EPIDEMIOLOGY OF INTESTINAL PARASITIC INFECTIONS AMONG HIV INFECTED POPULATION, IN BUNGOMA COUNTY- KENYA

BY

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DECLARATION

Declaration by the student

This thesis is my original work and has not been presented for examination in any other university. No part of this thesis can be produced without the prior permission of the author and/or University of Eldoret (UOE).

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Declaration by the supervisors

This thesis has been presented for examination with our approval as the University supervisors.

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DEDICATION

This thesis is dedicated to the Almighty God who has pulled me out of mud and mire and put me on an academic rock higher than my humble beginning. Praise, honour and all the glory be unto him forever. My dear wife Gentrix who intercedes for me; my dear children Josiah, Mordecai and Ruth Nekoye who have been challenged to see me read up to late hours in the night. To my aged parents Mzee Wanyama and mum Nang'unda who were unable to pay my college fees and to my dear friends.

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ABSTRACT

Intestinal parasitic infections are parasites that populate the gastro-intestinal tract of humans adding stress to both the humoral and cellular arms of the immune system already weakened by human immunodeficiency virus (HIV), worsening morbidity in the infected person. This study was conducted with an aim of determining the epidemiology of Intestinal parasitic infections among the HIV and AIDS patients in Bungoma County. This was a cross-sectional study of 240 HIV positive and 60 HIV negative individuals. Stool samples were observed for intestinal parasites. Statistical analysis was done using SPSS version 17.0. Data were summarized using descriptive statistics (frequencies, means and standard deviation). Differences in proportion of prevalence were analyzed using Pearson Chi-square test while differences in mean intensity were analyzed using the student t-test. Factors causing observed differences in the prevalence and intensity of the parasites were analyzed using multiple logistic regression to identify significant factors responsible for observed prevalence. Results were considered significant at $P<0.05$ α-level. Significantly higher (χ^2 = 23.764, df = 1, P = 0.002) prevalence of intestinal parasitic infections was recorded among the HIV and AIDS patients (33.4%) compared to (19.3%) in HIV-ve patients. Protozoan and helminthic parasites were the parasites found where the prevalence of intestinal protozoans was higher than that of helminths. The mean intensity of protozoans was found to be significantly ($P \leq 0.05$) higher than the helminths among the patients with HIV infection. Among the protozoans, *E. histolytica*, *E. coli* and *G. lamblia* were higher in intensity (< 100 ind/gm). The helminthic parasites found were *A. lumbricoides*, *A. duodenale*, *T. trichiura* and *S stercoralis*. All parasites displayed high prevalence during the rainy season (June-October 2010) and low prevalence during the dry period (November 2010-February (2011). Age, levels of education, income levels, smoking and drinking habits as well as dietary habits contributed significantly to increased prevalence of Intestinal parasitic infection among the HIV and AIDS patients. The magnitude of parasitic infection was high in both HIV and AIDS and HIV -ve. It is recommended that routine examination of stool samples for parasites would significantly benefit HIV infected and uninfected individuals by contributing to reduce morbidity.

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LIST OF ACRONYMS/ABBREVIATIONS

ART	Anti Retroviral Therapy
CCC	Comprehensive Care Clinic
CD	Cell density
CDC	Centre for Disease Control
GI	Gastro intestinal
IREC	Institutional Research and Ethics Committee
KNBS	Kenya National Bureau of Statistics
KEMRI	Kenya Medical Research Institute
KNDHS	Kenya National Demographic Health Survey
UN	United Nations
UOE	University of Eldoret
UNAIDS	United Nations Acquired Immuno-Deficiency Syndrome
WHO	World Health Organization

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Human Immuno-deficiency Virus, the Acquired Immuno-Deficiency Syndrome (HIV and AIDS) is one of the greatest challenges facing humanity in the 21st Century. Since 1980 when the first case was reported to a resident physician at a Medical Centre in the United States of America (USA), the scourge has continued unabated killing millions of people and leaving behind psychological, physical, social and economic suffering to individuals, families and communities (UNAIDS, 2006). Though the first public cases of HIV and AIDS were reported among homosexuals and drug users in the USA, the scourge has grown tremendously over the last two decades to become a pandemic and is currently prevalent in many parts of the world. From 1981 to the end of 2006, over 22.6 million people had died of HIV worldwide and 60 million people were living with the disease (UNAIDS/WHO, 2010; World Bank, 2010).

