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A Venue Based Assessment of Malaria and Health Needs among Migrant Farm Workers in Ethiopia

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An abstract of
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Abstract

A Venue Based Assessment of Malaria and Health Needs among Migrant Farm Workers in Ethiopia

By Rebekah Stewart Schicker

Background: Mobile populations present unique challenges to malaria control and elimination efforts. Each year, a large number of individuals travel to northwest Amhara Region, Ethiopia to seek seasonal employment on large-scale farms. Agricultural areas typically report the heaviest malaria burden within Amhara and migrant workers are likely at significant risk for infection. Yet little is known about them, including migration patterns, access to, and use of malaria prevention measures, housing accommodations, health care access and treatment-seeking behavior.

Methods and Findings: In July 2013, we conducted a venue-based survey of 605 migrant farmers in two districts of North Gondar, Amhara Region. Nearly all were male (97.7%); mean age was 22.8 years. Nearly all (95.6%) came from within Amhara Region, with more than half (51.6%) coming from within North Gondar zone. Most (76.9%) arrived in June or July, and 45.6% intended to leave in September. Around half (51.2%) lived in temporary shelters, while 20.5% slept outside. Only 11.9% of participants had access to an LLIN in the study area. Reported net use last night was 74.6% among those with net access and 8.8% overall. *Plasmodium* prevalence by rapid diagnostic test (RDT) was 12.0%; 28.4% were anemic (hemoglobin [Hb] <13 g/dl). Nearly one-third (30.1%) reported having fever within the past two weeks, of whom 31.3% sought treatment. Distance to a healthcare facility and cost were important reported barriers to seeking treatment.

Conclusions: The study population was found to be young and originate from relatively proximate areas. High prevalence of malaria and anemia were observed. Despite adequate malaria knowledge, low access to LLINs and transient sleeping arrangements place migrant farms workers at significant risk of malaria. Moreover, their access to care is limited, and they reportedly face substantial barriers to seeking appropriate healthcare while engaged in farm labor. Targeted interventions are needed to reduce the burden of malaria in this population.

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Acknowledgments

I would like to acknowledge the Ethiopian Bureau of Labor and Social Affairs and the Ethiopian Bureau of Land Administration and Environmental Protection at regional, zone and woreda levels for generously providing information during preliminary design of the study, as well as Zonal Health Department and the Woreda Health offices in North Gondar for providing survey personnel and facilitating the survey. I am forever grateful to Dr. Greg Noland for his tireless support, editing and partnership during this entire project as well as Dr. Neway Hiruy for his field support, personal support and supervision. This project would not have been possible without the hard work of these two colleagues. I am grateful to The Carter Center for entrusting and assisting me with this survey. I thank Aisha Stewart and Andrew Panfel for providing technical support and timely assistance at many critical junctures of this project. My sincere gratitude is extended specifically to the Amhara Regional Health Bureau, The Carter Center Ethiopia staff and to the Médecins Sans Frontières staff in West Armachiho who all assisted with this study and made my time in Ethiopia truly enjoyable. I would also like to thank the farm owners and managers for permitting access to farms and permission to enroll their farm workers in the survey. Last but not least, I sincerely appreciate the migrant farm workers, the survey teams and all other personnel involved in this survey. This research was made possible through funding by The Emory University Global Field Experience Fund, The Emory University Institute for Developing Nations and The Carter Center.

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Chapter 1: Introduction and Literature Review

Ethiopia, the most populous landlocked country in the world, is located in the Horn of Africa and is bordered by Kenya, Somalia, Djibouti, Eritrea, Sudan and South Sudan. Based on current estimates, there are 96,633,468 persons living in Ethiopia with 64% of them under the age of 25 [1]. Only 17% of the population lives in urban areas with the remainder (83%) residing in rural areas. Thus, it is not surprising that agriculture comprises nearly half (47%) of the country's Gross Domestic Product (GDP) and is responsible for 85% of employment and 80% of exports [2]. Ethiopia is divided into nine regions and two city administrations. Amhara region in northwestern Ethiopia (figure 2), is the second largest region by population (17 million people), the third largest by land area [3] and shares a border with Sudan.

Figure 1. Map of Ethiopia, highlighting the Amhara Region.
Source: Stanford's Developmap

In a similar fashion as seen in the rest of the country, 90% of the people of Amhara reside in rural areas [3] and 85% engage in agriculture. Topographically, the Amhara Region is divided into highlands (>1,500 meters above sea level) and lowlands (500-1,499 meters above sea level). While the highland area is mountainous, the lowland area is hot, rainy and suitable for farming many crops, most notably cotton, sesame and sorghum. In the northwest corner of Amhara, directly bordering Sudan and several hours from the nearest large city of Gondar, there are four lowland woredas (districts) that together make up approximately 245,000 hectares (605,408 acres) of farm land. The farms in this area are government owned and rented to investors on a yearly basis, who in turn employ managers and farmers to clear the land, plant, grow and harvest crops. Each year, conservative estimates suggest that 350,000 farm workers travel from outside these four woredas to engage in paid farm work during the months of June to December.

Photo 1. Migrant workers walking between farms.
Photo by R. Stewart Schicker

The total settled population in this area is approximately 338,022, thus the in-migration of farm workers during the farming season more than doubles the population in this area.

Woreda	Estimated Hired Work Force			Resident Population
	Investor-owned (2 per ha)	Personal (1 per ha)	Total	
W. Armachiho	156,000	58,000	214,000	36,090
Metema	60,000	20,000	80,000	121,963
Tegede	29,600	10,000	39,600	76,375
Quara	28,000	10,000	38,000	103,594
Total	**273,600**	**98,000**	**371,600**	**338,022**
Source: Bureau of Labor and Social Affairs				

Local government officials report that these large groups of farm workers have been arriving in this area seasonally to participate in farm labor for at least ten years and possibly much longer. Despite this, no formal investigations have ever been conducted on this population to understand precisely who they are, where they are traveling from and what situational challenges they face while working on the farms. The humanitarian organization, Médecins Sans Frontières (MSF), has been working in one of the towns adjacent to the farming area for the past ten years. Their primary focus in that town is to treat migrant workers for visceral leishmaniasis, also known as kala azar, and especially to care for farm workers who are co-infected with HIV and kala azar. Although formal studies had yet to be conducted, anecdotal reports from MSF workers as well as local officials emphasized the vastness of the area occupied by the farms and the incredible difficulties faced by anyone in traversing many of the roads between the nearest towns

and the farms, especially during the rainy season. Farmers as well as MSF workers often can only navigate between farms with large farming grade tractors.

Photo 2. Farming tractor in Metema, woreda, Amhara Region.
Photo by R. Stewart Schicker

The nearest healthcare facilities are located in the adjacent towns, and access to those facilities as well as to any other goods and services are subject to many challenges, including distance and mobility limitations. Investors are ultimately responsible for providing basic items to their workers including shelter, food and sanitation facilities. These are outlined in the contracts they sign when renting the land from the government, however these provisions are largely unregulated and amenities vary greatly from farm to farm. Thus, farm workers, who have left their homes and traveled significant distances

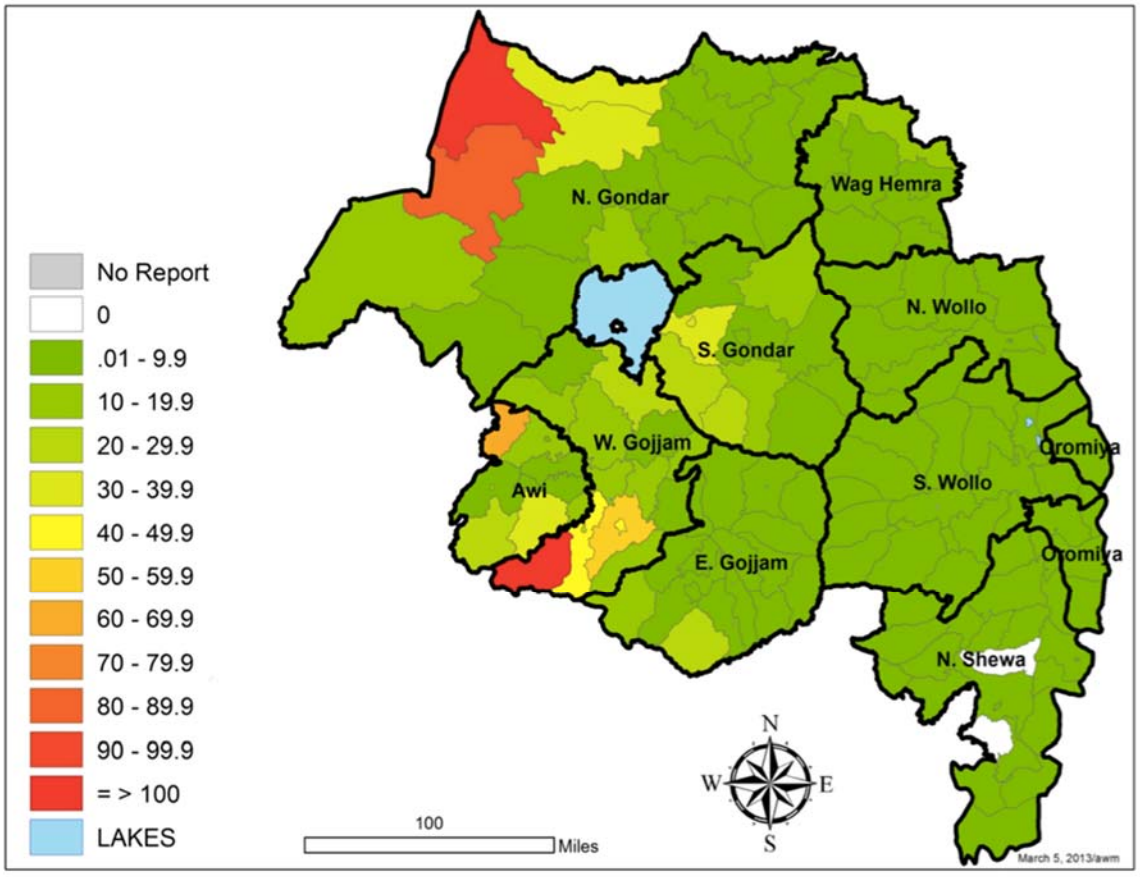
for paid labor opportunities, end up working in areas with varying degrees of access to basic resources and medical care. The potential vulnerability of these farm workers is further intensified when overlaid with an endemic infectious disease in the area such as malaria.

Malaria is a leading cause of outpatient visits, hospitalizations and deaths in Ethiopia [5]. It is a life-threatening parasitic disease, caused by infection with any of five species of *Plasmodium*, which is transmitted to humans through the bite of an infected *Anopheles* mosquito. Although not entirely understood, *Plasmodium* infection can cause anemia and even severe anemia through destruction and decreased production of red blood cells (erythrocytes) [6]. The disease is both preventable and treatable, yet annually there are an estimated 207 million cases and 627,000 deaths globally, with the vast majority of cases (80%) and deaths (90%) occurring in sub-Saharan Africa [4]. The *Anopheles* mosquito bites primarily at night and prefers to breed in water, making standing water near human dwellings a risk factor for malaria [4]. Additionally, many climatic factors contribute to mosquito abundance and survivability, including temperature, humidity and rainfall. Malaria transmission is thus seasonal in most endemic areas, peaking during and just after the rainy season. Transmission is also associated with elevation. In Ethiopia, those living in lowland areas (approximately 68% of the total population) are at greatest risk for malaria [5].

In 2005, Ethiopia embarked on a major scale-up of malaria prevention and control measures including: distribution of long-lasting insecticidal nets (LLINs), targeted indoor residual spraying (IRS) against mosquitoes, use of rapid diagnostic tests (RDTs) for confirmatory diagnosis of malaria, and introduction of artemisinin-based combination

therapy (ACT). These interventions have helped to reduce the national prevalence of *Plasmodium* infection to less than 1% in recent national surveys [7,8]. Despite the great success of the country as a whole in controlling malaria, there exist localized "hot-spots" of the country that continue to experience much higher burdens of malaria than the country at large. For example, a recent survey documented *Plasmodium* prevalence of 8% in the lowland woredas of Metema and Quara in western Amhara [9]. Routine surveillance data from health facilities within Amhara also reveal focal areas of high transmission in farming areas of northwest and southwest Amhara (Figure 3). For example, in November 2012, incidence was as high as 100 confirmed cases per 1,000 persons, while much of the rest of the region's incidence was less than 10 per 1,000.

Figure 2. Confirmed Malaria Incidence per 1,000 persons, in Amhara Region, by district, November 2012. Source: Amhara Regional Health Bureau/The Carter Center.



