During the 6-month and 12-month surveys, when we applied electronic data collection, the poor internet connectivity in most parts of the study area was a challenge to send data to the local server between interviews. Therefore, I collected the phones from the data collectors at the end of each working day and uploaded the data overnight from the zonal capital, Injibara town, where there was a better internet connectivity.

5.2.14. Data management

The baseline survey was conducted using a paper-based interview questionnaire. To maintain data quality, I conducted field data cleaning which involved checking the completeness and consistency of each questionnaire.

This was done before the team left the study area, and questionnaires having issues were returned to the field for corrections.

Data entry was conducted using *Epidata V.3.01* (EpiData Association, Odense) software based electronic templates. The template had features which helped to minimise errors during data entry. Then the data was exported to *Stata-14* (StataCorp LLC, Texas) statistical software for further data cleaning and analysis. The data cleaning targeted incomplete, inconsistent, and outlying values. The electronic records were constantly compared with the data recorded in the paper-based questionnaire. Corrections were made whenever there were disparities between the two versions of the tool.

The electronic data collection employed in the 6-months and 12-months surveys significantly improved data quality and shortened the lead time between data collection and producing the results. However, as indicated in the data collection procedures section, I had to modify the data structure of the 12-months survey to fit the data analysis plan. Once the modifications were completed the final dataset from all the three surveys was transferred to the BSMS administered OneDrive cloud server.

5.2.15. Data analysis plan

Descriptive analysis

Prevalence of scabies was estimated per 100 people with 95% confidence Interval (CI). The prevalence of scabies was calculated for all three data points, and the statistical significance of the difference in prevalence between the three data points was determined from the confidence intervals of the prevalence estimates.

Descriptive analysis was conducted both for variables pertaining to households and individual participants. Frequency of the responses was calculated to all the categorical variables that were involved in the analysis. Percentages of the categorical variables were calculated by dividing affirmative responses to the total responses per 100 people.

Though the mean and median time for a round trip to the nearest water source was equivalent, data on age of the participant and the time it took participants to walk to the nearest health care facility were right skewed. Because of this, median values of the three variables were used to summarize continuous data. To assess the range of dispersion, median scores were reported alongside the observations against the first and third quartiles (Q1-Q3) of the data from the respective three variables.

Participants were categorised into four ten-year age categories. The interval was determined based on previous publications and aiming to capture age-related behavioural patterns that predispose people to scabies infestation. Similarly, the time it took for a round trip to the nearest water source was classified into the categories $\leq$ 5 minutes, 6-30 minutes and $\geq$ 30 minutes. Those who had piped water or ground water in their compound were regarded as spending no time walking to a water source. However, these households were still classified under the category $\leq$ 5 minutes' walk to the water source.

Level of education data was categorised into six: Those who did not have formal education, primary level education, secondary and higher-level education. Formal education includes government and private owned schools, it doesn't include traditional and religious schools. Primary level education comprised grades 1 to 8 and secondary level included grades 9 and 10. According to the Ethiopian formal education curriculum, grades 11 and 12 were considered as college preparatory classes. Therefore, in our analysis participants in grade 9 and above including technical and vocational trainings or those who were either enrolled at or completed university degree were categorised under higher education.

Data from the occupation variable was categorised into five. In all these categories, I considered the main income-generating activity, even though some were engaged in more than one occupation. Since the study population was an agrarian community and pastoral farming was not common farmers were people who managed their own or use rental farms. All who were attending school, regardless of what they would do in the remainder of their time were classified as students. Children younger than school age were categorized under the student category. This was done to align with the classifications used in chapter three of this thesis. The unemployed category included participants who were not engaged in any income-generating activity but were looking for work at the time of the survey. In this community, where farming was the main stay of income generating-activity, men were regarded as the bread winners and women were responsible for domestic chores. With this consideration in mind, I had a separate category for housewives in the questionnaire. However, since I operationalized housewife as those who had no stake in farming related activities participants who fell under this category were very few and I recategorized them as farmers.

The categories under marital status observed both formal and traditional arrangements. Those who lived together were classified under the category of ‘married couple’. Though I originally had a separate category for divorced and widowed/widower, the affirmative responses to this category were few and I had to merge them with the category, unmarried. Participants younger than 16 years of age were not asked the marital status question and the ‘not applicable’ category was used to identify this group.

Though there were no standards for optimal frequency of bathing, I classified it into three (i.e., <1 time, 1-2 times and ≥3 times a week) aiming to further qualify the longer periods used in other studies to determine frequency of bathing (14, 185).

I classified the data on household size into <5 and ≥ 5 people benchmarking the average household size in Ethiopia (212).

Though I envisaged following a cohort of study participants across the three surveys, there was a difference in study participants in the survey rounds. This resulted from variations in the availability of participants at the time of the different survey rounds. The number of participants who participated in all three surveys, and formed a cohort were nine hundred thirty-six. However, the total number of participants in each survey round was greater than the number that formed the cohort. Therefore, in the descriptive statistics I separately analysed and reported the data from the panel and the total participants at each data point.

The cohort data was used to determine the incidence of scabies infestation. It was calculated by dividing the number of new scabies cases (people who developed scabies between the baseline and the 6-month surveys) per 100 participants. This data was also used to calculate the disappearance rate of scabies. The proportion of participants who had scabies at baseline but became scabies free in the six-month survey was calculated per 100 people.

Scabies prevalence was calculated in each survey rounds and these estimates were used to measure the secondar impact of the onchocerciasis MDA on scabies. All the data in each survey round was used to calculate respective scabies prevalence estimates.

5.3. Results

5.3.1. Study population

This chapter determines the secondary impact of ivermectin-based MDA aimed to eliminate onchocerciasis on scabies prevalence and the individuals' risk of acquiring the infestation. I used data from three successive surveys involving a total of 5347 study participants. As the sampling unit were households, only participants who were available at the time of the individual surveys participated in the study. Because of this, there was a difference in the number of study participants across the three data points. The baseline survey involved 1437 (78.9%) participants out of the 1833 potential participants who were part of the study households and the 6-month survey involved 1831 (101.3) participants. In this round 25 more people joined the study households increasing the number of study participants from baseline. 1610 (87.8%) people participated in the 12-months survey. Though the number of study participants at the three data points varies, 936 people constituted the core cohort of study participants who were available in all three data points. The cohort covered 65.1% of the participants of the baseline survey, 51.1% and 58.1% in the 6-months and 12-months surveys, respectively (Figure 5.1).

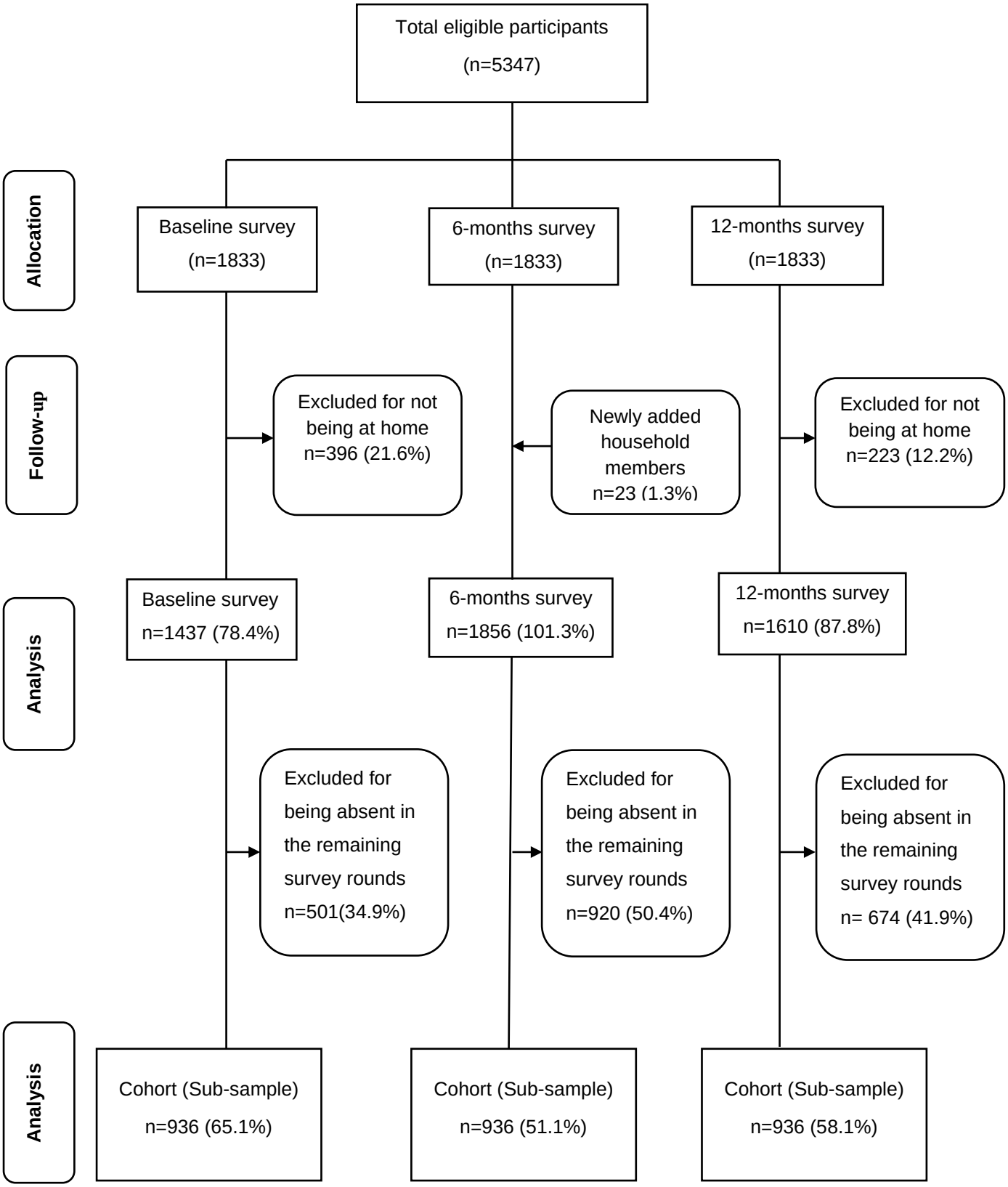

Figure 5.1 Flow diagram for participants of the three surveys and of the cohort.

Table 5.1. illustrates the sociodemographic characteristics of participants in the baseline and 12-months survey. Participants in the 6-months survey also have a comparable distribution across the characteristics indicated this table. The sex distribution of study participants both in the baseline and 12-months survey was equivalent. The median age of the study participants was 19 years in the baseline and 18 years in the 12-months surveys. Participants aged older than 41 making up around 20% of the total participants. This distribution did not differ greatly from the national demographics, where people older than 40 years of age comprised 16% of the total population (205). Participants with secondary level and above education made up 7% at baseline and 4.7% in the 12-months surveys. The remaining participants either had a primary level education or did not have formal education. In both surveys nearly half of the participants were young to be married (children and adolescents younger than 16 years of age) and married people constitute a third of the samples. 34.1% and 11.2% of the participants reported physical contact with a person exhibiting scabies manifestations in the baseline and 12-months surveys, respectively.

A sub-sample of participants were available in all the three surveys. This group of population with a range of background characteristics formed a cohort. The distribution of the cohort population against the background variables is typical of the parent survey data in all the three rounds. The sex distribution is comparable with a slight female preponderance (55.2%). The distribution by age ranged between 20.8%, those aged younger than 10 years, and 29.6% older than 41 years. More than half of the participants (59.5%) did not have formal education. Like participants of the total survey data participants who were young to be married (45.8%) and married people (27.6%) constituted most of the cohort population.

Table 5.1 Sociodemographic characteristics of baseline and 12-months surveys participants

Variables	Categories	Overall		Baseline		12-months	
		Baseline (n=1437)	12-months (n=1610)	No scabies (n=1245)	Clinical scabies (n=192)	No scabies (n=1257)	Clinical scabies (n=353)
Sex	Male	640 (44.5)	785(48.8)	539 (43.3)	101 (52.6)	612(48.7)	173(49.0)
	Female	797 (55.5)	825(51.2)	706 (56.7)	91 (47.4)	645(51.3)	180(50.9)
Age in years	<10	365 (25.4)	424 (26.3)	316 (25.4)	49 (25.5)	331 (26.3)	93 (26.4)
	11 – 18	346 (24.1)	390 (24.2)	287 (23.1)	59 (30.7)	305 (24.3)	85 (24.1)
	19 – 40	435 (30.3)	456 (28.6)	387 (31.1)	48 (25.0)	353 (28.1)	103 (29.2)
	>41	291 (20.3)	340 (21.1)	255 (20.5)	36 (18.8)	268 (21.3)	72 (20.4)
	Median age IQR (Q1- Q3)	19 (10-37)	18(10-38)	20 (10-38)	16 (10-30)	18(10-38)	18(10-38)
Level of education	No formal education*	849 (59.7)	918 (57.2)	745 (60.6)	104 (54.2)	702 (56.0)	216 (61.2)
	Primary education	474 (33.3)	612 (38.1)	401 (32.6)	73 (38.0)	488 (39.0)	124 (35.1)
	Secondary and higher	99 (7.0)	76 (4.7)	84 (6.8)	15 (7.8)	63 (5.0)	13 (3.7)
Occupation	Farmer	737 (52.2)	815 (50.6)	650 (53.3)	87 (45.3)	632 (50.3)	183 (51.8)
	Student	675 (47.8)	795 (49.4)	570 (46.7)	105 (54.7)	625 (49.7)	170 (48.2)
Marital status	Not married	228 (15.9)	181 (11.2)	204 (16.4)	24 (12.5)	148 (11.8)	33 (9.4)
	Married	558 (38.8)	690 (42.9)	487 (39.1)	71 (37.0)	531 (42.2)	159 (45.0)
	Young to be married#	651 (45.3)	739 (45.9)	554 (44.5)	97 (50.5)	578 (46.0)	161 (45.6)
Physical contact with a scabies case	No	947 (65.9)	1429 (88.8)	939 (75.4)	8 (4.2)	1237(98.4)	192 (54.4)
	Yes	490 (34.1)	181 (11.2)	306 (24.6)	184 (95.8)	20 (1.6)	161 (45.6)

*This category comprises children younger than school age
#Participants younger than 16 years of age

The difference in the distribution of participants against sociodemographic variables across the three survey rounds and the overall sociodemographic characteristics of participants who took part in the 6-months survey is described in Table 5.2.