The AIDS epidemic has reached crisis levels in Sub-Saharan Africa. Africa accounts for 70% of the world population living with HIV, and AIDS has become one of the major (if not the pre-eminent) causes of deaths in the region (WHO, 2008; UNAIDS, 2008). According to UNAIDS (2008), over 14,000 new HIV infections occur worldwide daily, more than a half of these infections occur in Sub-Saharan Africa (UNAIDS, 2008). In Kenya, it was estimated that 190,000 people had died of HIV in the year 2001 alone whereas by the end of the same year, those living with the killer virus were estimated to be 2.5 million (UNAIDS, 2007). The HIV statistics further pointed to 700 people dying daily in Kenya due to HIV. Kenya has been facing an

epidemic of HIV-1 subtype C, with low frequency of subtypes A and D. The infection of one with HIV has serious consequences on the immune system.

One of the major health problems among HIV seropositive patients is superimposed infections by opportunistic infectious agents due to the defect of immunity. Furthermore, intestinal parasitic infections are basic health problems in tropical region (Wiwanitkit, 2005) and are common in these patients. It is estimated that as much as 60% of the World's population is infected with intestinal parasites, which may play a significant role in morbidity (WHO, 1997). Intestinal parasitic infections are among the most common infections world-wide. It is estimated that some 3.5 billion people are affected, and 450 million are ill as a result of these infections (Getahun, 2005; Chacon-Cruz, 2009; WHO, 1997).

The rate of parasitic infection is remarkably high in Sub-Saharan Africa, where the majority of HIV and AIDS cases are concentrated (Jemaneh, 1998). In developing countries, problems caused by intestinal parasites are complicated and are a major cause of illness and kills millions of AIDS patients annually (Joshi *et al*., 2002). The progressive decline of mucosal immunologic defense mechanisms predisposes patients to precocious, intermediate, or late gastrointestinal manifestations such as diarrhoea (McGowan *et al*., 2007) and other infections. In the late stages of AIDS, the protective effects of nonspecific defense mechanisms, production of IgA antibodies and local cellular immune responses are diminished, thus increasing susceptibility to various intestinal opportunistic agents, such as *Cryptosporidium parvum, Isospora belli,* and *Microsporidium* species (Cimerman *et al*., 1999).

After the emergence of AIDS, opportunistic parasites, known until then solely in veterinary medicine, were no longer considered commensal organisms, and they are currently recognized as common opportunist pathogens affecting HIV infected patients, constituting a major secondary aggravating factor of the disease. These enteric infections frequently cause severe diarrhoea, which often is responsible for the grievousness of the disease, and may sometimes lead to death. In general, infection by intestinal parasites causes diseases that are significant causes of morbidity and mortality in all age groups, but immunocompromised and paediatric patients are more likely to experience more frequent and severe illnesses (Giannella, 2009). Intestinal parasites are highly prevalent in Kenya due to shortage of clean water, lack of sewage system and other unhygienic factors that increase the probability of infection (Meng'wa, 2010). Yet, reliable figures for the prevalence of intestinal parasites among HIV and AIDS patients in many areas in Kenya including Bungoma County are scarce largely due to the absence of any data or to the inadequacy of those available. In these studies, a cross sectional study to document the prevalence of intestinal parasitic infection in Kenyan HIV- infected patients was performed.

