ABSTRACT

Assessment of Knowledge, Attitudes, and Behaviors Associated with Human Intestinal Helminthes in a Traditional Community in Rural Western Kenya

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Neglected Tropical Diseases (NTDs) constitute a broad category of illnesses that continue to plague those living in developing nations. 85% of NTD morbidity results from helminthic infections; collectively, infections due to parasites produce a disease burden that is equivalent to up to one-half of sub-Saharan Africa's malaria disease burden and more than double that caused by tuberculosis. Specifically, soil-transmitted helminthes represent the most common condition affecting the poorest 500 million people living in sub-Saharan Africa.

This cross-sectional study evaluates the accuracy of knowledge, perceived importance, and behaviors related with helminthic infections within a sample of 199 people in a Luo population. Approximately one-half of the interviewees reported having a helminthic infection at the time of this study. A person in this community reported experiencing related symptoms for 9.43 months on average (SD=14.41). A knowledge score found that 59.30% of the population reported at least one correct answer in each category about the symptoms, causes, treatments and prevention methods. No difference was found between gender and age and the number of correct responses. Participants were also asked about knowledge concerning risk factors. Although15.58% of participants recognized contaminated water as a source of infection, 67.0% continue to use ground water as their primary drinking water source. Participating in geophagia, or eating rocks and dirt, was reported by 16.58% of the population despite the fact that 35.18% viewed this practice as a risk factor.

These results indicate that although the population may be aware of the main risk factors associated with helminthic infections, deeply rooted cultural beliefs and lack of access to clean, potable resources present limitations to decreasing the burden of helminthes. Such structural barriers must be addressed in conjunction with providing accurate knowledge and preventive chemotherapy of NTDs for sustainable control and reduction of morbidity.

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ASSESSMENT OF KNOWLEDGE, ATTITUDES, AND BEHAVIORS ASSOCIATED WITH HUMAN INTESTINAL HELMINTHES IN A TRADITIONAL COMMUNITY IN RURAL WESTERN KENYA

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By

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DEDICATION

This study is dedicated to the people of the Nyakach Plateau.

CHAPTER ONE

Introduction

Helminthes are parasitic worms. The earliest human records indicate that these pathogens have plagued humans since the beginning of time. Helminth eggs can be traced back in mummified feces of humans dating back thousands of years and characteristic clinical features of these infections can even be identified in the writings of Hippocrates, Egyptian medical papyri, and even the Bible. In some respects, these infections may have even changed the course of modern twentieth century world history (Cox 2002). One of the most common helminthis, the schistosome, was known to the Chinese as “the blood-fluke that saved Formosa” during the cold war because schistosomiasis sickened troops to the point where their attack of Taiwan (known as Formosa) had to be halted (Hotez 2008).

Helminthes can be categorized into two major phyla: nematodes (roundworms) and filarial worms. While most of the intestinal worms or soil-transmitted helminthes are classified as roundworms, lymphatic filariasis (LF), shistosomes, and onchocerciasis represent the filarial worms. The classic paper by Normal Stoll, “This wormy world” was published in 1947 and aimed at estimating the global prevalence of helminthes. In the past few decades, Stoll’s predictions have been verified as billions of people have been confirmed to harbor parasitic infections (Stoll 1947). Current estimates show that approximately one-third of the almost three billion people that live on less than two US dollars per day in developing regions of sub-Saharan Africa, Asia, and the Americas are infected with at least one helminth (Hotez 2007).

Soil-transmitted helminthes represent the most common helminthic infections (WHO 2012). Because these organisms thrive in similar tropical environments, people living in rural, impoverished villages throughout the tropics are most adversely affected by these pathogens. These populations are usually polyparasitized—they are chronically infected with several species of helminthes at any given time (Hotez 2006).

Compared with others, school-aged children and women experience the greatest helminthic infections for reasons not well understood. Consequently, children experience growth stunting as well as reductions in cognitive function (Drake 2000). Soil-transmitted helminthes sap children of their nutrition which accounts for diminished academic performance and increased school absences (World Bank 2005). In women, soil-transmitted helminthes and schistosomes cause neonatal prematurity and increased maternal morbidity and mortality (Christian 2004). The chronic and debilitating effects of helminthiasis are magnified in poverty-stricken populations. Hotez and colleagues point out "the effects of helminths translate into enormous poverty-promoting effects and represent a major reason why poor people remain mired in a downward cycle of destitution (2006).

Apart from the global morbidity that results directly from human helminthes, it is crucial to recognize the indirect effects helminthic infections have on HIV/AIDS and malaria. According to Borkow and colleagues, helminthiasis is usually coendemic with malaria and HIV/AIDS (2006). This is startling because such coinfections have additive effects, causing symptoms like chronic anemia. These synergistic impacts also cause increased transmission of the malaria-causing plasmodium parasite and more rapid progression of HIV to AIDS. Populations become more vulnerable to life-threatening diseases as a result of having a helminthic infection.

The short and long term effects of helminthic infections warrant launching a "global assault on parasitic worms" (Hotez et al. 2007). Of the tools that currently exist for these diseases, only four drugs have been successful (Chirac 2006). The lack of development of new drugs reflects how little we currently know about the unique biochemical metabolism of parasitic worms and the mechanisms by which these organisms colonize human bodies and establish chronic infections (Crompton 2002). This is exemplified when helminthic infections continue to be classified as neglected tropical diseases and the study of these conditions receives less than 1% of global research dollars (Hotez 2008).

Although helminthic infections represent neglected tropical diseases, recent advances by immunological helminthologists have demonstrated how the interesting molecular structure helminthes could someday lead to the development of new drugs, diagnostics, and vaccines to fight against an illness that continues to affect one in every three individuals in the world today (Hotez 2008).

CHAPTER TWO

Review of Literature

Prevalence

Soil-transmitted helminthic infections (STHs) refer to a group of parasitic diseases caused by intestinal roundworms such as hookworms, ascaris, and whipworm. Collectively, these pathogens are known as soil-transmitted helminthes and are trasmitted via contaminated soil. Helminthiasis has become the most common parasitic infection worldwide, notably in developing countries. Currently, the World Health Organization (2013) estimates that almost 2 billion people, or 1/3 of the global population, is infected with at least one helminthic infection. This number represents the individuals who currently live on less than two US dollars per day in developing regions of sub-Saharan Africa, Asia, and the Americas are infected with one or more helminth (Hotez 2008).

Figure 2.1

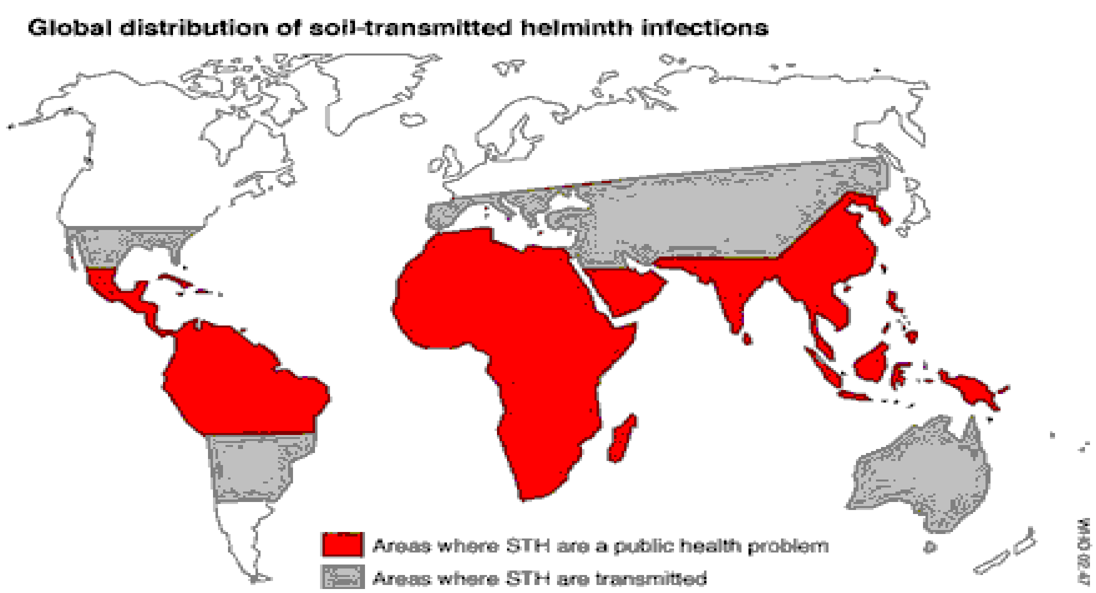
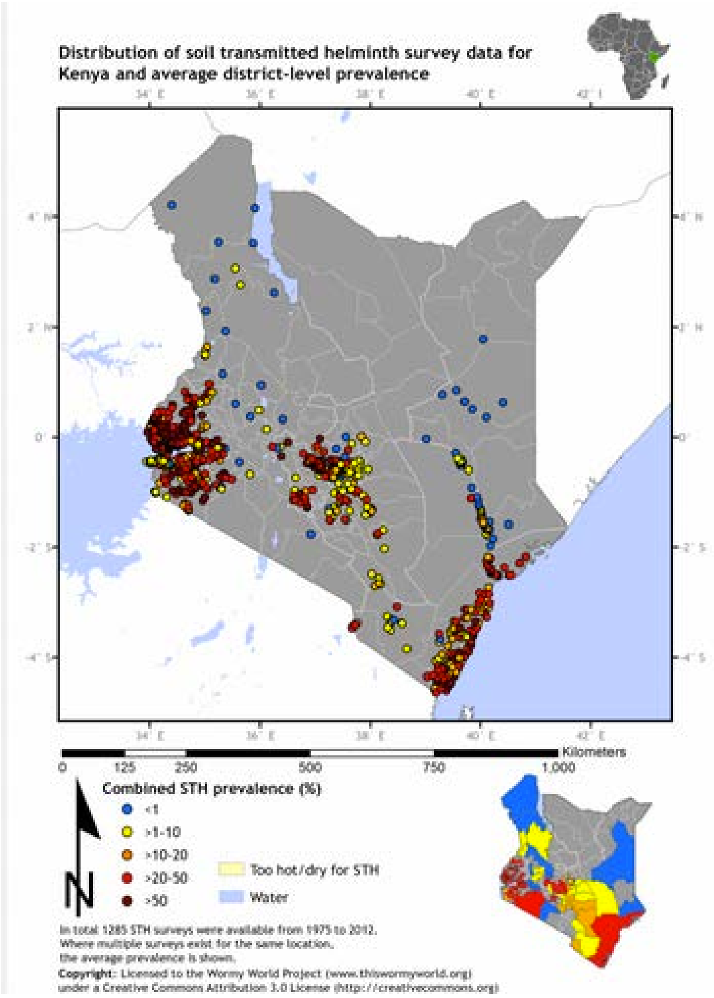


Figure 2.1 shows this trend. Though any human being is capable of becoming infected by a helminth, these infections pose a unique burden to the impoverished people living in developing nations, particularly Sub-Saharan Africa. Unfortunately, the more than 880 million children currently living with helminths represent the vast majority of those living without access to treatment for these parasites (WHO 2013). According to Harhay (2010), these infection rates are highest in school-age children living in Sub-Saharan Africa. East Africa carries an disproportional burden. According to Brooker and colleagues (2009), the highest reported estimates of STH prevalence are found in Western Province in Kenya, North and South Pemba in Tanzania, and Eastern and Western regions in Uganda. In fact, one study conducted in the Western Nyanza Province of Kenya found that over two-thirds (68%) of the sampled population of children tested positive for helminthic infections (Riesel 2010). The Global Atlas of Helminthic Infections (GAHI) is an organization of the London School of Hygeine and Tropical medicine focusing on the geographic mapping of the prevalence of helminths. According to GAHI, the left-hand panel in Figure 2.2 displays the regions within Kenya that experience the highest number of cases. The Western region has a prevalence between 20% and >50%. As visible in the Figure, a strong association between proximity to Lake Victoria and the prevalence of STH has been found. Contaminated water sources cause heminthes to have a focal geographical distribution (Brooker et al. 2001). The right–hand panel on Figure 2.2 shows where the present study was conducted. When the right-hand panel is compared to the left, it is clear that this study was conducted in a region in the Nyanza Province of Western Kenya that was predicted to have a high prevalence of helminthic infections, given its proximity to Lake Victoria.

Figure 2.2



Helminthic Infections as Neglected Tropical Diseases

Neglected Tropical Diseases (NTDs) constitute a broad category of illnesses that continue to plague those living in developing nations. These diseases refer to conditions that have known preventive measures and acute medical treatments that are readily available in the developed world but are not universally available in poorer areas. In most cases concerning helminthic infections, these treatments are relatively inexpensive. According to END7, a campaign seeking to end seven neglected tropical diseases by

2020, protecting a child against NTDs including helminthic infections 50¢. In 2008, Dr. Peter Hotez, leading advocate and scientist in the field of global health and NTD control, stated that "It is appalling that helminthic infections and other NTDs are having such a devastating impact on the poor in sub-Saharan Africa given that we have effective treatments to alleviate their sufferings." (Leventhal 2011)

Because access to these medications is limited, but known treatments exist, the term "neglected" is used to describe these diseases. NTDs are often contrasted with the big three diseases—HIV/AIDS, malaria, and tuberculosis. Contrasted to NTDs, these diseases generally receive greater funding and treatment. What may surprise some, however, is the fact that NTDs often perpetuate other conditions. NTDs can make HIV/AIDS and tuberculosis more deadly (Shanahan 2008). Feasey and colleagues argue that NTDs continue to be overlooked because these diseases mainly affect the poorest countries of the developing world, and recent emphasis on decreasing the mortality due to the "big three" trades off with providing resources for NTDs (2009).

The importance of NTDs continues to be underestimated, because many of these diseases can be asymptomatic and have long incubation periods (Fenwick 2012). This presents an important distinction between the morbidity and mortality resulting from diseases. Although helminthic infections do not directly cause the death of populations, they have a profound impact on morbidity. In fact, 85% of disease burden for the poorest 500 million people living in sub-Saharan Africa results from helminthic infections (Lustigman 2012). According to Katsivo and colleagues, infections due to parasites produce a disease burden that is equivalent to up to one-half of sub-Saharan Africa's malaria disease burden and more than double that caused by tuberculosis (2003).

Specifically, soil-transmitted helminthes represent the most common condition affecting the poorest 500 million people living in sub-Saharan Africa (Hotez 2009).

Hotez and colleagues report that most untreated helminthic infections result in long-term, inflammatory disorders that cause persistent health conditions such as anemia, growth stunting, malnutrition, fatigue, and poor cognitive development. These indirect effects are what make the morbidity due to STH infections astounding. In rural, impoverished nations, these effects are magnified (2010).

Pathogenesis

Because many different species of helminthes exist, modes of infection vary. STHs refer to adult intestinal parasites, larvae, and helminth eggs. These components are all present in the feces of infected people. Most STH eggs become agents of infection as they develop into larvae in the soil. A person can become infected with a helminth when they drink contaminated water, eat unwashed fruits or vegetables contaminated with soil-infested eggs, or when hands or fingers have been contaminated with dirt. Some species of helminthes, such as schistosomes, hatch in the soil and release larvae that are able to readily penetrate the skin and cause infection that way. The commonality among all helminthic infections is that all infections are acquired through contact with contaminated soil (Bethany 2006). Figure 2.3 visually depicts the general pathogenesis of helminthic infections.

Figure 2.3

STH vary greatly in size; the female helminthes are usually larger than males (Despommier 2005). The crucial feature of the epidemiology of STH is that they do not reproduce within the host (Bethany 2006). Once parasites in the adult stages have inhabited part of the host intestine, the helminthes reproduce sexually and produce eggs, which are then passed through the gut via the feces and excreted into the external environment. Since most households in developing countries lack latrine facilities, these eggs are usually deposited into the soil. Adult parasites can live in the human intestine for many years and produce thousands of eggs during their life span. These eggs remain viable in the soil for several months for species *A. lumbricoides* and *T. trichiura*. Hookworm larvae can survive in the soil for several weeks depending on environmental conditions (Mascarini-Serra 2011). A person becomes infected when they ingest helminth eggs or when larvae penetrate the host's skin (Brooker 2006).

Risk Factors

--Direct Consumption

The most direct way of acquring a helminthic infection is through soil consumption. Consequently geophagia, or the consumption of dirt or soil, plays a pivotal role in the infection of STH. While the motives behind eating soil are not completely understood, studies have pointed to two main reasons for this practice. Many in East Africa, notably in the Luo tribe in rural Western Kenya, believe that the earth symbolizes fertility and by eating soil, a person will become more fertile (Geissler 2000). As a result, Geissler and colleagues find that geophagia is largely a female endeavor (2000). Because many women consume significant amounts of dry soil, especially when they are pregnant, Eijk and colleagues (2009) suspect that this practice may be attributable to lack of prenatal care. Most women in these areas are iron-deficient and may crave soil for nutritional value (Eijk et al. 2009). Ultimately, geophagia represents a social practice that has become a cornerstone of developing societies as a result of complex interactions of body, mind, and culture, through which people incorporate and embody social relations and cultural values (Geissler 2000).

Geophagia is practiced almost exclusively by females and school-age children (Sousa-Figueiredo et al. 2008). This is problematic because geophagia is often associated with reinfection among pregnant and lactating women and the disease burden, or morbidity, due to STH infections is usually significantly worse in these populations (Luoba 2005). A study in 1997 showed that among 285 school-aged children in the Nyanza Province in Western Kenya, 73% of the children practice geophagia (Geissler et al. 1997). Most of these children preferred dry soil from the ground's surface and reported ingesting soil at least once daily (Geissler 1998A). Similar studies have shown that 48% of the soil samples that 77% of Kenyan school children consume are contaminated with helminthic infections. Studies conclude that helminthes, specifically ascariasis and trichiuriasis, are almost exclusively due to geophagia (Geissler 1998B).