Both farming and malaria transmission are inextricably linked to rainfall; the agricultural season (June to October) overlaps with the main rains (July to September) and subsequent major malaria transmission season (September to December), placing farm workers at significant risk of malaria. This is potentially exacerbated by the lack of access to malaria preventative measures, such as bed-nets and insecticide treated housing, as well as barriers to medical treatment such as distance and lack of transportation. Additionally, migrants may be at elevated malaria risk if they originate from areas with minimal or no malaria transmission, owing to a lack anti-malaria immunity, which only develops with repeated parasite exposure [10].

The vulnerability of migrants is not unique to northwest Ethiopia. Migrants have long been recognized as populations with unique and diverse health determinants, needs and vulnerabilities, which may place them at a greater risk for disease acquisition and may complicate elimination efforts [11]. In fact, human mobility has been cited as one of the factors influencing the failed malaria eradication campaign in the 1950s [12,13]. More recently, in 2008, the World Health Assembly brought increased attention to this issue by holding a special meeting to discuss the distinct health needs of migrants. They recognized that population movements made migrants more vulnerable to stress and disease and that often migrants are impoverished with little access to health and social services [14]. More recently, in 2014, Roll Back Malaria (RBM) issued The Victoria Falls Declaration that highlighted the potential role of migrants in malaria transmission and their likely disproportionate access to prevention and control measures [15]. Additionally, on World Malaria Day 2014, the International Organization for Migration (IOM) disseminated a press release recognizing the unique vulnerabilities of migrant

populations to malaria as well as their potential for contributing to malaria transmission [16]. They state that, "Often considered as 'hidden or hard to reach', migrants also frequently face complex obstacles in accessing continuity of health care and malaria control services…" and migrants "…still often fall outside traditional control strategies and plans of action, resulting in undetected and untreated infections that are caught too late [16]."

Increased risk of malaria in mobile populations has recently been demonstrated by two recent studies from Ethiopia [17,18]. A case control study by Yukich *et al.* in central Ethiopia found that travel away from the home village in the last 30 days was a significant risk factor for *Plasmodium falciparum* infection [17]. Another case control study was conducted in northwest Ethiopia among patients seeking treatment at health centers in high altitude areas. This study found that several factors were associated with malaria including male gender, travel away from home in the previous month and employment in agriculture [18]. While these studies point to mobility and farm labor as risk factors for malaria, investigations of migrant farmer populations are needed in order to better understand their identity, behaviors and malaria risk.

However, research among migrant populations poses further challenges. Traditional population-based malaria surveys such as Malaria Indicator Surveys utilize household sampling strategies. Sampling frames for these surveys, typically government census registers, can be outdated and are unlikely to account for dynamic populations or those not living in formal 'households'. Until this time, no formal study of this population had been undertaken. It was generally understood that they resided in a variety of places including hotels, temporary structures and potentially outside--none of which are suitable

for traditional survey methods. Often, migrant research is conducted using a convenience sample, which may be collected anywhere that is "convenient" for the researcher to access a group of migrant workers from which to sample. This method is wrought with problems that can lead to biases and even invalid data. Studies of malaria in migrants on the Thailand-Cambodia border employed respondent-driven sampling strategies (a derivative of chain-referral or "snowball" sampling) [19,20]. While respondent-driven sampling can overcome some biases associated with traditional non-probability chain-referral sampling [19], there are other methods that can generate representative or even probability-based samples of hard-to-reach populations. Venue based sampling (VBS), a form of time-space sampling, provides a framework to obtain a representative sample of a target population at specific times and locations [21,22]. Venue based sampling utilizes extensive formative research to first determine all of the locations or "venues" in which a desired population can be found. Further time is spent to understand the times a desired target population would be present at such venues and then the potential flow of the population through that venue at a given time. This information is compiled into a sampling universe, which is considered to be robust when subsequent formative research continually uncovers previously identified venues [21]. The universe of possible venues are then either randomly or purposely selected to account for as diverse a sample as possible. Possible respondents are then interviewed at specified times with a known flow of the desired population. VBS has most frequently been utilized in research of injection drug users [21-23] and men who have sex with men (MSM) [23-26]. Despite the ability of VBS to achieve probability based data and overcome many biases found with

convenience and even respondent driven sampling, it has not previously been used in the study of Malaria.

Photo 3. Migrant workers weeding before the rain. Photo by R. Stewart Schicker

Study Objective and Aims

The objective of this study is to investigate the demographics, general health needs, prevalence of malaria and anemia, and access to, coverage and use of malaria prevention and treatment measures among migrant farm workers in northwest Ethiopia, using a venue based sampling strategy.

There are four aims of this study.

1. **The first aim is to investigate the demographic characteristics of this population**. Through this study, we aim to be able to characterize this population according to age distribution, gender, ethnicity, language spoken and Amharic reading ability.

2. **The second aim of this study is to describe the migration patterns of this population.** Migration patterns have the potential to be very important in terms of malaria acquisition among the migrant farm workers as well as for malaria control measures in the country. We aim to capture information about the migrants' home areas, the timing of migration in and out of the farm area, the transportation utilized in travel, the number of previous migrations to this area and the planned destination after the farming season. The concept of a home area is very important for several reasons. For the farm worker, the home area will lend information about the historical likely exposure of the migrant to malaria. For Ethiopia's control measures, knowledge of the migrant farm workers home area gives information about where potentially infected persons could be returning after the period of work on the farm. The timing of in and out migration, as it relates to the malaria transmission season, is important when determining exposure risk as malaria prevalence in the country fluctuates with the seasons and particularly with rainfall. The type of transportation utilized is important for further describing this population as a whole as well as recognizing potential places of intervention. The number of previous migrations to the farming area allows for the determination of relative patterns of migration and the understanding of how familiar a migrant farm worker would be with the setting and available resources, as well as the potential impact of an intervention on the subsequent year. Knowledge about the planned destination allows further characterization of the migration patterns and further understanding about potential importation of malaria into an area previously controlled.

3. **The third aim of this study is understand this population's knowledge about malaria as well as their access to and use of malaria prevention, control and treatment measures.** This information is important for further understanding the population as a whole as well as assessing the current situation for malaria prevention and control as available to this unique population. It would also lead the way for future interventions.
4. **The fourth aim is to determine the prevalence of malaria and anemia among this population.** This estimate can then be compared to estimates of malaria among the local population to infer differences in exposure. Hemoglobin is an easy to collect proxy of basic health status and anemia is a sequellae of malaria and other infections such as visceral leishmaniasis (kala azar).

Through a formal, rigorous study of this population, we will be able to better understand this population's unique vulnerabilities and needs in regards to malaria prevention and treatment. In addition, data will be added to the building evidence about the importance of addressing migrants in malaria elimination efforts and demonstrate the use of probability based sampling technique, which can be used to gather more complete data about hard-to-reach populations.

Chapter 2: Manuscript

Title Page

Title: A Venue Based Assessment of Malaria and Health Needs among Migrant Farm Workers in Ethiopia

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Student Contribution

I developed and conducted all aspects of this study including development of the survey tool, translating it into an electronic format, designing the sampling strategy, training and supervising the data collectors, cleaning the data, analyzing the data, writing up the results for publication and constructing the tables and figures. All of this work was done in conjunction with and under the supervision of Dr. Gregory Noland of The Carter Center.

Abstract

Background: Mobile populations present unique challenges to malaria control and elimination efforts. Each year, a large number of individuals travel to northwest Amhara Region, Ethiopia to seek seasonal employment on large-scale farms. Agricultural areas typically report the heaviest malaria burden within Amhara and migrant workers are likely at significant risk for infection. Yet little is known about them, including migration patterns, access to, and use of malaria prevention measures, housing accommodations, health care access and treatment-seeking behavior.

Methods and Findings: In July 2013, we conducted a venue-based survey of 605 migrant farmers in two districts of North Gondar, Amhara Region. Nearly all were male (97.7%); mean age was 22.8 years. Nearly all (95.6%) came from within Amhara Region, with more than half (51.6%) coming from within North Gondar zone. Most (76.9%) arrived in June or July, and 45.6% intended to leave in September. Around half (51.2%) lived in temporary shelters, while 20.5% slept outside. Only 11.9% of participants had access to an LLIN in the study area. Reported net use last night was 74.6% among those with net access and 8.8% overall. *Plasmodium* prevalence by rapid diagnostic test (RDT) was 12.0%; 28.4% were anemic (hemoglobin [Hb] <13 g/dl). Nearly one-third (30.1%) reported having fever within the past two weeks, of whom 31.3% sought treatment. Distance to a healthcare facility and cost were important reported barriers to seeking treatment.

Conclusions: The study population was found to be young and originate from relatively proximate areas. High prevalence of malaria and anemia were observed. Despite adequate malaria knowledge, low access to LLINs and transient sleeping arrangements place migrant farms workers at significant risk of malaria. Moreover, their access to care is limited, and they reportedly face substantial barriers to seeking appropriate healthcare while engaged in farm labor. Targeted interventions are needed to reduce the burden of malaria in this population.

Introduction

Malaria is both preventable and treatable, yet annually there are an estimated 207 million cases and 627,000 deaths globally, with the vast majority of cases (80%) and deaths (90%) occurring in sub-Saharan Africa [1]. In Ethiopia, the second most populous country in Africa, around 68% of the 96 million people are at risk of malaria [2]. Both *Plasmodium falciparum* and *Plasmodium vivax* are prevalent and malaria is a leading cause of outpatient visits, hospitalizations and deaths across the country [2]. In 2005, Ethiopia embarked on a major scale-up of malaria prevention and control measures including: distribution of long-lasting insecticidal nets (LLINs), targeted indoor residual spraying (IRS) against mosquitoes, use of rapid diagnostic tests (RDTs) for confirmatory diagnosis of malaria, and introduction of artemisinin-based combination therapy (ACTs). These interventions have helped to reduce the national prevalence of *Plasmodium* infection to less than 1% in recent national surveys [3,4]. However malaria transmission in Ethiopia occurs with significant spatial, seasonal, and inter-annual variation [5-7]. This poses a challenge to the country's malaria elimination efforts [2].

Recent studies from Ethiopia have shown that history of travel is a significant risk factor for malaria [8,9]. One of the major forces driving macro-level population movements in Ethiopia is seasonal agricultural labor. Agriculture is a key industry, accounting for around half of the country's GDP, 80% of exports and 80% of total employment [2]. Vast portions of fertile lowland in northwest Ethiopia have been developed for large-scale agricultural farming of cash crops such as sorghum, sesame and cotton. It is estimated that annually at least 350,000 individuals travel to areas of North Gondar zone, along the border with Sudan, to seek temporary employment on such farms. As both

farming and malaria transmission are inextricably linked to rainfall, the agricultural season (June to October) overlaps with the main rains (July to September) and subsequent major malaria transmission season (September to December), placing farm workers at significant risk of malaria. Indeed, a recent study from Ethiopia found that the surface irrigation scheme of a large-scale sugar plantation resulted in increased mosquito abundance, higher mosquito sporozoite rate and greater prevalence of *Plasmodium* in the local compared to traditional or non-irrigated eco-systems [10]. North Gondar, one of ten zones in Amhara Region, accounted for 20.5% of all confirmed malaria cases reported in Amhara in 2012, with the agricultural areas of West Armachiho and Metema reporting two of the top five highest weekly malaria incidence rates for the year among the 166 districts (*woredas*) of Amhara [11]. This high force of transmission in agricultural areas, combined with a large influx of migrant laborers, is likely to generate a large pool of susceptible individuals. In addition, it is believed that many of the migrants come from higher elevation areas with lower or absent malaria transmission; thus returning migrants with untreated or subclinical infections present a risk of facilitating parasite transmission to other parts of the country. However, empiric data regarding seasonal migrant populations in northwest Ethiopia and their malaria risk are lacking.

While the role of mobile populations in malaria transmission has been previously recognized [12] malaria elimination efforts have focused increasing importance on migrants and other hard-to-reach populations [13,14] as highlighted by the recent Victoria Falls Declaration, which articulates a specific commitment to addressing the challenges posed by mobile populations [15]. One of the biggest challenges is use of appropriate survey methods to assess mobile populations. Traditional population-based

malaria surveys such as Malaria Indicator Surveys utilize household sampling strategies. However, sampling frames for these surveys, typically government census registers, can be outdated and are unlikely to account for dynamic populations or those not living in formal 'households'. Innovative sampling approaches are thus required. Studies of malaria in migrants on the Thailand-Cambodia border employed respondent-driven sampling strategies (a derivative of chain-referral or "snowball" sampling) [16,17]. While respondent-driven sampling can overcome some biases associated with traditional non-probability chain-referral sampling [18] other methods exist that can generate probability-based samples of hard-to-reach populations. Venue based sampling, a form of time-space sampling, provides a framework to obtain a representative sample of a target population at specific times and locations [18,19]. It has most frequently been utilized in research of injection drug users [20-23] and men who have sex with men (MSM) [24-28]. Here, for the first time in the context of malaria research, we applied a venue based sampling strategy to investigate the demographics, general health needs, prevalence of malaria and anemia, and access to, coverage and use of malaria prevention and treatment measures among migrant farm workers in northwest Ethiopia.