1.2 Statement of the problem

Problems of intestinal parasitic infections are not new in Kenya. Moreover, studies elucidating problems and prevention of intestinal parasitic infections among the populations in Kenya have been undertaken by several researchers. Majority of these studies have indicated a high prevalence of intestinal parasites like *A. lumbricoides, E. histolytica, G. lamblia, T. saginata* among populations (Hayashi, 2008); and have highlighted major ways of correct treatment to eliminate the intestinal parasitic infections.

Studies have further highlighted that among HIV and AIDS individuals prevalence of parasitic infections are likely to increase, than among the HIV negative individuals due to increasing levels of immunodeficiency (Odhiambo, 2001; Waihoro, 2005b; Thorps *et al*., 2008).

The use of other drugs to manage the HIV and AIDS pandemic has therefore brought to the fore the issue of combined management of the HIV and AIDS and treatment of intestinal parasitic infections. Rather than being viewed as a simple treatment protocol involving the use of intestinal therapeutic drugs, the magnitude looks complex and complicated by the development of the HIV and AIDS. However, none of the current treatment protocols has specific anti-parasitic drugs included, perhaps due to lack of information regarding the magnitude of parasitic infections among HIV and AIDS patients, HIV and AIDS healthy carriers and HIV negative healthy individuals. The purpose of these study was, therefore, to determine the magnitude of opportunistic and other intestinal parasitic infections among AIDS patients, HIV and AIDS healthy carriers and HIV negative individuals in Bungoma County, Kenya. The research also compared the prevalence of intestinal parasites among HIV and AIDS patients of different gender, age groups, and habits such as food habits, alcohol and smoking habits.

1.3 Justification of the study

The study also compared the prevalence of different intestinal parasitic infection among the HIV and AIDS patients attending Bungoma District Hospital. Such data would enable the Health facility administrators and pharmacy personnel in stocking appropriate drugs used for the treatment of the parasites. The drugs for parasites with higher prevalence would be stocked in higher quantity compared with those with lower prevalence.

Based on the study findings, it would be possible for the medical practitioners, government, and patients to base their medical decisions and actions on concrete knowledge of issues in intestinal parasitic infection based on research findings. The recommendations from these studies would help to improve the internal efficiencies of the hospitals in delivering proper HIV and AIDS care among people likely to be affected by intestinal parasites. The study also identify the most vulnerable groups of population who may be over exposed or less resistant to the infection or the kind of lifestyle which various groups lead that may contribute to the variation in the prevalence. These results would shed light on the knowledge of the contributing factors to the infection. Results would also be used to recommend on adoption of control measures to some specific groups of populations.

The researcher hoped that the study would form the basis for further research on the ways of enhancing treatment of intestinal parasitic infection among the most vulnerable groups of people. It would lead to the generation of new ideas, and add to other knowledge already present in many publications and literature that would result

to proper, better and more efficient management of HIV and AIDS pandemic among people infected by intestinal parasites.

1.4 Objectives of the study

1.4.1 Main objective

The study was carried out with an aim of determining the epidemiology of intestinal parasitic infections among HIV and AIDS patients in Bungoma County.

1.4.2 Specific objectives

The specific objectives were:

1. To identify and determine the prevalence of various intestinal parasitic infections among HIV and AIDS patients during the period of June 2010 to February 2011 in Bungoma County.
2. To determine the intensity of the various intestinal parasitic infections among HIV and AIDS patients in Bungoma County.
3. To determine the temporal (seasonal) variations in the prevalence of intestinal parasitic infections during the rainy and dry period of June 2010 to February 2011 in Bungoma County.
4. To determine some of the pre-disposing factors contributing to the prevalence of intestinal parasitic infections among the HIV and AIDS patients in Bungoma County.