Table 5.2. Sociodemographic characteristics of participants in the three surveys (n=4903)

Variables	Categories	Baseline (n=1437)	6-months (n=1856)	12-months (n=1610)	P-value
Sex	Male	640 (44.5)	916 (49.4)	785(48.8)	0.02
	Female	797 (55.5)	940 (50.7)	825(51.2)	
Age in years	≤10	365 (25.4)	482 (26.0)	424 (26.3)	0.80
	11 – 18	346 (24.1)	472 (25.4)	390 (24.2)	
	19 – 40	435 (30.3)	520 (28.0)	456 (28.6)	
	≥41	291 (20.3)	382 (20.6)	340 (21.1)	
Level of education	No formal education	849 (59.7)	1050 (56.6)	918 (57.2)	0.95
	Primary	474 (33.3)	711 (38.3)	612 (38.1)	
	Secondary and above	99 (7.0)	95 (5.1)	76 (4.7)	
Occupation	Farmer	737 (52.2)	935 (50.4)	815 (50.6)	0.18
	Student	675 (47.8)	921 (49.6)	795 (49.4)	
Marital status	Not married	228 (15.9)	188 (10.3)	181 (11.2)	0.01
	Married	558 (38.8)	793 (43.4)	690 (42.9)	
	Young to be married	651 (45.3)	848 (46.4)	739 (45.9)	
Physical contact with a scabies case	No	947 (65.9)	1597 (86.1)	1429 (88.8)	0.02
	Yes	490 (34.1)	259 (13.9)	181 (11.2)	

Scabies prevalence varied over the one-year follow-up period. In the baseline survey that was conducted in December 2018 the prevalence was estimated at 13.4%, 95%CI (11.7%-15.2%), in June 2019 the prevalence had slightly decreased to 11.7%, 95%CI (10.1%-13.2%). However, the decrease in prevalence was not statistically significant. In the 12-months survey the prevalence estimates showed a significant increase to 22.1%, 95%CI (20.1%-24.1%) (Table 5.3).

The absolute and relative decrease in prevalence between the baseline and the 6-months data was 1.7% and 12.7%, respectively. However, the prevalence estimates in the 12-months survey exceeded the estimates from the baseline and the 6-months surveys. The absolute increase in prevalence between the baseline and the 12-months survey was 8.7% marking a relative increase of 39.4%. The increase in prevalence was even greater between the 6-months and 12-months surveys, with the absolute and relative increase in prevalence being 10.4% and 47.1% respectively.

These estimates were based on the data from all the study participants in each round of the data collection. However, the total number of participants in each survey was greater than the size of the cohort. The 936 participants that participated in all the three surveys, the cohort population, constituted 64.8% of participants in the baseline survey, 50.4% and 58.1% of the 6-months and 12-months surveys, respectively. Though there was a difference in prevalence estimates between the cross sectional data and data from the cohort population the difference was not statistically significant. In the baseline survey scabies prevalence among the cohort was 14.2%, 95%CI (11.9%-16.4), in the six-month survey the prevalence decreased to 12.7%, 95%CI (10.5%-14.9%). Like the estimates in the cross sectional data the prevalence among the cohort increased to 20.2%, 95%CI (17.6%-22.8%) in the 12-months survey (Table 5.3.).

Table 5.3. Scabies prevalence by background characteristics

	Data points		
	Baseline	**6-months survey**	**12-months survey**
Source of data	**Prevalence (95%CI)**	**Prevalence (95%CI)**	**Prevalence (95%CI)**
Age			
≤ 5 years	14.5% (8.8%-20.1%)	11.2% (7.0%-15.4%)	22.8% (16.9%-28.8%)
≥ 6 years	13.2% (11.3%-15.0%)	10.8% (9.3%-12.3%)	21.8% (19.6%-24.0%)
Participated in the last MDA			
Yes	11.8% (9.9%-13.8)	11.3% (9.6%-13.0%)	*NA
No	17.4% (13.6%-21.2)	9.4% (6.7%-12.1%)	*NA
Cohort population	14.2% (11.9%-16.4)	12.7% (10.5%-14.9%)	20.2% (17.6%-22.8%)
Total survey population	13.4% (11.7%-15.2%)	11.7% (10.1%-13.2%)	22.1% (20.1%-24.1%)

*NA represents not applicable as there was no MDA in the past 6 months from the 12-months survey

The rates of scabies incidence and disappearance were calculated for the cohort of participants who were scabies free and diagnosed with the infestation at baseline, respectively. Of the 804 participants who were scabies-free at baseline 87 were diagnosed with scabies at 6-months, giving incidence rate of 10.5% (8.4%-12.6%). The incidence estimate was disaggregated by age and participation in the last MDA. The difference in incidence rate between participants of age younger and older than 5 years was not significant. However, incidence among children younger than 5 years is slightly higher 11.3% (4.6%-18.1%). The overall scabies disappearance rate among scabies cases was 82.6% (76.0%-89.1%). Participating in the MDA affected neither the incidence nor the disappearance rates. Due to the limited number of scabies cases the disappearance rate had low precision with wide confidence intervals. It is possible that studies with more power can observe differences (Table 5.4).

Table 5.4. Scabies incidence and recovery rates at 6-months from baseline

Variables	Incidence rate at 6-monthss (95%CI)	Disappearance rate at 6- months (95%CI)
Age		
≤ 5 years	11.3% (4.6%-18.1%)	72.2% (49.3%-95.1%)
≥ 6 years	10.4% (8.2%-12.2%)	84.2% (77.4%-91.0%)
Participated in the last MDA		
Yes	10.2% (7.9%-12.6%)	83.7% (76.0%-91.4%)
No	11.4% (7.0%-15.8%)	80.0% (67.0%-93.0%)
Total	10.5% (8.4%-12.6%)	82.6% (76.0%-89.1%)

5.4. Discussion

Scabies prevalence varied in the three surveys. At baseline the prevalence was estimated at 13% and in the 6-months survey it decreased to 11%. However, in the 12-months survey, the prevalence increased to 22%. Though there was a modest decrease in prevalence in the 6-months survey the difference was not statistically significant. The biggest difference in prevalence was between the 6-month and 12-months surveys where the prevalence showed a 47% relative increase. Scabies incidence and disappearance rates at six months from the baseline were high. However, the difference in disease prevalence and incidence by background characteristics were not statistically significant.

The reduction in prevalence between the baseline and the 6-months survey was modest. However, findings from previous publications indicated an important reduction in scabies prevalence following ivermectin-based MDA (26, 147). Effective preventative chemotherapies are also able to control outbreaks for years following MDAs (148). In our study, the MDA was carried out right after the baseline survey was conducted and I expected a comparable reduction in the two follow-up surveys, but that was not the case. This lack of significant reduction in prevalence can be mostly explained by nature of scabies, study population characteristics, and methodologic differences between the studies.

This study is distinctive from the preceding studies in objective, study design, and the study setting. The aim of this study was to examine the secondary impact of an MDA targeted to eliminate onchocerciasis. I followed a quasi-experimental approach with no control over the MDA which was organized and carried out by the district health office with the support of the Amhara Regional Health Bureau and organizations partner to the Ethiopian Ministry of Health. At the grassroots level, HEWs were responsible for community mobilization, managing the logistics and training the Health Development Army, who distributed ivermectin tablets to each household (24, 172). Most members of the HDA were busy famers and the harvesting season was upon them. This affected their ability to personally go to each household and directly observe people taking the tablets. Furthermore, the difficult task of addressing misconceptions about the MDA and clearing their doubts was left to the HDA, which may have had a negative implication on adherence.

Nonetheless, in our interview 76.5% of the participants reported taking tablets during the MDA. But this data was not based on direct observation and there is a room for over-reporting as the interview was conducted by health workers who could be presumed by the community to be advocates of the MDA.

Mass drug administration for onchocerciasis elimination prohibits involving pregnant women and children younger than 5-years of age as findings on the safety of the drug for these groups of population is inconclusive (150, 294). Consequently, pregnant women and under-5 children did not take ivermectin tablets during the MDA, and those who were diagnosed with scabies were merely issued a referral slip to get medical attention from the nearby health center. However, a recent systematic review showed that involving children and pregnant women in scabies MDAs and adequately treating all cases identified at baseline are key indicators of an effective MDA (149). In this study even though cases identified at baseline were referred to the nearest health center getting proper care was unlikely due to lack of anti-scabietic drugs in most health care facilities. Therefore, those who had the infestation could have remained as core transmitters of the infestation causing the resurgence. In previous publications, scabies prevalence among children is significantly higher than among adults (7, 13). Since the most important group (under-5 children) was not included in the MDA, the effectiveness of the MDA in undermining the scabies prevalence is likely to have been affected, and this perpetuated the transmission.

In earlier studies, investigators had full control over the intervention, and pregnant women and children were treated using acaricidal creams, recommended for these groups, at baseline (26). Furthermore, stocks of scabicides at health care facilities close to the study areas were maintained as part of the intervention to improve the standard care for scabies patients (26). This way, the interventions covered all potential sources of future outbreaks. Furthermore, in one of the studies, the MDA was followed-up with case finding and treatment of patients and their contacts (148). These focused interventions helped to reduce the risk of resurgence at least in the coming years following the intervention in the reference studies.

The sample population was part of a community in continuous interaction with neighbouring communities from adjacent districts. There were no geographic or other restrictions that impeded their movement or interactions.

It is possible that the modest decrease in prevalence during the first follow-up survey and the increase during the last round survey could be attributed to a reintroduction of the infestation from outside communities. There are no exact estimates of scabies prevalence in the neighbouring districts, however, the estimate for the wider region was remarkably high (35%) (13). In addition, in the eight districts that constitute Agew Awi zone, Ayu Guagusa district was the only district where ivermectin-based MDA was carried out and there was no significant intervention to control scabies outbreak in the remaining districts (205). This could mean easier reintroduction of the infestation from hyper-endemic surrounding districts, cutting short the effect of the MDA on scabies prevalence. In scabies hyper-endemic areas interventions involving small geographic areas do not guarantee lasting control. Since scabies can easily be reintroduced into the community unless control measures cover a wider geographic area (108). A study among a remote island community in Australia by Kearns et.al. found 88% relative increase in prevalence 12-months after a baseline survey. Like the current study the baseline survey was followed by a one-time MDA. Authors attributed this sharp increase in prevalence to the introduction of a crusted scabies case into the community and visitors arriving from the mainland to attend a funeral (150).

Ivermectin is a systemic drug active against scabies infestation (114). Though it can kill the larvae and adult mites, it does not sterilize scabies eggs (295). Therefore, for effective treatment of scabies, two doses of ivermectin should be administered in not less than a one week period (114). This will give enough time for all eggs to moult into larvae, a stage that can be effectively killed by the drug. In previous experimental studies that tested the effectiveness of MDA on scabies prevalence, effective treatment of patients identified at baseline was an integral part of the intervention and helped to clear all potential sources of future transmission at least among the sample population (26, 148, 150). However, in our study, ivermectin was given only once, during the MDA, to all people including sub-clinical and clinical scabies cases. This suboptimal treatment of scabies patients at baseline could have contributed both to the modest decrease in prevalence in the first follow-up survey and the later increase in the 12-months survey.

The WHO informal consultation on the control of scabies highlights the benefits of employing a mix of different intervention strategies at varying disease burdens to effect control (144). In communities with scabies prevalence $\leq$10% standard care is deemed sufficient.

However, when the prevalence exceeds this cut-off, yearly MDA is recommended, until the prevalence drops below 10% (144). However, in our study, the decrease in prevalence following a one-time MDA was not significant. Though there are different explanations for the modest decrease in prevalence following the MDA, this does not rule out the need to critically evaluate whether a one-time annual MDA is enough to control scabies. This recommendation should be contextualized as per the epidemiology of the disease, the strength of standard care in the intervention community, and effective treatment of cases and their contacts who are identified during the MDA. In settings where there is a strong primary health care structure, MDAs can also be coupled with active case finding to control resurgence between subsequent MDAs. Nonetheless, effectiveness of a one-time MDA for the control of scabies needs further investigation in a more controlled environment.

The limitation of this study emanates mainly from the design and conduct of the study. The study employed a quasi-experimental design but without a control arm to the intervention district. The lack of a control arm undermines the ability to adjust for confounding variables that affect the prevalence of scabies other than the intervention. The other limitation of this study is that since the MDA was carried out by the MoH we couldn’t directly observe medication administration. For this reason, our knowledge of individual’s participation in the MDA was primarily based on their verbal report in the interviews. This measure is less accurate and prone to social desirability bias.

5.5. Conclusions and recommendations

5.5.1 Key findings

The ivermectin onchocerciasis MDA did not reduce scabies prevalence between the baseline and the 12-months survey. However, it might have contributed to the modest decrease in prevalence at 6-months after the baseline survey, even though, the decrease was not statistically significant. The prevalence estimates in all the three surveys (i.e., baseline, 6-months, and 12-months) was high and the estimate in the 12-months survey was the highest with a significant increase from the estimate in the baseline survey. The MDA involved administering a single dose of ivermectin to a community living only in one district, in Agew Awi zone. Pregnant women and children under 5 years of age did not participate in the MDA.

Using data from a sub-sample that comprised the cohort of study participants, scabies incidence and disappearance rates were calculated at 6-months from the baseline. One in ten of the participants who were scabies free at baseline developed the infestation in the 6-month period from the baseline.

Disappearance rates were calculated of those who had scabies at baseline and were scabies free in the 6-months survey and 82% of the participants have recovered from the infestation in the period between the baseline and the six-month survey.

5.5.2 Policy recommendations

In the period studied the single dose ivermectin MDA did not impact scabies prevalence. The following optimizations to the onchocerciasis MDA may help bring an off-target impact on the prevalence of scabies. Increasing the number of doses of ivermectin per MDA, involving all groups of population in the MDA, widening the geographic coverage of the MDA. It is likely that the single dose ivermectin tablet did not effectively treat people who had scabies at the time of the intervention. Giving dose of ivermectin optimal to cure scabies may enhance its effectiveness. Therefore, two doses of ivermectin separated by a minimum of one week period is a therapeutic dose for scabies. However, the operational challenges associated with administering two doses needs further investigation.

The onchocerciasis MDA does not involve pregnant women and children aged younger than 5 years. Younger children are important sources of scabies infestation and leaving out this population subgroup undermines the secondary impact of the onchocerciasis

MDA on scabies and is a potential to initiate future outbreaks. Future ivermectin onchocerciasis MDAs should consider administering permethrin topical ointment or other scabicides that are safe to these population subgroups need to be considered.

Strengthening standard care for scabies and promoting access to these services should go together with MDAs. In settings where there is a conducive primary health care system, active case finding, and subsequent treatment of cases and their contacts would be important to prevent resurgence.

However, the effectiveness of all the recommended interventions is determined by the disease distribution and the degree of interaction of the intervention community with people in the neighbouring communities. MDA targeting a community that is in constant interaction with neighbouring communities that possibly has a high scabies burden may not bring a lasting reduction in the prevalence of scabies due to possible re-introduction of the disease into the intervention community. For this reason, MDAs should consider covering wider geographic areas, which are eligible to scabies MDA, to prevent re-introduction of the disease.