--Indirect Consumption

Soil can also be ingested indirectly, and this is usually the most common way of becoming infected. Ingesting contaminated food or drink, making direct contact with soil, and lack of hygiene can all lead to STH infections. Ground water sources that have not been filtered often contain soil particles that can harbor hundreds of helminthic eggs. A meta-analysis done by Esrey and colleagues analyzed 144 studies and determined that solely improving water sanitation can reduce helminthic infections by 77% and decrease child mortality by 55%, suggesting that clean water can have a substantial impact on preventing helminthic infections and prolonging child survival (1999). In addition to consuming dirt through contaminated water sources, frequently eggs become attached to vegetables and fruits and when food is not carefully cooked, washed, or peeled, ingestion can lead to an infection (WHO 2014). Finally basic hygiene plays a key role in the spread of helminthic infections. Eggs are often ingested by children who play in the soil and then put their hands in their mouths without washing; similarly, neglecting to washing hands after the bathroom is also a risk factor for contracting a helminthic infection. In addition to ingestion, some species of helminthes, such as hookworm, hatch in the soil and release mature larvae that have the ability to penetrate the skin. It is common for people to become infected by this STH by walking barefoot on contaminated soil (WHO 2014). Other studies have identified other specific factors such as the lack of latrines and soap as risk factors (Olsen 2001).

STH infections arise from direct or indirect contact with contaminated soil. There is no person-to-person transmission or infection from fresh feces because eggs passed in the feces need approximately three weeks to mature in the soil before becoming infective. Since worms do not actually multiply within the human host, reinfection occurs exclusively as a result of other contacts with infective stages of helminthes in the environment (WHO 2014).

Symptoms

While the overall effect of sapping nutrition from the host's body is common among all helminthic infections, some symptoms are variable dependent on the species of STH. As stated before, the most common soil-transmitted helminthes are: whipworm, hookworm, and roundworm.

T. trichiura, or whipworm, is the third most common roundworm in humans. According to USAID's NTD program (2014), the trichuriasis symptoms range from asymptomatic to vague digestive tract stress for lighter infections and emaciation, dry skin, and bloody diarrhea in heavily infected individuals. In children, these heavy infections usually lead to growth retardation. Long-term diarrhea will often lead to iron-deficiency anemia; some severe cases can cause rectal prolapse (2014). The CDC (2012) states that states finger clubbing—the swelling of nails and area around the nails—is the best clinical predictor of trichuriasis.

Human hookworm infections represent the leading cause of anemia and protein malnutrition in developing countries. Mild infections with this helminth can case mild diarrhea and abdominal pain, while more severe infections create especially serious problems in vulnerable populations including newborns, children, pregnant women, and malnourished individuals (USAID 2013). Dreyfuss and colleagues (2000) report that increased maternal and neonatal maternal mortality has been associated with hookworm iron-deficiency anemia. Generally, hookworm infection is usually associated with dermatitis, skin rash, and pneumonitis. GI symptoms are abdominal pain, nausea, vomiting, and anorexia.

Roundworm infections are the most geographically spread disease. While mild cases of this infection are asymptomatic, heavy infections can cause intestinal blockage and impair growth in children. Major problems related to roundworm infections result from the "mass effect," by which intestinal, biliary, and pancreatic obstruction can result. USAID states that the intensity of clinical signs is usually related to the worm burden in infected individuals. Infection with this helminth is closely related to child morbidity when associated with malnutrition, pneumonia, enteric diseases, and vitamin A deficiency.

A classic sign of all helminthic infections is a bloated, swollen belly. As larvae develop within the intestine, one of the body's mechanisms is to retain more water, which leads to a distended belly. Damage to the intestines and liver can cause further inflammation and swelling of the abdomen (Asaolu 2003). For reasons not understood, this sign is more readily present in children.

Polyparasitism

Although geographical mapping and studies have determined the prevalence of STH infections, estimates vastly underestimate the effects of polyparasitism. Polyparasitism refers to the condition in which a person is infected with two or more different types of worms (Pullan 2008). Drake and colleagues (2001) report that polyparasitism is considerably more common than single helminth infections. A study conducted in the Machakos District in Western Rural Kenya found that over 60% of the subjects were found to have more than one type of parasite. One patient in the study was infected with nine different strains of helminthes (Chunge 1995). Another study in the Bondo District of Western Kenya found that more than 2/3 of the school-age children in the community were co-infected with ascaris and trichuriasis (Thiong'o 2001). Health implications of polyparasitism are astounding. In 2008, Pullan and colleagues predicted that multiple human intestinal parasite species have an additive and/or multiplicative impact on nutrition status and organ pathology. For example, polyparasitic infections have been shown to lead to a 2-fold increase in wasting, or acute malnutrition, when compared to individuals with a single helminthic infection (Mupfasoni 2009). The impact of polyparasitic infections compared to single helminthic infections has serious implications for disease control; the most sensible, cost-effective mechanism is to reduce morbidity due to polyparasitism by controlling infections through a multiple species approach (Drake 2001).

STH and Malaria Co-Infection

Malaria is a disease caused by parasitic protozoans of the genus *Plasmodium.* Instead of thriving in the host's intestine, these organisms live in the human host's circulatory system. A few important relationships between STH and *Plasmodium* co-infections are becoming evident.

Spiegel and colleagues (2003) report an increase in the frequency of malaria attacks in subjects that are co-infected with intestinal worms and plasmodium falciparum. The study reports that those who are infected with intestinal worms actually become re-infected not only with helminthes at a much higher rate, but also are at a higher risk for reinfection with P. falciparum. Findings from the study show that compared to individuals with a STH infection, individuals free of helminthes had the same degrees of protection against malaria as that provided by the sickle-cell trait, the most potent factor of resistance to malaria (Spiegel et al. 2003).

Low socio-economic status has been established as a risk factor for co-infection with helminthes and plasmodium. As study conducted in a lakeside community near Lake Victoria, Uganda found a 24% co-infection rate (Kabatereine 2011). School-aged children are at the highest risk of co-infection with malarial parasites, which has an additive effect on hemoglobin reduction, perpetuating the problem of anemia (Brooker 2007). Using a Bayesian Hierarchical Modeling Approach, Koukounari and colleagues found that co-infection with P. falciparum and helminthic infections significantly lowered blood hemoglobin concentrations more so than each parasite did individually. This once again confirms the synergistic adverse effects that both of these parasites have together (Koukounari et al. 2008). Integrated interventions for NTDs and malaria are necessary to maximize the sustainability of disease control efforts.

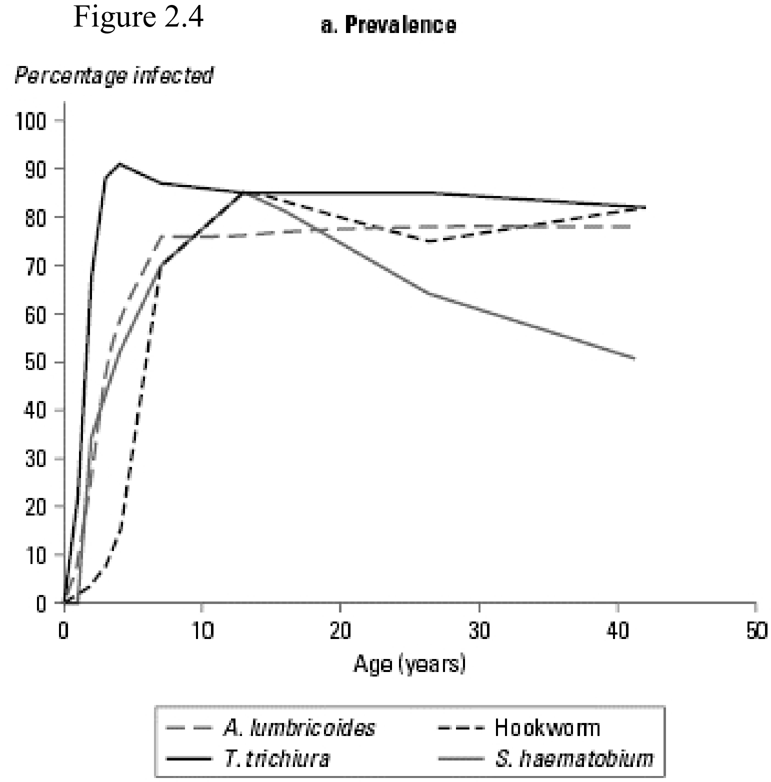
STH and HIV Co-Infection

While research regarding co-infection with helminthes and the human immunodeficiency virus has been limited, preliminary findings have revealed startling associations. In 2003, Fincham and colleagues reviewed 109 studies that suggested that helminthic infections in subjects with HIV actually caused the virus to infect and progress more rapidly into AIDS (Fincham 2003). Furthermore, helminthiasis has been noted to decrease the efficacy of some treatments against HIV (Mayer 2007). Although more studies are necessary to establish firm causation, there is reason to believe there is correlation between the two infections.

STH and School Absenteeism

Debiliating symptoms associated with the immense morbidity caused by helminthic infections often poses a serious challenge to children who are not able to attend school. Figure 2.4 shows the prevalence of STH infections according to age. The percentage of people infected is highest in school-age childen between the ages of 1 and 15. According to a World Bank report, morbidity due to helminth infections accounts for an estimated 20% of the disability-adjusted life years lost due to infectious diseases in children less than 14 years old (Bundy 1988).

Figure 2.4



The fact that STH infections affect younger populations foreshadows the impact that having a helminth can have on attending school. The primary cause of school absenteeism is anemia; the intimate relationship between STH infections and anemia is a major factor in determining how often a child is able to attend class. Stephenson and colleagues point out the synergism present between Trichuriasis, hookworm, and anemia. Intestinal inflammation inhibits growth and promotes anemia in preschool and primary-school age children (Stephenson et al. 2000). This relationship was proven by a study in 2004, in which a school-based mass deworming project boosted school attendance by 25%. Deworming substancially improved the health and school participation among untreated children in both treatment schools (Miguel 2004).

STH and Cognitive Function

Helminthic infections impede a child's healthy development by directly retarding growth and impairing cognitive processes. This indirectly affects the potential of children to benefit fully from their environment because young patients become lethargic and unmotivated (Drake 2000). Long-term outcomes of helminthic infections exacerbate this problem. Morbidities such as malnutrition, anemia, and failure to achieve genetic potential for growth hinder the developmental process (Simeon 1997, Watkins 1997). For example, a study done in a rural village in the Philippines found that after adjusting for age, sex, and nutritional status, helminthic infections were associated with a poor performance of tests of learning (OR=3.04), tests of memory (OR=2.2), and tests of verbal fluency (OR=4.5) (Ezeamama 2006). These alarming figures demonstrate how severely cognitive function is impaired as a result of helminthic infections. Although no specific pathophysiological pathways have been identified, these findings are still significant because a decrease in a child's inability to learn can lead to decreased success in school and a lower chance a secure future.

Treatment and Prevention

Current efforts to curtail worm infections are failing. 90% of helminthic infections in Sub-Saharan Africa are due to schistosomiasis and STH and less than 5% of the infected populations are currently receiving treatment for the infection (Hotez 2009). This represents a huge failure for the global community. Apart from the reason that these infections are not receiving adequate attention, the main problem with interventions to change the status quo is that most initiatives have different agendas. For example, while diagnosis and screening of schistosomiasis in some parts of Sub-Saharan Africa has been controlled (Engels 2002), knowledge, prevention, and personal hygiene continue to be neglected in some programs. Alum and colleagues claim that while more aggressive chemotherapeutic interventions are important, it is equally critical to emphasize simple preventive methods such as washing hands and avoiding contaminated water (Alum 2010). A holistic approach—one that encompasses prevention, intervention, and basic hygiene techniques is needed.

According to WHO in 2012, improved water sanitation has shown to reduce mortality due to helminthic infections by 77% overall, and 55% in children, suggesting the importance of clean water on the survival of an impoverished child. Another example can be noted in the Machakos District, Kenya, where a significant reduction in worm infections was noted only when modern and traditional health services were used interchangeably. While oral drug therapy had higher cure rates, it was actually the knowledge and perceptions of the causes of intestinal infections, preventive behavior, and development of community water supplies that led to a reduction in the STH infections (Kloos 1987).

Although preventive chemotherapy in the form of anti-helminthic drugs such as benzimidazoles (Albendazole and Mebendzole) are able to target a broad group of helminthes, these treatments are often temporary and provide only a short-term solution to eradicating worms. Additionally, some studies have noted a serious problem of antihelminthic drug resistance in mammal models (Tchuem 2011). The efficacy of single dose drugs against helminthes should be further investigated to allow the most reliable form of treatment (Albonico 2007).

The most sustainable option that is still being developed is a vaccination against helminthic infections. Although there remains a need for a mass-drug treatment, vaccination programs and knowledge can have an even larger effect in decreasing STH infections (Utzinger 2011). Hotez and colleagues (2008) are offering new insights into the application of helminth genomics, transgenesis, and RNA interference technologies in hopes of effectively developing and implementing a vaccine against helminthic infections.

Ultimately, in conjunction with preventive chemotherapy and possible vaccinations, it will be vital to take into consideration the knowledge of those affected by this disease. Education will be necessary in order to ensure that these populations are avoiding all risk factors and have a fundamental, accurate knowledge of the causes and ways to prevent helminthic infections.

Millenium Development Goals and Helminthic Infections

The long-term impacts of decreased STH infection prevalence are drastic. The Millennium Development Goals (MDGs) are eight international development goals that were established in 2000 following the Millennium Summit of the United Nations. Although none of the goals specifies helminthic infections, the importance of deworming initiatives and preventive methods become apparent concerning the outcomes of 7 out of 8 of the MDGs.

The first MDG pertains to the relationship between poverty and hunger. Improvements in intellectual and cognitive development have a huge impact on professional income later in life. Yet the only way to a professional career is to attend school and become educated, which, in turn, gets a person out of poverty. The benefits of a hookworm-free childhood, for example, attributes to 45% of adult wages (Bleakley 2007). A study specific to Kenya estimates that deworming may raise per capita income from present US $337 to almost US $500 (Fitzgibbon 2012). Prevalence of anemia skyrockets because diarrhea due to malnutrition is magnified in populations with helminthic infections. Yet simply deworming a child can prevent 82% of stunting that occurs without intervention; in other words, dewormed children show a 35% greater weight gain (WHO 2012).

Achieving universal primary education represents the second MDG. As stated earlier, school-aged children are perhaps the most adversely affected by helminthic infections, because the negative health impacts cause rates of school absenteeism to increase. Often times, children are unable to go to school due to diarrhea or severe anemia (Jamison 2000). If dewormed, primary school absenteeism is estimated to decrease by over 25%, ultimately leading to higher wages and a more sustainable community (WHO 2003). Of the estimated 562 million school-aged children in the developing world, 16 million students experience mental retardation due to helminthic infections and 200 million years of primary schooling have already been lost due to symptoms associated with helminthes (Bundy 2000).

Younger women are the most adversely affected by structural violence and gender inequality in the world today. The third MDG is to promote gender equality in order to empower women to become independent and successful. The key to success is a good education, which leads to the highest chance of finding employment. Although the gap has reduced over the years, the number of males in schools continues to outnumber females. Deworming programs have been shown to contribute to increased female enrollment in schools, which increases retention rates. For example, a study in rural Nepali schools in 2000 found that deworming tablets and healthy food resulted in a 43% increase in school enrollment for females. In addition, anemia significantly decreased as well (Khanal 2002).

The fourth and fifth MDG concern the improvement of maternal health. The main underlying causes of poor pregnancy outcomes in developing nations stem from poor nutrition and anemia. Since STH infections cause malnutrition, and therefore many cases of anemia, it is clear that administering deworming initiatives can contribute to maternal survival. The risk of dying during pregnancy or childbirth is up to 3.5 times higher in anemic women than in non-anemic women (WHO 2000). Evidence indicates that consistent deworming reduces anemia in women of childbearing age, therefore preparing them for a healthier pregnancy (WHO 2000). In Nepal, Women who were given Albendazole (a common deworming drug) during their second trimester of pregnancy had a lower rate of severe anemia during the third trimester (Christian 2004). In Sri Lanka, the deworming during pregnancy resulted in a 42% reduction in the proportion of stillbirths and perinatal deaths, as well as a 52% decrease in low-birth weight babies (De Silva 1999). These figures demonstrate the huge role that helminthic infections play in an unhealthy pregnancy. By focusing efforts to reducing helminthic infections, we can help with better pregnancy outcomes.

Although the mortality associated with helminthic infections is low, helminthes impair the health, physical, and mental development of the impoverished. By doing so, they anchor large populations in poverty. MDG 6 concerns combatting HIV/AIDS, malaria, and other diseases. STH infections would fall under the category of "other diseases." The impact of deworming may lead to better outcomes of HIV/AIDS, as recent studies have indicated that helminthic infections sometimes disrupt the immune response.

Importance of Qualitative Data & Purpose of Present Study

Although a plethora of studies about the prevalence and morbidity of STH infections exists, research is limited on the knowledge and cultural practices of those who have the diseases. Understanding a rural African community's perception of helminthic infections is crucial to the effective treatment and prevention of these diseases.

While our current understanding of helminthic infections is extensive, it is imperative to remember that the knowledge is limited for those who are affected by these diseases the most. Compared with other diseases, worm infections do not rank highly in the minds of those who are afflicted by STH-infections (Kamunvi, 1993). Even when stratified according to age, gender, and education levels, it is clear that, while respondents are aware of the problem, very few actually understand the impact it has on their nutrition, the causes of helminthes, and the effective treatments (Kamunvi, 1993).

These gaps in knowledge are appalling, especially when considering how much of an impact accurate knowledge can have. In other words, educating those living in impoverished areas can drastically reduce prevalence of STH-infections. A community in rural Kenya 2,219 people was mobilized through health education to effect changes in behavior regarding water contact, water use, and fecal disposal. After two years, the peoples' knowledge on schistosomiasis increased and the rate of infection significantly decreased (Katsivo 1993). Acka and colleagues conducted in-depth interviews and found that younger populations are most aware of intestinal infections when compared to other age groups (Acka et al. 2010). This is notable because it demonstrates the potential of school children as health change agents in rural western Kenya (Onyango 2005). As younger populations become more educated on accurate knowledge about the causes, treatment, and prevention of helminthic infections, behavioral changes are transferred from school-aged children to adults in their homes. In reality, there exists a need for health workers to discuss the critical task of targeting health messages through schools in order to reach the most susceptible schoolchildren. This will empower the schoolchildren with the basic knowledge and skills, ultimately protecting them from acquiring STH infections, while also enabling them to educate others in the community (Midzi 2011).