1.5 Null Hypotheses

1. The prevalence of various intestinal parasitic infections among HIV and AIDS patients during June 2010 to February2011 in Bungoma County was low.
2 The intensity of various intestinal parasitic infections among HIV and AIDS patients in Bungoma County was low
3 There was no significant difference in the temporal variations in the prevalence of intestinal parasitic infections during the rainy and dry period among the HIV and AIDS patients in Bungoma County during the study period
4 There were no pre-disposing factors contributing to intestinal parasitic infections prevalence among HIV and AIDS patients in Bungoma County.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Review of parasitic infections in relations to HIV AND AIDS patients

Intestinal infections have been described as constituting the greatest single worldwide cause of illness and disease (WHO,). The reason these organisms are called "parasites" is that they injure their hosts. By definition, non-pathogenic parasites do not exist (Bern and Glass, 2004). The only variable is the intensity of the effect caused to the host. Some parasites, such as Entamoeba *histolytica*, usually cause acute abdominal pain and profuse diarrhea while others, such as Giardia *lamblia*, are more commonly responsible for chronic malodorous gas and bloating, still others, such as Blastocystis *hominis*, may produce a state of chronic fatigue as their only noticeable effect; By these definitions, parasites cause epidemiological impacts to their hosts (Parker *et al*., 2003).

In general, all intestinal parasites place a significant stress on the immune system of infected person. In practice, greater than 50% of asymptomatic HIV +ve individuals test positive for at least one intestinal parasite (Lew *et al*., 2010). Most intestinal parasites are transmitted through contact with fecal matter (Poulin, 2003). The organisms themselves or their cysts are expelled through the rectum of their host and find their way in some fashion to the mouth of their next host. According to Visser *et al*. (2008), the fecal-oral route of transmission can occur in several ways: First, the intestinal parasites can be transmitted through sexual activity much more easily than the HIV virus. Common safe sex practices, including the use of condoms, are often insufficient at preventing their spread (Julia and Costa-Cruz, 1999). If a person removes a contaminated condom, then puts their hand to their mouth, they cannot

contract HIV, but they can become infected with some intestinal parasites. Secondly, individuals who present with recurring intestinal parasite infections, despite implementing careful hygienic measures, may be living in households with infected members (Getahun, 2005). Behavior as innocuous as using the same face towel previously used by an infected roommate can transmit these infections (Gills, 1999). Surfaces of toilets and bathrooms, and bathhouses, where people sit naked, can also be a hidden source of exposure. These therefore means that intestinal parasitic infections can be transmitted through other ways that remains less understood by the household. Apparently, therefore testing in the hospitals remains the best way to determine if one has intestinal parasitic infections.

2.2 Common Intestinal Parasites

Currently there are very many intestinal parasitic infections, infecting man. A search of literature in the Scopus and ISI web of Science combining the terms intestinal and parasites indicate that there are close to 2500 intestinal parasites in tropical regions alone. For the purpose of these studies the highlights were limited to few intestinal parasites. Based on the analysis of recent publications, parasites of genus Giardia, *Criptosporidium, Isospora, Cyclospora, and Entamoeba* are more common forms of intestinal parasitic infections infecting man (Beer and German, 2010).

Giardia *lamblia* most often resides in the small intestine. It attaches itself via a sucker to the mucosal cells of the intestinal wall and causes an inflammatory state to occur (IBID). When it detaches, it is swept into the feacal stream and transforms itself into a cyst before being expelled from the body. Infection is spread by the fecal-oral route, either directly or through ingestion of contaminated food and water. Entamoeba

histolytica, Entamoeba *coli*, Entamoeba *hartmanni*, Iodamoeba *butschlii and* Endolimax *nana* are some of the parasitic entamoebas that are cosmopolitan in their distribution among HIV and AIDS patients (WHO, 1997). The *E. histolytica* is most commonly linked to acute diarrhoea and other gastro-intestinal symptoms (Wiwanitkit, 2005). However, individuals may harbor *E. histolytica* without experiencing acute symptoms.