Materials and Methods

Study Area

This survey was conducted in Metema (permanent resident population: 122,000) and West Armachiho (permanent resident population: 36,000) districts of Amhara Region, Ethiopia. Elevation of both districts is <1000m. The survey took place in July of 2013 at the beginning of the farming season and immediately prior to the start of the rains that year.

Study Design and Venue Selection

The design was a cross sectional survey employing a venue-based sampling strategy. Prior to sampling, formative research was conducted in the area to identify all the locations and times that migrant farm workers could be contacted. Information was obtained through discussions with regional, zonal and woreda Health Bureau officials, Land Administration and Use Bureau officials, Labor and Social Affairs Bureau officials, farm managers and farm workers at 23 farms as well as Medicines Sans Frontier staff. Three types of venues were identified as locations where migrant farm workers were likely to be found: farms, roads between farms, and town centers in the study area. The sampling frame for farms consisted of a list of 104 “blocks” of land allocated for investor development in the study area obtained from the Regional Bureau of Land Administration and Environmental Protection. A block encompasses approximately 1000 hectares in Metema and 1500 hectares in West Armachiho. From this list, a total of 60 blocks were randomly selected. This number was predicted to yield the desired number of survey participants based on the number of migrants per venue observed during

formative research. Within selected blocks, survey teams approached the first farm that they encountered after entering the block. If there were individuals present (working or otherwise) at that farm, the teams would approach that group of persons and choose 33% of them for eligibility screening. Once individuals were sampled within a block, no further farms within that block were approached or sampled. If individuals were not present, the teams would move to the next visible farm within the block until they either found individuals to sample or visited all of the farms within that selected block. If individuals were not found within the entire block on the day of sampling, the block was not revisited and the absence of migrants at farms within that block was documented. Blocks without individuals were not replaced for sampling.

The same 60 blocks selected for farm sampling were also used for sampling at road venues. Within selected blocks, teams would also approach the first individuals that they encountered walking along the road in between farms and randomly select 33% of them for eligibility screening. If no migrants were found walking within an hour of arriving at the roadside within the selected block, then that venue was not revisited, not replaced, and the absence of individuals walking along the road within that block was documented. Ten towns were identified within the study area and all ten towns were utilized as venues for sampling. Formative research revealed that approximately 1,300 migrant workers were present during the early morning or early evening hours within the ten identified towns. Although the survey times (morning and evening) were randomly assigned, sampling was ultimately collected only during the morning time slot for security and safety reasons. At each town, all persons present were enumerated and 15.4% of them

were approached for eligibility screening. The proportions for the three venues were pre-determined to achieve 200 persons screened per venue type for a total sample size of 600.

Data Collection

Selected individuals were taken aside for confidential eligibility screening, data collection and blood testing. All migrants, 18 years of age or older who worked, or intended to work, on a farm in the study area at the time of the survey were eligible for inclusion. A migrant was defined as a non-resident of the study area who had traveled there within the previous six months.

Survey data were collected from consenting participants via an electronic, Amharic-language questionnaire created with SwiftInsights survey software [29] and loaded onto Android-based hand-held tablet computers (Samsung GalaxyTab2 7.0). The questionnaire and sampling procedures were pre-tested prior to the start of the survey. Each interview took approximately 15 minutes and was conducted in Amharic by trained data collectors.

Blood Testing

Survey participants were also offered blood testing for malaria and anemia. Consenting individuals were tested on-site by certified laboratory technicians for malaria by RDT (SD Bio-Line Malaria Ag P.f./P.v. POCT, Standard Diagnostics, Inc.) and anemia by handheld spectrophotometer (HemoCue Hb 201+). RDT testing was conducted according to manufacturer's instructions, and individuals with positive RDT results were offered on-site treatment according to national guidelines: artemether-lumefantrine (Coartem, Novartis AG) for non-pregnant individuals infected with *P. falciparum* or mixed infection, or chloroquine for *P. vivax* infections. Anemia was classified according

to WHO guidelines [30]. Normal (hemoglobin [Hb] $\geq$ 13 g/dL), mild (Hb 11.0 – 12.9 g/dL), moderate (Hb 8.0 – 10.9 g/dL), severe (Hb < 8.0 g/dL). Individuals with anemia were referred directly to the nearest health facility for evaluation and treatment.

Sample Size Determination

The survey was powered to detect a prevalence of malaria of 10% with absolute precision of +/-2.5% at the 95% significance level (two-sided), and design effect =1 and 10% non-response. This yields a sample size of 608 individuals.

Data Analysis

All electronic survey data collected on tablets were downloaded to laptop computer and exported into Excel format, where they were merged with blood sampling results. [comparison and regression methods] analyzed using Stata v13 (Stata Corp., College Station, TX).

Ethics Statement

Participation in this survey was voluntary and anonymous; names or other personal identifiers of participants were not recorded. Only individuals 18 years of age or older were eligible to participate. Consent discussions were conducted in the local language (Amharic) and hard-copy versions of the consent script (Information Sheets) were made available to participants. Participants could refuse to answer any question or stop the interview at any time. Participants were not compensated for their participation. Individual oral consent was obtained and recorded on hand-held tablets prior to interview and also prior to blood testing. The survey was approved by the Ethical Review

Committee of Amhara National Regional State and Emory University's Institutional Review Board (protocol IRB00066825).

Results

Survey population

A total of 639 persons from 93 venue-time locations were selected for inclusion in the survey (Figure 1). An additional 37 venues (12 farms, 25 roads), were visited at which no migrant workers were found. Of selected individuals, one (0.2%) declined to participate, while 33 (5.2%) persons did not meet inclusion criteria (15 persons under the age of 18 years; 18 persons because they had been in the survey area longer than 6 months). This resulted in a final sample population of 605 persons.

Demographics

Nearly all (97.7%) of the surveyed individuals were male (Table 1). Overall mean age of survey participants was 22.8 years (standard deviation [SD], 6.5 years; range (18—65 years), with the majority (74.2%) less than 25 years of age. The most common ethnicity overall was Amhara (96.0%), followed by Tigre (2.8%), Oromo (0.5%), Sudanese (0.2%) and other (0.3%). Nearly half (48.4%) of respondents were able to read a full sentence in Amharic. Parts of an Amharic sentence could be read by 12.9% of respondents, while 38.4% could not read at all. More than one-third (36.0%) of migrants reported that they traveled to the study area with a family member. Of these, niece or nephew was the most common (51.8%) response followed by siblings (30.7%). The majority (72.9%) of migrants were currently employed in paid farm work at the time of survey. A greater proportion of those surveyed on roads (46.9%) and in towns (33.8%) were not yet working compared to 18.3% of those found on farms who were not yet working.

Travel History

Of the survey participants, 79.3% indicated that they have a "home area" (defined as an area to which they return to at least once a year when not engaged in paid farm work elsewhere). Nearly all (95.6%) of those who identified a home area came from within the Amhara Region (See Figure 1). Of those from Amhara Region, more than half (51.6%) identified North Gondar as their home zone, followed by South Gondar (27.8%) and West Gojam (12.9%, including 3.7% from Bahir Dar Town). Of those from North Gondar Zone, nearly half (45.6%) of migrants came from three woredas: Dembia (18.1%), Gondar Zuria (14.4%) and Wogera (13.1%).

As shown in Table 2, the majority (62.7%) of survey participants who designated a home area stated that they usually spend more than six months per year in their home area. When asked the location from which they most recently traveled to the study area for farm work, 86.1% of migrants said they most recently traveled from their home area. The majority of survey participants reported arriving into the study area in either June (39.2%) or July (37.7%), though some arrived as early as January. Public transportation (bus, truck, bajaj [three-wheel motorized taxi], hired car or hired motorcycle) was the most common reported method of transportation to the study area (98.6%), followed by walking (66.2%). Other less common methods are reported in Table 6. A majority of respondents (78.8%) reportedly worked in this area at least one previous year. Only 22.8% of migrants reported working for pay in other farm locations outside the study area in the past twelve months.

When asked what month they intended to leave the study area, almost half planned to leave in September (45.6%), with the majority (84.8%) indicating they will return to their home area.

Malaria Risk Factors and Prevention Measures

The majority of respondents (51.2%) reported a temporary shelter as their usual sleeping space when doing paid farm work (Table 3). Temporary shelters are typically thatch structures constructed by the migrants or other farm laborers during the farming season and can house 50 to 100 persons in very close quarters. Approximately one-fifth of respondents indicated sleeping outside (20.5%) or in a house (18.2%).

Of those living in a permanent housing structure (house or hotel/dormitory) the majority (56.6%) did not know if the structure had been sprayed with IRS in the past 12 months, while 40.0% reported that the structure had not been sprayed. Only 3.5% of respondents reported that the structure had been sprayed with IRS.

Twelve percent of migrants reported having access to a LLIN while working here; of those, 61.1% reportedly owned the net. Of those who had access to a net, 42.0% said they obtained the net from their farm employer (who likely received nets from the Amhara Regional Health Bureau), while around one-fifth obtained their LLIN from either a private shop or market (20.8%) or a health post or health center (19.4%). Other less common responses are listed in Table 3. The majority (72.2%) of those with access to a net indicated that they obtained the net in the study area. Of those who had access to an LLIN, 73.6% reported that they had slept under it last night. Reported net use last night among the total survey population was 8.8%. Of workers who stated they were already working already, 10.6% reported that they work after dark at least sometimes.

Prevalence of Plasmodium Infection

Prevalence of *Plasmodium* infection by rapid diagnostic test was 12.0% overall: 9.6% *P. falciparum*, 1.7% *P. vivax*, and 0.7% mixed infections (Table 4). The relative proportions of infections were 80.3% *P. falciparum*, 14.1% *P. vivax*, and and 5.6% mixed. There was not a significant difference found in *Plasmodium* prevalence between the three different venues (farms, roads and towns), the two sampled woredas (Metema and West Armachiho) (Table 5) or between age categories (Table 6).

Unadjusted Odds Ratio of Migration Variables association with Plasmodium infection

Seven migration variables were examined for association with *Plasmodium* infection (Table 6). Of those, two variables were found to have a significant association, which were a planned destination other than the home area (odds ratio [OR] = 4.02) and a family member traveling with the participant (OR = 0.43). Recent travel, number of months spent in the home area, the month of arrival, previous travel to the study area and month of planned departure were tested and were not found to be associated with *Plasmodium* infection.

Prevalence of Anemia

Results from anemia testing were available from 569 survey participants due to one malfunctioning hemacue device during one field day (Table 8). Mean hemoglobin (Hb) was 13.8 g/dl (SD = 1.8; range 7.2 – 18.7). Overall prevalence of anemia (Hb < 13 g/dl) was 28.3% (Table 3), with 22.8% of individuals diagnosed as mildly anemic (Hb 11.0 — 12.9 g/dl), 5.3% moderately anemic (Hb 8.0 — 10.9 g/dl), and 0.2% severely anemic (Hb <8 mg/dl). Anemia was significantly associated with RDT result ($P < 0.001$), with more

than half (53.4%) of RDT-positive individuals diagnosed with anemia, compared to 25.0% of those with negative RDT result.

Malaria Knowledge

Nearly all (94.7%) survey participants reported having heard of malaria. Of those who had heard of malaria, around half (48.5%) correctly identified a mosquito bite as the primary cause of malaria. Of those who had heard of malaria, more than half of respondent identified fever (65.5%), chills (55.3%), shivering (50.6%), and headache (50.1%) as the signs or symptoms of malaria; sleeping under an LLIN was the most commonly reported (75.9%) method of protection against malaria among those who had heard of malaria.

Health Care Concerns, Access and Care-Seeking Behavior

This survey also inquired about respondents' general health care concerns, access to care, and treatment seeking behavior. Malaria was the most commonly reported (78.0%) single greatest health concern while working on the farms reported by migrant workers. Nearly one-third (30.1%) of survey participants reported having a fever within the preceding two weeks. Of those, 31.3% reported seeking some sort of treatment for their fever. Among those who sought treatment for a fever, nearly half (45.6%) went to a government health center, while 36.8% went to a private hospital/clinic. Among those who had a fever, but did not report seeking treatment, lack of financial resources (40.8%) was the most common reason given.