In order to understand the variables that can influence the success of these efforts, it is vital to know more about how people currently understand and experience these diseases, as well as a description of the physical and social context in which these diseases are occurring. This cross-sectional study aims at gathering both this qualitative and quantitative data through an assessment of knowledge, attitudes, and practices related to helminthic infections.

CHAPTER THREE

Hypothesis

Research Question 1:

What is the level of accurate knowledge of causes, symptoms, treatments, and prevention, and what is the perceived importance of helminthic infections in a Luo population of rural western Kenya?

Hypothesis 1: The overall knowledge related to causes, symptoms, treatments, and prevention is low in this Luo community, and, compared to other health problems (i.e. malaria, HIV/AIDS), helminthic infections are not ranked to be as important as other conditions.

Null Hypothesis: The accuracy of knowledge related to helminthic infections will not be low and helminthic infections will be ranked as having no less importance than HIV/AIDS and malaria.

Research Question 2:

Does age affect a person's knowledge of causes, symptoms, treatments, and methods of prevention and their ranking of helminthic infections relative to HIV/AIDS and malaria?

Hypothesis 2:

Younger people will have a more accurate knowledge of helminthic infections than older people, and younger people will be more likely than older people to rank these infections as being more important than malaria but less important than HIV/AIDS.

Null Hypothesis: There will not be a statistically significant difference in the knowledge or ranking of helminthic infections based on age.

Research Question 3:

Does gender affect a person's knowledge of causes, symptoms, treatments, and methods of prevention and their ranking of helminthic infections relative to HIV/AIDS and malaria?

Hypothesis 3: Women will have a less accurate knowledge of helminthic infections than men, and women will be more likely than me to rank these infections as being less important than both malaria and HIV/AIDS.

Null Hypothesis: There will not be a statistically significant difference in the knowledge and rankings of helminthic infections between males and females on the plateau.

Research Question 4:

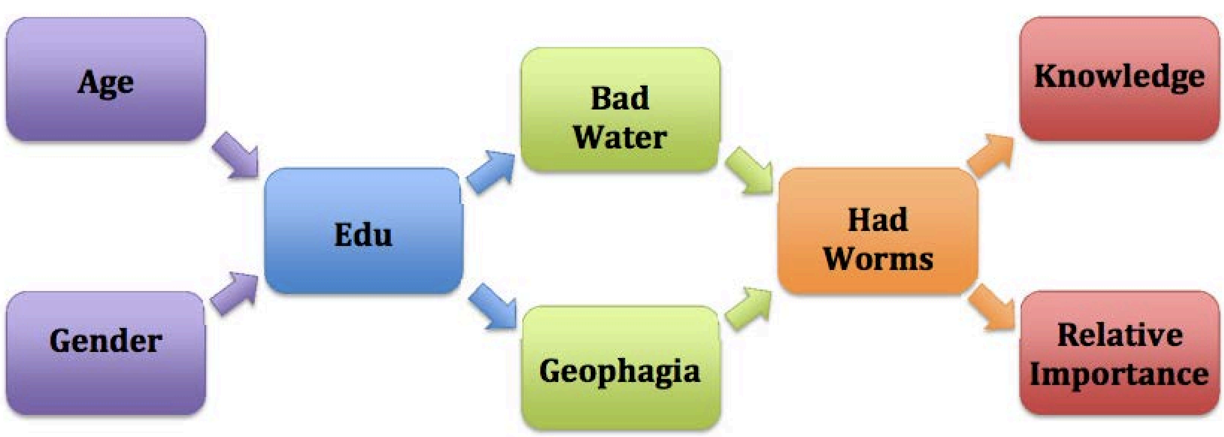
To what extent does a higher level of education correspond to knowledge of the causes, symptoms, treatments, and methods of prevention and to the ranking of helminthic infections relative to HIV/AIDS and malaria?

Hypothesis 4: People with higher levels of education will have a more accurate knowledge of helminthic infections less than educated people, and more educated will be more likely than less educated people to rank these infections as being more important than malaria but less important than HIV/AIDS.

Null Hypothesis: There will not be a statistically significant difference in knowledge or ranking of helminthic infections in people based on level of education.

Description of Study:

This cross-sectional study documents the knowledge, attitudes, and practices regarding STH in a sample of Luo children and adults. The study also determined the perceived importance of helminthic infections when ranked against other common health problems in a Luo population. The data were collected through a structured interview to better understand the specific cultural implications of helminthic infections in a rural community in the Nyanza Province of western Kenya. Furthermore, the study investigates the roles that age, gender, and level of education play in a person's accurate assessment of the causes, treatments, and methods of prevention of helminthic infections and the perceived importance of worm infections when compared with malaria and HIV/AIDS.



CHAPTER 4

Methodology

Setting

Straw to Bread is a non-profit organization that sponsors a team who work for two weeks each year on the Nyakach Plateau in rural western Kenya among the Luo tribe. This annual activity represents a grassroots involvement with this community where there are a plethora of ongoing development and research projects focused on health care, food and sustainable agriculture, safe water sources, education, and small business development.

Data for this study was collected from surveys administered to the patients who visited the annual Straw to Bread clinic between Monday, May 20th and Friday, May 30th.

Sample

The sample for this study was collected from a convenience sample of people who came to the Straw to Bread clinic.

Inclusion Criteria: This study is inclusive of persons who live on the Nyakach Plateau and are consequently affected by helminthic infections. This includes those who have suffered from the condition, but also people who may have never had a helminthic infection, but who can effectively provide information about their perceptions and knowledge of worm infections. Surveys were administered to males and female between the ages of 10 and 90.

Exclusion Criteria: This study excludes individuals who were not able to adequately describe their knowledge and experience of helminthic infections. This included children below the age of 10 or those with speech impediments.

Research Design

This cross-sectional study aims at evaluating the biopsychosocial factors that affect a person's knowledge, practices, and perceived importance of helminthic (worm) infections.

Measurements: Measurements were collected through structured interviews administered through local translators (see Appendix 1). In this survey, closed and open-ended questions are included to thoroughly assess the beliefs of the Luo population. The questions pertain to demographic, social, and academic information, as well as knowledge of helminthic infections and preventative measures that can be taken to avoid becoming afflicted by these diseases. Questions were also asked about the perceived importance of helminthic infections compared to HIV/AIDS and malaria.

Outcome Variable:

Knowledge: Total accurate knowledge of each participant was based on the number of correct responses to questions concerning the knowledge of helminthic infections.

Relative Importance: Each individual's perceived importance of helminthic infections relative to other common diseases, such as HIV/AIDS and malaria, was identified by categorizing their response into categories describing helminthic infections as "very important," "not very important," or "not important at all."

Predictor Variables:

Demographic: Gender, age, and education were recorded based on the subject's self-report.

Exposure to Environmental Factors

Unsanitary Water: Source for drinking water, whether or not fruits and vegetables are washed first in filtered water before eating.

Geophagia: Whether or not the participant had ever eaten "soft rocks," soil or mud, or any other atypical food, and the last time they ingested these materials.

Disease Status: Self-report by participant of past or present helminthic infection and time of last infection.

Statistical Analyses

Data Entry: Data were double-entered into Microsoft Excel and then imported into SAS 9.3, the statistical program that was used for data analysis.

Descriptive: Frequencies, percent and cumulative percent, mean and standard deviation (when applicable), and range will be reported for each variable.

Analytic

Multivariate:

Multivariate analysis was used to assess interaction effects and the relative contribution of each predictor variable to the outcome variable. Multiple regression, logistic regression, and analyses of variance were used. In some cases, data were stratified and contingency table analysis was done to assess the modification of the relationship between the predictor and outcome variables.

IRB Approval

The study was approved by the Baylor University Institutional Review Board. All data from human subjects was anonymous and informed consent was obtained before a subject was interviewed.

CHAPTER FIVE

Results

The following results are divided into four categories as follows:

DEMOGRAPHIC INFORMATION

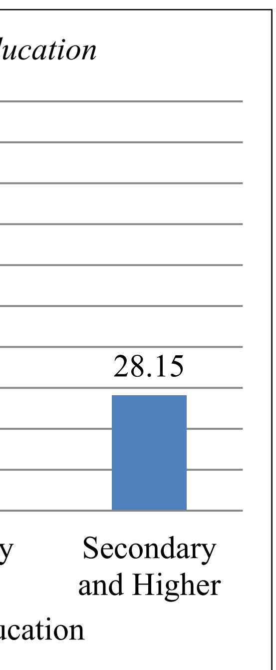
Data were collected May 19th – June 3, 2013 from patients who came to the annual temporary Straw to Bread clinic on the Nyakach Plateau of the U.S.-based nonprofit organization. The sample consisted of 199 Luo males and females between the ages of 10 and 90 years old, with an average age of 37.92 years (SD=21.26). Among those interviewed, 40.20% were male and 59.80% were female.

Level of Education

Approximately 60% of the interviewees had a primary education, while less than 30% attained a secondary education and beyond (see Table 5.1). Notably, almost 90% of interviewees reported having at least a primary level of education; however, over 10% of the population remains uneducated.

Table 5.1: Level of Education

Level of Education	Frequency	Percentage
No Education	24	12.06
Primary	119	59.8
Secondary and Higher	56	28.15



There was a significant differene in education level depending on age ($p<0.0001$). The average age for those no education was 55.79 years (SD=17.45). The average age for those with at least a primary education was 35.45 years (SD=20.58).

There was also a significant difference between males and females in their education ($p<0.0001$) (See Table 5.2). Figure 5.3 shows that among those who received no education, 100% were females. Approximately 60% of those who received a primary education were females, whereas only 46% of those with a secondary education or better were females.

Figure 5.3: Level of Education vs. Gender

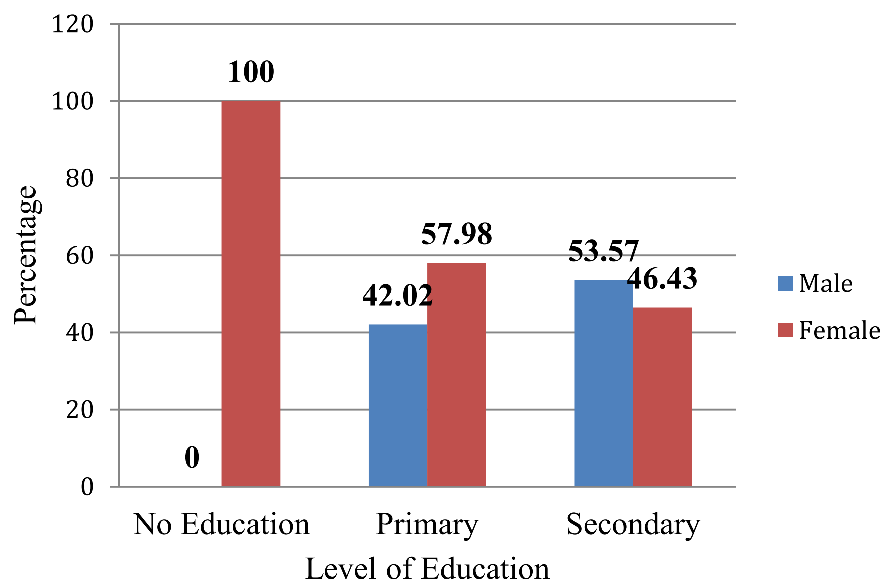


Table 5.2: Gender vs. Level of Education				
Gender	Level of Education			
	No Education	Primary	Secondary +	Total
Male Frequency Percent Row Pct Col Pct	0 0.0 0.00 0.00	50 25.13 62.50 42.02	30 15.08 37.50 53.57	80 40.20
Female	24 12.06 20.17 100.00	69 34.67 57.98 57.98	26 13.07 21.85 46.43	119 59.80
Total	24 12.06	119 59.80	56 28.14	199 100.00

DESCRIPTIVE FINDINGS

Perceived Causes

Data pertaining to all perceived causes of worm infections are shown in Figure 5.4. Participants were asked about all ways in which they thought a person could contract worms. By far the most commonly reported causes were eating spoiled or "cold" food and geophagia. All frequencies and percentages can be found in Table 5.3.

Figure 5.4: All Reported Causes

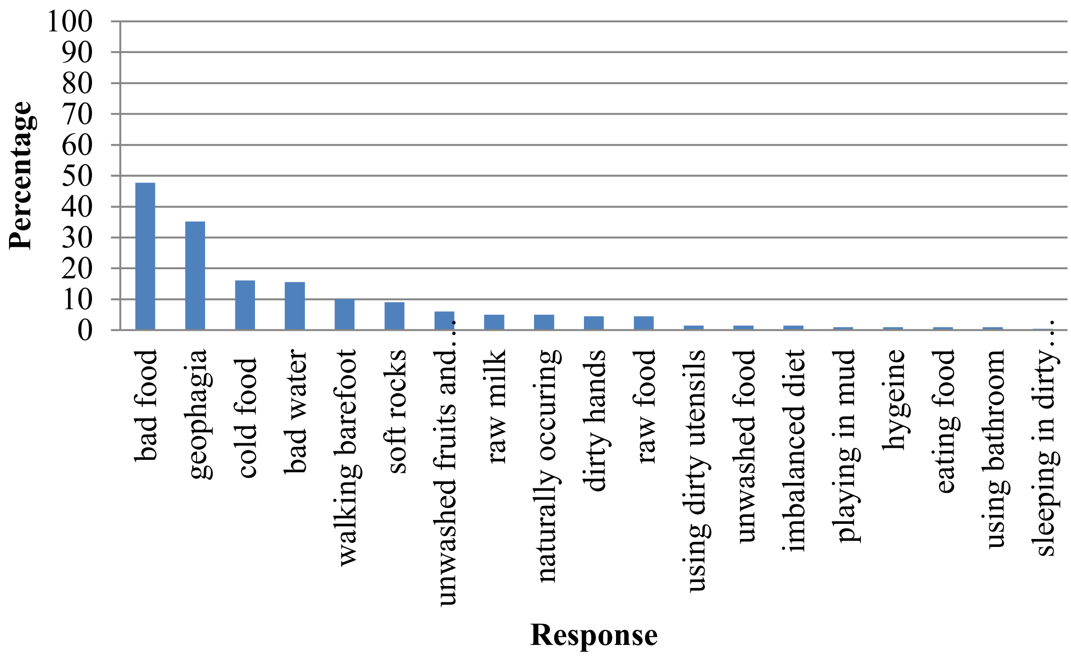
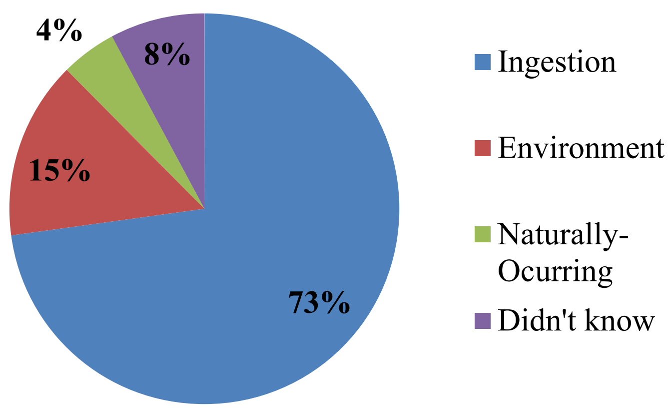


Table 5.3: All Reported Causes		
Reported Cause	**Frequency**	**Percentage**
Bad Food	95	47.74
Geophagia	70	35.18
Cold Food	32	16.08
Bad Water	31	15.58
Walking Barefoot	20	10.05
Soft rocks	18	9.05
Unwashed fruits and vegetables	12	6.03
Raw milk	10	5.03
Naturally occurring	10	5.03
Dirty Hands	9	4.52
Raw Food	9	4.52
Using dirty utensils	3	1.51
unwashed food	3	1.51
imbalanced diet	3	1.51
Playing in mud	2	1.01
Hygiene	2	1.01
Eating food	2	1.01
Using bathroom	2	1.01
Sleeping in dirty places	1	0.5
Didn't know	17	8.54

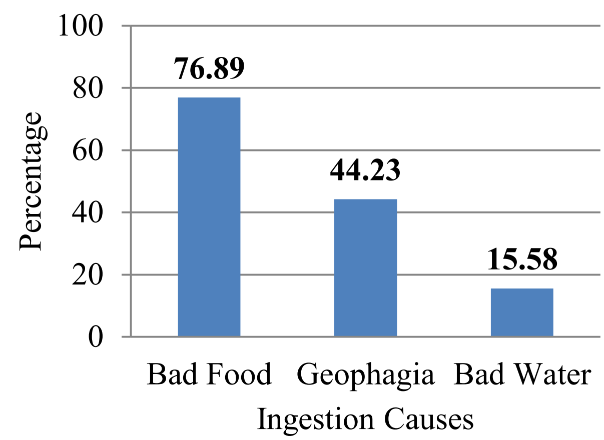
All perceived causes were classified into one of three categories: ingestion, environment, or naturally-occurring, as shown in Figure 5.5. Among the 199 interviewees, about 80% identified ingestion as a factor in causing helminthic infections, 15% attributed the infections to environmental factors, and 5% said that worm infections were a naturally occurring, normal condition.