The other amoebas have been associated with chronic GI symptoms though they are not recognized to be pathogens (Ikpeba and Ojololo, 2005). Variations in an organism's virulence and/or host resistance factors may explain differences in the severity of the observed symptoms among patients with HIV AND AIDS (UNAIDS/WHO, 2010). Amoebas are spread most frequently by ingestion of their cysts. Studies have also shown that Blastocystis *hominis* is a common intestinal parasitic infection that is more prevalent than any other parasite, but often goes undetected due to poor laboratory technique (Cheesbrough, 1998; Giannella, 2009). Next to fungal overgrowth, *B. hominis* is the most frequently observed pathogenic organism in the fecal samples of HIV +ve patients. A significant weight of evidence supports treating *B. hominis* as a pathogen. Acute symptoms from this parasite include abdominal pain, bloating, nausea, vomiting, weight loss, diarrhoea, insomnia, dizziness, low appetite, and rash; also *B. hominis* has been reported to be a cofactor to many chronic conditions such as irritable bowel syndrome, chronic fatigue syndrome, autoimmune conditions, and arthritis which also appears to be responsible for reactivating HIV activity and may explain why some antiviral drug regimens fail prematurely (Cimerman *et al*., 1999). The Dientamoeba *fragilis* is an organism that commonly causes parasitic infections especially among HIV patient, but often goes

undetected due to poor laboratory technique (Jemaneh, 1998). It lives in the colon and is transmitted by direct ingestion through the feacal-oral route. Its symptoms include diarrhea, fatigue, and abdominal bloating (Adeyeba and Okinlabi, 2002).

2.3 Diagnosis and treatment of intestinal parasites

The diagnosis of intestinal parasites is straightforward. The name of the test is called Stool for Ova & Cyst and one sample is required (it is abbreviated as Stool for O & C). While local hospital laboratories usually do a decent job of identifying intestinal parasites, specialty laboratories are able to significantly increase the yield of the test because of their additional expertise (McCrindle *et al*., 2010). For example, batching the samples together and putting them through a concentration step helps improve the sensitivity of the test. It is therefore believed that the increased training of staff of a specialty laboratory receives, as well as the greater number of samples per day they process, plus the higher quality equipment that they often use, are all factors that improve their ability to find parasites in the samples (Joshi *et al*., 2002).

Parasite sap energy, interfere with the gut's absorption of nutrients, and most importantly, they put an added stress on the immune system, which is definitely not what someone with HIV infection needs, (Reunala *et al*., 2000). According to Lew *et al*. (2010), the vast majority of CD4 cells reside in the mucosal lining of the gut, not in the blood or lymph nodes. The more these immune cells are activated and stimulated, the more quickly CD4 cells will die from HIV. Gut pathogens, such as intestinal parasites, activate CD4 cells and due to this activation, make it much more likely to be infected by HIV (Lew *et al*., 2010). They are then more prone to die off leaving the CD4 count negatively affected. This is one of the hidden reasons that,

despite taking antiviral medications for several years, many people do not see their CD4 counts rise. It is also one of the reasons for ongoing symptoms of chronic fatigue and intestinal symptoms such as gas and loose stools in people with undetectable viral loads (Foudraine, *et al*., 1998).

Treatment of intestinal parasite varies depending on the genus species of parasite involved: protozoa flagellates and amoebas are treated with amoebacides such as metronidazole, while coccidians respond to sulphonamides such as co-triomoxazole (Franklin 1999).

2.4 Epidemiology of intestinal parasitic infections

Although there are several intestinal parasites that infect humans, they display more or similar epidemiology in their infectivity (Andersen *et al*., 2008). For this review detailed epidemiology of parasitic infections was highlighted using one example- Giardiasis. Giardia *lamblia* is a flagellated protozoan parasite that has the distribution of being the most common intestinal pathogen of humans in developed countries (Meyer 1985). It is also common in underdeveloped areas (Andersen *et al*., 2008) but may be only one of a plethora of other pathogenic agents. During the past 2 decades, *Giardia* infection has become recognized as one of the most common causes of waterborne disease (found in both drinking and recreational water) in humans in the United States and other countries (Beer and German, 2010). About 200 million infections occur in the world each year, but there have been few or no death ascribed to this parasite both in the normal and HIV AND AIDS infected patients (Joshi *et al*., 2002). The parasite shows great variability in pathologic conditions and clinical changes but is characterized by gastrointestinal disorders. The most serious pathologic

condition is malabsorption, due to toxic effects of the parasites attached to intestinal cells and to mechanical blockage caused by the enormous numbers of the parasites (Kirkpatrick and Farrell, 1982).