I also argue that MDA being carried out only once a year could have contributed to its insignificant immediate impact and rather an increase in the long-term. Increasing the frequency of the MDA two times per year may help decrease the prevalence of scabies.

5.5.3 Future research

The findings from this research are not conclusive as there were gaps in the design. First, I did not have full control over the intervention and studies of this nature are prone to bias. Future research needs to consider employing experimental study design in the context of an ongoing ivermectin MDA for onchocerciasis to minimise the bias associated with the quasi-experimental nature of the current research. The research agenda for possible future experimental studies should include determining the effective dose of ivermectin per round of a preventive chemotherapy and how many rounds a year is optimal to bring down the prevalence of scabies.

5.5.4. Doctoral candidate development

The longitudinal nature of this research was an important addition to my research project management skills. Field work preparations for three survey rounds that required arranging logistics, communicating with health system administrators and local gate

keepers, recruiting data collectors, and identifying study kebeles and study households in each round gave me ample exposure to project management. What is unique to this design is that I could learn from earlier rounds of data collection and make improvements to the way things are managed in the later rounds. One of the changes I made was shifting from paper-based to electronic system of data collection in the 6-months and 12-months surveys. To increase response visiting households during holidays and weekends to meet participants who were not available at home during the first visit. Engaging security officials before starting the field work so that they would be aware of our presence in the field and provide us with the necessary guidance. These were some of the improvements made to the field operations in the successive survey rounds.

The ivermectin onchocerciasis MDA was carried out by the Ministry of Health and our role was merely evaluating the impact. However, to have a good understanding of the conduct of the MDA I stayed in the field, after the baseline survey, and made field observations. I observed the community mobilization campaign, orientation sessions for HEWs who led the MDA activities at the grass roots. I witnessed first-hand when drug administration was carried out. This field observation gave me practical experience far more than what I read in the onchocerciasis MDA protocol documents.

Data management aspects of the study was challenging. Particularly linking the data on participants who were available across the three rounds and stablishing the cohort created some difficulties. The data management software needs to uniquely identify individual cases to link the dataset from the three rounds. To create unique identifiers for each participant, I had to combine codes of several variables included in the baseline survey such as *kebele, gote*, household and household member codes. However, in the follow up surveys the identifiers generated at baseline were labelled on the data collection forms before the start of the data collection. This addressed the challenge I had in linking the dataset from the subsequent rounds.

Chapter Six

Summary of main findings, public health implications, and conclusion

Chapter 6 : Summary of main findings, their public health implications, policy, and research recommendations

This thesis has built on the existing literature to bring new insights from original field research, which shines new light on the complex and challenging problem of the NTD scabies in Ethiopia. Publications on the clinical aspects of scabies, its epidemiology and public health implications were reviewed and documented to determine what is known, so far, about scabies. A systematic review was conducted on articles concerning scabies in Ethiopia. This review helped to view the local evidence gap in the light of the existing global knowledge on scabies. Data on disease epidemiology, at a population level, and the impact of scabies on aspects of life beyond physical health are limited. In this project I estimated scabies prevalence, identified the determinants and measured its effect on life quality of patients. The epidemiologic data generated in the process was an input for the main research that investigated the spill over effect of ivermectin onchocerciasis MDA on the prevalence of scabies.

6.1. Key findings

Scabies being one of the NTDs targeted for control by 2030 there is a growing need for scabies data globally. However, the evidence on scabies is limited and the existing publications are mostly from facility-based studies (health care facilities, schools, and care homes for the elderly). This limits our understanding of the disease burden in the general population. There are few community-based studies, but most of these studies are from high scabies burden settings. In Ethiopia, scabies outbreak was reported in 2015 and to design control interventions local data on the disease epidemiology and the effectiveness of control interventions is required. This added to the need for local evidence apart from the global initiative to generate data on all NTDs. However, the systematic review aimed to generate synthesis of the published knowledge of scabies in Ethiopia indicated the considerable gap in scabies research. In the past 25 years there were not more than 22 scabies related publications and nearly three quarters of these articles were published in the past five years. Apart from the limited number of research work, the research agenda addressed, the narrow scope and skewed geographic distribution of the studies limited our understanding of the disease.

Most of the studies were descriptive and aimed to measure disease burden and identify associated factors with scabies infestation. None of these studies investigated implications of the disease on social functioning and life quality of scabies patients. Such data is vital to understand the complex process of disease causation and the far-reaching impacts of the infestation on individuals' wellbeing and community health. Chapter four of this thesis addresses the knowledge and perception of the community toward scabies and the effect of the infestation on life quality of patients. To my knowledge there is no local evidence that addressed the research agenda thereof. The cumulative effect of scabies on life quality of patients was moderate with variations in the extent of its effect on different aspects of life. From the questions included in the Cardiff DLQI tool items pertaining to unfavorable sensations from the affected skin (such as itch, pain, soreness, and stinging sensations) and the impact of the infestation on the patient's feelings (embarrassment and self-consciousness) scored high. This is also reflected in the community perception data which indicated a covert stigma attached to scabies patients. People preferred to avoid scabies patients and the same sentiment is believed by the participants to be shared by the community at large. Though my data does not have sufficient depth to make conclusions, fear of transmission can be one reason for the rejection of scabies patients. These findings indicate that the effect of scabies on the wellbeing of the infested person goes beyond one's physical health into social and mental wellbeing, and control interventions should target all aspects of individual's life that can be affected secondary to the infestation.

The geographic distribution of scabies studies conducted in Ethiopia so far only covered a limited area. In the systematic review (chapter 2), out of the 12 regions of Ethiopia, scabies studies only involved five regional states and nearly half of the publications were from Amhara regional state. Though there are reasons for the skewed geographic distribution of scabies studies, it has limited our understanding of the disease burden and distribution at the national level. The considerable sociocultural differences between the regions further contributes to the incomprehensive understanding of the epidemiology of scabies in Ethiopia that originates in the studies conducted thus far. Cognizant of the need to study scabies epidemiology in diverse settings, I estimated the prevalence in a district where there was a long standing ivermectin onchocerciasis MDA. Both in the baseline survey, detailed in chapter thee, and successive survey rounds scabies prevalence in the district was high.

Considering ivermectin is also an effective acaricidal used to treat scabies I originally expected the prevalence would be lower than the estimates for areas where there were no similar interventions.

The impact of the ivermectin MDA against onchocerciasis on the prevalence of scabies was investigated by conducting three successive surveys over a one-year period. The marginal decrease in scabies prevalence in the 6-months survey and rather an increase in the 12-months survey round indicated that the MDA did not have a secondary impact on scabies prevalence in the study period. However, lack of scabies prevalence data prior to the baseline survey and the absence of control clusters limited the observation only to the changes in the study period. Due to these limitations, I cannot rule out the possibility of the MDA decreasing the burden of scabies from an even higher magnitude.

6.2. Policy recommendations

Due to its high prevalence, rapid transmission and future sequelae, scabies is a pressing public health challenge in Ethiopia. Based on the findings of studies conducted in the past few years, the overall scabies prevalence in Ethiopia is high. This was also true in all the three successive surveys I conducted in Ayu Guagusa district, northern Ethiopia. In this district there had been ivermectin onchocerciasis MDA since 2015. In this study, I evaluated the secondary impact of the MDA carried out near the end of 2018 on the prevalence of scabies. The MDA did not have impact on the burden of scabies in the study period. In all the three survey rounds the prevalence remained high, with the estimate in the 12-months survey being even higher than at baseline. The WHO informal consultation on the control of scabies recommends, in settings where community-based prevalence estimate is greater than 10% MDA employing effective scabicides should be used until the prevalence decreases below 2% (144). The ongoing ivermectin MDA against onchocerciasis was expected to impact the high scabies prevalence in the district, but this did not happen. Therefore, optimizing ivermectin onchocerciasis MDA is needed to cause a secondary impact on the prevalence of scabies.

MDA against onchocerciasis excludes pregnant women and children younger than five years of age. Leaving out these subgroups creates a medium for scabies to continue circulating in the community even after the MDA is carried out. Future onchocerciasis MDAs should cover these important sub-groups with drugs that are safe for use in

young children and pregnant women. Ivermectin is a systemic drug, and its administration is more convenient than other topical acaricides. For this reason, ivermectin is recommended for use in MDAs against onchocerciasis, lymphatic filariasis and scabies. So far, except for a general understanding that ivermectin is a safe drug, there is no conclusive evidence on the safety of using ivermectin in children and pregnant women. However, there are studies which indicate that its use among infants and young children does not cause serious adverse events (296). If ivermectin is approved for use in young children and pregnant women, onchocerciasis MDAs could cover all groups in intervention communities. Until then, the onchocerciasis MDA should include scabicides that are safe and effective in young children and pregnant women to enhance the impact of onchocerciasis MDAs on scabies.

The dose of ivermectin and frequency of administration is the other point to consider in optimizing onchocerciasis MDA. Currently, a single dose of ivermectin is administered in each round of onchocerciasis MDA. Typical dosing of ivermectin to treat scabies is two doses separated by one to two weeks period. The reason for this is that ivermectin can kill the larva or adult stages of the parasite, but not the eggs; and so, after a single dose, the eggs will later hatch, propagating the infestation. This may be one of the reasons that the onchocerciasis MDA did not reduce scabies infestation, during the study period. Future onchocerciasis MDA should consider increasing the number of doses of ivermectin administered per round of the MDA. This would enhance effectiveness of the MDA in treating people with scabies, suppressing disease propagation even after the MDA campaign. However, the cost-effectiveness of administering two doses of ivermectin needs further investigation. Data availability on co-endemicity and the threshold to initiate integrated MDA for the two disease needs further study.

MDAs are more effective against communicable diseases in a more controlled environment, where community members have limited interaction with people in neighboring communities. In the case of our study community, people living in the intervention district had regular interactions with people from neighboring districts due to numerous social events. However, the MDA only targeted Ayu Guagusa district avoiding adjacent districts where scabies endemicity was likely. This limited geographic coverage of the MDA, primarily guided by the epidemiology of onchocerciasis, could have allowed reintroduction of scabies from the adjoining districts undermining the impact of the onchocerciasis MDA on the prevalence of scabies.

Future integration of onchocerciasis and scabies MDAs need to consider determining the epidemiology of both diseases before conducting the MDA. In circumstances where scabies is endemic in neighboring communities, onchocerciasis MDA should be combined with preventive chemotherapy in the neighboring districts to the intervention district.

The contribution of strengthening standard care alongside MDAs should not be ignored. Though optimized onchocerciasis MDA is likely to cure most scabies cases, promoting access to scabies care will help maintain the gains from the MDA. Once scabies prevalence is lower than 2% the MDA will be stopped, and it will be up to the standard care to maintain this low prevalence and prevent future outbreaks. Furthermore, MDAs are dependent on the commitment of donors in providing the drugs until local government can finance drug procurement for MDAs. In addition, organizing MDA campaigns is expensive and draws on the limited time of health workers. These resources are limited in under-resourced settings where there is a high burden of scabies. Therefore, strengthening standard care may help prevent recurrent outbreaks and minimize the need for MDAs.

In Ethiopia, geographic access to healthcare facilities and the availability of scabies care in existing facilities is limited. Though infectious diseases are priorities within Ethiopian health policy, most NTDs including scabies have had insufficient policy and programmatic attention. However, following the outbreak in 2015, scabies was made one of the weekly reportable diseases in the Ethiopian Integrated Disease Surveillance and Response (IDSR) system. This is a step forward for early detection and response to scabies outbreaks. Other than this important development in scabies surveillance, response to outbreaks and access to standard scabies care needs further strengthening. There needs to be a constant supply of scabicides in all primary health care facilities so that all seeking care will get a timely treatment.

In the Ethiopian health system, the health extension program can be used as a platform to bring services closer to the community. Currently, health extension workers are actively participating in NTD MDA programs such as those for LF, onchocerciasis, trachoma, and scabies but they do not provide standard clinical care for any of these diseases.

However, in the presence of diagnostic algorithms validated for use in the context of the local skin disease epidemiology, and scabicides that are safe for use in field settings, providing scabies care at the lowest level of the primary health care unit may help promote access.

Beyond the impact of scabies on the physical well-being of patients, it undermines the life quality of patients. For this reason, improving life quality should be one of the main objectives of scabies care. This may mean symptomatic treatment, alongside administering acaricides, to reduce effects on life quality secondary to the symptoms such as itch and skin lesions.

The significant impact of scabies on self-perception and feelings of patients is partly a result of the community's attitude towards scabies and its symptoms. There is covert stigma attached to scabies and a considerable proportion of the community would rather avoid scabies patients. To improve its effect on this life quality domain and enhance overall knowledge of the community toward scabies, evidence based educational interventions are important. The presence of a significantly high proportion of participants who wish to know more about scabies presents a good opportunity for the effectiveness of such interventions.

6.3. Future research

Scabies is one of the under researched diseases globally and in Ethiopia. Based on the review of all publications in the past 25 years, I found only few articles in peer reviewed journals on any aspect of scabies in Ethiopia, and these publications mainly emanated from studies conducted in Amhara region. Amhara is the region most affected by the latest scabies outbreak. This partly explains why most of the more recent articles are from this area. However, the skewed distribution of publications limits our knowledge of the disease in Ethiopia to the data mainly from Amhara and few more regions. This necessitates alternative source of scabies data that is representative of most parts of the country.

Scabies was included among the list of weekly reportable diseases under the IDSR system of Ethiopia in 2015. This was an important step to generate real time scabies related data. However, the surveillance system only captures scabies patients visiting health care facilities.

According to the baseline survey data health care seeking for scabies is low (32.3%) indicating that the data from the IDSR system could underestimate the disease burden in the general population. This signifies the need for large scale population-based study that can estimate the national level prevalence and determine its distribution to guide community-based control interventions.

Apart from generating data that can help target areas of high prevalence more data is needed to ensure control interventions address the multifaceted impacts of scabies on individual patients and the community. As indicated in the preceding chapters of this thesis scabies affects physical well-being, life quality and social functioning of patients and this will have a collective impact on the community at large. However, its effect on the role of people in their communities and the community's perception of scabies needs in depth analysis. Such data is also vital to contextualize control interventions in a way that fits the sociocultural context and along the way increasing the effectiveness of interventions. To this end, research methods used in social sciences can be adopted to have a deeper understanding of the effect of community perception on social functioning and life quality of scabies patients.

Despite the high burden of scabies and the need for effective control interventions evaluative research that measures the effectiveness of the different scabies control strategies, including MDAs, is very sparse. There are a few evaluative research that measured the effectiveness MDAs for specific MDAs and even fewer generated data that help integrating control interventions. Since scabies and other NTD control interventions are carried out in an existing sociocultural ecosystem more research is needed to generate data on a range of health system, social and cultural factors that are barriers to effective intervention.