Of those who had a fever in the past two weeks and who sought treatment, 52.6% reported that a blood test for malaria was performed, with test results communicated to

70.0% of those who were tested. The vast majority (94.7%) of survey participants who sought treatment for a fever received medication.

Discussion

This is the first time a formalized survey has been conducted among this migrant farm-worker population in the farming areas of Western Amhara. Although migrant workers have been traveling to this area for several years, all of the previously available information about this population was from anecdotal reports. Prior to this survey, it was not understood that this population originated within the same region of the farms. Although this region is large and encompasses marked gradations in elevation and risk factors, the migrants are primarily contained within this one region, thus depositing the risk of transmission as well as the burden of their welfare upon this region.

RDT testing showed a prevalence of *Plasmodium* at 12.0% among the migrant workers. This is much higher than the average for the country at a prevalence of less than 1% but is roughly the same settled population in that area, which was 8% in May of 2013 [11]. We are unable to determine from our study whether the infection was acquired from the study site, from the migrant's home area or along the road. Previous studies in Ethiopia and among migrants to this area have shown associations between agricultural work and travel history and malaria infection [8,9], suggesting that it is more likely that the infection was either acquired during the travel period or while engaging in farm labor rather than in the home area. Furthermore, many of the home areas listed by migrant workers were in non-endemic areas for malaria due to their elevation, while the study site is endemic for malaria [2,8]. Although it was beyond the scope of this survey to

determine if this migrant population could be implicated in malaria transmission, this survey, along with other recent research [8] does highlight that the possibility exists and indeed is likely. If a migrant worker becomes infected while working on the farm and returns to his home without treatment, he could fuel transmission in his home area, which may have previously reached malaria elimination or near-elimination status due to household level interventions.

Two of the primary strategies for malaria control and elimination in Ethiopia have been through the distribution and usage of LLINs and coverage of IRS for mosquitos [2]. In 2011, the MIS showed a prevalence of net ownership by household of 73.7% in Amhara [4]. Although we cannot compare directly as the migrants do not live in households, the percentage of migrants in our study who reported access to a net was 11.9%. Utilization among those with access to a net was high at 73.6%, however overall utilization among all migrants was 8.8% as many of them lacked access. We cannot compare utilization because the MIS did not report utilization among men. One barrier unique to the migrant workers with regard to LLIN ownership and utilization is sleeping accommodations. Nets are designed to be hung from indoor structures and 51.2% of migrant workers are sleeping in large, crowded, temporary shelters that are not conducive to hanging an individual net. A further 20.5% are sleeping outside. This clearly undermines the primary prevention strategies as put forth by the national strategic plan for malaria [2]. Among the small percentage of migrants staying in more permanent structures, only 3.5% of them believed them to be sprayed with IRS within the previous 12 months, compared with 53% in Amhara as reported by the 2011 MIS [4]. Innovations in malaria prevention that are targeted to the migrant's unique situation are needed.

A key component of Ethiopia's malaria control and elimination strategy is aimed at providing prompt, effective and affordable diagnosis and treatment of malaria to 100% of the population [2]. However, the public healthcare system within Ethiopia is supplied with ACT and malaria testing materials based on the population within their catchment area as well as through the materials used during the previous month. Similarly, the number of health extension workers (HEWs) provided to a town is based on the population of the town. As the migrant workers are not included in the town's population estimates, their presence, when ill, could quickly overwhelm the resources available at the public health centers. This is particularly important when considering that the estimated number of migrants in some cases more than double the town's settled population during the farming season.

Migrant workers also reported barriers to seeking healthcare that were not related to the resources at the health centers. Of the 30.1% who reported a fever within the prior two weeks, 31.3% reported seeking advice or treatment for their fever although malaria was listed as the number one health concern of migrants (78.0%). Of all of the reasons given for not seeking treatment the cost and distance associated with treatment were listed most frequently. Of note, malaria treatment in Ethiopia is free when provided at a government health center, other than the minimal cost of obtaining a health card. This highlights either a lack of education on the provision of free healthcare for malaria or other hidden costs such as the cost of transportation and time away from work or other expenses not otherwise considered. Distance, as a barrier, is best understood when considering the spatial distribution of farms in relationship to nearby towns. The distance is dependent on location with some farms within several miles of a town and health center, while

others are significantly farther from a nearby town and health center and would require the use of a vehicle, often a tractor, to reach health care. This means that a worker who fell ill while working on the farm would first need to overcome the financial barrier of losing work and paying for transportation and then would need to find transportation that could take him to the nearest town and then, once treated, find transportation back.

In the same way that prevention and healthcare measures are household directed, the information obtained about malaria within the country is largely based on malaria indicator surveys, which are household based surveys. Depending on the timing of MIS, migrant workers may not be captured by these surveys within their home area and they are not being captured by the surveys within the farm area.

When considering malaria transmission and prevention, it is imperative to consider the impact that migrant populations may have on elimination efforts. The results have demonstrated a lack of targeted prevention and treatment measures for this population. Further study that could demonstrate this transmission phenomenon is warranted as it could highlight the importance of targeted interventions for the migrant, not only for the migrant's sake but also for the sake of Ethiopia's malaria elimination efforts.

During review meetings to discuss these results, many ideas for targeted intervention have been considered. The results of this survey provide specific information about this population that can be used to guide planning and implementation. For example, it is known that this population arrives primarily in July and leaves either in September, October or another time after the end of the farming season. One potential solution would be to test and treat migrant workers for malaria at roadside stations set up at entry and exit points to the farming areas. Another idea would be to scale up the number of

HEWs and/or nurses in proportion to the number of migrant workers and to place the additional staff at specified locations within the farms. This would increase access to testing and treatment without the aforementioned barriers to reaching the closest town centers. Finally, efforts directed at prevention have also been considered, including large scale LLINs to cover an entire temporary shelter or insect repellant for worker's clothing. This survey demonstrates an innovative method of surveying populations, such as migrant workers, who are not residing in traditional households and thus cannot be drawn from a systematic sampling frame. To our knowledge, this is the first time that venue based sampling has been applied to malaria research; traditionally it has been used in surveys of men who have sex with men, sex workers and HIV positive people [18-26]. Other used methods in similar populations have included non-probability sampling such as respondent driven sampling [16,17], which introduces significant bias to the sample and also limits generalizability. Because this method utilizes extensive formative research to determine venues and randomly samples individuals within the venues, it allows the researcher to construct a sample with known properties, make statistical inferences and understand potential bias [19]. Venue based sampling could be utilized to improve the study of similar populations in non-traditional settings without the benefit of a comprehensive sampling frame.

Limitations

This survey was conducted in July 2013. Due to delays in rain, major agricultural activity had not yet started in the area, and 26.8% of survey participants had not yet started working at the time of survey. This allowed for collection of information relating to both working and non-working migrants immediately prior to the main agricultural

season—an important aspect as migrants are at risk for malaria and other infectious diseases while waiting for work in towns and moving between farms searching for work. Nonetheless, the inclusion of a significant proportion of non-working migrants has implications for our results including, but not limited to: sleeping accommodations, net availability, time of day spent working, resource availability of survey participants, and healthcare seeking behavior.

Additionally, formative research conducted during the survey suggested that two waves of migrants come to the study area. The first wave is thought to be younger and work on these farms during breaks in the school calendar. Our results seem consistent with this, as the population was young, mainly arrived in June or July and planned to leave in September. A second wave of migrant laborers is thought to arrive around the end of August during peak harvest period, and is thought to be older than the first population. Thus there may be important differences in demographics, home areas, disease risks, and health care seeking behavior between these two populations. Care should be taken when extrapolating results from this survey to all migrant farm workers in the region.

Likewise, the surveyed population may not be reflective of migrant populations in other agricultural areas in Amhara Region or Ethiopia. Subsequent surveys are recommended to understand the identity, disease risks, and behaviors of the purported second wave of migrants in this study area as well as other major migrant farm labor populations in Ethiopia.

While we believe that towns, farms, and roads represented the primary venues where migrants could be located, there may be additional locations where migrant farm workers might be found. This could lead to, or be the result of, differences between such

populations and the surveyed population. For example, women comprised only 1.0% of the sampled population. Anecdotal reports suggest that women accompany migrant workers to serve as cooks or other supportive domestic functions. That they did not appear in significant proportion in this survey suggests that their relative proportion is lower than previously believed, or that additional measures may be needed to identify locations where women affiliated with migrant farmers can be contacted. Furthermore, this study was not designed to estimate the total number of migrant farm workers to the area. Additional survey designs are required for that task.

As this was a cross sectional survey, we are unable to determine the source of *Plasmodium* infection—whether the study area, somewhere else along the migration route or in the home area. Further research into the acquisition of malaria by this migrant population is important to understand parasite transmission dynamics in the Region. Similarly, baseline hematology results were not accessible and the field-testing for anemia did not include a full CBC or differential. Therefore, it is not possible to ascertain the cause of the anemia, nor differentiate between chronic and acute anemia. Finally, although care was taken to not provide an incentive that would influence participation, it is possible that migrant workers learned we would be testing for malaria and anemia and made a decision to stay and be enumerated at a venue based on their perceived need for testing and treatment. Although this phenomenon was not observed during data collection, this self-inclusion/exclusion cannot be entirely ruled out and would influence the survey results.

Conclusion

This is the first time a formalized survey has been conducted among this migrant farm-worker population in the farming areas of Western Amhara. This is primarily a local migrant population traveling within the same region for paid farm labor. They are present within a malarias area of Ethiopia during the high malaria transmission season. Their prevalence of malaria is high compared with the country and their access to malaria prevention measures is low. They face many barriers to seeking healthcare and could be contributing to malaria transmission within the Amhara region. Targeted malaria strategies for this unique population are necessary as an important part of malaria control and elimination in Ethiopia.

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Tables & Figures

Table 1. Characteristics of migrant farm worker study population in Metema and West Armachiho districts, Amhara Region, Ethiopia, July 2013 (N=605)

Variable		N (%)
Sex	Male	591 (97.7)
	Female	6 (1.0)
	Missing	8 (1.3)
Age (years)	18-19	201 (33.2)
	20-24	247 (41.0)
	25-29	97 (16.0)
	30-34	21 (3.5)
	35-65	34 (5.6)
	Missing	5 (0.8)
Ethnicity	Amhara	581 (96.0)
	Tigre	17 (2.8)
	Oromo	3 (0.5)
	Sudanese	1 (0.2)
	Other	2 (0.3)
	Missing	1 (0.2)
Ability to read Amharic	Can read whole sentence	293 (48.4)
	Can read only parts of a sentence	78 (12.9)
	Cannot read sentence at all	232 (38.4)
	Blind/visually impaired	0 (0.0)
	Missing	2 (0.3)
Accompanied family member(s)	Yes	218 (36.0)
	No	384 (63.5)
	Missing	3 (0.5)
Relationship of traveling family member(s) (multiple responses possible)	Niece or Nephew	113 (51.8)
	Siblings	67 (30.7)
	Aunt or Uncle	20 (9.2)
	Children	5 (2.3)
	Parents	4 (1.8)
	Spouse	2 (0.9)
	Other	23 (10.6)
Started paid farm work	Yes	441 (72.9)
	No	162 (26.8)
	Missing	2 (0.3)

Table 2. Migration patterns of migrant farm workers in Metema and West Armachiho districts, Amhara Region, Ethiopia, July 2013 (N=605)

Variable		N (%)
Month of arrival in study area	January – April	46 (7.6)
	May	92 (15.2)
	June	237 (39.2)
	July	228 (37.7)
	Missing	2 (0.3)
Transportation method to study area (multiple responses possible)	Public transportation	597 (98.6)
	Walking	401 (66.2)
	Tractor	69 (11.4)
	Owned car/motorcycle	2 (0.3)
	Animal/animal cart	2 (0.3)
	Missing	3 (0.5)
Most recent location prior to arrival in study area	Home area	520 (86.1)
	Not home area	68 (11.2)
	No home area identified	11 (1.8)
	Missing	6 (1.0)
Month of planned departure from study area	August	33 (5.5)
	September	276 (45.6)
	October	60 (9.9)
	November	56 (9.3)
	December	54 (8.9)
	January	43 (7.1)
	February - April	5 (0.8)
	More than one year	8 (1.3)
	No intention to leave	9 (1.5)
	Don’t know	52 (8.6)
	Missing	9 (1.5)
Departure destination	Home area	513 (84.8)
	Not home area	60 (9.9)
	No home area identified	10 (1.7)
	Don’t know	14 (2.3)
	Missing	8 (1.3)
Number of times to study area for paid farm labor	Never	125 (20.7)
	Once	115 (19.0)
	Twice	101 (16.7)
	Three times	91 (15.0)
	More than three times	170 (28.1)
	Missing	3 (0.5)
Performed paid farm work outside of study area in previous 12 months	Yes	138 (22.8)
	No	459 (75.9)
	Don’t know	2 (0.3)
	Missing	6 (1.0)

Usual time spent in home area† (If a home area identified, N=480)	< 6 months > 6 months Missing	176 (36.7) 301 (62.7) 3 (0.6)

†'Home area' defined as an area to which participants return to at least once a year when not engaged in paid farm work elsewhere.