Figure 5.5: Classification of Causes

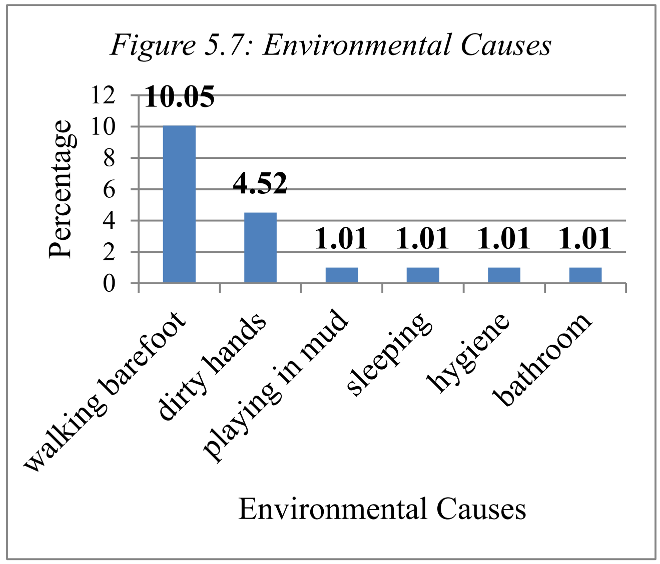


Causes relating specifically to ingestion are shown in Figure 5.6. Among those who reported ingestion causes, approximately 75% said that eating bad (spoiled, old, or cold) food is a cause, 45% attributed worm infections to soft rock consumption and geophagia, and 15% said that drinking bad water could lead to the disease.

Figure 5.6: Ingestion Causes



Environmental causes are shown in Figure 5.7. Among those who identified an environmental cause of worm infections, the most common response was "walking barefoot" at approximately 10% of the total sample.



Self-Diagnosis vs. Clinical Assessment

Regarding how people know that they have worms, only about 3% of the sample reported that they did not know how to tell if they had ever had worms. Figure 5.8 shows that among the people who reported knowing how they found out they had worms, the overwhelming majority of people (86%) believed that they had worms because of signs or symptoms. Only 11% of the population confirmed their infections either through a clinical assessment by a health worker at the clinic or by a stool test.

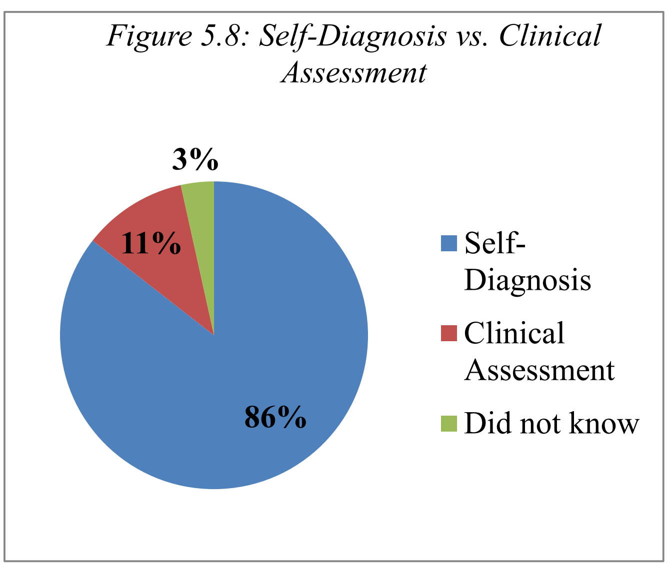
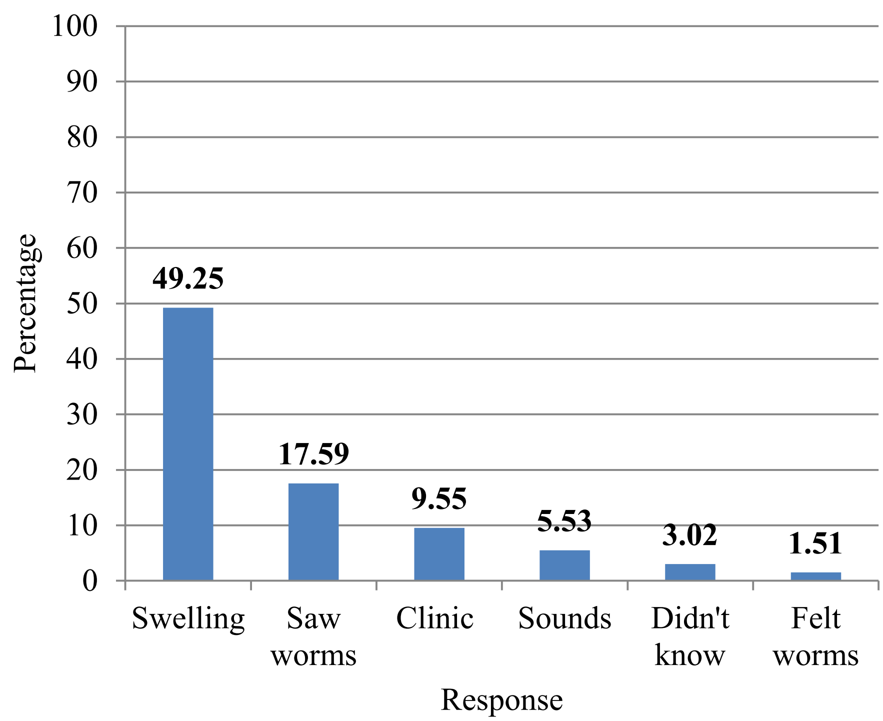


Figure 5.9 shows the specific responses given when interviewees were asked the survey question. Almost half of those interviewed knew they had worm infections when they noticed abdominal swelling. 18% of the participants found out they had a worm infection when they were able to see worms in their stool, only 10% either got checked by a health worker or had a stool sample taken for testing, 5% knew they had a parasite when they heard digestive sounds, such as stomach “rumbling,” and a few (1%) could “feel the worms running or playing inside.”

Figure 5.9: How did you know you had worms?



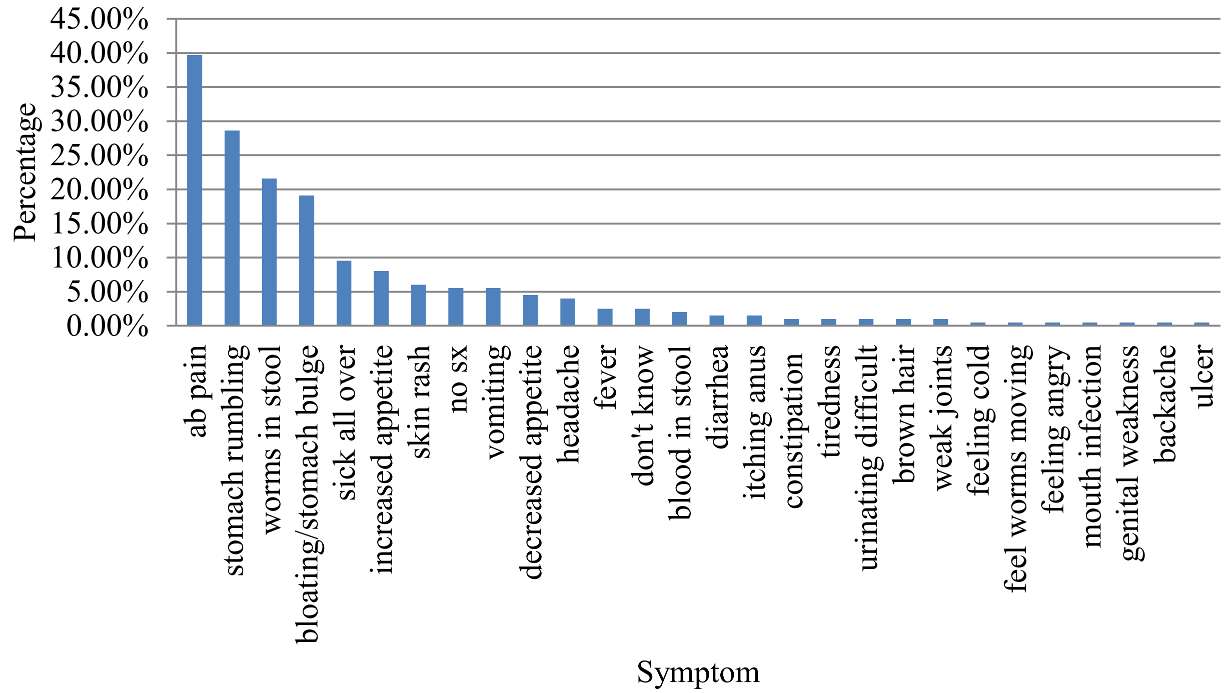
Signs and Symptoms

To assess the signs and symptoms associated with having a worm infection, interviewees were first asked about their own subjective experience with the disease—the symptoms, then questioned about the objective evidence of the disease—the signs.

Symptoms: Patient's Subjective Experience

Figure 5.10 and Table 5.4 indicate the symptoms that the interviewees reported experiencing personally. Approximately 5% of the population reported experiencing no symptoms themselves. Among those who reported having symptoms, most common symptoms included abdominal pain, stomach rumbling, seeing worms in stool, bloating, and feeling sick all over.

Figure 5.10: All Reported Symptoms



urinating difficulty	2	1.01
brown hair	2	1.01
weak joints	2	1.01
feeling cold	1	0.5
feel worms moving	1	0.5
feeling angry	1	0.5
mouth infection	1	0.5
genital weakness	1	0.5
backache	1	0.5
ulcer	1	0.5

Signs: Patient's Objective Experience

While Figure 5.10 shows the subjective experience of the illness, Figure 5.11 displays the objective signs that a person reported to notice on another individual when they thought the other person had a worm infection.

Figure 5.11: All Reported Signs

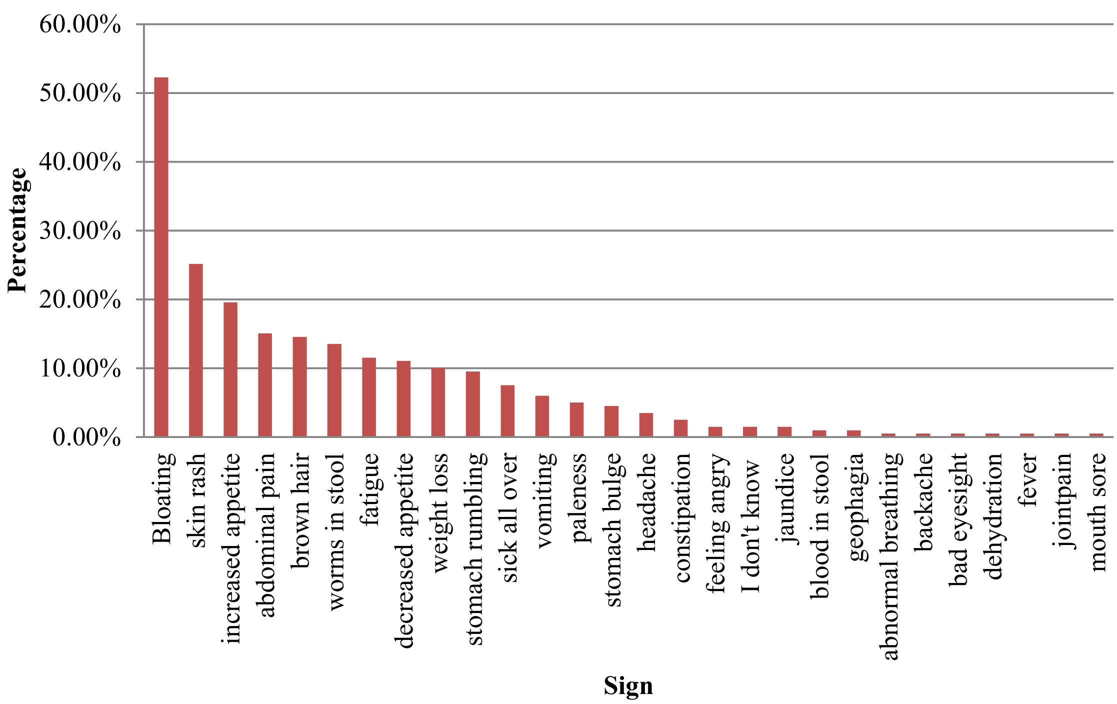


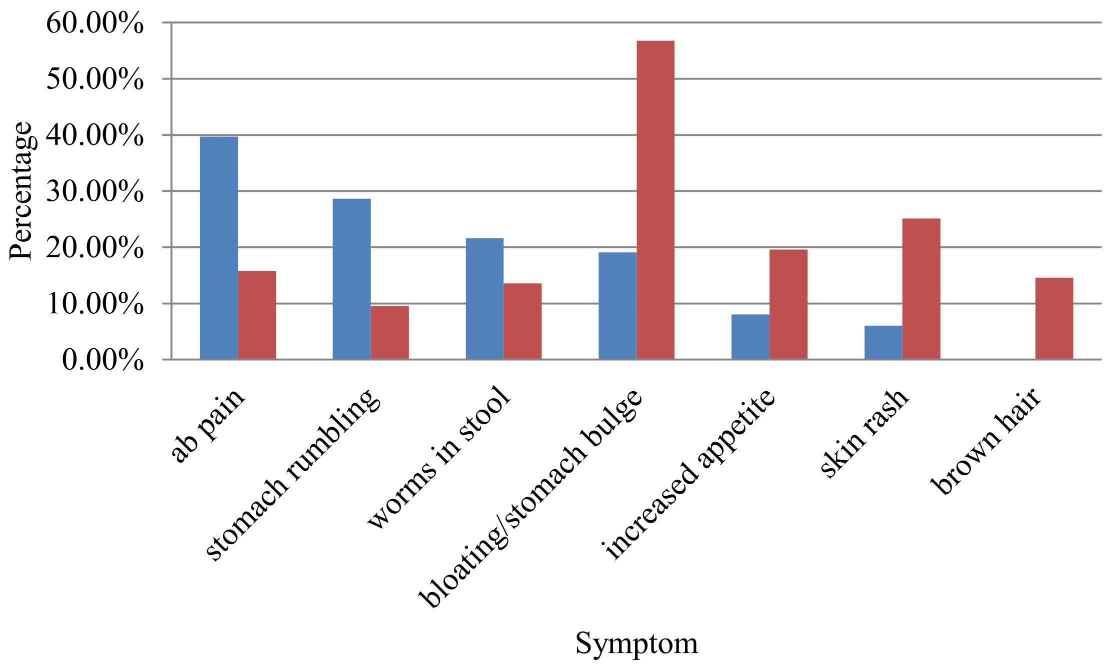
Figure 5.8 shows how interviewees could tell that other people had worms. Table 5.5 displays the frequencies and percentages associated with all reported signs. The most commonly reported signs that others display when they have worms are bloating/stomach bulge, skin rash, increased appetite, abdominal pain, brown hair, and worms in stool.

Table 5.5: All Reported Signs		
Signs	Frequency	Percentage
bloating	104	52.26
skin rash	50	25.13
increased appetite	39	19.6
ab pain	30	15.08
brown hair	29	14.57
worms in stool	25	12.56
fatigue	23	11.56
decreased appetite	22	11.06
weight loss	20	10.5
stomach rumbling	19	9.55
sick all over	15	7.54
vomiting	12	6.03
paleness	10	5.03
stomach bulge	1	0.5
headache	5	2.51
constipation	5	2.51
feeling angry	3	1.51
I don't know	3	1.51
jaundice	3	1.51
blood in stool	2	1.01
geophagia	2	1.01
abnormal breathing	1	0.5
backache	1	0.5
bad eyesight	1	0.5
dehydration	1	0.5
fever	1	0.5
joint pain	1	0.5
mouth sore	1	0.5

Comparison: Signs vs. Symptoms

Figure 1.12 compares the top symptoms and signs reported subjectively for the patient's personal experience and for objectively for identifying signs in others. While more internal symptoms, such as abdominal pain and stomach rumbling were associated with the patient's personal experience, the visible, external symptoms, such as skin rash, brown hair, increased appetite, and stomach bulge were reported as ways to tell when others were sick with worm infections.

Figure 1.12: Symptoms vs. Signs (Subjective vs .Objective Experience)



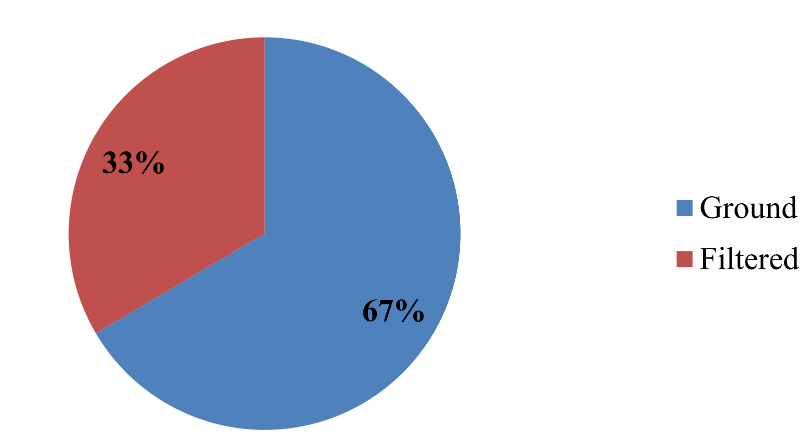
Exposure to Risk Factors

Unsanitary Water: Drinking and Washing Water Source

Drinking Water

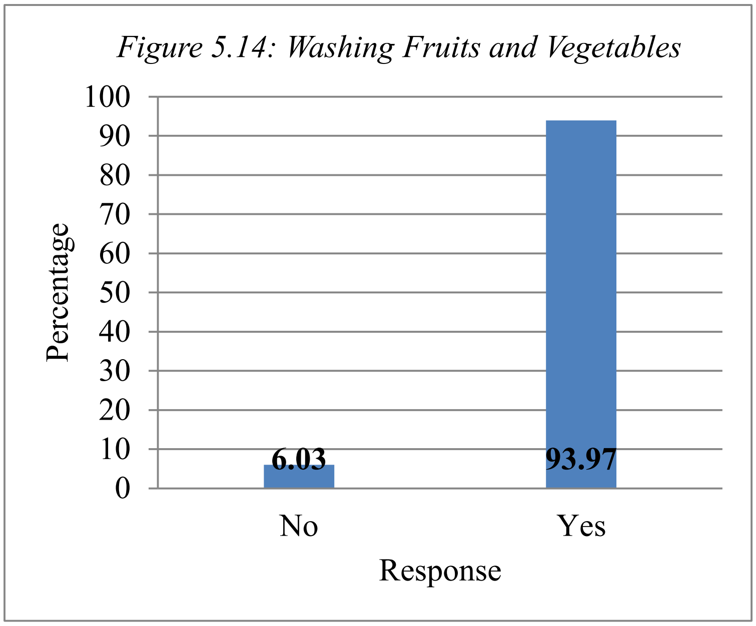
Groundwater represents any sources of water that were not filtered prior to consumption (e.g. water from tap and streams). Two-thirds of the population continues to ingest unfiltered ground water, while the other one-third reports consuming drinking clean water (Figure 5.13).