This project aimed to evaluate the secondary impact of MDA against onchocerciasis on scabies. Pregnant women and children younger than five years did not take part in the intervention. Given scabies has high prevalence among young children failing to cover this segment of the population with the intervention undermines its effectiveness in reducing scabies prevalence. Future evaluative research should consider covering this group of population with safe acaricides such as topical creams. This way I will be able to address sources of infestation that undermine its effect on scabies epidemiology and help measure the secondary impact with a better accuracy.

I evaluated the secondary impact of the MDA over a period of 12 months. In this short period, I observed a significant change in the epidemiology of scabies. This signifies the need to investigate the long-term impact of MDAs on the disease epidemiology. This recommendation goes to studies that aim to measure both the primary and secondary impact of MDAs on scabies.

The limited control I had over the intervention was one of the major limitations of the study design (quasi-experimental) I employed. Future research with direct control over the intervention including directly observed administration of ivermectin will help to minimize bias. Future experimental studies with more intervention arms and a control group are necessary to measure the impact of changes in drug dose and rounds of MDAs has on disease prevalence.

6.4. Doctoral candidate development

Participating in various aspects of the PhD training program and leading my research project helped me develop as an independent researcher. Identifying a research question, determining the research approach fit to address a research agenda, and developing a statistical analysis plan and undergoing analysis are some of the areas that I have significantly improved since I joined the program. Research management is another skill I developed in the past few years of conducting my PhD research project.

It was the first time that I conducted a systematic review, evaluated a health intervention, the MDA, using longitudinal data, and assessed the impact of a health condition on life quality of patients. The process of conducting these studies and the subsequent development of each chapter helped me acquire knowledge on a range of research methods that can be used to answer the different research questions. To this end, I had to attend online lectures, read articles, and discuss with supervisors. Apart from enhancing my knowledge on the subject matter, the exercise also taught me how to synthesize knowledge from different resources. Determining the procedures needed to address the research objective, noting my personal knowledge and skill gaps to undergo the procedures, identifying the right sources of information, and synthesizing knowledge from these sources were the main steps involved in the process of building capacity to conduct the study.

Engaging in my PhD research project (which spanned developing the protocol, leading the field work, and conducting the analysis) enhanced my research project management skills. For most part, the project management skill I acquired was a result of experiential learning. Involving the scabies focal person of the Ethiopian MoH when introducing the project to regional and local health office administrators was key to facilitating the research team's communication with local experts and health office heads. Subsequently, I involved the leadership of zonal and district health offices and NTD program focal persons in planning the field work. These discussions were very important to understand the local context, decide when would be the right time to conduct the field work, who the gate keepers of each community were and how to contact them. In addition, the support I got in recruiting data collectors, who were clinicians working for different health facilities in the district and securing permission to keep them in the field for several weeks was a major support to the project. In the last two surveys there was recurrent conflict around the borders of the study district. In our discussions with the local authorities, security was one of the discussion points and steps I needed to follow to ensure the safety of the team were suggested. These are some examples of the benefits I obtained by engaging local stakeholders early on in planning the field work and this is one of the important lessons I learned in organizing and conducting the field work.

Data management was one of the challenges I faced in my PhD journey. The baseline survey was conducted using paper-based survey tools. Due to the large number of participants, data cleaning and data entry activities took a long time. Learning from this I shifted to an electronic data collection system for the remaining two survey rounds. Android application enabled smart phones were used for the data collection. This system significantly enhanced data quality and shortened the turnaround time to start data analysis. However, generating unique identifiers for people who participated in all the three rounds was demanding because of the shift from paper-based to electronic data collection. I had to go line-by-line and make sure that it was the same people who participated in all the three rounds which formed a cohort of participants, a sub-sample of the bigger dataset.

In summary my PhD journey had rewarding moments and challenges. However, all these encounters were necessary to equip me with the necessary skillset to become an independent researcher. At this juncture I am confident that I have developed the skills necessary to start a carrier in research.

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Annex

Annex A: List of background variables involved in the baseline survey

Variable	Definition
Age	Age was reported in completed years.
Sex	Sex of the study participants was determined based on the data collector's observation of the participants' sex.
Marital status	Participant reported marriage arrangements and observing both the legal and cultural arrangements.
Education	The highest level of schooling the participant had, and it was reported in completed grades.
Occupation	Any income generating activity, including self-employment or as an employee of a public or private organization.
Household member	An individual who regularly lived with the household. For individuals who occasionally stay away from the household, their membership status was determined as per the perceptions of the respondents.
Household size	The total number of household members.
Household wealth	Households were categorised based on household asset ownership. Principal component analysis was used to categorized households into wealth quintiles, from the poorest to the richest households.
How many rooms does the household occupy	Refers to functional rooms the household uses on regular bases, excluding bathrooms, kitchens, and storage spaces.
How large is the total living space	The total floor area of the living space, omitting the part covered by bathrooms, kitchens, and storage rooms.
How many members of the household regularly sleep in the main house	Refers only to household members who regularly spend a night in the house where majority of the household members lived in.

Variable	Definition
Do you have a separate bedroom in your house	Separate bedroom is a room dedicated mainly for members to spend the night in.
How many members of your household regularly sleep in each bedroom	The number of household members who regularly sleep in the bedroom, this definition excludes members who sleep in any other room or outside of the living house.
What is the size of the room you sleep in	Floor size of any room, other than a bedroom, where a participant claims to sleep at night on a regular basis.
Sleeping space	A space where the participant sleeps on at night-time, it includes bed, mattress, or a floor mat.
What is your typical sleeping arrangement	This question asks about the typical sleeping arrangement of the participant, regardless of whom he/she shares a sleeping space with. This question does not consider sexual relations.
In the past two months how often did you share sleeping space	The number of nights the participant has shared sleeping space is counted, but the duration of stay of the participant with the other person is not considered.
How often do you take bath	The number of times in a week where the participant washes his/her whole body.
Do you use soap or other detergents when you take bath	The soap could be a factory produced detergent or traditional herb commonly used to take bath or wash clothes with
Water point	Any kind of water source including river, spring, ground, or piped water source.

Variable	Definition
What is the main source of water used by your household to wash your clothes	The source of water used by the household to wash clothes for good part of the year.
How long does it take to go to the water source and come back	The time it takes to fetch water from the main source of water and get back home. This also includes the time spent in queue waiting to get to the water source.
How often do you wash your clothes	The number of times the participant washes or has the clothes (including underwear) washed per week.
Distance from the nearest health care facility	Walking distance to the to the health care facility regarded close by the participant.
Have you received a medication to prevent onchocerciasis in the past 6-months	Whether the participant took ivermectin tablets during the MDA campaign against onchocerciasis

Annex B: Information sheet for respondents of questions in the household questionnaire

Study Title: How common is scabies and what is the best way to reduce it.

Hello. My name is _____ and I am working for the Addis Ababa University, College of Health Sciences. We are conducting a study about the skin disease scabies. We want to know how common it is, and who is most likely to get it and check wether the drug you have been taking to prevent onchocerciasis decreases the possibility of acquiring scabies. We hope you will take part in this study. The information you give will help us inform the government to develop better strategies to control scabies.

Any information you give us will be kept strictly confidential and will not be shown to anyone other than members of our survey team.

It is up to you whether you take part. If we ask you any question you don't want to answer, just let me know and I will go on to the next question or you can stop the interview at any time. However, we hope that you will take part in survey since your views are important.

First, I am going to ask you questions about your household members. We would then like to ask a different set of questions to each individual member of this household.

Do you want to ask me anything about the study?

If you have any questions related to the study; or want to have the information you give dropped at any time even after we leave the study area you may contact

Dr. Abebaw Fekadu (Head, Center for Innovative Drug Development and Therapeutic Trials for Africa (CDT-Africa), Addis Ababa University)

- Phone: 251-912-894975
- Email: abebaw.fekadu@aau.edu.et

Mr. Robel Yirgu (Center for Innovative Drug Development and Therapeutic Trials for Africa (CDT-Africa), Addis Ababa University, Co-investigator)

- Phone: 251-924-40718
- Email: bsms9g1z@sussex.ac.uk

To report on research ethics related matters, you can communicate Addis Ababa University, College of Health Sciences Institutional Review Board (IRB) based at Tikur Anbessa Hospital Campus. (Phone- 251-118-961396)

Annex C: Consent form for the respondents of the household roster

Name of the researcher and School: Robel Yirgu; NIHR Global Health Research Unit on Neglected Tropical Diseases, Brighton, and Sussex Medical School; Centre for Innovative Drug Development and Therapeutic Trials for Africa (CDT- Africa).

	Please tick box	
	YES	**NO**
• I consent to being interviewed by the researcher	☐	☐
• I understand that any information I provide is confidential, and that no information that I disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party	☐	☐
• I have read the information sheet, had the opportunity to ask questions and I understand the principles, procedures and possible risks involved.	☐	☐
• I understand that my personal data will be used for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with data protection legislation.	☐	☐
• I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.	☐	☐
• I agree to take part in the above Addis Ababa University and Brighton and Sussex Medical School (BSMS) research project.	☐	☐

Name:

Signature:

Date:

Annex D: Information sheet for individual participants of the study

Study Title: How common is scabies and what is the best way to reduce it.

Hello. My name is _____ and I am working for the Addis Ababa University, College of Health Sciences. We are conducting a study about the skin disease scabies. We want to know how common it is, and who is most likely to get it and check wether the drug you have been taking to prevent onchocerciasis decreases the possibility of acquiring scabies. We hope you will take part in this study. The information will help us inform the government to plan better strategies to control scabies. The interview usually takes between 10 to 15 minutes. Whatever information you provide will be kept strictly confidential and will not be shown to anyone other than members of our research team.

Participation in this study is voluntary, and if we should come to any question you don't want to answer, just let me know and I will go on to the next question; or you can stop the interview at any time. However, we hope that you will participate in this study since your views are important.

There are no direct personal benefits to being involved in the study. Some participants may feel a sense that they are helping others by being involved in research that will help better understand circumstances surrounding scabies in the community, since this information will help us inform the government to better plan scabies control strategies.

The study will not cause any harm other than the time you spend responding to our questions. If you have any questions related to the study; or want to have the information you give dropped at any time even after we leave the study area you may contact: Dr. Abebaw Fekadu (Head, Center for Innovative Drug Development and Therapeutic Trials for Africa (CDT-Africa), Addis Ababa University)

- Phone: 251-912-894975
- Email: abebaw.fekadu@aau.edu.et

Mr. Robel Yirgu (Center for Innovative Drug Development and Therapeutic

Trials for Africa (CDT-Africa), Addis Ababa University, Co-investigator)

- Phone: 251-924-40718
- Email: bsms9g1z@sussex.ac.uk

To report on research ethics related matters, you can communicate the Addis Ababa University, College of Health Sciences Institutional Review Board (IRB) based at Tikur Anbessa Hospital Campus.

- Phone- 251-118-961396

Annex E: Consent form for participants of the individual participant interviews

Name of the researcher and School: Robel Yirgu; NIHR Global Health Research Unit on Neglected Tropical Diseases, Brighton, and Sussex Medical School; Centre for Innovative Drug Development and Therapeutic Trials for Africa (CDT- Africa).

	Please tick box	
	YES	**NO**
• I consent to being interviewed by the researcher	☐	☐
• I understand that any information I provide is confidential, and that no information that I disclose will lead to the identification of any individual in the reports on the project, either by the researcher or by any other party	☐	☐
• I have read the information sheet, had the opportunity to ask questions and I understand the principles, procedures and possible risks involved.	☐	☐
• I understand that my personal data will be used for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with data protection legislation.	☐	☐
• I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.	☐	☐
• I agree to take part in the above Addis Ababa University and Brighton and Sussex Medical School (BSMS) research project.	☐	☐

Name:

Signature:

Date:

Annex F: Interview questionnaire for the baseline survey

Household Questionnaire

Questionnaire.ID		_____				
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**				
IDENTIFICATION **Please record the following identifying information prior to beginning the interview.**						
001	**Name of the interviewer**					
002	**Profession of the interviewer**					
003	**Date and time**	Date	Month	Day	Year	
004a	**Region**	Tigray .....1 Afar.....2 Amhara.....3 Oromia.....4 Ethiopia Somali.....5 Benishangul Gumuz .....6 SNNPR.....7 Gambella .....8 Harari.....9 Addis Ababa .....10 Dire Dawa.....11				

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
004b	**Zone**		
004c	**District**		
004d	**Locality (Kebele) name**		
004e	**Gote**		
005	**Household number**	Number [ ]	
006	**Number of visits to the house hold?**	Number [ ]	
007	**Respondents first name**		
008	**Relationship of the respondent to the study household?**	HH member……..1 Neighbor……2 A friend of the family……3 Community leader……4 Don't know……-88 No response……-99	

SECTION 1.1 – Household Roster **I am now going to ask you a series of questions about usual members of the household**								
Name of HH member	**Relationship to head of the HH**	**Age at the last birth day**	**Gender**	**Education**	**Marital status**	**Occupation**	**Scabies symptoms**	**Referred for verification**
	101.What is (name) relationship to (name of the head of the HH)? Head……..1 Wife/Husband...2 Son/Daughter…3 Son/Daughter-in-law .....4 Grandchild…..….5 Parent.……6	102.How old is (name)?	103.Is (name) male or female? Male……1 Female……2	104.What is the highest level of school (name) attended? *Document the last completed grade.* Never Attended..... 0 Primary ..... 1 Secondary ..... 2 Technical & vocational 3 Higher 4	105.What is (name) marital status? Married..... 1 Living with a partner ..... 2 Divorced / separated..... 3 Widow /	106.What is (name) occupation? Farmer…..1 Government employee..2 Daily laborer..3 Merchant..4 Student…5 Unemplyed.6	107.Did (name) complain itchy skin rash/papules in the past two months? Yes…….1 No……...2	108. The participant is sent for verification? Yes…….1 No……...2

	Parent in law…..7 Brother/Sister…8 House help…….9 Other_____ Don't know……-88 No response.…-99			No response…….-99	widower..... 4 Never Married.. ..... 5 NA…….6 Don't know…-88 No response.-99	Notapplicable..7	No response…-99 Don't know-88	

CHAPTER - I - HOUSEHOLD CHARACTERISTICS

SECTION-1 HOUSEHOLD CHARACTERISTICS

Section 1. 2 – Household asset

Now I would like to ask you a few questions about the asset your household owns, this information helps us to assess the contribution of household wealth to the health status of members of the household

NO	QUESTIONS AND FILTERS	CODING CATEGORIES	Skip to:
109	**Please tell me about the items your household owns. Does your household have:** *Read out all types and select all that apply.* *If an item is reported broken but said to be out of use only temporarily, select the item. Otherwise do not select the item.*	Electricity ..... 1/0 A watch/clock ..... 1/0 A radio..... 1/0 A television..... 1/0 A mobile phone ..... 1/0 A non-mobile telephone ..... 1/0 A refrigerator ..... 1/0 A table..... 1/0 A chair..... 1/0 A bed with cotton/sponge/spring mattress ..... 1/0 An electric mitad..... 1/0 A kerosene lamp/pressure lamp.... 1/0 A bicycle..... 1/0 A motorcycle/ scooter..... 1/0 An animal-drawn cart ..... 1/0 A car/truck..... 1/0 None of the above.....-77 No response.....-99	