Table 3. Malaria risk factors and prevention measures among migrant farm workers in Metema and West Armachiho, Amhara Region, Ethiopia, July 2013 (N=605)

Variable		N (%)
Sleeping Accommodations	Temporary shelter	310 (51.2)
	Outside	124 (20.5)
	House	110 (18.2)
	Hotel/Dormitory	33 (5.5)
	Tent	2 (0.3)
	Other	16 (2.7)
	Missing	10 (1.7)
Accommodation sprayed with IRS in the past 12 months (if accommodations are a house or hotel/dormitory, N=145)	Yes No Don't know	5 (3.5) 58 (40.0) 82 (56.6)
LLIN available	Yes	72 (11.9)
	No	528 (87.3)
	Missing	5 (0.8)
Source of LLIN (If LLIN available, N=72)	Farm employer	30 (42.0)
	Private shop/market	15 (20.8)
	Health post/center	14 (19.4)
	Family/friend	5 (7.0)
	Mass distribution	3 (4.2)
	Private clinic	1 (1.4)
	NGO	1 (1.4)
	Other	2 (2.8)
	Missing	1 (1.4)
Used LLIN last night (If LLIN available, N=72)	Yes No Missing	53 (73.6) 18 (25.0) 1 (1.4)
Work outside after dark at least sometimes	Yes	64 (10.6)
	No	394 (65.1)
	Not yet working	135 (22.3)
	Missing	12 (2.0)

Table 4. RDT-diagnosed *Plasmodium* infection by species among migrant farm workers, Metema and West Armachiho districts, Amhara Region, Ethiopia, July 2013 (N=592)

RDT Results	N (%)
Plasmodium falciparum	57 (9.6)
Plasmodium vivax	10 (1.7)
Mixed *Pf*/*Pv*	4 (0.7)
RDT Negative	521 (88.0)

Table 5. Woreda by *Plasmodium* infection among migrant farm workers, Metema and West Armachiho, Amhara Region, Ethiopia, July 2013 (N=568)

Woreda	RDT Negative (N, %)	RDT Positive (N, %)	Total N
Metema	172 (89.1)	21 (10.9)	193
West Armachiho	325 (87.8)	45 (12.2)	370
Pearson chi2 = 0.2012, P = 0.654			

Table 6. *Plasmodium* infection by age categories among migrant farm workers, Metema and West Armachiho, Amhara Region, Ethiopia, July 2013 (N=568)

Age Category	RDT Negative (N, %)	RDT Positive (N, %)	Total N
18-19	171 (90.5)	18 (9.5)	189
20-24	193 (85.8)	32 (14.2)	225
25-29	83 (91.2)	8 (8.8)	91
30-34	17 (85.0)	3 (15.0)	20
35+	30 (90.9)	3 (9.1)	33
Pearson chi2 = 3.4560, *P* = 0.485, Fisher's exact = 0.489			

Table 7. Unadjusted odds ratio of migration variables association with *Plasmodium* infection among migrant farm workers in Metema and West Armachiho, Amhara Region, Ethiopia, July 2013 (N=436)

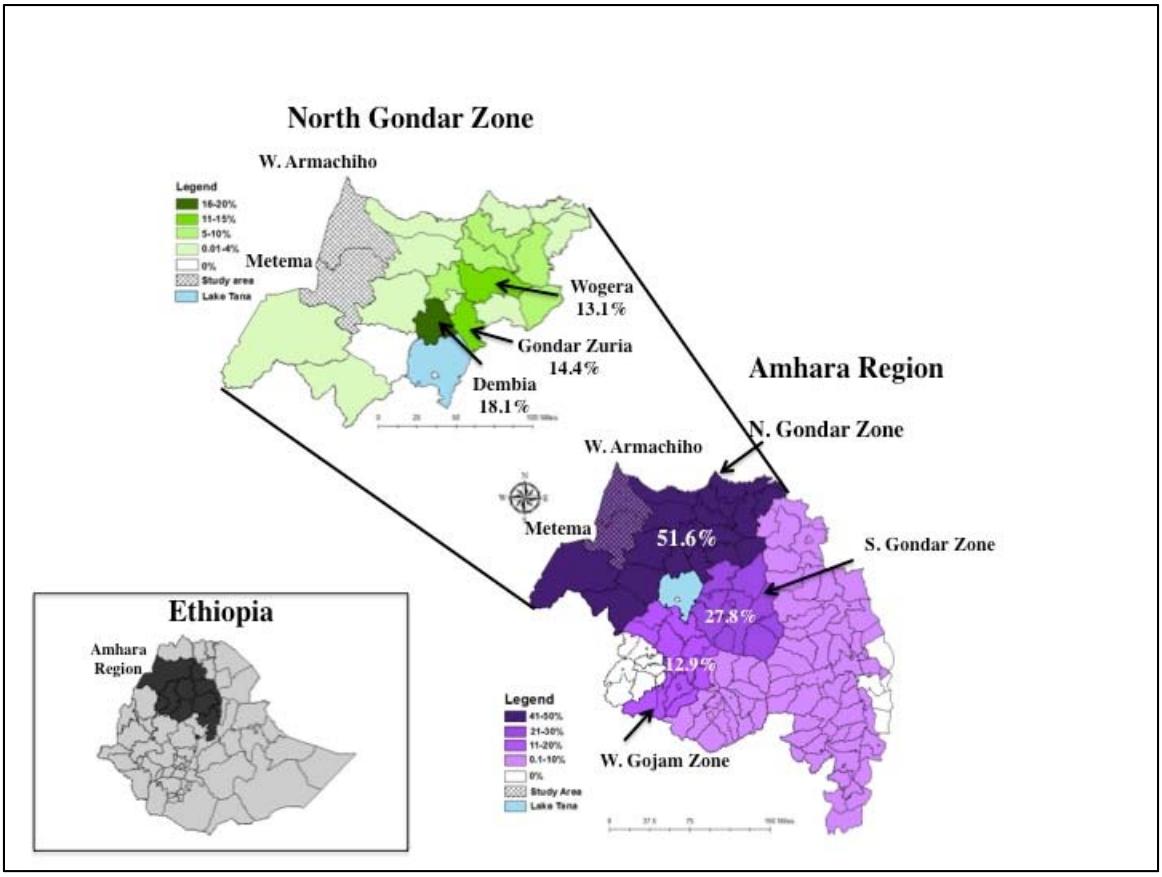
Variable	Odds Ratio	95% CI	P-Value
Most recent travel origin			
Home area	1		
Not home area	1.01	0.22 – 4.53	0.993
Time typically spent in home area annually			
Less than 6 months	1		
More than 6 months	0.78	0.43 – 1.42	0.414
Month of arrival to study area			
Before May	1		
June	0.62	0.30 – 1.28	0.197
July	0.58	0.27 – 1.21	0.147
Previous travel to study area			
No	1		
Yes	1.03	0.51 – 2.09	0.934
Month of planned departure from study area			
Aug-Sept	1		
Oct-Nov	1.04	0.47 – 2.33	0.918
Dec-Jan	1.16	0.53 – 2.52	0.709
Other	0.82	0.10 – 6.69	0.855
Don't know	2.17	0.74 – 6.28	0.155
Next planned destination			
Home area	1		
Not home area	4.02	1.17 – 13.88	0.028*
Don't know	1.15	0.14 – 9.55	0.898
Family traveling with migrant			
No	1		
Yes	0.43	0.21 - .089	0.023*

*Indicates significance at the 95% confidence level

Table 8. Anemia prevalence, by severity, among migrant farm workers, Metema and West Armachiho, Amhara Region, Ethiopia, July 2013 (N=569)

Anemia	N (%)
Normal (hemoglobin [Hb] $\geq$13.0 g/dl)	408 (71.7)
Mild anemia (Hb 11.0 – 12.9 g/dl)	130 (22.8)
Moderate anemia (Hb 8.0 – 10.9 g/dl)	30 (5.3)
Severe anemia (Hb < 8.0 g/dl)	1 (0.2)

Figure 1. Home areas of migrant farm workers by percentage in Metema and West Armachiho, Amhara Region, Ethiopia, July 2013



Chapter 4: Public Health Implications & Recommendations

The first public health implication of this study focuses on the migrant workers. Although clearly vulnerable and largely outside of Ethiopia's malaria control and intervention measures, their situation had not been previously described and therefore, not previously addressed. This study provides an in-depth description of this study population and characterizes its demographics, migration patterns, knowledge and use of malaria prevention measures and the many barriers to optimal health the migrant workers face. This information can be used to tailor health programs uniquely suited to the migrant situation and needs in order to improve working conditions and to mitigate risks while migrant workers are engaging in such economically important and yet often unprotected work. Ultimately, this kind of health programming will take concerted effort and commitment in order to make a significant impact. The information obtained from this survey was shared in a preliminary format immediately after collection with representatives from the Amhara Regional Health Bureau in July of 2013. Completed and fully analyzed data from this survey was then presented by The Carter Center in Ethiopia in March of 2014 at a meeting that included the Head and Deputy Head of the Amhara Regional Health Bureau as well as representatives from other relevant regional and zonal bureaus and MSF. At the time, it was largely agreed that developing an inter-agency regional body devoted to migrant issues would be the best way to tackle the multifaceted needs of this population.

However, it is unclear whether this recommendation was actually implemented. In addition, The Carter Center ceased its support for malaria projects in Ethiopia in 2014 due to funding constraints. Representatives from The Carter Center as well as the

investigator are engaged in conversations with other donors and agencies to find a way to address the problems uncovered by this study. One issue uncovered during the formative research leading up to the study as well as through conversations with the migrant workers, health officers and local government officials is the lack of incentives and resources to protect the migrant workers from illness or injury. This seems to stem from questions of responsibility as well as from concerns about cost. Local health officers highlight that migrant workers are not included in their yearly budgeted supplies and funding, as they are not counted in the census that determines each health facility's catchment area. Investors are using the land for economic gain by farming cash crops and can easily replace a worker if they become ill or injured, thus removing incentive for them to be concerned with each individual worker's health. This, like many other migrant populations, is truly disenfranchised and in need of advocates.

The insight gained by this study sets the stage for several possible approaches to addressing the needs of the migrant worker population. While it is clear that traditional prevention and control strategies for malaria such as IRS and single-occupant LLINs would not be feasible, there are other current methods in Ethiopia that could make a difference. In Ethiopia, a federal program was initiated in 2005 to improve primary health services in the rural areas using a community-based approach that focuses on prevention, healthy living and curative care [41]. This was named the Health Extension Worker (HEW) program. HEW's consist of people from the various communities who undergo a year of training in order to be able to carry out basic primary health care initiatives in their communities with a ratio of 1 HEW to 2,500 population [41]. One regular activity that HEWs participate in is testing for malaria using RDTs and treating

positive cases with oral therapy. However, despite the approximate 350,000 migrant workers present in the farming areas, there was not a single HEW deployed to work in that area. Using the ratio of 1 HEW: 2,500 population, at least 140 HEWs should be deployed to address the primary health care needs of the migrant population. These HEWs could be stationed at various farms within the area or could even be trained farm workers or family members of farm workers. Involving the migrant workers themselves in the intervention would make any program more likely to succeed and to be sustainable. This population would benefit greatly from simple interventions such as regular testing and treatment for malaria and other minor health ailments. Each country and community that is considering a migrant population's need for health care access needs to develop a strategy that is feasible, scalable and specific to the needs of the particular population. Rather than a one size fits all approach, studies like this one provide the necessary information to develop customized interventions.