Figure 5.13: Primary Source of Drinking Water

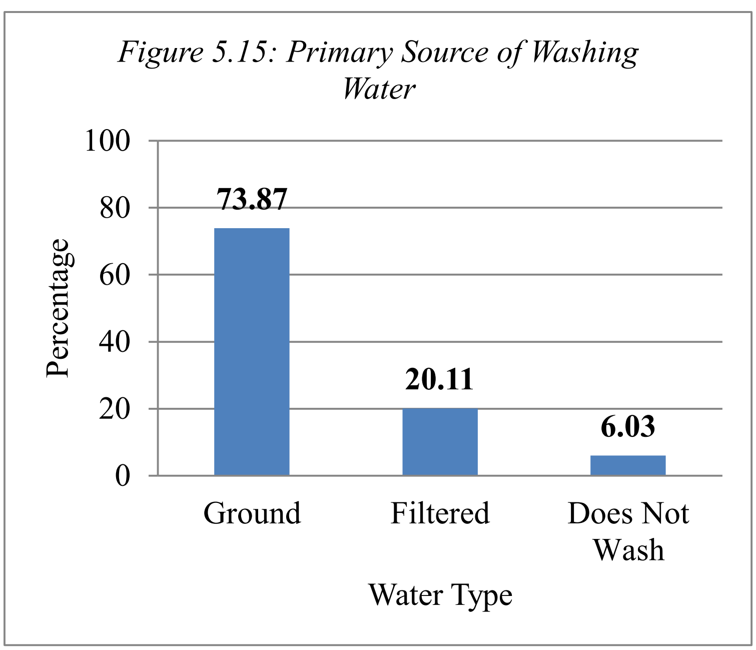


Washing Water

More than 90% of the population washed fruits and vegetables prior to consumption (Figure 5.14). However, among those who washed their fruits and vegetables, approximatley three-quarters of the population reported washing foods in ground water (streams, wells, and tap) prior to consumption, whereas only 20% utilized filtered water sources to wash (Figure 5.15).



From these data it is clear that although the majority of the population is washing their produce prior to consumption, they are actually washing it in unfiltered, dirty water. It is vital to consider whether more harm is being done than good in this specific instance. Despite the fact that some individuals are consuming clean water, these individuals may still be vulnerable to getting infected by simply washing their fruits and vegetables in unsanitary water and eating the produce.



Geophagia: Soil-Eating

Figure 5.16 shows that approximately 80% of this sample reported never eating soil, mud, or soft rocks. Among people who participated in geophagia, there was no statistical difference in age ($p>0.06$) or gender ($p>0.2$)

Figure 5.16: Prevalence of Geophagia

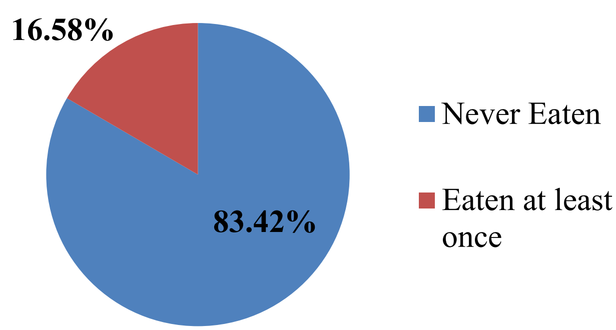
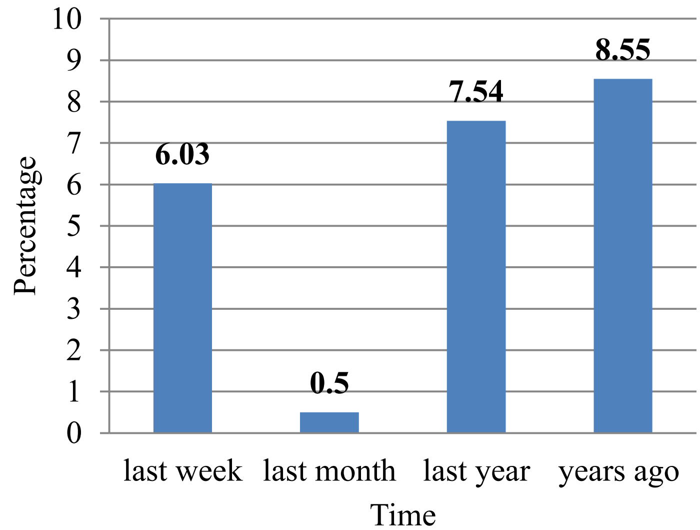


Figure 5.17 displays the most recent time the interviewees engaged in geophagia. About 6% of the interviews reported ingesting soil within the last week, 0.50% in the last month, 8% within the last year, and 9% said they ate soil years ago as a child.

Figure 5.17: Most Recent Geophagia

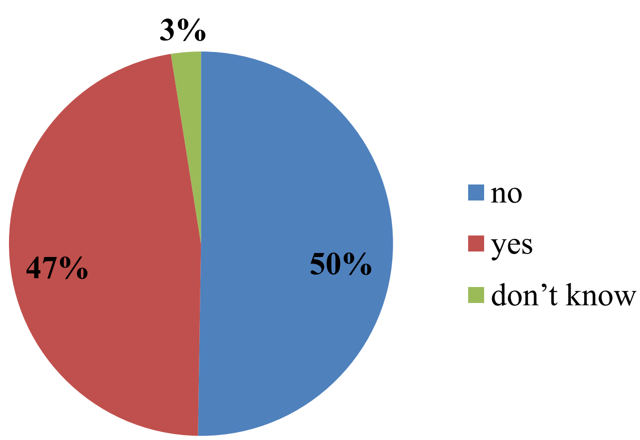


Disease Status

Current Worm Infection

Figure 5.18 indicates that almost half of the sample reported having a worm infection at the time the study was conducted.

Figure 5.18: Current Worm Infection?



Number of Infections and Duration

In addition to their current disease status, participants who have experienced helminthic diseases also identified the number of times they have been infected. The average number of times that people suffer from worm infections is 1.27 times with a standard deviation of 0.94 and a range of 0-5 (Table 5.6).

Table 5.6: Number of Infections

Number of Infections	Frequency	Percentage
None	35	17.58
One	99	49.74
Two	44	22
Three	15	7.3
Four	4	1.8
Five	2	0.6

Figure 5.19 and Table 5.7 shows the duration of helminthic worm infections. The average length of time that people reported having helminthic infections is 9.43 months with a standard deviation of 14.41. Over half of the population surveyed did not know how long they had the infection.

Figure 5.19: Duration of Infection

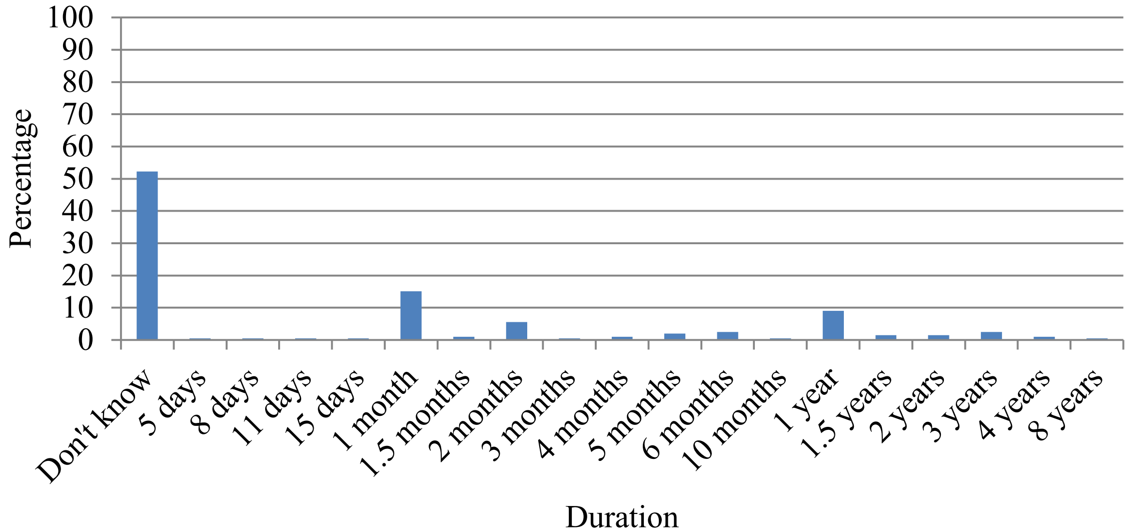


Table 5.7: Duration of Infection

Duration (in proportion of months)	Frequency	Percentage
Don't know	104	52.26
5 days	1	0.5
8 days	1	0.5
11 days	1	0.5
15 days	1	0.5
1 month	30	15.08
1.5 months	2	1.01
2 months	11	5.53
3 months	1	0.5
4 months	2	1.01
5 months	4	2.01
6 months	5	2.51
10 months	1	0.5
1 year	18	9.05
1.5 years	3	1.51
2 years	3	1.51
3 years	5	2.51

4 years	2	1.01
8 years	1	0.5

Less than 45% of the population indicated having an infection in the last three months at the time at which the survey was administered (see Figure 5.20). Table 5.8 displays the specific frequencies and perentages of the most recent infections.

Figure 5.20: Most Recent Infection

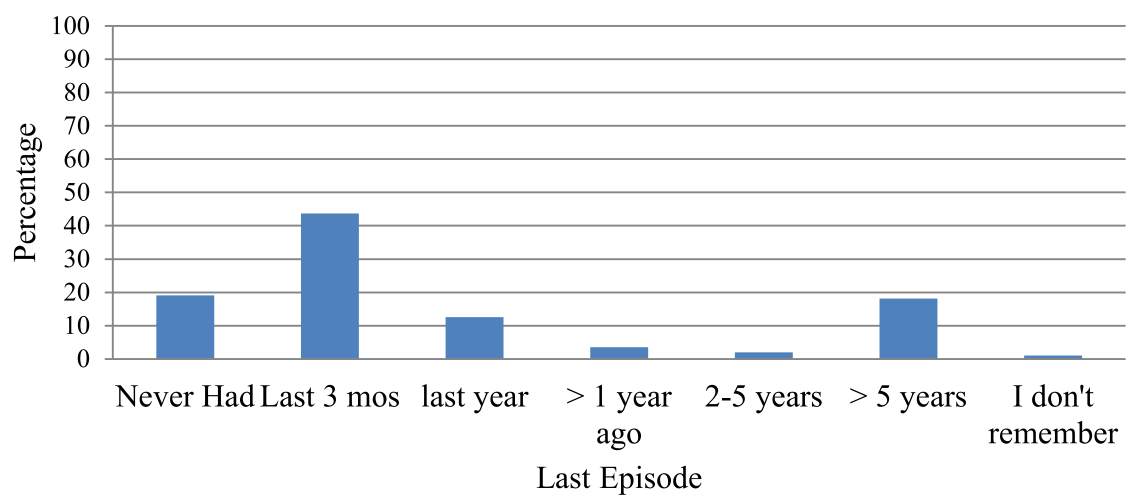


Table 5.8: Most Recent Infection		
Last Episode	Frequency	Percentage
Never	22	11.06
Last 3 months	87	43.72
Last year	25	12.56
> one year	7	3.52
2-5 years	4	2.01
> 5 years	36	18.09

Treatments

In order to better assess the knowledge of helminthic treatments, responses were dichotomized into medical and non-medical (traditional, herbal) treatments. Figure 5.18 displays whether or not the individuals responded that helminthic infections were treatable. 86.43% of the sample identified medicine as the treatment, but 9.04% of the interviewees did not believe there was treatment available for helminthic infections.

Figure 5.18: Existence of Treatment

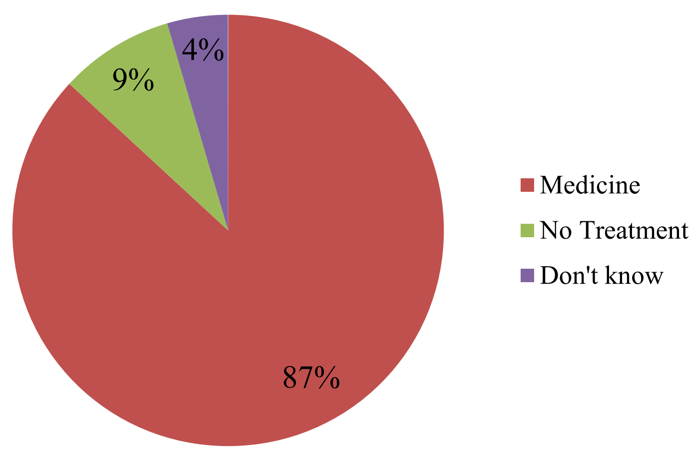
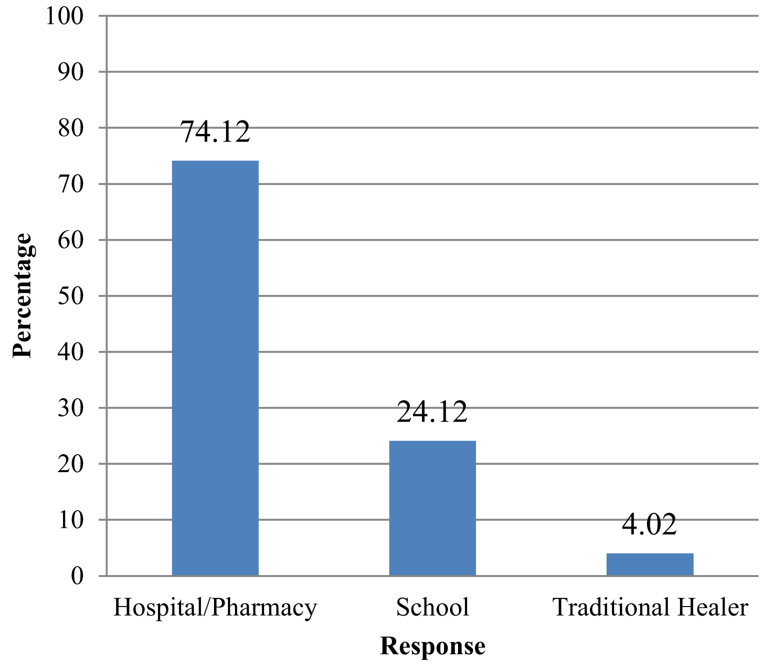


Figure 5.19 shows where individuals said they went to receive treatment. Most of the sample stated that treatment was available at the hospital or pharmacy.

Figure 5.19: Treatment Location



Alternate Forms of Treatments

While 76.88% of the population claimed that there was no other treatment, 23.32% of the interviewees believed that other treatments did exist (see Figure 5.20)

Figure 5.20: Do other treatments exist?

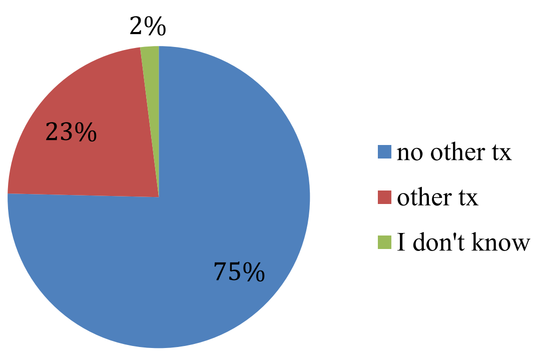
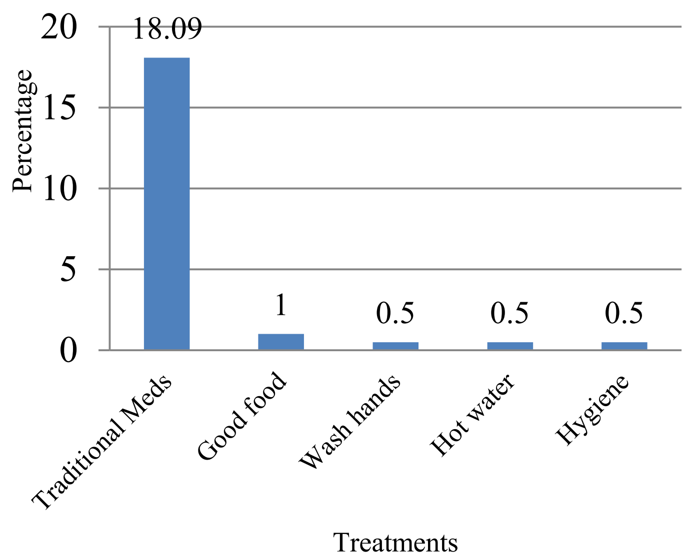


Figure 5.21 shows that among the 46 people who said that alternative forms of treatment were available, 18.09% attributed these treatments to traditional Luo medicine. This response was typically

characterized by a description of a particular herb or plant that was said to have medicinal properties against helminthic infections. Other factors such as eating well-prepared food and being hygienic were also recognized as ways to treat non-medically.

Figure 1.21: Other Non-Medicine Treatments



Prevention Methods

Data pertaining to all methods of prevention for worm infections are shown in Figure 5.22 and all frequencies are listed below.