Giardia *lamblia* infections may be asymptomatic or associated with a variety of symptoms, ranging from mild or vague disorders that are transient and resolve spontaneously, to acute cases of diarrhoea which can lead to severe long standing disease often associated with malabsorption (Thomas *et al.*, 2002). The disease may contribute to protein-calorie malnutrition in disadvantaged groups (Parker *et al.*, 2003). *G. lamblia* has an enormous host range, affecting many species of mammals, birds, and reptiles. For a long time *G. lamblia* was classified on the basis of host occurrence even though most species in mammals were morphologically indistinguishable; a situation that was rationalized by Marcogliese *et al.* (2001 local studies), who proposed the existence of only three species on the basis of distinct morphological differences and host occurrence. Of the three species, *G. duodenale* (syn. *G. lamblia*) has the widest host range, affecting many species of mammals as well as reptiles and birds.

Water-borne outbreaks of giardiasis may result in epidemic infections. These are associated with defective water-treatment plants where, for example, filters are defective, chlorination is inadequate and sedimentation is interfered with. The role of wild animals in such outbreaks is unclear. In a study in Washington, Krist *et al.* (2000) found that giardiasis was not associated with pet ownership but wild animals (three beavers), were found infected near the source of water for the township. Box

(1981) found the organism associated with diarrhoea and death in budgerigars and suggested that it may be a public health hazard in these birds.