Another important implication is the contribution of this study to the mounting evidence about the necessity of addressing migrant populations in malaria elimination efforts. While other studies have demonstrated an association between farm work, travel and malaria infection in Ethiopia [17,18], no previous studies had described the work destination or the situations on the ground that might increase a worker's risk of malaria acquisition. Although mobile populations have long been understood as possible traveling parasite reservoirs for malaria and their role in transmission has been suspected, only recently has attention been paid to specific migrant populations within specific malaria elimination areas. The farming areas of Western Amhara are lowland areas that are known to experience a higher burden of malaria than other parts of the region. This

study demonstrates that the workers are traveling primarily from other woredas within Amhara, many of them from areas that have already achieved low levels of malaria transmission. However, this mobile population that participate in a yearly circular migration patterns from their home community with low malaria transmission to the farming area with high malaria transmission and back again could hamper elimination efforts in that community and ultimately in the country. In countries or communities that are closing in on malaria elimination, increasing attention needs to be paid to non-traditional populations and their unique risks and requirements for control in order for malaria elimination and eradication efforts to be realized in full. This has important implications for malaria control programming. This is a multi-faceted issue that, like addressing the health needs of specific migrant populations, needs an insightful and innovative approach in order to be successful. A good first step for malaria control programs would be to firmly establish that migrant populations are, in fact, the ones transmitting malaria back to areas previously controlled. Case-control studies like the one conducted by Alemu, et al [18] go a long way towards showing that travel and work in agriculture are risk factors for malaria. However, more evidence is needed if organizations and ultimately donors are going to direct their funds and efforts towards these populations. In the setting described in this research, it would be possible to set up testing and treatment stations at all of the major roads leading in and out of the farming areas. All workers could be tested as they are entering at the beginning of the season and as they leave at the end of the season in order to determine if their parasite load is traveling in with them or being acquired during their work time. Those migrant workers who test positive could receive oral treatment at these stations. Similar programs may be

feasible in other migrant populations as well, although each setting and situation should be considered independently. While there should be no relaxation in traditional methods in communities that have interrupted transmission—indeed, interventions need to be vigorously maintained while risk of importation is present—it is clear that country programs need flexible staff and budgets to concentrate on non-traditional populations and methods required for elimination and post-elimination surveillance.

Again, it is imperative that the migrant population themselves, regardless of who they are, should be involved as much as possible in the idea generating sessions and implementation programs in order for them to be successful.

Studying hard to reach populations in a way that provides meaningful data continues to be a challenge for public health practitioners. Previously, studies focused on migrant workers have often used convenience sampling or, in some cases, respondent driven sampling such as snowball sampling [19,20]. This study is the first time that venue based sampling has been utilized in malaria research. Utilizing intensive formative research and eliminating biases associated with respondent based sampling, VBS is a feasible and comprehensive way to study a hard to reach population that doesn't fit into a standard sampling frame. The methods utilized in this study can be replicated by other researchers in similar predicaments to generate probability based sampling results in a non-traditional population. Ultimately, it would be incredibly useful for a body such as the World Health Organization (WHO) or the Centers for Disease Control and Prevention (CDC) to put forward a toolkit of methods for sampling hard to reach populations. The WHO estimates that there are 1 billion migrants globally, comprising 214 million international and 740 million internal or domestic migrants [11]. Migrants and mobile populations are

a diverse group, which include workers, refugees, students and others, all of which have unique and diverse health determinants, needs and levels of vulnerability. Migrant populations will continue to be a challenge for not only malaria elimination efforts but for all health related work around the world. Having an available toolkit for researching and addressing these unique populations would streamline efforts by all partners involved. The United Nation's Millennium Development Goal 6.C aims to halt malaria by 2015 and begin to reverse the incidence of malaria [42]. As Ethiopia and other countries work towards this goal and respond to encouragement by international donors and agencies, the importance of identifying key at-risk and under-addressed populations is becoming increasingly evident. Public health research, such as this, that directly singles out these populations and identifies tailored interventions will become progressively necessary as each country, continent and finally the world works towards eradication of this devastating disease. The insight provided by this study can lead the way for future research among migrant populations and can ultimately, if appropriately addressed, provide insight for malaria control among even those hardest to reach.

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(Manuscript in-text citations will not match this list – See Manuscript References)

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Appendices

Appendix 1: Survey Tool with Code

Amhara Migrant Worker Survey Tool

Date/Time
Venue ID
Team ID
Recorder ID
Random Number (contactid)
Sequence ID (seq_num)

Eligibility Screening.

1. Are you at least 18 years old? **(elig_age)**
   - Yes (Go to next question) **1**
   - No (End screening) **0**

2. Did you travel to this area (Metema or West Armachiho) in the last 6 months in order to work on a farm? **(elig_trav)**
   - Yes (Go to next question) **1**
   - No (End screening) **0**

I. Demographic Information

3. Read consent form. Do you consent to participate in this survey? **(consent)**
    - Yes (Go to next question) **1**
    - No (End survey) **0**
4. Have you started working in this area this season? **(sta_work)**
    - Yes **1**
    - No **0**
5. How old were you at your last birthday? **(age)**
    - _____ (years)
6. Is respondent male or female? **(sex)**
    - Male **1**
    - Female **2**
7. What is your ethnicity/nationality? **(ethn)**
    - Amharic **1**
    - Oromo **2**
    - Tigre **3**
    - Sudanese **4**
    - Other **88**
    - Don't know **99**
8. Do you have a home area you return to at least once a year when you are not doing paid farm work? (Defined as "home area" in remainder of survey). **(homearea)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 14) **0**
    - Don't know (Go to Q. 14) **99**
9. If yes, where is that home area located? (Read options). **(home_loc)**
    - Amhara (Go to next question) **1**
    - Not Amhara, but another region of Ethiopia (Go to Q. 12) **2**
    - Sudan (Go to Q. 13) **3**
    - Another Country (Go to Q. 13) **4**
10. If Amhara, in which zone is that home area located? (For any answer other than North Gondar, go to Q. 13) **(home_amh)**
    - North Gondar (Go to Q. 11) **1**
    - South Gondar **2**
    - North Wello **3**
    - South Wello **4**
    - Oromia **5**
    - North Shewa **6**
    - West Gojam **7**
    - East Gojam **8**
    - Wag Hemra **9**
    - Bahir Dar Special **10**
    - Awi **11**
    - Don't know **99**
11. If North Gondar, in which woreda is that home located? (Go to Q. 13) **(home_ng)**
    - Gondar Town **1**

- Gondar Zuria **2**
- West Belesa **3**
- East Belesa **4**
- Dembia **5**
- Chilga **6**
- Takusa **7**
- Alefa **8**
- Metema **9**
- Quara **10**
- West Armachiho **11**
- Tegede **12**
- Tach Armachiho **13**
- Lay Armachiho **14**
- Wogera **15**
- Dabat **16**
- Debark **17**
- Aderkay **18**
- Beyeda **19**
- Teselemt **20**
- Janamora **21**
- Debark Town **22**
- Gendewuha **23**
- Don't know **99**

12. If not Amhara, in which region outside of Amhara is the home area located? **(home_reg)**
    - Oromia **1**
    - Tigray **2**
    - Afar **3**
    - Benishangul-Gumaz **4**
    - Gambela **5**
    - SNNPR **6**
    - Somali **7**
    - Addis Ababa **8**
    - Dire Dawa **9**
    - Harhari **10**
    - Other **88**
    - Don't know **99**
13. How many months per year do you usually spend at this home area? **(mo_home)**
    - Less than 3 months **1**
    - 3-6 months **2**
    - 7-9 months **3**
    - More than 9 months **4**
    - Don't know **99**
14. Do respondent speak Amharic? **(speak_amh)**
    - Yes **1**
    - No **0**

15. Does respondent read Amharic? Have respondent read a sentence. **(read)**
    - Able to read whole sentence **1**
    - Able to read only parts of the sentence **2**
    - Cannot read sentence at all **3**
    - Visually impaired **4**

II. Travel history

16. Where did you most recently travel **from**? (Read options). **(trav_from)**
    - Home area **(place identified in "home area" sequence)** (Go to Q. 21) **1**
    - Not home area (Go to next question) **2**
    - Home area was not identified in "home area" sequence (Go to next question) **3**
    - Don't know (Go to Q. 21) **99**
17. If not home area, or no home area identified in "home area sequence", where did you most recently travel from? **(trav_reg)**
    - Amhara (Go to next question) **1**
    - Not Amhara, but in Ethiopia (Go to Q. 20) **2**
    - Sudan (Go to Q. 21) **3**
    - Another country(Go to Q. 21) **4**
    - Don't know (Go to Q. 21) **99**
18. If Amhara, which zone in Amhara did you most recently travel **from**? (For any answer other than North Gondar, go to Q. 21) **(trav_zone)**
    - North Gondar (Go to Q. 19) **1**
    - South Gondar **2**
    - North Wello **3**
    - South Wello **4**
    - Oromia **5**
    - North Shewa **6**
    - West Gojam **7**
    - East Gojam **8**
    - Wag Hemra **9**
    - Bahir Dar Special **10**
    - Awi **11**
    - Don't know **99**
19. If North Gondar, which woreda did you most recently travel from? **(trav_wor)**
    - Gondar Town **1**
    - Gondar Zuria **2**
    - West Belesa **3**
    - East Belesa **4**
    - Dembia **5**
    - Chilga **6**
    - Takusa **7**
    - Alefa **8**
    - Metema **9**
    - Quara **10**

- West Armachiho **11**
- Tegede **12**
- Tach Armachiho **13**
- Lay Armachiho **14**
- Wogera **15**
- Dabat **16**
- Debark **17**
- Aderkay **18**
- Beyeda **19**
- Teselemt **20**
- Janamora **21**
- Debark Town **22**
- Gendewuha **23**
- Don't know **99**

20. If outside Amhara, which region in Ethiopia did you most recently travel from? **(trav_reg2)**
    - Oromia **1**
    - Tigray **2**
    - Afar **3**
    - Benishangul-Gumaz **4**
    - Gambela **5**
    - SNNP **6**
    - Somali **7**
    - Addis Ababa **8**
    - Dire Dawa **9**
    - Harhari **10**
    - Don't know **99**
21. In the past 12 months, did you travel to any place other than Metema and West Armachiho to do paid farm work? **(paid_farm)**
    - Yes **1**
    - No **0**
    - Don't know **99**
22. How many times prior to this season have you come to this area to do paid farm work? **(times_here)**
    - Never before **1**
    - Once before **2**
    - Twice before **3**
    - Three times before **4**
    - More than three times before **5**
    - Don't know **99**
23. When did you arrive in this area this season? **(arrive)**
    - January **1**
    - February **2**
    - March **3**
    - April **4**
    - May **5**

- June **6**
- July **7**
- August **8**
- September **9**
- October **10**
- November **11**
- December **12**
- Don't know **99**

24. How did you travel to this area this season? (Do not read answers. Multiple answers possible. Ask: "Anything else?" once before continuing to the next question). **(transp)**
    - Car or motorcycle that you own **1**
    - Public transportation (bus, truck, hired car, hired motorcycle, bajaj) **2**
    - Tractor **3**
    - Animal/Animal Cart **4**
    - Walking **5**
    - Bicycle **6**
    - Other **88**
    - Don't know **99**
25. When do you plan to leave this area? **(leave)**
    - July **1**
    - August **2**
    - September **3**
    - October **4**
    - November **5**
    - December **6**
    - January **7**
    - February **8**
    - March **9**
    - April **10**
    - May **11**
    - June **12**
    - I plan to leave after a year or more **13**
    - I don't have intention to leave **14**
    - Don't know **99**
26. Where do you plan to go to next after the work in this area is finished? **(go_next)**
    - Home area **(place identified in "home area" sequence)** (Go to Q. 31). **1**
    - Not home area (Go to next question) **2**
    - Home area was not identified in "home area" sequence. (Go to next question) **3**
    - Don't know (Go to Q. 31) **99**
27. If not home area or home area not provided, where do you plan to go next? (Read options). **(area_next)**
    - Amhara (Go to next question) **1**
    - Not Amhara, but in Ethiopia (Go to Q. 30) **2**
    - Sudan (Go to Q. 31) **3**