110a	**Does this household own any livestock, herds, other farm animals, or poultry?** *These livestock can be kept anywhere, not necessarily on the homestead.*	Yes..... 1 No ..... 0 No response.....-99	0 → 111a
110b	**How many of the following animals does this household own?** **Zero is a possible answer. Enter -88 for do not know. Enter -99 for no response.** *The household can keep the livestock anywhere but must own the livestock recorded here.*	Milk cows/bulls/oxen [ ] Horses/donkeys/mules [ ] Camels [ ] Goats [ ] Sheep [ ] Chickens [ ] Beehives [ ]	
110c	**Are any of the livestock, herds, other farm animals, or poultry kept in the homestead?**	Yes.....1 No.....2 Don't know.....-88 No response.....-99	0 → 111a
110d	**Which animals are kept in the homestead?** *Only refer to those animals which were mentioned in 109c*	Milk cows/bulls/oxen .....1 Horses/donkeys/mules.....2 Camels.....3 Goats.....4 Sheep.....5 Chickens.....6 Don't know.....-88 No response.....-99	

The next questions are about the source of water your household regularly use for different purposes.			
111a	**Which of the following water sources does your household use on a regular basis for any part of the year for any purpose?** *Read out all types and check all that are used.*	Piped Water Piped into dwelling/indoor.. 1/0 Pipe to yard/plot……... 1/0 Public tap/standpipe ……1/0 Tube well or borehole ……1/0 Dug Well Protected Well ……..1/0 Unprotected Well ……1/0 Water from Spring Protected Spring ……..1/0 Unprotected Spring ……1/0 Rainwater ……1/0 Tanker Truck ……1/0 Cart or Bicycle with Small Tank …1/0 Surface water (River / Dam / Lake / Pond / Stream / Canal / Irrigation Channel) ……..1/0 Bottled Water ……...1/0 Sachet Water ……1/0 No Response _____ -99	

111b	**What is the main source of water used by your household to take shower?** *Read out Q110a selections only.*	Piped Water Piped into dwelling/indoor.. 1/0 Pipe to yard/plot……... 1/0 Public tap/standpipe ……1/0 Tube well or borehole ……1/0 Dug Well Protected Well ……..1/0 Unprotected Well ……1/0 Water from Spring Protected Spring ……..1/0 Unprotected Spring …….1/0 Rainwater …….1/0 Tanker Truck ……1/0 Cart or Bicycle with Small Tank …1/0 Surface water (River / Dam / Lake / Pond / Stream / Canal / Irrigation Channel) ……..1/0 Bottled Water ……...1/0 Sachet Water ……1/0 No Response _____ -99	

111c	**What is the main source of water used by your household to wash cloths?** *Read out 110b selections only.*	Piped Water Piped into dwelling/indoor.. 1/0 Pipe to yard/plot……... 1/0 Public tap/standpipe ……1/0 Tube well or borehole ……1/0 Dug Well Protected Well ……..1/0 Unprotected Well ……1/0 Water from Spring Protected Spring ……..1/0 Unprotected Spring …….1/0 Rainwater …….1/0 Tanker Truck ……1/0 Cart or Bicycle with Small Tank …1/0 Surface water (River / Dam / Lake / Pond / Stream / Canal / Irrigation Channel) ……..1/0 Bottled Water ……...1/0 Sachet Water ……1/0 No Response……-99	
111d	**How long does it take to go to [MAIN WATER SOURCE]get water, and come back?** *Zero is a possible answer* *Enter -88 for do not know* *Enter -99 for no response* *Report the time into minutes.* *Answer includes waiting time in line.*	Minutes:	

SECTION-1 HOUSEHOLD CHARACTERISTICS

Section 1. 3 – Household Observation

To fill the next part of the questionnaire I need to actually observe what materials you have used to build the floor, wall and roof of your house. I also wish to take a look at the place where members of the household wash their hands. Is it ok if I take a walk with you in the compound and do the observations?

112	**Main material of the floor** *Observe.*	Earth/Sand .....1 Dung .....2 Wood Planks.....3 Palm/Bamboo.....4 Polished wood.....5 Asphalt strips.....6 Ceramic Tiles .....7 Cement .....8 Carpet .....9 Other_____ Don't know……-88	

113	**Main material of the roof** *Observe.*	No Roof.....1 Thatch/Leaf/ Mud .....2 Rustic Mat/Plastic Sheets.....3 Bamboo.....4 Wood Planks.....5 Cardboard .....6 Corrugated Iron/Metal .....7 Asbestos/Cement Fiber.....8 Cement/Concrete .....9 Roof Shingles.....10 Others_____ Don't know……-88	

114	**Main material of the exterior walls** *Observe.*	No Walls.....1 Trunks/Bamboo.....2 Dirt.……...3 Wood with Mud .....4 Stone with Mud .....5 Uncovered Adobe .....6 Plywood .....7 Cardboard .....8 Reused Wood .....9 Corrugated sheets..……10 Cement .....11 Stone with Lime/Cement .....12 Bricks .....13 Cement Blocks.....14 Covered Adobe .....15 Wood Planks/Shingles .....16 Others_____ Don't know……-88	
115a	**We would like to learn about the places that households use to wash their hands. Can you please show me where members of your household most often wash their hands?**	Observed, fixed place……1 Observed, mobile .....2 Not observed, not in yard/plot .....3 Not observed, no permission to see4 Not observed, other reason.....5 No response.....-99	
115b	**At the place where the household washes their hands, observe if:** *Check all that apply.*	Soap is present .....1/0 Stored water is present .....1/0 Running water is present .....1/0 None of the above.....-77	

SECTION – 2 SCABIES AT A HOUSEHOLD LEVEL

Now I am going to ask you about skin complaints, whether you have seen or heard any of your household members complaining [small or medium fluid containing or solid itchy or non-itchy rashes with a burrow connecting the bumps and mainly affecting the finger webs, the wrist, back of the knee, around the ankle or beneath the breast or the buttock].

[➡ Show picture set no 1]

201	**Have you seen or heard any of your household members complaining [***Repeat the manifestations indicated in the preamble***]?**	Yes……1 No……..0 Don't know……-88 No response……-99	0 → 205
202	**How many of the household members exhibited [***Repeat the manifestations indicated in the preamble***]?**	Number_____	
203	**Which members of the household presented [***Repeat the manifestations indicated in the preamble***]?** *Take name/code of members of the household from section 1(Household roster)*	1. 2. 3. 4. 5.	

204	**What signs have you observed on their skin [Show picture set no 2]?** *This question is about any of the household members* *More than one answer is possible*	Vesicles……1 Papules ……2 Pustules ……..3 Bumps……4 Scabies burrows……..5 Crust……...6 Scratch……..7 Others_____ Don't know……-88 No response……..-99	
Next, I will ask you few questions about health service availability and utilization			
205	**What is the nearest health facility to your home?**	Health post……1 Health center……2 Private clinic……..3 Hospital……....4 Don't know……-88 No response……-99	
206	**Where do you usually go if you are sick, or to treat a general health problem?**	Health post……1 Health center……2 Private clinic……..3 Hospital……....4 Traditional healers……5 Holly water……6 Prayer……7 Don't go anywhere……8 Others_____ Don't know……..-88 No response……...-99	

207	**How far do you live from the (***The facility selected in Q.no.205***)?** *The response could be recorded either in KMS or the time it takes to get to the facility, walking on foot.* *The time should be filled in minutes*	In KMS ☐ Time it takes if walked on foot ☐	
208	**How do you travel to (***The facility selected in Q.no.205***)?**	On foot……1 On a horse back……2 On a chariot……3 By car……...4 By other motorized vehicles…….5 Others_____ Don't know……-88 No response……-99	

CHAPTER-2

INDIVIDUAL QUESTIONNAIRE FOR MEMBERS OF THE SELECTED HOUSEHOLD

HH number: _____

Name of HH head :_____

Code HH member :_____

SECTION 3 – SCABIES MANIFESTATIONS ON INDIVIDUAL PARTICIPANTS

I am going to ask you if you have skin complaints, such as itch and rash, we ask these questions to all participants in order to understand the occurrence of the skin condition that we are interested to know about. For some of the questions you can simply tell me whether you have the symptoms, but for some I will ask you to show me parts of your body affected by the condition. I hope it is ok, but if you feel uncomfortable to show me your body you can tell me and we can skip the part which asks to show me your skin.

NB: All members of the household will be asked questions 301-310

301	**Relationship of the respondent with the participant of the study?** *This question will be asked only if the participant is a minor*	Parent……..1 Care taker……2 Relative……3 Others_____ Don't know……-88 No response……..-99	
302	**Do you feel itch on any part of your body?**	Yes……1 No……..0 Don't know……-88 No response……-99	0 → 305
303	**How do you grade the itch?**	Mild……1 Moderate……..2 Intense……..3 Don't know……-88 No response……-99	
304	**On which part of your body do you mainly feel the itch?** *More than one response is possible* *Please help the respondent use the body map*	The wrist……1 Inter digital space……2 The elbow……..3 Abdomen……4 Back of the knee……...5 Ankle area……..6 The head……7 The neck area……..……8 Genital area……...9 The buttock……10 Others_____ Don't know……-88 No response……..-99	

305	**Do you have a skin rash on any part of your body?**	Yes……1 No……..0 Don't know……-88 No response……-99	0→401
306	**Is the rash associated with an itchy sensation?**	Yes……1 No……..0 Don't know……-88 No response……-99	
307	**Which part of your body does the rash mainly involve?** *More than one response is possible*	The wrist……1 Inter digital space……..2 The elbow……..3 Abdomen……4 Back of the knee……...5 Ankle area……..6 The head……7 The neck area……..……8 Genital area……...9 The buttock……10 Others_____ Don't know……-88 No response……..-99	
308	**Can you show me parts of your body affected by the skin rash?** *Observe and select parts of the body affected by the rash* *More than one body part can be checked*	The wrist Inter digital space The elbow Abdomen Back of the knee Ankle area The head The neck area	Yes / No

		The below two body parts could be documented based on history Genital area The buttock Others_____ Don't know…….-88 No response……..-99	
309	**Characterize the rash you have observed on the respondent?** *This question is for the data collector*	Vesicles……1 Papules ……2 Pustules ..……..3 Bumps……4 Scabies burrows……..5 Crust……...6 Scratch……..7 Others_____ Don't know…….-88 No response……..-99	
310	**How many lesions were observed on the patient.**	≤10……1 10-50……2 ≥ 50……..3	

SECTION 4 – SCABIES TRANSMISSION

The skin condition which we are interested to know about has manifestations like; [*small or medium fluid containing or solid itchy or non-itchy rashes with a burrow connecting the bumps mainly affecting the finger webs, on the wrist, back of the knee, around the ankle or beneath the breast or the buttock*]. Since one of the major mode of transmission of this condition is a close physical contact with the infected person, knowing all about the possibilities which invites close physical contact is pretty important for us to understand the disease transmission.

The physical contact should be [*In the past two months]*

[➡ Show picture no 1]

NB: Only adults will respond to questions 401-403

401	**Do you know anyone presenting the symptoms [**Read the manifestations indicated in the preamble**]?**	Yes……1 No...……..0 No response……-99 Don't know……-88	0 → 501
When answering questions 402a-c please think of three people, with the mentioned manifestations, whom are closer to you in comparison to the others with manifestations. We will refer to these people as person 1-3.			
402a	**How do you know person 1?**	Friend…….....1 Neighbour……...2 Business associate……....3 From the market place……...4 From school……5 On a public/private transport……....6 Spouse…….....7 Sexual partner…….....8 Other members of the household…9 Others_____ No response……-99 Don't know……-88	

402b	**How do you know person 2?**	Friend…….....1 Neighbour……..2 Business associate……....3 From the market place……...4 From school……5 On a public/private transport……....6 Spouse…….....7 Sexual partner…….....8 Other members of the household…9 Others_____ No response……-99 Don't know……-88	
402c	**How do you know person 3?**	Friend…….....1 Neighbour……..2 Business associate……....3 From the market place……...4 From school……5 On a public/private transport……....6 Spouse……....7 Sexual partner…….....8 Other members of the household…9 Others_____ No response……-99 Don't know……-88	
When answering questions **403a-c**, please think of the type of contact you had with each one of the three people, you have referred to in questions 402a-c.			

403a	**Which one of the listed encounters did you have with person 1?** *The encounter should be a minimum of one time.* *More than one answer is possible.* *Categories **7 and 8** will only be mentioned as possible responses if the reported contacts are spouses, sexual partners or household members.*	Sat together...……...1 Shook hands with....……2 Dine together...……3 Shared work related materials..……4 Shared utensils…….……5 Shared cloths…..…….....6 *Shared a bed/resting space…...…...7* *Took shower together….……..8* Others_____ Don't know…...……-88 No response…...……..-99	
403b	**Which one of the listed encounters did you have with person 2?** *The encounter should be a minimum of one time.* *More than one answer is possible.* *Categories **7 and 8** will only be mentioned as possible responses if the reported contacts are spouses, sexual partners or household members.*	Sat together...……...1 Shook hands with....……2 Dine together...……3 Shared work related materials..……4 Shared utensils…….……5 Shared cloths…..…….....6 *Shared a bed/resting space…...…...7* *Took shower together….……..8* Others_____ Don't know…...……-88 No response…...……..-99	

403c	**Which one of the listed encounters did you have with person 3?** *The encounter should be a minimum of one time.* *More than one answer is possible.* *Categories **7 and 8** will only be mentioned as possible responses if the reported contacts are spouses, sexual partners or household members.*	Sat together...……...1 Shook hands with...……2 Dine together...……3 Shared work related materials..……4 Shared utensils……5 Shared cloths…..……....6 *Shared a bed/resting space…...…...7* *Took shower together….……..8* Others_____ Don't know…...……-88 No response…...……..-99	

SECTION-5 SUMMARY OF THE REPORTED MANIFESTATIONS

This part summarizes the reported symptoms and observed signs on the skin of the participant. This table is to be filled only by the provider, and at the end of this section the HEW will report her impression of the participants condition.