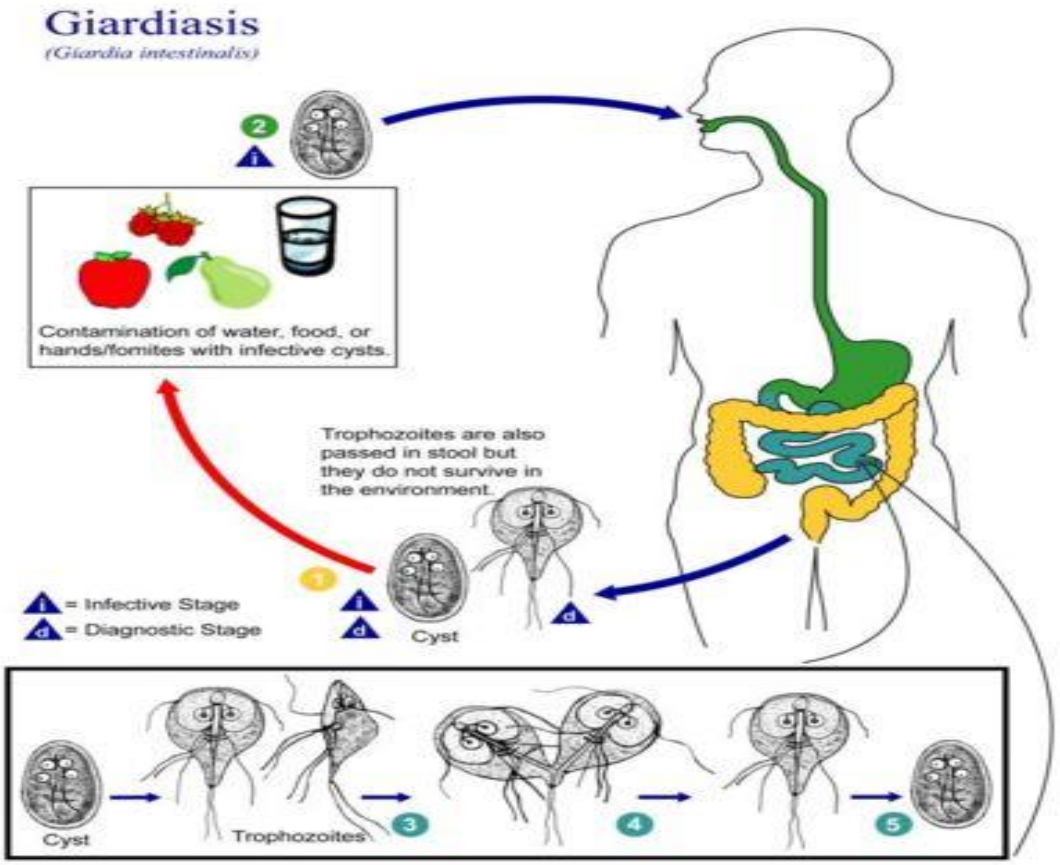

Fig.2.1 Life cycle of *Giardia lamblia (CDC, 2004)*

Deduction from the above figure indicates that infection from Giardia can occur from consuming contaminated food or water; this includes clean-looking mountain streams. It can also be transferred from animal or human feaces. Not every person displays symptoms of infection, but they can still serve as a carrier of the disease. *G. lamblia* infection is a concern for people camping in the wilderness or swimming in contaminated streams or lakes, especially the artificial lakes formed by beaver dams (hence the popular name for giardiasis, "Beaver Fever") (CDC, 2004). The life cycle begins with a noninfective cyst being excreted out through feaces of an infected

individual. Once out in the environment, the cyst may remain viable in moist surrounding for up to two weeks, when cystic forms become infective. A distinguishing characteristic of the cyst is 4 nuclei and a retracted cytoplasm. Once ingested by a host, the trophozoite emerges to an active state of feeding and motility. It feeds on mucous inside the digestive tract and causes the host to have epigastric pain, excessive gas, and diarrhoea with fat and mucous but no blood. After the feeding stage, the trophozoite undergoes asexual replication through longitudinal binary fission. The resulting trophozoites and cysts then pass through the digestive system in the feaces. Distinguishing features of the trophozoites are large karyosomes and lack of peripheral chromatin, giving the two nuclei a halo appearance. This is a primitive form of protozoa and also lacks mitochondria (CDC, 2004).

2.5 Prevalence and intensity of intestinal parasitic infections

Sub-Saharan Africa, a region of intestinal helminth endemicity in rural and urban settings, (Chan, 1987) is disproportionately burdened by infection with human immunodeficiency virus (HIV), with an estimated 70% of the world's cases in 11% of the world's population (US Census Bureau, 2002). An overlapping distribution of the pathogens becomes important because concomitant infection with HIV and intestinal parasites may potentiate the virulence of each within a coinfected host (Bentwich *et al*., 2000; Bentwich, 2000). However, the few studies published to date indicate that intestinal parasitic infections may occur with equal frequency and intensity in HIV-infected and HIV uninfected persons (Feitosa *et al*., 2001). Despite increasing interest in the pathologic interactions between the two infections, few epidemiologic studies have assessed the occurrence of parasitic infections and associated predictive factors in HIV infected persons. General prevalence surveys are more commonly done in

children and none, to our knowledge, have examined risk factors for intestinal parasitic infection among HIV-1 infected adults in an urban sub-Saharan African setting.

Low prevalence of parasitic infections have been reported in other tropical areas such as Thailand and especially among the HIV and AIDS individuals at different immune status (Stringer *et al*., 2004). Other studies conducted in Haiti also showed a marked rate of intestinal parasites, in Elsavador, Mexico and Cuba. Odhiambo (2001) reported high prevalence of amoebiasis in Kisumu District and observed that out of 1432 stool specimens 338 (about 26.3%) were positive for intestinal parasites. The author attributes the widespread distribution of intestinal protozoa among HIV +ve, especially *E. histolytica* and *E. coli*, in the district due to poor sanitation.