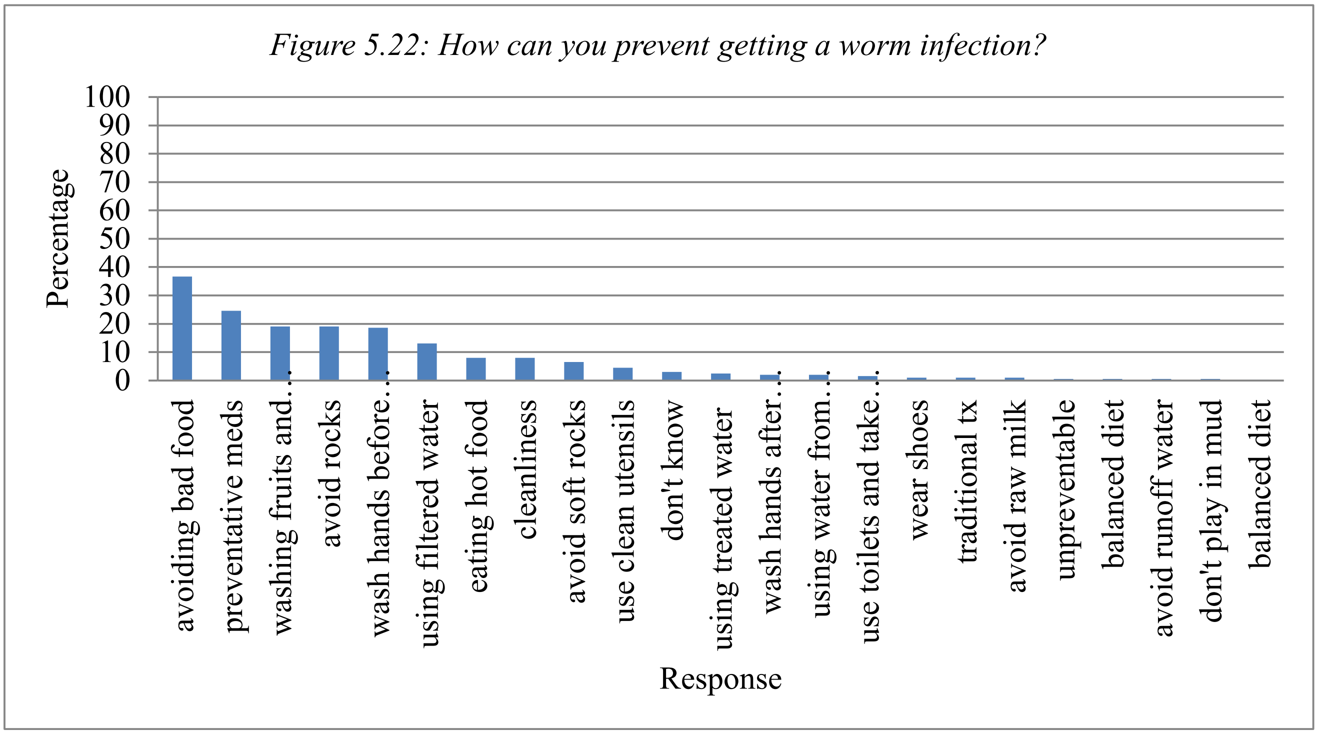


Table 5.9 shows the most commonly reported methods of prevention. If the method is listed in blue it corresponds to an environmental factor, red is related to eating unclean foods/water, and green stands for people who reported taking preventative anti-helminthic infections as a way to prevent getting the infection.

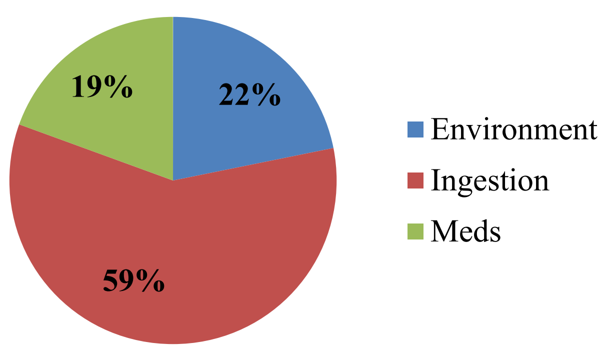
Table 5.9: Most Commonly Reported Preventive Methods

Prevention Methods (n=198)	Percentage	Frequency
Washing hands before eating	18.59%	37
Wash hands after using toilet	2.01%	4
Wear shoes	1.01%	2
Cleanliness	8.04%	16

Use toilets and showers	1.51%	3
Do not play in mud	0.50%	1
Drink clean water (e.g. tank, filtered)	17.09%	35
Avoid bad food (spoiled, cold, raw)	45.45%	90
Wash fruits and vegetables before eating	19.10%	38
Avoid geophagia	19.10%	38
Take preventative medications	24.62%	49

Figure 5.23 represents the above data from Table 5.9 in its broader categories. Each preventative method was classified into one of three categories: environment, ingestion, and medication. Most people said that helminthic infections could be prevented by eating and drinking the proper things.

Figure 5.23: Classification of Prevention Methods



Data relating to the knowledge of prevention methods was an important aspect of the accurate knowledge score.

Knowledge Score

A knowledge score was developed to assess the accuracy of knowledge pertaining to the symptoms, causes, treatments, and prevention methods relating to helminthic infections. Responses from seven questions were analyzed for accuracy. Correct responses were those that represented the most common, well-documented answers in the literature. Incorrect answers were any answers that were not included as explicitly correct answers. In other words, if a correct answer (as listed below) was not stated, the interviewee did not receive a point for that question. Answers that were reported but were not deemed as being explicitly correct received no points for accuracy of knowledge. Table 5.10 shows each question with its respective possible correct answer choices.

Table 5.10: Knowledge Score Items: Questions with Correct Respective Answers

Question	Possible Correct Responses

1. What are the symptoms a person experiences when they have a worm infection?	-Abdominal Pain -Swelling -Worms in stool -Skin rash
2. How do worms get inside your body?	-playing in the mud -walking barefoot -dirty hands -lack of hygeine -spoiled, rotten food -dirty water -geophagia/soft rocks -raw milk -unwashed fruits and vegetables -dirty utensils -raw meat
3. How can you treat worm infections?	-Medications
4. What do worms do inside your body?	-Take food -Destroy GI -Suck your blood -Deprive body of nutrients -Make you sick
5. Are some people more likely to get worms?	-children -pregnant women -people with poor hygeine -people who eat soft rocks -women
6. Where can you get treatments?	-Pharmacy -Clinic/hospital -School
7. How can you prevent getting worms?	-washing hands before eating -washing hands after using the toilet -wearing shoes -cleanliness -using toilets/showers to be clean -not playing in the mud -using filtered/tank water -avoiding rotten, bad food -washing fuits and vegetables before eating -avoiding raw milk -avoiding geophagia/soft rocks

Using the knowledge score items, two distinct scores were developed: a “good score” and a “bad score. “

The good score measured the number of correct responses the interviewee provided to the above seven questions. Table 5.11 shows this score in terms of how many correct answers were reported by interviewees in each of the seven categories. For example, 100% of the population reported at least one correct answer to two of the questions above. Approximately 34% people provided at least one correct answer to all seven questions. 65% of the individuals got between 2 and 6 correct answers for the above questions. Table 5.12 breaks down the good score by each knowledge item. The category that had the highest number of people who reported at least one correct answer were where to get treatment, prevention methods, and “wormy people.” The “wormy people” category refers to people who were reported to be more vulnerable or likely to be infected by worm infections. Among the people who provided at least one correct answer to at least one of the knowledge questions, there was no statistical difference in age ($p=0.28$) or gender ($p=0.21$) (See Table 5.13).

Table 5.11: Good Score (number of correct answers reported)

Number of Correct Responses/Category	Frequency	Percentage
0	0	0
1	0	0
2	1	.5
3	2	1.01
4	12	6.53
5	29	14.57
6	86	43.22
7	68	34.17

Table 5.13: Good Score vs. Age, Gender, Disease Status		
Overall: F=1.38, p=0.2550		
Variable	F=	p=
Age	1.19	0.28
Gender	1.56	0.21
Worms Now	2.8	0.09

Table 5.12: Good Scores According to Category		
Category	Frequency	Percentage
Where Treatment	195	98.49
Prevention	195	98.49
Wormy People	192	96.48
Worms Inside	175	87.94
Treatments	172	86.43
Causes	171	85.93
Symptoms	102	51.26

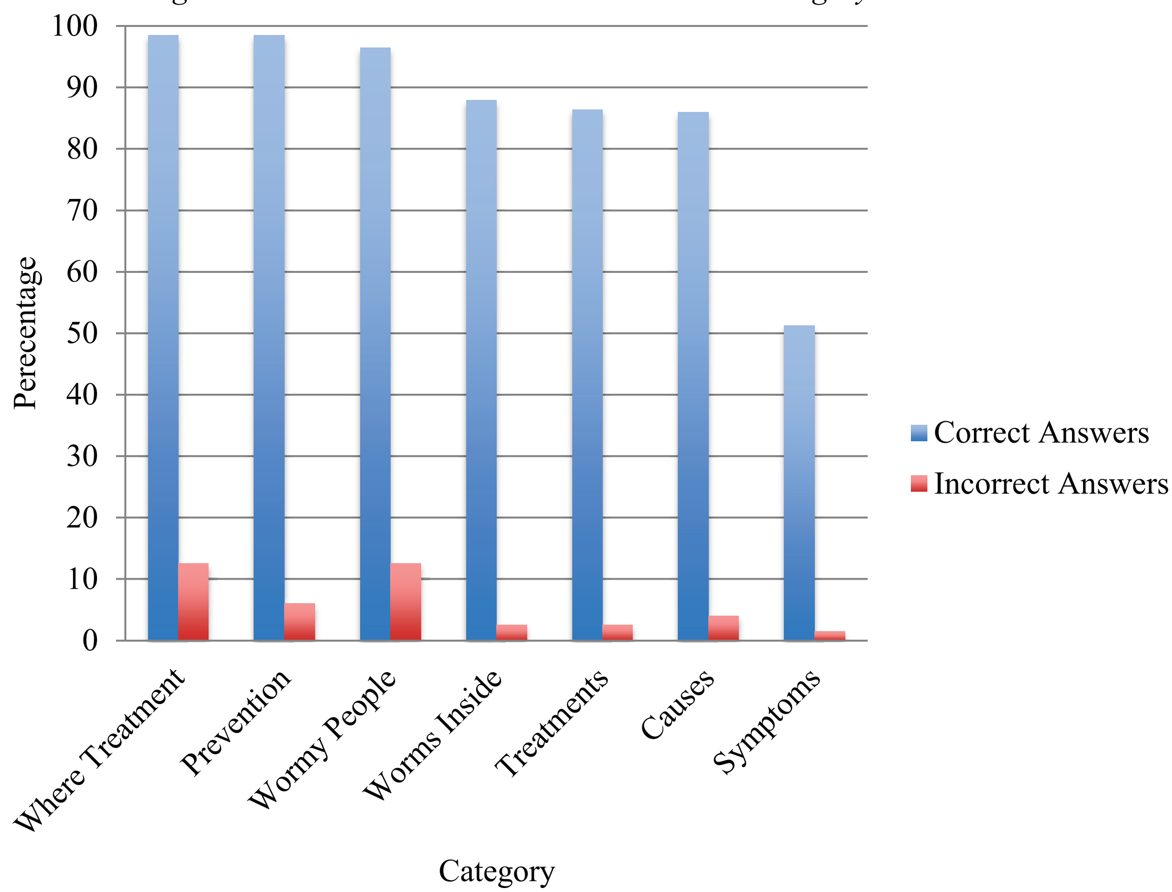
The bad score measured the number of incorrect responses reported. Table 5.14 shows this score in terms of the number of wrong answers reported by the interviewees. Almost 60% did not report an incorrect answer to any of the above items. About 30% of the population provided at least one wrong answer to one of the questions. Less than 10% reported at least one incorrect answer in two of the above categories. And 1% had at least one wrong answer to 3 or 4 of the items. No participants reported an incorrect answer to every single question—in other words, there were no "perfect" scores in the bad knowledge score. Table 5.15 breaks down the bad score by each knowledge item—the categories which had the highest number of people who reported at least one incorrect answer included identifying what worms do inside a person's body, treatments, and symptoms. Among the people who provided at least one wrong answer to at least one of the knowledge questions, there was no statistical difference in age (p=0.75) or gender (p=0.89), as shown in table 5.16. Figure 5.24 displays the number of correct and incorrect answers reported in each category.

Table 5.14: Bad Score (Number of Incorrect Answers Reported)		
Number of wrong answers/category	Frequency	Percentage
0	118	59.30
1	60	30.15
2	19	9.55
3	1	0.5
4	1	0.5
5	0	0
6	0	0
7	0	0

Table 5.15: Bad Scores According to Category		
Category	Frequency	Percentage
Wormy People	5	2.51
Where Treatment	8	4.02
Prevention	3	1.51
Causes	12	6.03
Worms Inside	24	12.06
Treatments	27	13.57
Symptoms	25	12.56

Table 5.16: Bad Score vs Age, Gender, Disease Status		
Overall F=0.29, p=0.7478		
Variable	F=	p=
Age	0.55	0.75
Gender	0.03	0.89
Worms Now	0.44	0.51

Figure 5.24:Correct and Incorrect Answers vs. Category



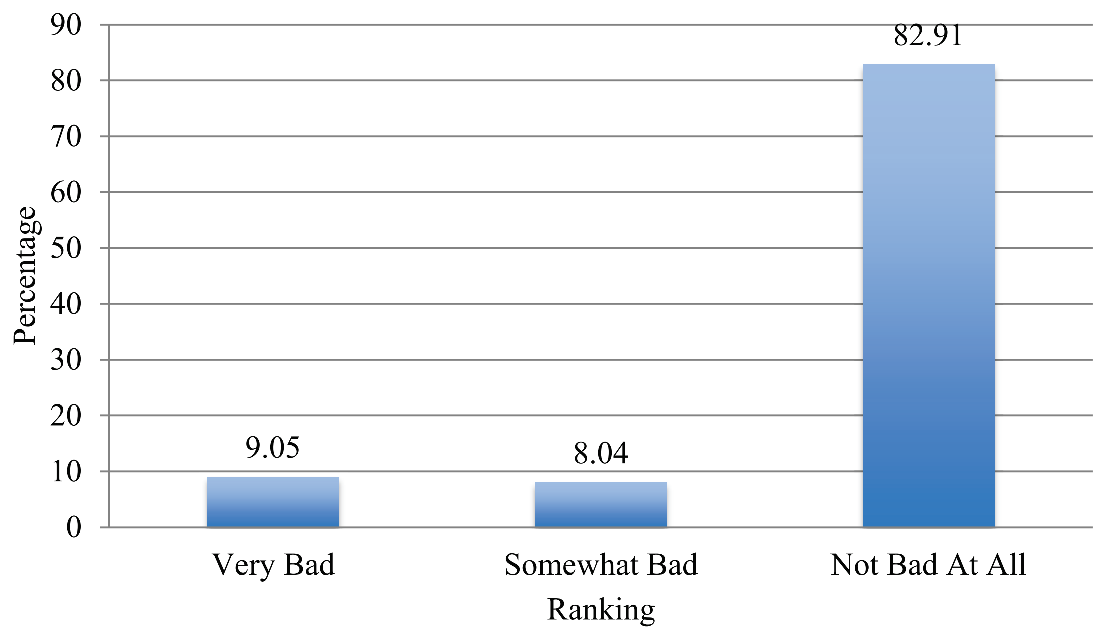
Relative Importance

Each individual's perceived importance of helminthic infections relative to other common diseases was identified by categorizing helminthic infections as "very important," "not very important," or "not important at all" compared to HIV/AIDS and malaria. Shown below are the responses classified by the comparison to HIV/AIDS followed by malaria.

Helminthic Infections vs. HIV/AIDS

Figure 5.25 shows that less than 10% of those interviewed perceived worms as being "very bad" compared to HIV/AIDS) and the more than 80% of the interviewees who answered this question believed that helminthic infections were "not bad at all" compared to HIV/AIDS.

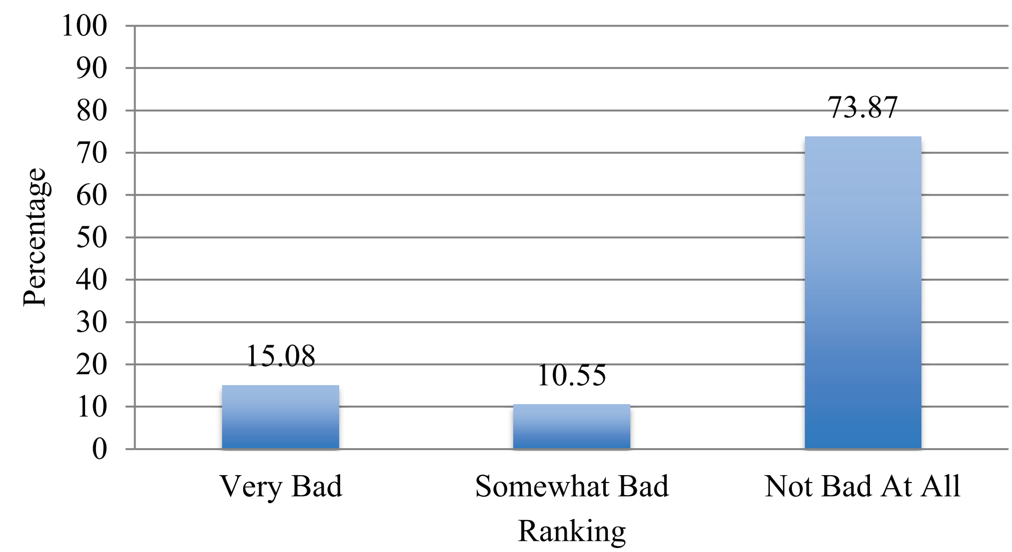
Figure 5.25: Helminthic Infections vs. HIV/AIDS



Helminthic Infections vs. Malaria

Figure 5.26 shows that only 15% of those interviewed perceived worms as being "very bad" compared to malaria and the about three-quarters of the sample believed that helminthic infections were "not bad at all" compared to malaria.

Figure 5.26: Helminthic Infections vs. Malaria



Relative Importance Score

In order to score the relative importance of helminthic infections compared to HIV/AIDS and malaria to see which diseases people considered to have a higher ranking, three scores were developed. A score of 1 corresponds to situations when worms were ranked as "very bad" compared to both HIV/AIDS and malaria. When worms were ranked "very bad" compared HIV/AIDS OR malaria when HIV/AIDS or malaria ranked as "somewhat bad." A score of two is when worms were ranked as being "somewhat bad" compared to both HIV/AIDS and malaria, when worms were ranked as being "very bad" compared to HIV/AIDS OR malaria and HIV/AIDS or malaria were ranked as being "not bad at all." Finally, a score of 3 refers to situations in which both HIV/AIDS and malaria were considered to be "very bad" compared to worm infections, when HIV/AIDS or malaria were classified as "somewhat bad" and HIV/AIDS or malaria was considered to be "very bad" (see Table 5.17).