	Main criteria	**Yes**	**No**	**Not sure**	
501	Scabies burrows				
502	Typical lesions affecting male genitalia				
503	Typical lesions in a typical distribution				
504	Atypical lesions or atypical distribution				
	History features				
505	Itch				
506	Close contact with an individual who has itch or typical lesions in a typical distribution				

507	**What is the impression of the health extension worker based on the above information?**	Clinical scabies……1 Suspected scabies……..2 Other skin diseases……3 Others_____ Don't know…….-88 No response……..-99	
508	**Remarks on the diagnosis from the provider**		

SECTION-6 HEATH SEEKING

Based on the symptoms you told me before I think you might probably have an infestation called scabies and we will reach at a confirmatory diagnosis after we discuss with the skin doctors at the health center. But up until then I would like to ask you few questions about your condition.

NB: Only participants with clinical scabies will be asked questions 601-606

601	**What was the first manifestation of the disease?**	Itch……1 Rash……2 Papules……3 Nodules……4 Ulcer……5 Crust……6 Don't know……-88 No response……-99	
602	**For how long did you stay with the disease counting from the day you experienced the [**The response to Q.no 601**]**? *Assist the respondent to remember the day when he/she had the first manifestation*	Number of days ☐	
603	**Have you done anything to treat the symptoms?**	Yes……1 No……..0 Don't know……-88 No response……-99	0→ 701

604	**What did you do for the first time to get rid of the symptoms?** *This question pertains to both modern and traditional health care services*	Home remedy……1 Traditional medicine……2 Holly water……3 Prayer……4 Health care from a health post…...5 Health care from a health center…6 Health care from private clinic.……7 Health care from hospital……8 Others_____ Don't know……..-88 No response……...-99	If 1,2,3,4 → 701
605	**How many days after the onset of the first symptom did you visit [**Health care facility from Q.no.604]**?**	Number of days ☐	
606	**Why didn't you visit** [The facility from Q.no.604] **earlier?**	Not sure where to go……1 The symptoms were not serious…2 Could recover on its own……3 I didn't have time……..4 Fear of stigma……...5 Didn't think there is a medicine for it……..6 Distance/lack of transport to go to the health facility…….....7 Fear of high treatment cost……....8 Others_____ Don't know……-88 No response…….....-99	

SECTION- 7- DERMATOLOGIC QUALITY OF LIFE QUESTIONS

The following questions are intended to measure the effect of your skin condition on your overall quality of life. The responses are organized in a way which reflects the degree of severity of your skin condition on the indicated aspect of your life. So before you give your responses please take a moment to rate how severely it has affected you. The responses range from *not at all to very much*, please select the response which describes your condition appropriately.

NB: Questions 701-708 will only be directed to adult (≥18 years) participants.

701	Over the last week, how itchy, sore, painful or stinging has your skin been?	Very much……..4 A lot……3 A little……2 Not at all……1	
702	Over the last week, how embarrassed or self conscious have you been because of your skin?	Very much……..4 A lot……3 A little……2 Not at all……1	
703	Over the last week, how much has your skin interfered with you going shopping or looking after your home or garden?	Very much……..4 A lot……3 A little……2 Not at all……1	
704	Over the last week, how much has your skin influenced the clothes you wear?	Very much……..4 A lot……3 A little……2 Not at all……1	
705	Over the last week, how much has your skin affected any social or leisure activities?	Very much……..4 A lot……3 A little……2 Not at all……1	
706	over the last week how much has your skin been a problem at work or studying?	Very much……..4 A lot……3 A little……2 Not at all……1	

707	Over the last week, how much has your skin created problems with your partner or any of your close friends or relatives	Very much……..4 A lot……3 A little……2 Not at all……1	
708	Over the last week, how much has your skin caused any sexual difficulties?	Very much……..4 A lot……3 A little……2 Not at all……1	

SECTION-8 KNOWLEDGE ABOUT SCABIES

I will ask you few questions about your knowledge about scabies. You will just tell me what you know about the disease, you are expected to tell me what you know about the disease. It doesn't need to be the right answer.

NB: Questions 801-810 are for adult (>18 years of age) study participants.

801	**Have you ever heard about scabies?**	Yes……1 No……..0 Don't know……-88 No response……-99	0 → 1001
802	**Where did you first learn about scabies?** *Check all that are mentioned*	Newspapers and magazines……1 Radio……2 TV……3 Billboards……4 Brochures, posters and other printed materials……..5 Health extension workers……6 Health workers……7 Family, friends, neighbors and colleagues……8 Religious leaders……9 Teachers……10 Others_____ Don't know……..-88 No response……...-99	

803	**What are the signs and symptoms of scabies?** *Check all that are mentioned* *Don't read the choices to the respondent*	Itch……1 Rash/papules……..2 Ulceration of the skin…….3 Skin crust…….4 Others_____ Don't know……..-88 No response……...-99	
804	**How can a person get scabies?** *Check all that are mentioned* *Don't read the choices to the respondent*	Prolonged physical contact with a patient….…….…….1 Sharing clothes with the infected person……..……2 Sharing bedding with the infected person…...……3 Through droplets when coughing….4 Through blood contact……5 Due to evil spirit……6 From the soil……7 From contaminated water……..8 Others_____ Don't know..……..-88 No response..……...-99	
805	**Can a person with scabies be cured?**	Yes……1 No……..0 Don't know……..-88 No response……...-99	

806	**In your opinion who can catch scabies?** *Check all that are mentioned* *Don't read the choices to the respondent*	Anybody……..1 Poor people……2 Rich people……3 Homeless people……...4 People from the city……...5 Farmers……...6 Commercial sex workers……..7 Prisoners……8 Others_____ Don't know……..-88 No response……...-99	
807	**How can someone with scabies get cured?**	With therapeutic cream or tablets…..1 With traditional healers……2 With holly water……3 With prayer……4 Others_____ Don't know……-88 No response…….....-99	
808	**Do you feel you are well informed about scabies?**	Yes……1 No……..0 Don't know……..-88 No response……...-99	
809	**Do you wish to get more information about scabies?**	Yes……1 No……..0 Don't know……..-88 No response……...-99	

810	**Which medium can best reach people like you, who are in need of information on scabies?**	Newspapers and magazines……1 Radio……2 TV……3 Billboards……4 Brochures, posters and other printed materials……..5 Health extension workers……6 Health workers……7 Family, friends, neighbors and colleagues……8 Religious leaders……9 Teachers……..10 Other_____ Don't know……..-88 No response……...-99	
SECTION-9 ATTITUDE TOWARDS SCABIES **The following few questions are intended to assess your attitude towards scabies** ***NB: Questions 801- 807 will be asked for scabies free adults (Aged ≥ 18 years)***			
901	**Do you think you can get scabies?**	Yes……1 No……..2 Don't know……..-88 No response……...-99	
902a	**Why do you think you can catch scabies?**	Reason_____ _____	
902b	**Why do you think you don't catch scabies?**	Reason_____ _____	

903	**What would you feel if you found out that you have scabies?** *Check all that are mentioned* *Don't read the choices to the respondent*	Nothing……1 Fear……..2 Shame……..3 Surprise……4 Sadness……5 Others_____ Don't know……..-88 No response……...-99	
904a	**What would you do if you think you had scabies?**	Go to a health facility……..1 Wait till it goes away on its own……2 Seek self-treatment options……...3 Go to traditional healers…….4 Go to a pharmacy……5 Others_____ Don't know……..-88 No response……...-99	
904b	**Why wouldn't you want to go to a health facility?** *Check all that are mentioned* *Don't read the choices to the respondent*	Not sure where to go……1 The symptoms were not serious……2 Could recover on its own…….3 I didn't have time……..4 Fear of stigma……...5 Didn't think there is a medicine for it..6 Distance/lack of transport to go to the health facility.....7 Fear of high treatment cost……....8 Others_____ Don't know…….-88 No response…….....-99	

905	**How expensive do you think the care for scabies at health care facilities?** *Check only one response*	Reasonable price……1 Moderately expensive..……...2 Very expensive…….3 Free of charge……..4 Don't know…….-88 No response…….....-99	
906a	**Do you know people who have/had scabies?**	Yes……1 No……..2	
906b	**Which of the following statements best describe your feeling towards scabies patients?** *Check only one response*	I don't feel anything……1 It is their problem I don't get scabies..2 I feel compassion and want to help....3 I feel compassion but prefer to stay away……4 I fear they may infect me…….5 Others_____ Don't know…….-88 No response…….....-99	
907	**In your community how does a person with scabies get treated?** *Check only one response*	Most people prefer to reject him/her..1 People appear friendly but they prefer to reject him/her……2 They get help/support……..3 Others_____ Don't know…….-88 No response…….....-99	

SECTION 10 – PERSONAL HYGIENE AND ONCHO MDA RELATED QUESTIONS

Now I would like to ask you a few questions about water, sanitation and hygiene

NB: All participants will be asked questions 1001-1010.

1001	**How often do you take shower?**	Number of times: In a week ☐ In a month ☐ In a year ☐	
1002	**Do you use soap or other detergents when you take shower?**	Yes, always……1 Yes, sometimes……..2 No……...3 Others_____ No response……-88	
1003	**How often do you wash your cloths?**	In a week ☐ In a month ☐ In a year ☐	
1004	**Do you use soap or other detergents when you wash your cloths?**	Yes, always……1 Yes, sometimes……..2 No……..3 Others_____ No response……-88	
Questions 1005-1010 are about onchocerchiasis MDA given in your kebele, so you will answer the following questions based on your past experience.			
1005	**Have you ever received a medication to treat or prevent onchocerciasis?**	Yes……1 No ……..0 Don't know……-88 No response……..-99	0 → END
1006	**How many times have you received a medication to treat or prevent onchocerciasis?**	Number ☐	

1007	**When was the last time you received a medication to treat or prevent onchocerciasis?**	Day___Month____Year_____	
1008	**Did you take the medication you received the last time?**	Yes……1 No……..0 Don't know……-88 No response…..……..-99	1 → 1010
1009	**Why didn't you take the medication?**	It makes me itch……..1 Not good for my health.……..2 I was fasting……..3 My friends/family told me not to…….4 Others_____ Don't know……-88 No response…..……..-99	
1010	**Where did you get the medication from?**	Health center……1 Hospital……2 HEWs……3 HDA……...4 Others_____ Don't know……-88 No response……-99	
END	**I have completed the interview thank you for your time.**		

Annex G: Interview questionnaire for the 6-month survey

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
IDENTIFICATION **Please record the following identifying information prior to beginning the interview.**			
ID001	**Name of the interviewer**	Fitsum Desalegn…….1 Reta Tesera……..2 Alene Wele……..3 Atinkut Yismaw……4 Solomon Bitew……5 Other_____	Always
ID002	**Date and time**	Date / Month / Day / Year	Always
ID003a	**Region**	Amhara……1	Always
ID003b	**Zone**	Agew Awi zone……..1	Always
ID003c	**District**	Ayehu Guagusa……..1	Always
ID003d	**Locality (Kebele) name**	Chibachibasa……..1 Arbit……..2 Dekunadereb……..3 Degera……4 Ambera……5 Envara……6	Always
ID003e	**Gote**	Adguha……1 Alamer……..2 Lay dekuna……..3 Gibdi……4 Kuada……..5 Shimel Hager……6	Always

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
ID004	**The data collector who conducted the last round survey?** *This information will be recorded using the household identifier labeled on the dwelling unit*	Fitsum Desalegn……1 Reta Tesera……2 Alene Wele……..3 Atinkut Yismaw……4 Solomon Bitew……5 Other_____	Always
ID005	**Household label?** *Record the household identifier labeled on the dwelling unit during the last survey.*		Always
ID006	**Household unique identifier?** *Record the identifier indicated in the separate list of unique household identifiers*		Always
ID007	**Household head's full name?**	_____	Always
ID008	**The respondent's full name?**	_____	Always
ID009	**Relationship of the respondent with the study household?**	Household member……..1 Neighbor……2 Friend to the family……...3 Someone from the neighborhood..4 Others_____	Always
ID010	**Name of the data collector for this round survey?**	Fitsum Desalegn……1 Reta Tesera……2 Alene Wele……..3 Atinkut Yismaw……4 Solomon Bitew……5	Always
ID011	**Number of visits to the household?**	One……1 Two……2 Three……3	Always
	INFORMED CONSENT *Find the participant and read the following greeting verbatim.*		

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
	Hello (NAME OF POTENTIAL PARTICIPANT), my name is (NAME OF THE DATA COLLECTOR), and I am from Addis Ababa University. Thank you for contacting us regarding the discussion I wish to have with you for our scabies research. The purpose of this project is to understand the distribution and characteristics of the skin disease scabies in your community. This information will help us inform the government to better plan health services and control scabies outbreaks. The interview usually takes 10 to 15 minutes to complete. Whatever information you provide will be kept strictly confidential and only fully de-identified data will be used when conducting analyses, presenting results, or sharing the data. Your participation either in the survey or individual research questions, is entirely voluntary. If we should come to any question you don't want to answer, just let me know and I will go on to the next question; or you can stop the interview at any time. However, we hope that you will participate in this study since your views are important for our understanding of the disease.		Always
CONSENT	Ask the respondent: **May I begin the interview now?**	Yes.....1 No 0	Always

SECTION 1.1. Changes in household size and composition			
The following questions are asked to know whether there is a change in the number of your household in the past 6-months. This information helps us know the total population size of your community and identify how many people are affected by scabies. ***N.B. Sections 1.1 and 1.2*** *refer to the household collectively, and responses to all the questions in these two sections will be filled out by interviewing one adult member of the household.*			
HH101	**What is the total number of your household members?** *It includes all individuals who regularly live together regardless of the type of the relationship with each other.*		Always
HH102	**Is there anyone who newly started living with the household, in the past six months?** *Help the respondent to remember that this question is about the people who newly joined the household since June 2019.* *This question is asked regardless of the kind of relationship the new individual has with the household, and it includes babies who were born to any member of the household in the past six months.*	Yes……1 No……..0 Don't know……-88 No response……-99	Always

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
HH103	**How many new people started living with the household in the past six months?** *[ODK calculates; HH103 < HH101]*		Relevance=> HH102 =1
HH104	**Is there anyone who left the household, in the past six months?** *Remind the respondent that this question is about people who left the household since June 2019.* *This question is asked regardless of the kind of relationship the individual has with the household members and it includes members who passed away in the past six months.*	Yes……1 No……..0 Don't know……-88 No response……-99	Always
HH105	**In the past six months, how many people left the household?**		Relevance=> HH104 =1