- Another Country(Go to Q. 31) **4**
- Don't know (Go to Q. 31) **99**

28. If Amhara, which zone in Amhara do you plan to go next? (For any answer other than North Gondar, go to Q. 31) **(zone_next)**
    - North Gondar (Go to Q. 29) **1**
    - South Gondar **2**
    - North Wello **3**
    - South Wello **4**
    - Oromia **5**
    - North Shewa **6**
    - West Gojam **7**
    - East Gojam **8**
    - Wag Hemra **9**
    - Bahir Dar Special **10**
    - Awi **11**
    - Don't know **99**
29. If North Gondar, which woreda do you plan to go to next? **(wor_next)**
    - Gondar Town **1**
    - Gondar Zuria **2**
    - West Belesa **3**
    - East Belesa **4**
    - Dembia **5**
    - Chilga **6**
    - Takusa **7**
    - Alefa **8**
    - Metema **9**
    - Quara **10**
    - West Armachiho **11**
    - Tegede **12**
    - Tach Armachiho **13**
    - Lay Armachiho **14**
    - Wogera **15**
    - Dabat **16**
    - Debark **17**
    - Aderkay **18**
    - Beyeda **19**
    - Teselemt **20**
    - Janamora **21**
    - Debark Town **22**
    - Gendewuha **23**
    - Don't know **99**
30. If outside Amhara, which region do you plan to go to next? **(reg_next)**
    - Oromia **1**
    - Tigray **2**
    - Afar **3**
    - Benishangul-Gumaz **4**

- Gambela **5**
- SNNP **6**
- Somali **7**
- Addis Ababa **8**
- Dire Dawa **9**
- Harhari **10**
- Other **88**
- Don't know **99**

31. Did any family members travel to this area with you this year? **(fam_trav)**
    - Yes (Go to next question). **1**
    - No (Go to Q. 33). **0**
32. Which family members travelled to this area with you this year? (Do not read answers. Multiple answers possible, probe once – anyone else?) **(which_fam)**
    - Spouse **1**
    - Children **2**
    - Parents **3**
    - Siblings (brother, sister, brother-in-law, sister-in-law) **4**
    - Aunt or Uncle **5**
    - Niece or Nephew **6**
    - Other **88**
    - Don't know **99**

III. Malaria Risk Factors and Prevention

33. Where do you usually sleep while working here? **(sleep)**
    - In a house (Go to next question) **1**
    - Multi-unit dwelling (hotel, dormitory) (Go to next question) **2**
    - In a tent (Go to next question) **3**
    - In a temporary shelter **4**
    - Outside **5**
    - Other **88**
    - (specify) _____(Go to next question) **(spec_sleep)**
34. What is the payment arrangement? **(pay_sle)**
    - Employer provides free of charge **1**
    - Rent **2**
    - Freely provided by friends/family **3**
    - I own the structure **4**
    - Other **88**
35. In the last 12 months has anyone sprayed the interior walls of the dwelling here against mosquitoes (indoor residual spray [IRS])? **(IRS)**
    - Yes **1**
    - No **0**
    - Don't know **99**
36. Is there a mosquito net available for you to use while working here? **(net_here)**
    - Yes (Go to next question) **1**

- No (Go to Q. 42) **0**

37. Do you own the net here? **(net_own)**
    - Yes **1**
    - No **0**
    - Don't know **99**
38. From where did you obtain the net? **(net_plac)**
    - Mass distribution campaign **1**
    - Health post/health center **2**
    - Private clinic **3**
    - Hospital **4**
    - Private shop/market **5**
    - Farm employer **6**
    - Family/friend **7**
    - NGO **8**
    - Other **88**
    - Don't know **99**
39. 38 In what area did you obtain the net? **(net_area)**
    - Within this area **1**
    - Another woreda within North Gondar **2**
    - Another zone in Amhara **3**
    - Outside Amhara **4**
    - Other **88**
    - Don't know **99**
40. Did you sleep under a mosquito net last night (any net)? **(net_sleep)**
    - Yes (Go to Q. 42) **1**
    - No (Go to next question) **0**
41. If no, what is the main reason why not? (Do not read answers. Only record first one mentioned.) **(not_sleep)**
    - No net available **1**
    - Net too old, dirty, torn **2**
    - No mosquitoes/nuisance insects **3**
    - No risk of malaria **4**
    - Too hot **5**
    - Difficult to hang net **6**
    - Don't like smell of net **7**
    - Does not work/Ineffective **8**
    - Other **88**
    - Don't know **99**
42. In this area have you used other mosquito prevention methods to prevent mosquitoes this season? **(mosq_prev)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 43) **0**
    - Don't know (Go to Q. 43) **99**
43. What other methods have you used to prevent mosquitoes in your sleeping space? (Do not read answers. Multiple responses possible. Ask: "Anything else?" once before continuing to the next question). **(oth_meth)**

- Fleet or other insect spray in house or air (aerosol can) **1**
- Insect repellant ointment/spray **2**
- Burn leaves/smoke **3**
- Environmental modification **4**
- Other **88**
- Don't know **99**

44. What time of the day do you usually start working? **(work_sta)**
    - 7pm-10pm **1**
    - 11pm-2am **2**
    - 3am-6am **3**
    - 7am-10am **4**
    - 11am-2pm **5**
    - 3pm-6pm **6**
    - I have not started working yet **7**
    - No consistent pattern **8**
    - Don't know **99**
45. What time of the day do you usually stop working? **(work_stop)**
    - 7pm-10pm **1**
    - 10pm-2am **2**
    - 3am-6am **3**
    - 7am-10am **4**
    - 10am-2pm **5**
    - 3pm-6pm **6**
    - No consistent pattern **7**
    - I have not started working yet **8**
    - Don't know **99**
46. What time of the day do you usually lie down to sleep while working here? **(sleep_time)**
    - 7pm-10pm **1**
    - 11pm-2am **2**
    - 3am-6am **3**
    - 7am-10am **4**
    - 11am-2pm **5**
    - 3pm-6pm **6**
    - I have not started working yet **7**
    - No consistent pattern **8**
    - Don't know **99**
47. How often do you also work after it is dark outside? **(work_noc)**
    - Never **1**
    - Sometimes **2**
    - Usually **3**
    - Always **4**
    - I have not started working yet **5**

IV. Malaria Knowledge

48. In your opinion, what is the greatest health concern you face while doing agricultural work in this area? (Do not read answers. Only record the first one mentioned). **(gre_heal)**
    - Chronic health conditions (includes heart disease, high blood pressure, diabetes, cancer, etc.) **1**
    - HIV/AIDS **2**
    - TB **3**
    - Malaria **4**
    - Trachoma **5**
    - River Blindness **6**
    - Lymphatic Filariasis (in Amharic: Elephantiasis) **7**
    - Anemia **8**
    - Injuries **9**
    - Pesticide exposure **10**
    - Sun/heat exposure **11**
    - Kala-azar **12**
    - Diarrheal disease **13**
    - Lack of food **14**
    - Lack of water **15**
    - Snake/scorpion bite **16**
    - Other (specify) **88**
    - Don't know **99**
49. Specify your greatest health concern_____ **(spec_gre_heal)**
50. Was specify question completed? **(spe_com)**
    - No **0**
    - Yes **1**
51. Secondly, what other health problems are concerning you? (Do not read answers. Multiple responses possible. Ask: "Anything else?" once before continuing to the next question). **(oth_healt)**
    - Chronic health conditions (includes heart disease, high blood pressure, diabetes, cancer, etc.) **1**
    - HIV/AIDS **2**
    - TB **3**
    - Malaria **4**
    - Trachoma **5**
    - River Blindness **6**
    - Lymphatic Filariasis (in Amharic: Elephantiasis) **7**
    - Anemia **8**
    - Injuries **9**
    - Pesticide exposure **10**
    - Sun/heat exposure **11**
    - Kala-azar **12**
    - Diarrheal disease **13**
    - Lack of food **14**
    - Lack of water **15**

- Snake/scorpion bite **16**
- Other (specify) _____ **88**
- Don't know **99**

52. Specify what other health problems concern you_____ **(spec_oth_healt)**
53. Have you ever heard of an illness called malaria? **(heard_mal)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 57) **0**
    - Don't know (Go to Q. 57) **99**
54. Can you tell me the signs or symptoms of malaria? (Do not read answers. Multiple responses possible. Ask: "Anything else?" once before continuing to the next question). **(sx_mal)**
    - Fever **1**
    - Chills **2**
    - Shivering **3**
    - Headache **4**
    - Nausea/Vomiting **5**
    - Loss of appetite **6**
    - Body ache or joint pain **7**
    - Loss of consciousness **8**
    - Jaundice **9**
    - Other **88**
    - Don't know **99**
55. In your opinion, what is the primary cause of malaria? (Do not read answers. Single response). **(caus_mal)**
    - Mosquito bites **1**
    - Eating immature sugarcane **2**
    - Eating maize **3**
    - Inhaling pollen **4**
    - Hunger **5**
    - Eating other dirty food **6**
    - Drinking dirty water **7**
    - Getting soaked with rain **8**
    - Cold or changing weather **9**
    - Witchcraft **10**
    - Drinking milk **11**
    - Eating goats meat **12**
    - Sleeping on wet ground **13**
    - Increased workload **14**
    - Poor personal hygiene **15**
    - Other **88**
    - Don't know **99**
56. What are all the ways that someone can protect themselves against malaria? (Do not read answers. Multiple responses possible. Ask: "Anything else?" once before continuing to the next question). **(prot_mal)**
    - Sleep under mosquito net **1**

- Use mosquito repellant **2**
- Avoid mosquito bites **3**
- Take preventative medicine **4**
- Spray house with insecticide **5**
- Cut grass around the house **6**
- Fill in puddles (stagnant water) **7**
- Burn leaves **8**
- Don't drink dirty water **9**
- Don't eat bad food **10**
- Use window coverings/screens **11**
- Eat garlic **12**
- Nothing can protect against malaria **13**
- Drinking alcohol **14**
- Eating hot pepper **15**
- Not eating maize/sugarcane **16**
- Other **88**
- Don't know **99**

V. General Healthcare Access

57. Have you been ill with a fever while working in this area at any time in the last two weeks? **(fever)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 67) **0**
    - Don't know (Go to Q. 67) **99**
58. Did you seek advice or treatment for the fever from any source? **(fever_tx)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 65) **0**
59. From what source did you seek advice or treatment? (Multiple responses possible. Ask "Anything else?" once before continuing to the next question). **(fe_tx_sou)**
    - Gov't hospital **1**
    - Gov't health center **2**
    - Gov't health post **3**
    - Gov't Mobile clinic **4**
    - Private hospital/clinic **5**
    - Pharmacy **6**
    - Shop **7**
    - Traditional practitioner **8**
    - Farm management **9**
    - NGO **10**
    - Other **88**
    - Don't know **99**
60. In what area did you seek that treatment? (Read answers) **(fe_tx_ar)**
    - Home area (place identified in "home area" sequence). **1**
    - Within this district **2**
    - Somewhere else in North Gondar other than this district **3**

- Another zone within Amhara **4**
- Another region outside of Amhara **5**
- Sudan **6**
- Another country other than Sudan or Ethiopia **7**
- Don't know **99**

61. Was a blood test for malaria performed? **(test_ma)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 63) **0**
    - Don't know (Go to Q. 63) **99**
62. If yes, did the health provider tell you the results of the blood test? **(test_res)**
    - Yes **1**
    - No **0**
    - Don't know **99**
63. Did you take any drugs for the fever? **(dru_fev)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 67) **0**
    - Don't know (Go to Q. 67) **99**
64. What drugs did you take? (prompt once – any other drugs? Record all mentioned. Ask to see drugs if type of drug is not known. If type of drug is still not determined, show typical antimalarial drugs to respondent). **(what_dru)**
    - Coartem **1**
    - Chloroquine **2**
    - Quinine **3**
    - Other anti-malarial **4**
    - Aspirin **5**
    - Acetaminophen/Paracetamol **6**
    - Ibuprofen **7**
    - Other non anti-malarial **8**
    - Don't know **99**
65. If you did not seek treatment, why not? (Do not read answers. Multiple answers possible. Ask: "Anything else?" once before continuing to the next question). **(fe_no_tx)**
    - Too expensive **1**
    - Healthcare providers don't speak my language **2**
    - Too far away **3**
    - No transportation **4**
    - Don't know where to go **5**
    - Not open during worker's off hours **6**
    - Poor quality of care **7**
    - I would lose my job/I cannot leave work **8**
    - Healthcare providers don't treat me with respect **9**
    - Illness was not serious enough to seek treatment **10**
    - I did not have money **11**
    - Other (specify) **88**
    - Don't know **99**