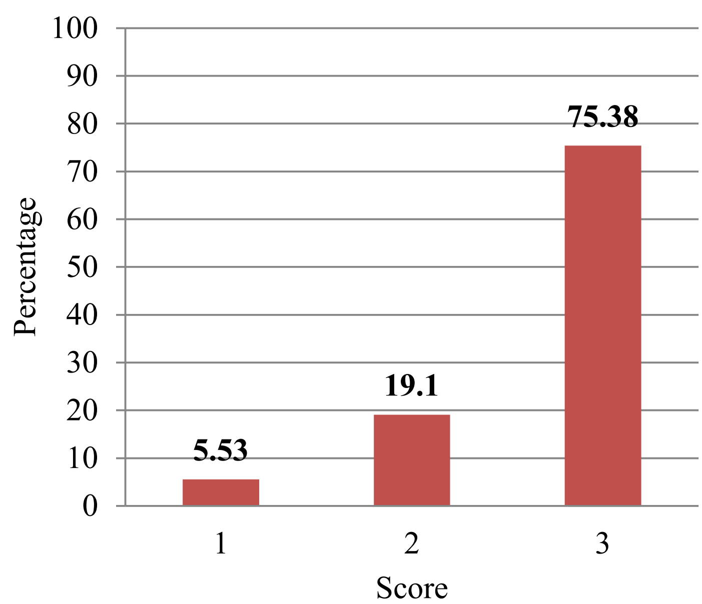
Table 5.17: Relative Importance Score

Score	HIV/AIDS	Malaria
1	Not bad at all	Somewhat bad
1	Somewhat Bad	Not bad at all

2	Somewhat Bad	Somewhat bad
2	Very bad	Not bad at all
2	Not bad at all	Very bad
3	Very bad	Very bad
3	Very bad	Somewhat bad
3	Somewhat Bad	Very bad

Figure 5.27 depicts the values from Table 5.17. Only 5% the interviewees reported worms as being more important than both HIV/AIDS and malaria. Less than 20% said that worms were "somewhat bad" in relation to HIV/AIDS and malaria. The majority stated that helminthic infections were "not bad at all" compared to HIV/AIDS and malaria.

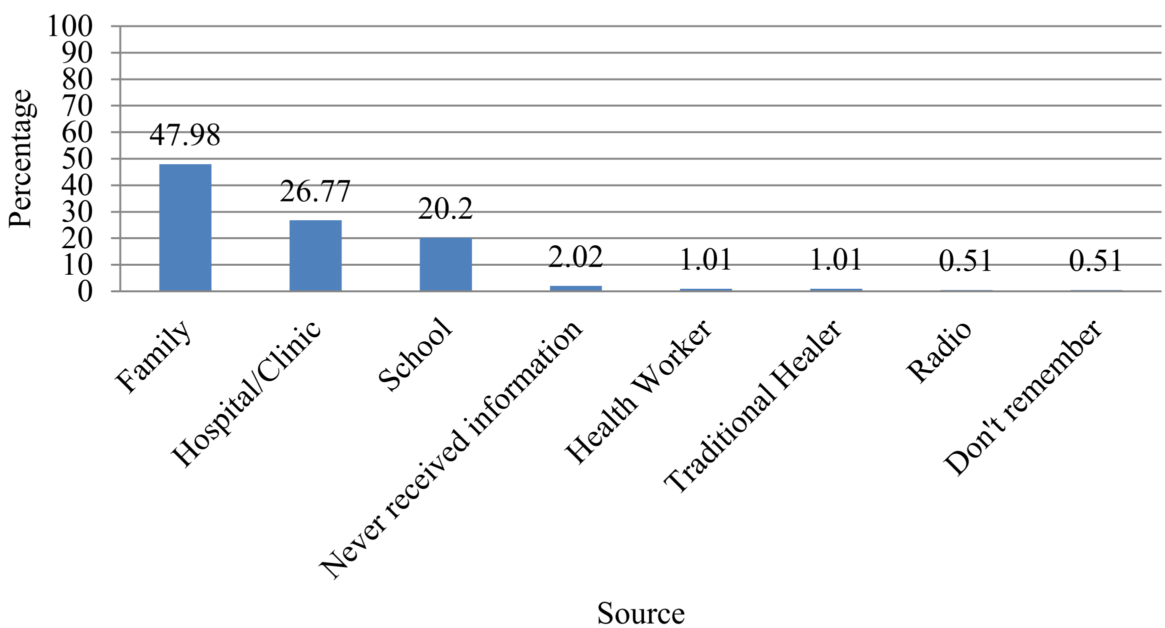
Figure 5.27: Relative Importance of Worms



Source of Information

Interviewees were asked about their source of information; in other words, where they had learned about worm infections. Figure 5.28 shows that almost half of the population reported learning about heminthic infections from a family member, while 25% of the population found out about the disease from a medical facility. About 20% of the interviewees learned about the infections from school.

Figure 5.28: Where did you learn about worm infections?



HYPOTHESES

Hypothesis 1: The overall knowledge related to causes, symptoms, treatments, and prevention is low in this Luo community and compared to other health problems (i.e. malaria, HIV/AIDS), helminthic infections are not ranked to be as important as other conditions.

An association was found between high accurate knowledge and low inaccurate knowledge. The "good score" shows that 100% of the population had at least one correct answer to two of the seven knowledge questions. Only 34% of the sample received a perfect "good score," signifying at least one correct answer in all seven knowledge categories. The bad score found that almost 60% of the population recorded no incorrect responses to any of the knowledge items and only 30% reported at least one wrong answers to one of the questions. A minority (<10%) reported at least one incorrect answer to two to four knowledge items. None of the interviewees reported incorrect answers to all seven knowledge questions. This proves that a high amount of correct knowledge exists. The ratio of correct to incorrect responses was high.

Results show that the highest number of correct responses did not always correlated with the lowest number of incorrect responses. The highest number of correct answers was reported in the prevention category. The highest number of incorrect response was reported in the treatments category. The sample has the most accurate knowledge about prevention related to helminthic infections, as this was the only category in which there were a high number of correct responses and a very low number of incorrect responses. Overall knowledge was very high. 80% of the population reported at least one correct answer in every category except for symptoms, in which only about half of the population reported a correct symptom.

The results supporting the second part of hypothesis 1 found that only 5.53% of the total sample reported helminthic infections as being more important than HIV/AIDS and/or malaria. 19.10% believed helminthic infections were “somewhat bad” compared HIV/AIDS and/or malaria. More than three-quarters of the population reported that HIV/AIDS and/or malaria were “very bad” compared to helminthic infections. Overall, the sample views HIV/AIDS and malaria as a greater threat to their health than helminthic infections.

Hypothesis 2: Younger people will have a more accurate knowledge of helminthic infections than older people, and younger people will be more likely than older people to rank these infections as being more important than malaria but less important than HIV/AIDS.

No association was found between age and accurate knowledge. Both the “good” and “bad” scores failed to show any relationship between age and the number of correct/incorrect responses given. According to the “bad score,” among those who provided at least one wrong answer to at least one of the knowledge questions, there was no statistical difference in age ($p=0.28$). According to the “good score,” among the people who provided at least one correct answer to at least one of the knowledge questions, there was no statistical difference in age as well ($p=0.75$).

There was also a lack of association between age and relative importance. Findings show that age is not a factor in determining the relative importance of helminthic infections compared to HIV/AIDS and malaria (p=0.506).

Hypothesis 3: Women will have a less accurate knowledge of helminthic infections than men, and women will be more likely than men to rank these infections as being less important than both malaria and HIV/AIDS.

No association was found between gender and accurate knowledge. Both “good” and “bad” scores failed to demonstrate that gender plays any role in the amount of accurate knowledge in this community. According to the “bad score,” among those who provided at least one wrong answer to at least one of the knowledge questions, there was no statistical difference in gender (p=0.90). According to the “good score,” among the people who provided at least one correct answer to at least one of the knowledge questions, there was no statistical difference in age as well (p=0.84).

There was also a lack of association between gender and relative importance. Findings show that gender is not a factor in determining the relative importance of helminthic infections compared to HIV/AIDS and malaria (p=0.31).

Hypothesis 4: People with higher levels of education will have a more accurate knowledge of helminthic infections than less educated people, and more educated individuals will be more likely than less education individuals to rank these infections as being more important than malaria but less important than HIV/AIDS.

No association was found between level of education and accurate knowledge. Both “good” and “bad” scores failed to demonstrate that gender plays any role in the amount of accurate knowledge in this community. According to the “bad score,” among those who provided at least one wrong answer to at least one of the knowledge questions, there was no statistical difference in gender ($p=0.15$). According to the “good score,” among the people who provided at least one correct answer to at least one of the knowledge questions, there was no statistical difference in age as well ($p=0.74$).

There was also a lack of association between gender and relative importance. Findings show that gender is not a factor in determining the relative importance of helminthic infections compared to HIV/AIDS and malaria ($p=0.22$).

CHAPTER SIX

Discussion

Hypothesis 1: The overall knowledge related to causes, symptoms, treatments, and prevention is low in this Luo community and compared to other health problems (i.e. malaria, HIV/AIDS), helminthic infections are not ranked to be as important as other conditions.

For the primary hypothesis, the null hypothesis was not rejected, as the overall knowledge related to the causes, symptoms, treatments, and prevention was high. Because more correct answers were reported than incorrect answers, it is evident that the ratio of accurate to inaccurate knowledge is high. There is a strong association between a high accurate knowledge and low inaccurate knowledge. This is encouraging, as it proves that this Luo tribe living on the Nyakach Plateau has an accurate baseline knowledge related to helminthic infections.

As determined by the good score, 100% of the population reported at least one correct answer to two of the seven knowledge questions. While only 34% of the population received a "perfect" good score, signifying at least one correct response in all 7 categories, almost 2/3 of the population did not have a perfect good score. The bad score found that almost 60% of the population reported no incorrect answers to any of the knowledge questions, 30% reported at least one wrong answer to one of the questions, a minority (<10%) reported at least one incorrect answer to two questions, and 1% had at least one wrong answer to 3 or 4 knowledge questions. No participants had wrong answers to all seven questions. These results indicate that although this sample has a basic knowledge of helminthic infections, the majority of the population does not have accurate knowledge uniformly about all aspects of the disease.

When each knowledge score item was assessed individually, the results were interesting because the questions with the highest number of correct responses did not always correlate with having the lowest number of incorrect responses. For example, the lowest number of correct responses was reported for the symptoms category. Only 51.26% of the population correctly identified at least one correct symptom of helminthic infections. 12.56% of the interviewees gave at least one wrong answer to this question. Despite receiving the fewest number of correct answers, the symptoms question did not receive the highest number of incorrect answers. Instead, the question related to treatments of helminthes received the highest number of incorrect answers. Instead, the question related to treatments received the highest number of incorrect answers. 13.57% of the population reported at least one incorrect way to treat helminthic infections. Even though 86.43% of the population knew that anti-helminthic medications could treat a person's infection, interviewees also reported wrong responses, such as herbal and traditional Luo treatments as valid ways to treat helminthes. The prevention category was the only question that followed the predicted trend of having the fewest reported incorrect answers and highest correct answers. In this category, 98.97% of the interviewees gave at least one correct response to this question. As expected, only 1.51% reported at least one wrong way to prevent getting helminthic infections. This is the trend that was expected for the other categories as well, but was only evident concerning preventive mechanisms.

This population has the most accurate knowledge concerning prevention of helminthic infections and the least accurate knowledge about the symptoms related to helminthes. This may be due to the fact that this community is commonly afflicted with multiple diseases at one time, including HIV/AIDS, malaria, and TB. Therefore it is possible that the people in this community cannot differentiate which symptoms correspond with each disease.

The overall knowledge concerning helminthic infections in this traditional community was high. For all but one category at least 80% of the population reported a correct answer. The exception was the symptoms category, in which only about half of the population reported an incorrect symptom. In all categories, however, the number of wrong answers reported was consistently below 15%. It is therefore clear why the null hypothesis was not rejected. These trends indicate that while the population does have more accurate knowledge about most aspects of helminthic infections, some myths still must be dispelled in order to boost accurate knowledge for all aspects of helminthic infections. These findings support the literature to some extent, because there is evidence that some inaccurate knowledge in this community must be eradicated and replaced with accurate information; however, contrary to the literature, our results show that this rural population is mostly well educated about helminthic infections.

The second part of this hypothesis rejected the null hypothesis, because there was a low relative importance of worm infections when ranked in comparison to HIV/AIDS and malaria as predicted. This measure was notable, as only 5.53% of the total interviewees reported helminthic infections as being more important than HIV/AIDS and/or malaria; these interviewees reported that HIV/AIDS and/or malaria were "not bad at all" compared to helminthic infections. 19.10% of the sample believed that HIV/AIDS and/or malaria were "somewhat bad" compared to helminthic infections. However, the overwhelming majority (75.38%) reported that HIV/AIDS and or/malaria were "very bad" and compared to helminthic infections. All of these trends support the hypothesis that helminthic infections are overlooked because these infections are often overshadowed by the mortality caused by HIV/AIDS and/or malaria.

The literature reports that helminthic infections are taken less seriously, largely due to the fact that rates due to HIV/AIDS and malaria are alarmingly high when compared to helminthic infections. While helminthes present a disease burden which increase the morbidity in a population, fewer people are dying because of helminthes.

In order to boost awareness of the importance of helminthic infections, it will be necessary to raise the awareness of the community of the secondary effects of STH infections. While these infections are not directly causing the death of family members and friends, helminthic infections have devastating chronic effects, make populations more susceptible to illness, and make it more difficult to respond to treatment and prevention of the conditions with higher mortality.

Hypothesis 2: Younger people will have a more accurate knowledge of helminthic infections than older people, and younger people will be more likely than older people to rank these infections as being more important than malaria but less important than HIV/AIDS.

The lack of significant relationship between accurate knowledge and age is surprising. As documented in the literature, younger populations were expected to have a better knowledge of helminthic infections because more consistent education programs have been implemented in rural Kenyan schools since 2008. However, our findings failed to support this idea. There was not a statistically significant difference found in the accuracy of knowledge between younger and older generations. Age was compared against both the good score—which accounted for the number of correct responses—and the bad score—the number of incorrect answers. Both results failed to demonstrate that age plays a significant role in the amount of accurate knowledge a person has in this community. According to the bad score, among those who provided at least one wrong answer to at least one of the knowledge questions, there was no statistical difference in age ($p=0.28$). According to the good score, among the people who provided at least one correct answer to at least one of the knowledge questions there was also no statistical difference in age ($p=0.75$). Results indicate that age does not play a role in the accurate comprehension and knowledge of the causes, symptoms, treatment, and preventive mechanisms related to helminthic infections. In fact, our findings show that after a child has reached the age of 10 years (the minimum age in this sample), his or her knowledge does not change drastically throughout their lifespan. The 90-year old in our study had the same comprehension of helminthic infections as a 10-year old. Accurate knowledge of helminthic infections is equally distributed among different age groups. The lack of an inverse correlation with age and knowledge may also be affected by study limitations such as sample size.

There was also a lack of association between age and the relative importance variable. Though it was predicted that younger generations would rank worm infections as being more important than malaria but less important than HIV/AIDS, results indicate that age is not a factor in determining the relative importance of helminthic infections compared to the other two conditions (p=0.506).

Based on these findings, it is clear that other influences such as culture and family may play an even bigger role in one's knowledge and perception of helminthic infections than implemented education programs in schools. It is also possible that an effective education program has not been fully implemented in this community. One-half of the population (47.98%) reported learning about worm infections from their family. Only about 20.20% of the population stated school as their primary means of acquiring knowledge related to helminthes. Consequently, it can be inferred that familial knowledge, often rooted deeply in culture, most likely has the greatest effect on accuracy of younger generations' knowledge and their perception of the importance of helminthic infections. This community may value the information learned in their family setting over knowledge that is taught in school. Further studies are needed to investigate the sources of knowledge in this community.

Hypothesis 3: Women will have a less accurate knowledge of helminthic infections than men, and women will be more likely than men to rank these infections as being less important than both malaria and HIV/AIDS.

The lack of significant relationship between accurate knowledge and gender is astounding. As documented in the literature, females are expected to have less accurate knowledge about helminthic infections. However, our findings did not reject the null hypothesis that there would not be a statistically significant difference the knowledge of helminthic infections between males and females on the plateau. Gender was compared against both the good score and bad scores. Both results failed to demonstrate that gender plays any role in the amount of accurate knowledge a person has in this community. According to the bad score, among those who provided at least one wrong answer to at least one of the knowledge questions, there was no statistical difference in gender ($p=0.90$). According to the good score, among the people who provided at least one correct answer to at least one of the knowledge questions there was also no statistical difference in gender ($p=0.84$). These findings demonstrate that gender does not play a role in the accurate comprehension and knowledge of the causes, symptoms, treatment, and preventive mechanisms related to helminthic infections. Accurate knowledge of helminthic infections is equally distributed among males and females. The lack of a relationship between gender and accuracy of knowledge could be due the lack of a representative sample, or the results may indicate that men in this community truly do know as much as women about helminthic infections.

There was also a lack of association between gender and relative importance. Though it was predicted that females would rank worm infections as being less important than both malaria and HIV/AIDS, results indicate that gender is not a factor in determining the relative importance of helminthic infections compared to the other two conditions ($p=0.31$).