SECTION 1.2. Household Roster **The following questions are about the sociodemographic characteristics of the household members who either left or newly joined the household in the past six months.**								Relevance=> HH102=1 &/or HH104=1
HR106 .Code	HR107.Name of the HH member	HR108.What is (name) relationship to (name of the head of the HH)? Head……..1 Wife/Husband…....2 Son/Daughter……3 Son/Daughter-in-law ..... 4 Grandchild…..……5 Parent.…….6 Parent in law.……7 Brother/Sister…….8 House help…….9 Other_____ Don't know ……-88 No response……-99	HR109.How old is (name)? ***Age at the last birthday*** 0 if <1 year	HR110.Gender? Male……1 Female…2	HR111.What is the highest level of school (name) attended? Never Attended..... 0 Primary ..... 1 Secondary ..... 2 Technical & vocational. ..... 3 Higher ..... 4 NA……5 No response…….-99 ***In completed grades***	HR112.What is (name) marital status? Married..... 1 Living with a partner ..... 2 Divorced / separated..... 3 Widow / widower ..... 4 Never Married.. 5 NA…….6 Don't know….-88 No response..-99	HR113.What is (name) occupation? Farmer……..……1 Merchant……2 Daily laborer…….3 House wife……...4 Govt employee.....5 Un employed…….6 Student……..…….7 NA……...……..8	HR 114.Status Moved in……1 Moved out…..2

SECTION 1.3. Housing condition and living arrangement related questions The following questions are asked to estimate the size of your dwelling space to determine whether these characteristics affect scabies transmission. If you know the total area of your dwelling unit you can tell me, or I will take an estimate of the size of the dwelling unit from within the house. I hope that is ok with you, but if you don't feel comfortable with me getting in to your house you can tell me now and I will try a different approach to measure the size of the house.				
HH115	**Did your household change a house in the past two months?**	Yes……1 No……..0 Don't know……-88 No response……-99		Always
HH116	**Have you done structural modifications to your house in the past six months?**	Yes……1 No……..0 Don't know……-88 No response……-99		Always
HH117	**How many rooms does the household occupy (excluding bathroom, toilet, kitchen)?**	Rooms ☐		Relevance=> HH115=1 or HH116=1
HH118	**How large is the total living space (excluding bathroom, toilet, kitchen)?** *The data collector verifies the respondents estimate*	In m^2 ☐		Relevance=> HH115=1 or HH116=1
HH119	**Do you have a separate bedroom in your house?**	Yes……1 No……..0 Don't know……-88 No response……-99		Always
HH120	**How many bedrooms do you have?**	Number ☐		Relevance=> HH119=1
HH121	**What is the size of each bedroom?** *Calculate the size in m^2* *[ODK generates equal number of fields to the reported number of bed rooms in HH120]*	Bedroom 1		Relevance=> HH119=1 & HH115=1 or HH116=1
		Bedroom 2		
		Bedroom 3		
HH122	**How many members of your household regularly sleep in each bedroom?**	Bedroom 1		Relevance=> HH119=1
		Bedroom 2		

	[ODK calculates the number of people in each bedroom, which shouldn't be greater than the total number of households in HH101; and the sum of HH members sleeping in each bed room shouldn't be greater than the total number of HHs in HH101.]	Bedroom 3		
HH123	**What is the size of the room the household sleep in?** *This question will be asked only if there is no a separate bedroom in the house but a living room.* *The size will be measured by the data collector.*	In m^2 ☐		Relevance=> HH119=0 & HH115=1 or HH116=1
HH124	**How many members of your household regularly sleep in the sleeping space within the house?** *[ODK calculates the number of people sleeping in the room, which shouldn't be greater than the total number of households in HH101]*	Number ☐		Relevance=> HH119= 0

CHAPTER- II

INDIVIDUAL PARTICIPANT LEVEL CHARACTERISTICS

SECTION 2.1. Scabies presentation on individual patients

I am going to ask you if you have skin complaints, such as itch and rash, we ask these questions to all participants to understand occurrence of the skin condition that we are interested to know about. For some of the questions you can simply tell me whether you have the symptoms, but for some I will ask you to show me parts of your body affected by the condition. I hope it is ok, but if you feel uncomfortable to show me your body parts you can tell me and we can skip that section.

Most of the questions are concerning symptoms of the disease called scabies ***[small or medium fluid containing or solid itchy or non-itchy rashes with a burrow connecting the bumps and mainly affecting the finger webs, the wrist, back of the knee, around the ankle or beneath the breast or the buttock and the genital area].***

This chapter applies to all members of the household regardless of age of the participant

[ODK generates linked Chapter-II forms with chapter-I to each participating members of the household, the number of individual forms should be equal to the total number of household members (HH101)]

ID201	**Household head's full name**	

ID202	**Household unique identifier?** *Record the identifier indicated in the separate list of unique household identifiers file* **[ODK verifies with the entry to field ID006]**		
ID203	**Study participant's full name**		
ID204	**Study participant's unique identifier** *Record the identifier indicated in the separate list of unique study participant identifiers*		
Link_DAS	**Age of the participant?**	Number ☐	
IQ205	**Were you interviewed about scabies by AAU staff six months back?**	Yes……1 No……..0 Don't remember……-88 No response……..-99	Always
IQ206	**Have you ever had** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]?* [Show picture no 01]	Yes……1 No……..0 Don't know……-88 No response……-99	Always
IQ207	**When last did you experience** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]*?	Date: day/month/year ___/____/_____	Relevance=> IQ206=1
IQ208	**Do you have a skin rash on any part of your body now?**	Yes……1 No……..0 Don't know……-88 No response……-99	Always
IQ209	**Is the rash associated with an itchy sensation?**	Yes……1 No……..0 Don't know……-88 No response……-99	Relevance=> IQ208=1

IQ210	**Which part of your body does the rash mainly involve?** *More than one part of the body can be selected* [Show picture no 02_Body map]	The wrist……1 Inter digital space…….2 The elbow……..3 The axilla……4 Abdomen……5 Back of the knee……...6 Ankle area……..7 The head……8 The neck area..……9 Genital area……...10 The buttock……11 Others_____ Don't know…….-88 No response……..-99	Relevance=> IQ208=1
IQ211	**Can you show me parts of your body affected by the skin rash?** *Inspect and select parts of the body affected by the rash.* *More than one body part can be checked.*		
		Yes	No
		The wrist Inter digital space The elbow The axilla Abdomen Back of the knee Ankle area The head The neck area	Relevance=> IQ208=1
		The data on the following two body parts can be documented based on the response of the participant	
		Genital area Gluteal area	
		Others_____ Don't know…….-88 No response……..-99	

IQ212	**Characterize the rash you have observed on the respondent?** *This question is to be filled by the data collector. More than one type of lesion can be reported, and make sure that you have documented all the different types of lesions.*	Vesicles……1 Papules ……2 Pustules…...……..3 Bumps……4 Scabies burrows……..5 Crust……...6 Scratch marks……..7 Scabietic scars……..8 Others_____ Don't know……-88 No response……..-99	Relevance=> IQ211=1 (to any of the categories)
IQ213	**How many active lesions were observed on the patient?** *This question is to be filled by the data collector.*	≤10……1 10-50……2 ≥ 50……..3	Relevance=> IQ211=1
IQ214	**What is the first day you experienced the symptom when you had** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]* **for the last time**?	Date: day/month/year ___/____/_____	Relevance=> IQ208=1
IQ215	**The last time you had** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]* **what did you do about it?** *More than one response is possible* *This question also refers to those participants who currently have the manifestations of scabies*	Took a tablet prescribed by a health care provider..……..1 Applied an ointment prescribed by a health care provider..……..2 Took a medication provided by a HEW……3 Used holy water……..4 Used traditional herbs.……....5 Other home remedies……6 I did nothing..……7 Others_____ Don't know..……-88 No response……..-99	Relevance=> IQ206=1
IQ216	**Have you taken a medication to prevent scabies transmission in the past six months?** *Please remind the participant that this question is whether the participant has taken a medication as of June 2019.*	Yes……1 No..……0 Don't know..……-88 No response……..-99	Always

IQ217	**What medication did you take?** *More than one response is possible*	Tablet……1 Ointment……...2 Others_____ Don't know……-88 No response……..-99	Relevance=>IQ216=1
IQ218	**Have you taken a medication to prevent onchocerciasis transmission in the past six months?** *Please remind the participant that this question is whether the participant has taken a medication as of June 2019.*	Yes……1 No……0 Don't know……-88 No response……..-99	Always
IQ219	**What medication did you take?** *More than one response is possible*	Tablet……1 Ointment……...2 Others_____ Don't know……-88 No response……..-99	Relevance=>IQ218=1
Section 2.2. Sleeping arrangement related questions Next, I am going to ask you about your usual sleeping arrangements. These questions will help the team figure out whether there is an association between sleeping arrangement and transmission of scabies.			
IQ220	**What is your typical sleeping arrangement?**	I usually share a sleeping space……1 I sometimes share a sleeping space……2 I have never shared a sleeping space……3 Don't know……-88 No response……..-99	Always
IQ221	**In the past two months how often did you share a sleeping space?** *A sleeping space could be a bed, a mattress, a mat or a bare ground. The main aim of this question is to assess proximity of the participant to other members of the household while sleeping.*	Number of days ☐	Relevance=>IQ220=1or2
IQ222	**In the past two months have you shared a sleeping space with anyone who has** [ODK: *Repeats the manifestations indicated in the preamble of section 2.1*]?	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance=>IQ220=1or2
Section 2.3. Summary of the reported manifestations This section summarizes the reported symptoms and observed signs on the skin of the participant. The table is to be filled out by the data collector, and the data collector will document his/her impression at the end.			

	Main criteria	Yes	No	Not sure	
SUM223	Scabies burrows	1	0	2	
SUM224	Typical lesions affecting male genitalia	1	0	2	
SUM225	Typical lesions in a typical distribution	1	0	2	
SUM226	Atypical lesions or atypical distribution	1	0	2	
	History features				
SUM227	Itch	1	0	2	
SUM228	Close physical contact with an individual who has itch or typical lesions in a typical distribution	1	0	2	
SUM229	Clinical diagnosis?	Clinical scabies……1 Suspected scabies……..2 Other skin diseases……3 No skin problem has been identified……4 Others_____ Don't know……-88 No response……..-99			

Section 2.4. Ownership and contact with pets and cattle
The following questions are asked to know if you have a physical contact with pets and livestock and whether there is a possible animal to human transmission of the disease.

IQ230	**Does your household own pets?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Always
IQ231	**What pets does your household own?**	Dogs……1 Cats……2 Others_____ Don't know……-88 No response……..-99	Relevance => IQ230=1
IQ232	**Did you see symptoms of skin disease on any of the pets?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ230=1

IQ233	**What symptoms did you observe on the pet?**	Intense itch……1 Skin redness……2 Skin rash……3 Skin sores……4 Hair loss……5 Skin crust ……6 Others_____ Don't know……-88 No response……..-99	Relevance => IQ232=1
IQ234	**On which pet did you observe the manifestations?**	Dogs……1 Cats……2 Others_____ Don't know……-88 No response……..-99	Relevance => IQ232=1
IQ235	**On how many pets did you observe the manifestations?**	Number _____	Relevance => IQ232=1
IQ236	**When was the last time you observed the manifestations on any of the pets?**	< 6 months 6months to 1year ago 1 to 2 years ago >2 years ago	Relevance => IQ232=1
IQ237	**Did you have a physical contact with the pet showing** [ODK repeats the manifestations reported in IQ233]**?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ232=1
IQ238	**Does your household own livestock?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Always
IQ239	**What livestock does your household own?**	Yes / No Milk cows/bulls/oxen Horses/donkeys/mules Camels Goats Sheep Others_____	Relevance => IQ238=1
IQ240	**Did you observe symptoms of skin disease on any of the livestock?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ238=1

IQ241	**What symptoms did you observe on the livestock?** *More than one response is possible*	Intense itch……1 Skin redness……2 Skin rash……3 Skin sores……4 Hair loss……5 Skin crust ……6 Others_____ Don't know……-88 No response……..-99	Relevance => IQ240=1
IQ242	**On which livestock did you observe the manifestations?** *More than one response is possible*	Milk cows/bulls/oxen……..1 Horses/donkeys/mules……..2 Camels……3 Goats……4 Sheep……5 Don't know……-88 No response……..-99	Relevance => IQ240=1
IQ243	**On how many of the livestock did you observe the symptoms?**	Number [ ]	Relevance => IQ240=1
IQ244	**When was the last time any of the livestock showed the manifestation?**	< 6 months 6months to 1year ago 1 to 2 years ago >2 years ago	Relevance => IQ240=1
IQ245	**Did you have a physical contact with the livestock which showed** [ODK lists the symptoms mentioned in IQ241]?	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ240=1

Annex H: Interview questionnaire for the 12-month survey

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
IDENTIFICATION **Please record the following identifying information prior to beginning the interview.**			
ID001	**Name of the interviewer**	Fitsum Desalegn…….1 Reta Tesera…….2 Alene Wele……..3 Atinkut Yismaw……4 Solomon Bitew……5 Other_____	Always
ID002	**Date and time**	Date / Month / Day / Year _____	Always
ID003a	**Region**	Amhara……1	Always
ID003b	**Zone**	Agew Awi zone……..1	Always
ID003c	**District**	Ayehu Guagusa……..1	Always
ID003d	**Locality (Kebele) name**	Chibachibasa……..1 Arbit……..2 Dekunadereb……..3 Degera……4 Ambera……5 Envara……6	Always
ID003e	**Gote**	Adguha……1 Alamer……..2 Lay dekuna……..3 Gibdi……4 Kuada……..5 Shimel Hager……6	Always

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
ID004	**The data collector who conducted the last round survey?** *This information will be recorded using the household identifier labeled on the dwelling unit*	Fitsum Desalegn……1 Reta Tesera……2 Alene Wele……..3 Atinkut Yismaw……4 Solomon Bitew……5 Other_____	Always
ID005	**Household label?** *Record the household identifier labeled on the dwelling unit during the last survey.*		Always
ID006	**Household unique identifier?** *Record the identifier indicated in the separate list of unique household identifiers*		Always
ID007	**Household head's full name?**	_____	Always
ID008	**The respondent's full name?**	_____	Always
ID009	**Relationship of the respondent with the study household?**	Household member……..1 Neighbor……2 Friend to the family……...3 Someone from the neighborhood..4 Others_____	Always
ID010	**Name of the data collector for this round survey?**	Fitsum Desalegn……1 Reta Tesera……2 Alene Wele……..3 Atinkut Yismaw……4 Solomon Bitew……5	Always
ID011	**Number of visits to the household?**	One……1 Two……2 Three……3	Always

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
	Hello (NAME OF POTENTIAL PARTICIPANT), my name is (NAME OF THE DATA COLLECTOR), and I am from Addis Ababa University. Thank you for contacting us regarding the discussion I wish to have with you for our scabies research. The purpose of this project is to understand the distribution and characteristics of the skin disease scabies in your community. This information will help us inform the government to better plan health services and control scabies outbreaks. The interview usually takes 10 to 15 minutes to complete. Whatever information you provide will be kept strictly confidential and only fully de-identified data will be used when conducting analyses, presenting results, or sharing the data. Your participation either in the survey or individual research questions, is entirely voluntary. If we should come to any question you don't want to answer, just let me know and I will go on to the next question; or you can stop the interview at any time. However, we hope that you will participate in this study since your views are important for our understanding of the disease.		Always
CONSENT	Ask the respondent: **May I begin the interview now?**	Yes ..... 1 No..... 0	Always

SECTION 1.1. Changes in household size and composition

The following questions are asked to know whether there is a change in the number of your household in the past six months. This information helps us know the total population size of your community and identify how many people are affected by scabies.