66. Specify reason for not seeking treatment_____**(spec_fe_no_tx)**
67. Either this season or the last time you came to this area to do paid farm work, did you ever become ill from any cause (excluding fever in the last two weeks)? **(ill)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 73) **0**
    - Don't know (Go to Q. 73) **99**
68. The most recent time you were ill in this area (not including fever in the past 2 weeks), did you seek advice or treatment for the illness from any source? **(ill_tx)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 71) **0**
69. From what source did you seek advice or treatment? (Multiple responses possible. Ask "Anything else?" once before continuing to the next question) **(ill_tx_so)**
    - Gov't hospital **1**
    - Gov't health center **2**
    - Gov't health post **3**
    - Gov't Mobile clinic **4**
    - Private hospital/clinic **5**
    - Pharmacy **6**
    - Shop **7**
    - Traditional practitioner **8**
    - Farm management **9**
    - NGO **10**
    - Other **88**
    - Don't know **99**
70. In what area did you seek that treatment? (Read answers) **(ill_tx_ar)**
    - Home area (place identified in "home area" sequence). **1**
    - Within this area (Metema or West Armachiho **2**
    - Somewhere else in North Gondar other than this district **3**
    - Another zone within Amhara **4**
    - Another region outside of Amhara **5**
    - Sudan **6**
    - Another country other than Sudan or Ethiopia **7**
    - Don't know **99**
71. If you did not seek treatment, why not? (Do not read answers. Multiple answers possible. Ask: "Anything else?" once before continuing to the next question). **(ill_no_tx)**
    - Too expensive **1**
    - Healthcare providers don't speak my language **2**
    - Too far away **3**
    - No transportation **4**
    - Don't know where to go **5**
    - Not open during worker's off hours **6**
    - Poor quality of care **7**
    - I would lose my job/I cannot leave work **8**
    - Healthcare providers don't treat me with respect **9**

- Illness was not serious enough to seek treatment **10**
- I did not have any money **11**
- Other (specify) **88**
- Don't know **99**

72. Specify reason for not seeking treatment_____**(spec_ill_no_tx)**
73. If you were to become ill in the future while working here in this area, would you go to a health facility? **(ill_fut)**
    - Yes (Go to Q. 76) **1**
    - No (Go to next question) **0**
    - Don't know/not sure/neutral (Go to next question) **99**
74. If no or don't know, why not? (Do not read answers. Multiple answers possible. Ask: "Anything else?" once before continuing to the next question). **(ill_fut_no_tx)**
    - Too expensive **1**
    - They don't speak my language **2**
    - Too far away **3**
    - No transportation **4**
    - Don't know where to go **5**
    - Not open during worker's off hours **6**
    - Poor quality of care **7**
    - I would lose my job/I cannot leave work **8**
    - They wouldn't treat me with respect **9**
    - Other (specify) **88**
    - Don't know **99**
75. Specify reason for not seeking treatment in the future_____**(spec_no_fut_tx)**
76. Did you participate in a MalTra campaign in the past 12 months? **(malta)**
    - Yes (Go to next question) **1**
    - No (Go to Q. 80) **0**
    - Don't know **99**
77. Did you receive medicine for trachoma in context of the Maltra campaign in the past 12 months? **(trachoma)**
    - Yes **1**
    - No **0**
    - Don't know **99**
78. Were you screened for fever in the context of the MalTra campaign in the past 12 months? **(fever_scr)**
    - Yes **1**
    - No **0**
    - Don't know **99**
79. Were you offered education about malaria during the MalTra campaign in the past 12 months? **(mal_ed)**
    - Yes **1**
    - No **0**
    - Don't know **99**

80. Did you receive medicine for onchocerciasis (river blindness) in the past 12 months? (Show respondent tablets to confirm). **(med_onc)**
    - Yes **1**
    - No **0**
    - Don't know **99**
81. Did you receive medicine for lymphatic filariasis in the past 12 months? (Show respondent tablets to confirm). **(med_lf)**
    - Yes **1**
    - No **0**
    - Don't know **99**
82. Have you ever heard of an illness called Kala-azar? **(hear_ka)**
    - Yes (Continue to next question) **1**
    - No (End survey) **0**
83. If yes, what do you think are the symptoms of Kala-azar? (Do not read answers, multiple responses possible. Ask: "Anything else?" once before continuing to the next question). **(kal_sx)**
    - Fever **1**
    - Chills **2**
    - Shivering **3**
    - Headache **4**
    - Nausea/Vomiting **5**
    - Lack of appetite **6**
    - Body ache or joint pain **7**
    - Abdominal swelling (includes spleen and liver swelling) **8**
    - Weight loss **9**
    - Anemia **10**
    - Facial wounds **11**
    - Other wounds **12**
    - Night sweating **13**
    - Discolored urine **14**
    - Tiredness **15**
    - Nose bleed **16**
    - Other **88**
    - I don't know **99**
84. What are all of the ways someone can protect themselves against Kala-azar? **(kal_prev)**
    - Sleep under a bed net **1**
    - Sleep near a bed net **2**
    - Sleep in a closed house **3**
    - Use insect repellant **4**
    - Wear shoes **5**
    - Cover all parts of body **6**
    - Stay inside at night **7**
    - Fill in cracked earth **8**
    - Stay away from red acacia trees **9**
    - Stay away from termite mounds **10**

- Only live in highland areas **11**
- Nothing can protect against Kala-azar **12**
- Stay away from cracked black soil **13**
- Other **88**
- I don’t know **99**

Thank you for your time!

Appendix 2: Consent Forms

Verbal Informed Consent for Interview

North Gondar Migrant Survey 2013

Script for verbal informed consent for interview

Principal Investigator

The principal investigator for this study is Dr. Gregory S. Noland, who works for The Carter Center.

Funding

Funding for this study is provided by The Carter Center.

Introduction

Greetings, my name is _____ and I work with the Amhara National Regional State Health Bureau.

You are being asked to be in a study. This form is designed to tell you everything you need to think about before you decide to consent (agree) to be in the study or not to be in the study. **It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the study. You can skip any questions that you do not wish to answer.**

Before making your decision:

- Please carefully listen as this form is read to you
- Please ask questions about anything that is not clear

You can take a copy of this consent form, to keep. Feel free to take your time thinking about whether you would like to participate. Do not agree to participate unless you have

had a chance to ask questions and get answers that make sense to you. By agreeing to participate you will not give up any legal rights.

Study Overview

We are asking questions to migrant farm workers in North Gondar to understand their health needs, access to and use of malaria prevention tools, and prevalence of malaria and anemia. Approximately 400 people will be included in this study.

Procedures

I would like to talk with you for about 45 minutes and ask a few questions related to your recent travel patterns, health care access, and use of malaria prevention methods. You will also be offered testing for malaria and anemia.

Risks

There are no known risks from participating in the household interview.

Benefits

There are no direct benefits to you or your household for participating in this study. This study is designed to learn more about health care needs of migrant farm workers. The study results may be used to help others in the future.

Compensation

You will not be offered payment or compensation for participating in this study.

Other Options Outside this Study

If you decide not to enter this study, there is care available to you through your local health facility (health post, health clinic, or hospital).

Confidentiality

Your name or other personal identifying information will not be collected or published. A number rather than your name will be used on study records.

Certain offices and people other than the researchers may look at study records. U.S. government agencies and Emory University employees overseeing proper study conduct may look at the study records. These offices include the Office for Human Research Protections, the Emory Institutional Review Board, the Emory Office of Research Compliance and the Office for Clinical Research. Study funders may also look at the study records. Emory will keep any study records we create private to the extent we are required to do so by law.

Study records can be opened by court order. They may also be produced in response to a subpoena or a request for production of documents.

Voluntary Participation and Withdrawal from the Study

Your participation is entirely voluntary. You may refuse to do any procedures you do not feel comfortable with, or answer any questions that you do not wish to answer.

Contact Information

Contact the Amhara National Regional State Health Bureau, Ato Belay Bezabih at + 251 918 764416, or The Carter Center country advisor, Dr. Zerihun Tadesse at 011 661 5980:

- if you have any questions about this study or your part in it,
- if you have questions, concerns or complaints about the research

Contact the Emory Institutional Review Board at +1-404-712-0720 or irb@emory.edu:

- if you have questions about your rights as a research participant.
- if you have questions, concerns or complaints about the research.
- You may also let the IRB know about your experience as a research participant through our Research Participant Study at http://www.surveymonkey.com/s/6ZDMW75.

Consent

Do you agree to participate?

Thank you for your time.

Appendix 2: Consent Forms

Verbal Informed Consent for Malaria and Anemia Testing

North Gondar Migrant Survey 2013

Script for verbal informed consent for malaria and anemia tests

Principal Investigator

The principal investigator for this survey is Dr. Gregory S. Noland, who works for The Carter Center.

Funding

Funding for this survey is provided by The Carter Center.

Introduction

Greetings, my name is _____ and I work with the Amhara National Regional State Health Bureau.

You are being asked to be in a research study. This form is designed to tell you everything you need to think about before you decide to consent (agree) to be in the study or not to be in the study. **It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the study. You can skip any questions that you do not wish to answer.**

Before making your decision:

- Please carefully listen as this form is read to you
- Please ask questions about anything that is not clear

You can take a copy of this consent form, to keep. Feel free to take your time thinking about whether you would like to participate. Do not agree to participate unless you have had a chance to ask questions and get answers that make sense to you. By agreeing to participate you will not give up any legal rights.

Study Overview

We are asking questions to migrant farm workers in North Gondar to understand their health needs, access to and use of malaria prevention tools, and prevalence of malaria and anemia. We are also comparing two methods for anemia testing. Approximately 400 people will be included in this study and offered testing for malaria and anemia.

Procedures

You have been randomly selected for this study. A finger-prick to draw two drops of blood will be done by a nurse with a sterile lancet in the same way that they do it at the clinic. One drop of blood will be used for a rapid diagnostic test for malaria, which will be conducted in your presence. The second drop of blood will be used to test for anemia. The results of the rapid diagnostic test and the anemia tests will be given to you immediately.

Additionally, anemia will also be measured by a non-invasive method in which a plastic clip will be placed on your finger for 60 seconds.

Risks

The finger-pricking will be momentarily uncomfortable. The drugs used to treat malaria are safe and effective, but any drugs can cause side effects in a small number of people. The non-invasive anemia measurement does not pose any known risk.

Benefits

If you are diagnosed with malaria, you will be offered treatment according to Ministry of Health guidelines. If you are pregnant, you will be offered malaria treatment that will not harm the baby. If you are anemic (short of blood), you will be referred to the nearest health facility for treatment.

This study is designed to learn more about malaria. The study results may be used to help others in the future. You will be able to receive all benefits or assistance from any future program even if you refuse to participate in this interview.

Compensation

You will not be offered payment or compensation for participating in this study.

Other Options Outside this Study

If you decide not to enter this study, there is care available to you through your local health facility (health post, health clinic, or hospital).

Confidentiality

Your name or other personal identifying information will not be collected or published. A number rather than your name will be used on study records.

Certain offices and people other than the researchers may look at study records. U.S. government agencies and Emory University employees overseeing proper study conduct may look at the study records. These offices include the Office for Human Research Protections, the Emory Institutional Review Board, the Emory Office of Research Compliance and the Office for Clinical Research. Study funders may also look at the study records. Emory will keep any study records we create private to the extent we are required to do so by law.

Study records can be opened by court order. They may also be produced in response to a subpoena or a request for production of documents.

In Case of Injury

If you get ill or injured from being in the study, the organizers would help you to get medical treatment. Emory and ANRSHB have not, however, set aside any money to pay you or to pay for this medical treatment. The only exception is if it is proved that your

injury or illness is directly caused by the negligence of an Emory or sponsor employee. "Negligence" is the failure to follow a standard duty of care.

If you believe you have become ill or injured from this research, you should contact the Amhara National Regional State Health Bureau, Ato Belay Bezabih at + 251 918 764416, or The Carter Center country advisor, Dr. Zerihun Tadesse at 011 661 5980. You should also let any health care provider who treats you know that you participated in this study.

Costs

There will be no costs to you for participating in this study. You will not be charged for any of the research activities.

Voluntary Participation and Withdrawal from the Study

Your participation is entirely voluntary. You may refuse to do any procedures you do not feel comfortable with, or answer any questions that you do not wish to answer.

Contact Information

Contact the Amhara National Regional State Health Bureau, Ato Belay Bezabih at + 251 918 764416, or The Carter Center country advisor, Dr. Zerihun Tadesse at 011 661 5980:

- if you have any questions about this study or your part in it;
- if you feel you have had a study-related injury or a bad reaction to drug treatment;
- if you have questions, concerns or complaints about the study.

Contact the Emory Institutional Review Board at +1-404-712-0720 or irb@emory.edu:

- if you have questions about your rights as a research participant.
- if you have questions, concerns or complaints about the research.
- You may also let the IRB know about your experience as a research participant through our Research Participant Study at http://www.surveymonkey.com/s/6ZDMW75.

Consent

Do you agree to participate?

Thank you for your time.