These findings indicate that males and females have the same knowledge of helminthes and both sexes view helminthes as being less important than HIV/AIDS and malaria. Although literature reports that females usually have less accurate knowledge of helminthic infections due to acquiring a lower level of education, our results show that females have the same level of knowledge as their male counterparts. However, our findings did support the literature as far as the relationship between females and level of education was concerned. Analysis of the predictor variables gender and level of education indicated that 100% of those who received no education in our sample population were women. In other words, all men in the study had at least a primary level of education. Among those who received a primary education, 42.02% were men and 57.98% were women and among those who received a secondary (high school) education or higher, 53.57% were men and 46.43% were women. These results match literature because a woman in this community is far less likely than a man to receive education beyond primary school. Additionally, females are less likely to get education in general. This well supported trend usually also correlates with women having less knowledge about helminthes. However, in our study, although females received considerably less education than males, they still had the same amount of knowledge about helminthic infections. This is an encouraging trend—women do not have to rely on going to school to acquire accurate information about the disease. We predict that this may be due to the fact that knowledge about helminthes is passed down through generations of family and culture and learning about helminthic infections in school is not as influential. As a result, despite not going to school for as long as males, females are still able to acquire a basic, accurate knowledge of worms.

Hypothesis 4: People with higher levels of education will have a more accurate knowledge of helminthic infections than less educated people, and more educated individuals will be more likely than less education individuals to rank these infections as being more important than malaria but less important than HIV/AIDS.

No association was found between level of education and accuracy of knowledge. Among people who had reported at least one correct answer for at least one of the questions (good score), there was no difference in level of education (p=0.7443). Among those who had reported at least one wrong answer to at least one of the questions (bad score), there was no difference in level of education (p=0.1521).

These findings did not reject the null hypothesis that there is no statistically significant difference in knowledge or ranking of worm infections in people with higher levels of education. This may be due to the fact that knowledge related to helminthes is passed down generations of family and therefore does not change regardless of levels of education. While 20.20% of people did report to learn about helminthic infections in a school setting, perhaps this knowledge is not viewed as to be as important as knowledge acquired through family. This would explain why the accuracy of knowledge does not change with increasing levels of education. Since knowledge passed down through family represents an unchanging source of information, the knowledge one acquires about helminthes remains consistent throughout their lifestyle and they pass on this information to their children. Consequently, our results show that getting an education has no effect on boosting one's knowledge about helminthic infections. These findings are surprising considering the fact that the Kenya's Ministry of Health has already implemented a Primary School Intervention that aims to education and provide de-worming initiatives in schools in the western region. Based on the fact that educated individuals have the same knowledge as uneducated individuals, it is clear that the effects of de-worming initiatives are not being noted in this community. However, it is also important to consider that differences may not be noted in this study because the sample population had a consistently high knowledge of helminthic infections.

In addition to analyzing the hypotheses, the descriptive findings of this study are invaluable because they provide us with a glimpse of the daily life of a person living in this community. The majority of the answers received to the open-ended questionnaire fall under the "descriptive" category. In the following section, we discuss the implications of the cultural perceptions of helminthic diseases in this sample.

Perceived Causes

When participants were asked about all the ways in which they believed a person could acquire a helminthic infection, almost ¾ of the population attributed a cause related to ingestion and 15% reported that infections arise from environmental conditions.

¾ the population that reported causes related to ingestion believed that eating "bad food" could cause infection. The translator interpreted bad food as meaning spoiled or cold food. 45% of the interviewees reported soft rock consumption and geophagia as causes of helminthic infections. Another 15% reported ingestion of contaminated water as a risk factor. The fact that such a large proportion of the sample population could identify these risk factors is reassuring because these are well-documented, accurate causes of helminthic infections as stated in literature. However, it is interesting to note that only 15% of the population explicitly views contaminated water as a source of infection. Since this is one of the most significant ways in which helminthes as spread, results indicate the need to further educate this population of the importance of drinking clean, filtered water.

Among the people who reported environmental causes, 10% said that walking barefoot, 5% said dirty hands (not washing hands),1% attributed other causes related to hygiene such as sleeping on the ground or not using a pit latrine.

Together, causes related to ingestion and the environment comprise 95% of the population, indicating that the majority of the population views helminthic infections as having tangible, specific causes as opposed to thinking of these infections as being naturally-occurring diseases. The fact that the majority of the population in this study can clearly identify causes related to ingestion versus the environment supports the literature because the behaviors that put a person most at risk for soil-transmitted helminthic infections are related to eating or drinking contaminated foods.

Self-Diagnosis vs. Clinical Assessment

Over 85% of the population reported self-diagnosing themselves when they had helminthic infections and only about 10% confirmed infections by going to a clinic and seeing a health worker or taking a stool test. These results are interesting because some symptoms of helminthic infections are so unique to this condition that they make self-diagnosis an appropriate method of diagnosing. Among the people who reported self-diagnosing, 50% said they did so by noticing abdominal swelling or actually seeing worms in their stool (18%). These findings indicate that the population does not seek medical attention in a clinical setting because they see no need to confirm helminthic infections. This makes sense because the symptoms of certain helminthes can sometimes be so obvious that they is often no need to get a stool test done to confirm this infection.

Contrasting Signs and Symptoms

When comparing the signs and symptoms that patients reported, results indicate interesting trends. Patients were asked about specific symptoms they experienced and common symptoms reported were abdominal pain, rumbling, seeing worms in stool, and bloating/swelling. It is important to note that all of these symptoms are subjective experiences of helminthic infections. In other words, these symptoms are what the interviewees reported feeling themselves. What is interesting is that most of these symptoms represent internal sensations that only the patient can feel himself. While seeing worms is an outward symptom, it is nonetheless a very personal symptom that others would likely not report for the patient themselves.

Contrasting signs to symptoms, it is clear that signs represent a more objective manifestation of helminthic infections. For this item, the patient was asked about specific signs they noticed in other people that indicated the other person had a helminthic infection. The most commonly reported signs were swelling/stomach bulge, skin rash, increased appetite, abdominal pain, and brown hair. This is fascinating because almost all of the physically noticeable signs of helminthic infections were reported for this question.

While all of the most commonly reported signs and symptoms were accurate an supported by literature, the way in which people differentiate between helminthic infection afflicting themselves versus others is notable. Although a person likely experiences visible, external symptoms, they report more internal symptoms as being significant.

Exposure to Risk Factors

This study aims to measure the knowledge and behaviors related to two of the most well-documented, common exposures: contaminated water and geophagia. While contaminated water can be classified as an environmental factor, geophagia is closely tied to both the environment and ingestion.

Conclusions linking helminthic infections and unsanitary water consumption were based the interviewees' primary source of drinking water and whether or not fruits and vegetables were washed in filtered water before consumption. In this study, contaminated water was defined as any water source that was unfiltered, ground water. Although 16% of the population reported drinking contaminated water as a source of acquiring helminthes, 2/3 of the population continues to ingest unfiltered ground water. It is therefore evident that this Luo population is well aware of the fact that contaminated water can cause helminthic infections, but continues to ingest ground water. A similar trend was noticed with washing food in water. Although 90% of the population reported washing fruits and vegetables prior to consumption, ¾ of these people utilized contaminated water sources to wash their fruits and vegetables.

From this data it is clear that although the majority of the population is washing their produce prior to consumption, they are actually washing it in unfiltered, dirty water. It is vital to consider whether more harm is being done than good in this specific instance. Despite the fact that some individuals are consuming clean water, these individuals may still be vulnerable to getting infected by simply washing their fruits and vegetables in contaminated water and then eating the produce.

Findings related to geophagia are analogous to the results with contaminated water. Although only 16.58%, of the population in my study reported eating "soft rocks," soil or mud, or any other atypical foods, 35.18% stated geophagia as a risk factor for helminthic diseases. It is puzzling that despite knowing that geophagia can make someone more likely to have a helminthic infection, people continue to ingest soil. Although literature reports this practice as being more prevalent among school-age children and women, our findings found no statistical difference in age ($p=0.06$) and gender ($p=0.2$)

It is vital to understand why this Luo population continues to engage in these risky behaviors of using contaminated water and eating soil despite attributing these conditions to helminthic infections. This may be due to lack of access to potable, clean water sources and deeply rooted cultural beliefs regarding geophagia that pose limitations against avoiding these exposures.

Disease Status at Time of Study

In order to roughly gauge the prevalence of helminthic infections, the participant was asked if he or she had worms at the time of the study. The responses were evenly split, approximately half of the interviewees reported having an infection at the time. This trend is well-supported by the Global Atlas of Helminthic Infections, which predicts between 20 and >50% prevalence in the region of Western Kenya where this study was conducted. In addition to answering whether or not they had an infection at the time, interviewees also statted that they suffered from helminthic infections 1.27 times on average. The average length of time that this population is afflicted with helminthes is about 9.43 months. This duration is appalling, as it represents 75% of a year. Despite being affected with symptoms related to helminthic infections for this length period of time, this Luo population continues to think of this disease as a normal condition.

Treatments

Knowledge of treatments was very high in this study, as greater than 85% of the population could identify at least one treatment against helminthes. However, it is surprising that approximately 10% of the population did not believe there was treatment available for helminthes, and a final 5% did not know if a treatment existed for the infection. These findings are encouraging because the population is aware that treatments exist, but they are also puzzling because 10% remains uneducated that medical treatments are available. Among those who knew of ways to treat helminthes, ¾ stated that the treatment was available at a hospital or pharmacy and ¼ stated that treatment could be received at a school. A small percent (4%) went to a traditional healer to be treated. One of the secondary focuses of this study was to understand alternate forms of treatment. In order to study this, interviewees were asked to identify whether unconventional treatment methods existed. Although approximately ¾ of the population claimed that no other treatments besides medicine existed, 23.32% of the interviewees recognized other treatment methods. 18.20% of these included descriptions of traditional Luo medicine, which were specific plants or herbs that were thought to have medicinal properties against helminthic infections. Two health workers in the area, various translators, and Pastor Habil Ogola notified me that these so-called traditional medicines perpetuate one's health by destroying healthy body cells in addition to the parasites. These findings warrant the need for a deeper understanding of traditional Luo treatments against helminthes is necessary.

Limitations of the Study

There were several potential sources of error in this study. Because these surveys relied heavily on translation, translational errors were possible. A translator administered the survey in Luo to the interviewees and most questions appear to have been translated effectively, as reported answers seem logical and appropriate. Errors could have also occurred when translating responses from Luo into English. Notably, the translator notified me of some phrases that were difficult to translate into English; these included the phrase "worms are playing in my stomach" in response to the question "how do you feel when you are sick with the infection?" and the answer "worms bite your insides" as an answer to the question "what do worms do inside your body?" All questionable answers were further translated by Pastor Habil Ogola. Though some error could have resulted from the translating, the translators greatly reduced the chances of misinterpretation and provided ample information to the open-ended questions.

Apart from the translational errors, there was also possibility of error when discussing culturally sensitive topics such as disease status, geophagia, and personal symptoms. Because answers were open-ended and self-reported, it is possible that information was withheld from the translator and incomplete answers were reported. Although helminthic infections are one of the most common conditions in this community, it is possible that the interviewees did not feel entirely comfortable reporting honest answers to all of the questions in the questionnaire.

Since this study was a cross-sectional study, many of the responses received were true for that specific period in time. This could have lead to errors for a few of the questions. For example, the number of people afflicted with helminthic infections may vary depending on the season or time of year. Since this study asked participants to identify whether or not they had an infection at that specific point in time in May, this number may be variable and change depending on the time at which this questionnaire was administered.

Results from this study could have been improved with a larger sample size. Given the time needed to conduct the interview and availability of translators and interviewers, more interviews could not be completed during the time allotted. However, more time, translators, and interviewers could have increased the sample size. This could have led to relationships that were not statistically significant to be significant in a larger sample size. Since this study was measuring the knowledge and perceived importance of helminthes in males and females ages 10-90, a sample size larger than 199 would decrease Type II error and also increase statistical significance.

CHAPTER SEVEN

Conclusion

This study assesses the knowledge, attitudes, and behaviors related to helminthic infections in this traditional, Kenyan community. The goals of this study were to collect qualitative information regarding the population's specific knowledge in regards to the causes, symptoms, treatments, and prevention of helminthic infections. Additionally, the interviewees were asked about the importance of helminthic infections relative HIV/AIDS and malaria. Although the overall knowledge and relative importance of helminthic infections in this community were the main focuses of this study, associations related to age, gender, level of education, and disease status were also analyzed. All associations related to these predictor variables were unsupported, revealing the need for further studies with larger sample sizes to explore these relationships on a deeper level.

Although the overall knowledge was found to be high in this Luo population, descriptive data indicate the need to emphasize the importance of clean water sources, preventive chemotherapy medications, secondary effects of helminthic infections, and reduction in geophagia for long-term control of helminthes. However, many of these practices, notably geophagia will have to be addressed with an internal intervention. This type of intervention can be contrasted with an imposing intervention, in which our Straw to Bread team would implement programs to directly educate the community ourselves. A more effective strategy would be to allow individuals within the community who have the most accurate knowledge of helminthic infections to educate the community by dispelling myths related to helminthes. Results from this study can serve as the impetus for change. Because geophagia and other myths related to helminthic infections are deeply rooted cultural phenomenon, structural barriers must be addressed in conjunction with providing anti-helminthic medications. The community must be involved in order to ensure discussion of the issues at hand.

Although this study presents preliminary results about this community's perception of helminthic diseases, future studies are needed to better understand some concepts. The most important finding that warrants further exploration is why half of this population continues to suffer from helminthic diseases despite having baseline knowledge of how to prevent helminthic infections. Future studies should address this issue through semi-structured interviews aimed at fully understanding where myths and practices related to helminthic infections originate from and why they continue to be so prevalent in the Luo community today. Before taking any drastic steps toward attempting to eliminate practices such as geophagia or the use of herbal treatments to alleviate symptoms, it is imperative for us as researchers to comprehend why these myths and behaviors exist today. Without a full understanding how this population interprets helminthes and their burden on health, no intervention will be effective. If the population agrees that they would like to see changes in these practices related to helminthic infections, further discussion should be pursued to decide the best way to overcome these obstacles in order to decrease the exposures that make people more prone to developing these infections.

Further studies can also assess the efficacy of school-based deworming and education programs. Although the population reported the school as being a source of information related to helminthic infections, the main source of information continues to be family. If the Ministry of Health's goals are being met in this community, all students in primary school should be receiving preventive medications every three months. This needs to be further studied to ensure whether school-aged children are receiving treatment. If the children are receiving the preventive medications, it is important to observe whether they are actually taking the treatments. Cases in which children have disposed the treatments received from school have been noted.

Future efforts should focus on increasing awareness of the importance of medication and decrease the population's reliance on traditional, herbal plants that may be detrimental to their health. Additionally, the lack of access to clean water sources must be addressed. Although water tanks have been implemented in this community in the past, it is crucial to further educate this population about the importance of ingesting filtered water and not washing fruits and vegetables in ground water. New studies should assess the effect on the knowledge and prevalence of helminthic infections after these interventions have taken place.

Findings in this study have provided key insight to better understand how this population views helminthic infections and where potential gaps in knowledge exist. We now have a better comprehension of the knowledge, practices, and behaviors related to these infections of helminthes of the Luo tribe on the Nyakach Plateau. Our baseline results indicate that although the population may be aware of the main risk factors associated with helminthic infections, deeply rooted cultural beliefs and lack of access to clean, potable resources present limitations to decreasing the burden of helminthes. Such structural barriers must be addressed in conjunction with providing accurate knowledge and preventive chemotherapy of NTDs for sustainable control and reduction of morbidity

APPENDICES

Worm Survey

1. Patient Name: ________________
2. Patient ID: ___________________
3. Date: _______________________
4. Interview Setting: ______________
5. Age: ________________________
6. Birthday: _____________________
7. Gender: M F
8. Highest Level of Education: ________
9. Height: ______________________
10. Weight: _____________________
11. Waist circumference: ___________
12. Mid-Upper Arm Circ:___________
13. Urine Test: + -
14. Do you have worms now? Y N
15. How long have you had the problem?
    Don't have worms _____ months
16. How did you know you had worms?
    a. Doctor at S2B clinic told me
    b. Someone at local clinic told me
    c. Saw worms in stool
    d. Could tell by the way I felt
    e. A family member told me
    f. Other: _________________
17. Which symptoms did you experience?

____

____

18. What are the things a person can do to make the worms go away?
    a. There is no treatment
    b. Medication
    c. Traditional Treatment
    d. Other: _________________
19. Are you taking medication for worms now? NA Y N
20. Are you doing anything else to make the worms go away?
    ____

21. How many times have you had worms in the past? ____________________
22. When was the last time you had worms?
    a. Never had them
    b. Within the last three months
    c. Last year
    d. More than a year
    e. 2-5 years
    f. 5+ years
23. When was the last time treated?
    a. There is no treatment
    b. Never treated
    c. Within last three months
    d. Last year
    e. More than 1 year
    f. 2-5 years
    g. 5+ years
24. Have you ever quit working or missed schools because the worms made you feel bad? Y N
25. Have you ever eaten soft rocks?
    N Y, rarely Y, often
26. Have you ever eaten things besides soft rocks that were not food, such as mud or dirt?
    N Y, rarely Y, often
27. When was the last time you ate something that was not food?
    a. Never
    b. In the last week
    c. Last month
    d. Last year
    e. Years ago when I was a child
28. Where do you get your drinking water?
    a. Ground water
    b. Tank only
    c. Filter only
    d. Tank and filter
    e. Collected rain water
29. Does your family wash fruits and vegetables with water before eating them?
    Y N
30. What kind of water does your family wash fruits and vegetables in?
    a. My family does not wash fruits and vegetables
    b. Ground water
    c. Tank only
    d. Filter only
    e. Tank and filter

f. Rain water collected in buckets

31. Compared to having HIV/AIDS, how bad is it to have worms?
    a. Very bad
    b. Somewhat bad
    c. Not bad at all
32. Compared to having malaria, how bad is it to have worms?
    a. Very bad
    b. Somewhat bad
    c. Not bad at all
33. When someone is sick with worms, what are all the ways they can tell they are sick?
34. What do worms do inside your body?
35. What kinds of people are more likely to get worms?
36. How do worms get into your body?
37. Where can you get treatment for worms?
38. How can you prevent getting worms?
39. Where did you learn about worm infections?

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