N.B. Sections 1.1 and 1.2 *refer to the household collectively, and responses to all the questions in these two sections will be filled out by interviewing one adult member of the household.*

HH101	**What is the total number of your household members?** *It includes all individuals who regularly live together regardless of the type of the relationship with each other.*		Always
HH102	**Is there anyone who newly started living with the household, in the past six months?** *Help the respondent to remember that this question is about the people who newly joined the household since June 2019.* *This question is asked regardless of the kind of relationship the new individual has with the household, and it includes babies who were born to any member of the household in the past six months.*	Yes……1 No……..0 Don't know……-88 No response…….-99	Always
HH103	**How many new people started living with the household in the past six months?** *[ODK calculates; HH103 < HH101]*		Relevance => HH102=1

Questionnaire.ID		_____	
NO	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**	
HH104	**Is there anyone who left the household, in the past six months?** *Remind the respondent that this question is about people who left the household since June 2019.* *This question is asked regardless of the kind of relationship the individual has with the household members and it includes members who passed away in the past six months.*	Yes……1 No……..0 Don't know……-88 No response…….-99	Always
HH105	**In the past six months, how many people left the household?**		Relevance => HH104=1

SECTION 1.2. Household Roster **The following questions are about the sociodemographic characteristics of the household members who either left or newly joined the household in the past six months.**								Relevance=> HH102=1 &/or HH104=1
HR106 .Code	HR107.Name of the HH member	HR108.What is (name) relationship to (name of the head of the HH)? Head……..1 Wife/Husband…....2 Son/Daughter……3 Son/Daughter-in-law ..... 4 Grandchild…..……5 Parent.…….6 Parent in law.……7 Brother/Sister…….8 House help…….9 Other_____ Don't know ……-88 No response……-99	HR109.How old is (name)? ***Age at the last birthday*** 0 if <1 year	HR110.Gender? Male……1 Female…2	HR111.What is the highest level of school (name) attended? Never Attended..... 0 Primary ..... 1 Secondary ..... 2 Technical & vocational. ..... 3 Higher ..... 4 NA……5 No response…….-99 ***In completed grades***	HR112.What is (name) marital status? Married..... 1 Living with a partner ..... 2 Divorced / separated..... 3 Widow / widower ..... 4 Never Married.. 5 NA…….6 Don't know….-88 No response..-99	HR113.What is (name) occupation? Farmer……..……1 Merchant……2 Daily laborer…….3 House wife……...4 Govt employee.....5 Un employed…….6 Student……..…….7 NA……...……..8	HR 114.Status Moved in……1 Moved out…..2

SECTION 1.3. Housing condition and living arrangement related questions			
The following questions are asked to estimate the size of your dwelling space to determine whether these characteristics affect scabies transmission. If you know the total area of your dwelling unit you can tell me, or I will take an estimate of the size of the dwelling unit from within the house. I hope that is ok with you, but if you don't feel comfortable with me getting in to your house you can tell me now and I will try a different approach to measure the size of the house.			
HH115	**Did your household change a house in the past two months?**	Yes……1 No……..0 Don't know……-88 No response……-99	Always
HH116	**Have you done structural modifications to your house in the past six months?**	Yes……1 No……..0 Don't know……-88 No response……-99	Always
HH117	**How many rooms does the household occupy (excluding bathroom, toilet, kitchen)?**	Rooms [ ]	Relevance=> HH115=1 or HH116=1
HH118	**How large is the total living space (excluding bathroom, toilet, kitchen)?** *The data collector verifies the respondents estimate*	In m^2 [ ]	Relevance=> HH115=1 or HH116=1
HH119	**Do you have a separate bedroom in your house?**	Yes……1 No……..0 Don't know……-88 No response……-99	Always
HH120	**How many bedrooms do you have?**	Number [ ]	Relevance=> HH119=1
HH121	**What is the size of each bedroom?** *Calculate the size in m^2* *[ODK generates equal number of fields to the reported number of bed rooms in HH120]*	Bedroom 1 Bedroom 2 Bedroom 3	Relevance=> HH119=1 & HH115=1 or HH116=1
HH122	**How many members of your household regularly sleep in each bedroom?**	Bedroom 1 Bedroom 2	Relevance=> HH119=1

	[ODK calculates the number of people in each bedroom, which shouldn't be greater than the total number of households in HH101; and the sum of HH members sleeping in each bed room shouldn't be greater than the total number of HHs in HH101.]	Bedroom 3		
HH123	**What is the size of the room the household sleep in?** *This question will be asked only if there is no a separate bedroom in the house but a living room.* *The size will be measured by the data collector.*	In m^2		Relevance=> HH119=0 & HH115=1 or HH116=1
HH124	**How many members of your household regularly sleep in the sleeping space within the house?** *[ODK calculates the number of people sleeping in the room, which shouldn't be greater than the total number of households in HH101]*	Number		Relevance=> HH119= 0

CHAPTER- II

INDIVIDUAL PARTICIPANT LEVEL CHARACTERISTICS

SECTION 2.1. Scabies presentation on individual patients

I am going to ask you if you have skin complaints, such as itch and rash, we ask these questions to all participants to understand occurrence of the skin condition that we are interested to know about. For some of the questions you can simply tell me whether you have the symptoms, but for some I will ask you to show me parts of your body affected by the condition. I hope it is ok, but if you feel uncomfortable to show me your body parts you can tell me and we can skip that section.

Most of the questions are concerning symptoms of the disease called scabies ***[small or medium fluid containing or solid itchy or non-itchy rashes with a burrow connecting the bumps and mainly affecting the finger webs, the wrist, back of the knee, around the ankle or beneath the breast or the buttock and the genital area].***

This chapter applies to all members of the household regardless of age of the participant

[ODK generates linked Chapter-II forms with chapter-I to each participating members of the household, the number of individual forms should be equal to the total number of household members (HH101)]

ID201	**Household head's full name**	

ID202	**Household unique identifier?** *Record the identifier indicated in the separate list of unique household identifiers file* **[ODK verifies with the entry to field ID006]**		
ID203	**Study participant's full name**		
ID204	**Study participant's unique identifier** *Record the identifier indicated in the separate list of unique study participant identifiers*		
Link_DAS	**Age of the participant?**	Number ☐	
IQ205	**Were you interviewed about scabies by AAU staff six months back?**	Yes……1 No……..0 Don't remember……-88 No response……..-99	Always
IQ206	**Have you ever had** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]?* [Show picture no 01]	Yes……1 No……..0 Don't know……-88 No response……-99	Always
IQ207	**When last did you experience** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]*?	Date: day/month/year ___/____/_____	Relevance=> IQ206=1
IQ208	**Do you have a skin rash on any part of your body now?**	Yes……1 No……..0 Don't know……-88 No response……-99	Always
IQ209	**Is the rash associated with an itchy sensation?**	Yes……1 No……..0 Don't know……-88 No response……-99	Relevance=> IQ208=1

IQ210	**Which part of your body does the rash mainly involve?** *More than one part of the body can be selected* [Show picture no 02_Body map]	The wrist……1 Inter digital space…….2 The elbow……..3 The axilla……4 Abdomen……5 Back of the knee……...6 Ankle area……..7 The head……8 The neck area……9 Genital area……...10 The buttock……11 Others_____ Don't know…….-88 No response……..-99		Relevance=> IQ208=1
IQ211	**Can you show me parts of your body affected by the skin rash?** *Inspect and select parts of the body affected by the rash.* *More than one body part can be checked.*		Yes	No
		The wrist Inter digital space The elbow The axilla Abdomen Back of the knee Ankle area The head The neck area		Relevance=> IQ208=1
		The data on the following two body parts can be documented based on the response of the participant		
		Genital area Gluteal area		
		Others_____ Don't know…….-88 No response……..-99		

IQ212	**Characterize the rash you have observed on the respondent?** *This question is to be filled by the data collector. More than one type of lesion can be reported, and make sure that you have documented all the different types of lesions.*	Vesicles……1 Papules ……2 Pustules……..3 Bumps……4 Scabies burrows……..5 Crust……...6 Scratch marks……..7 Scabietic scars……..8 Others_____ Don't know…….-88 No response……..-99	Relevance=> IQ211=1 (to any of the categories)
IQ213	**How many active lesions were observed on the patient?** *This question is to be filled by the data collector.*	≤10……1 10-50……2 ≥ 50……..3	Relevance=> IQ211=1
IQ214	**What is the first day you experienced the symptom when you had** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]* **for the last time**?	Date: day/month/year ___/____/_____	Relevance=> IQ208=1
IQ215	**The last time you had** *[ODK: Repeats the manifestations indicated in the preamble of section 2.1]* **what did you do about it?** *More than one response is possible* *This question also refers to those participants who currently have the manifestations of scabies*	Took a tablet prescribed by a health care provider..……..1 Applied an ointment prescribed by a health care provider...2 Took a medication provided by a HEW……3 Used holy water……..4 Used traditional herbs…....5 Other home remedies…….6 I did nothing……7 Others_____ Don't know..……-88 No response……..-99	Relevance=> IQ206=1
IQ216	**Have you taken a medication to prevent scabies transmission in the past six months?** *Please remind the participant that this question is whether the participant has taken a medication as of June 2019.*	Yes……1 No..……0 Don't know……-88 No response……..-99	Always

IQ217	**What medication did you take?** *More than one response is possible*	Tablet……1 Ointment……...2 Others_____ Don't know……-88 No response……..-99	Relevance=> IQ216=1
IQ218	**Have you taken a medication to prevent onchocerciasis transmission in the past six months?** *Please remind the participant that this question is whether the participant has taken a medication as of June 2019.*	Yes……1 No……0 Don't know……-88 No response……..-99	Always
IQ219	**What medication did you take?** *More than one response is possible*	Tablet……1 Ointment……...2 Others_____ Don't know……-88 No response……..-99	Relevance=> IQ218=1
Section 2.2. Sleeping arrangement related questions Next, I am going to ask you about your usual sleeping arrangements. These questions will help the team figure out whether there is an association between sleeping arrangement and transmission of scabies.			
IQ220	**What is your typical sleeping arrangement?**	I usually share a sleeping space……1 I sometimes share a sleeping space……2 I have never shared a sleeping space……3 Don't know……-88 No response……..-99	Always
IQ221	**In the past two months how often did you share a sleeping space?** *A sleeping space could be a bed, a mattress, a mat or a bare ground. The main aim of this question is to assess proximity of the participant to other members of the household while sleeping.*	Number of days [ ]	Relevance=> IQ220=1or2
IQ222	**In the past two months have you shared a sleeping space with anyone who has** [ODK: *Repeats the manifestations indicated in the preamble of section 2.1*]?	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance=> IQ220=1or2
Section 2.3. Summary of the reported manifestations This section summarizes the reported symptoms and observed signs on the skin of the participant. The table is to be filled out by the data collector, and the data collector will document his/her impression at the end.			

	Main criteria	**Yes**	**No**	**Not sure**	
SUM223	**Scabies burrows**	1	0	2	
SUM224	**Typical lesions affecting male genitalia**	1	0	2	
SUM225	**Typical lesions in a typical distribution**	1	0	2	
SUM226	**Atypical lesions or atypical distribution**	1	0	2	
	History features				
SUM227	**Itch**	1	0	2	
SUM228	**Close physical contact with an individual who has itch or typical lesions in a typical distribution**	1	0	2	
SUM229	**Clinical diagnosis?**	Clinical scabies……1 Suspected scabies……..2 Other skin diseases……3 No skin problem has been identified……4 Others_____ Don't know……-88 No response……..-99			
Section 2.4. Ownership and contact with pets and cattle The following questions are asked to know if you have a physical contact with pets and livestock and whether there is a possible animal to human transmission of the disease.					
IQ230	**Does your household own pets?**	Yes……1 No……..0 Don't know……-88 No response……..-99			Always

IQ231	**What pets does your household own?**	Dogs……1 Cats……2 Others_____ Don't know……-88 No response……..-99	Relevance => IQ230=1
IQ232	**Did you see symptoms of skin disease on any of the pets?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ230=1
IQ233	**What symptoms did you observe on the pet?**	Intense itch……1 Skin redness……2 Skin rash……3 Skin sores……4 Hair loss……5 Skin crust ……6 Others_____ Don't know……-88 No response……..-99	Relevance => IQ232=1
IQ234	**On which pet did you observe the manifestations?**	Dogs……1 Cats……2 Others_____ Don't know……-88 No response……..-99	Relevance => IQ232=1
IQ235	**On how many pets did you observe the manifestations?**	Number _____	Relevance => IQ232=1
IQ236	**When was the last time you observed the manifestations on any of the pets?**	< 6 months 6months to 1year ago 1 to 2 years ago >2 years ago	Relevance => IQ232=1
IQ237	**Did you have a physical contact with the pet showing** [ODK repeats the manifestations reported in IQ233]**?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ232=1

IQ238	**Does your household own livestock?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Always
IQ239	**What livestock does your household own?**	Yes / No Milk cows/bulls/oxen Horses/donkeys/mules Camels Goats Sheep Others_____	Relevance => IQ238=1
IQ240	**Did you observe symptoms of skin disease on any of the livestock?**	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ238=1
IQ241	**What symptoms did you observe on the livestock?** *More than one response is possible*	Intense itch……1 Skin redness……2 Skin rash……3 Skin sores……4 Hair loss……5 Skin crust ……6 Others_____ Don't know……-88 No response……..-99	Relevance => IQ240=1
IQ242	**On which livestock did you observe the manifestations?** *More than one response is possible*	Milk cows/bulls/oxen……..1 Horses/donkeys/mules……..2 Camels……3 Goats……4 Sheep……5 Don't know……-88 No response……..-99	Relevance => IQ240=1
IQ243	**On how many of the livestock did you observe the symptoms?**	Number [ ]	Relevance => IQ240=1

IQ244	**When was the last time any of the livestock showed the manifestation?**	< 6 months 6months to 1year ago 1 to 2 years ago >2 years ago	Relevance => IQ240=1
IQ245	**Did you have a physical contact with the livestock which** **showed** [ODK lists the symptoms mentioned in IQ241]?	Yes……1 No……..0 Don't know……-88 No response……..-99	Relevance => IQ240=1
PIC	[If you are not certain about the diagnosis, take a picture of a skin lesion which you assume best describes the general dermatologic condition of the patient]		Always
GPS	Take the GPS coordinates of the household	GPS	Always
RES	Result code	Completed……..1 Partly completed……2 Postponed……..3 Refused……..4 Not at home……5	Always Or Relevance =>Consent=0
END	END of the interview		