2.6 Predisposing factors contributing to intestinal parasitic infections more

Man becomes infected with intestinal protozoa (E. *histolytica*) through the ingestion of food and water contaminated with faecal material containing the cystic stages of the organisms. Swallowed cysts pass through the stomach unchanged and hatch in the duodenum or upper jejunum, where they liberate trophozoites. The trophozoites then pass on with the contents of the bowel into the large intestine where they attach themselves onto the mucous membrane and secrete a powerful cytolytic enzyme which destroys the tissue cells. Cytolysed tissue cells together with red blood cells serve as their food (Franklin, 1999).

Apart from eroding the intestinal mucosal lining, they may invade the liver via the portal vein, the lungs, and occasionally the brain. The clinical manifestations can

range from very mild or none to very gross such as rupture of an amoebic abscess into the pericardium and a multitude of others (Chan, 1997). The public-health importance of amoebiasis, for instance, discussed in many works but its impact on urban and rural life needs more serious study and elucidation. Although most of the past work shows a small prevalence in some urban centres, the trend might have changed due to congestion in slums where toilets are inadequate and poorly constructed.

2.7 Temporal variations in the prevalence of intestinal parasitic infections

Many taxa of parasites have evolved complex life cycles in which distinct developmental stages must go through a suite of different host species to complete their life cycle (Choisy *et al*. 2003; Parker *et al*. 2003; Lefebvre and Poulin, 2005a; Poulin, 2007). The evolution of such complex life-history strategies from simple one-host cycles is thought to offer several advantages for the parasites such as longer life span, greater body size, higher fecundity (Parker *et al*. 2003) or greater access to sexual partners (Brown *et al*. 2001). On the other hand, the life cycles of these species have become a series of unlikely events for which parasites have had to develop a range of adaptations to increase the likelihood of completion (Thomas *et al*. 2002; Poulin, 2007).

In some systems, a radical strategy has evolved in which parasites skip one or several hosts from their life cycles (Combes, 2001; Poulin, 2007). The resulting decrease in the number of transmission steps in the cycle is likely to be the main benefit of the cycle's abbreviation; shorter life cycles should be easier to complete. This strategy is widespread in trematode parasites; numerous species have independently evolved abbreviated life cycles (Fontan *et al*., 2000; Barger and Esch, 2000; Poulin and Cribb,

2002; Lefebvre and Poulin, 2005b). Why so many phylogenetically unrelated species have dropped one or two hosts from the typical 3-host trematode life cycle remains unclear in most cases. One hypothesis is that, in many systems, one host in the life cycle, often the vertebrate definitive host, is periodically absent. In these situations, life-cycle truncation should be favoured by selection (Poulin, 2001). For example, in parasites using predation to reach their definitive host, seasonally low (or null) consumption rates of intermediate host prey by definitive host predators could drive the evolution of such alternative strategies (Poulin and Cribb, 2002).

The most frequent way in which trematode parasites abbreviate their life cycle is by adopting progenesis: following the infection of the second intermediate host, the parasite matures precociously and produces eggs by self-fertilization, most trematodes being hermaphroditic (Lefebvre and Poulin, 2005b). While in some species all individuals adopt the shorter life cycle, in other cases, only a certain proportion of the population uses the abbreviated route. Such developmental plasticity in life cycles could serve to increase the probability of completing the cycle (Davies and McKerrow, 2003). In species where life cycle abbreviation is facultative, one of the possible explanations for the co-existence of the two developmental strategies is that the shorter life cycle could be a conditional strategy adopted in response to variable environmental conditions (Poulin and Cribb, 2002; Poulin and Lefebvre, 2006). The normal cycle may be preferable under favourable conditions, when definitive hosts are abundant, while a switch to the abbreviated life cycle would be favoured when ecological conditions change. However, other environmental and host related factors might influence life-history strategies in these species and the relative importance of each factor is also likely to vary over time (Lefebvre and Poulin, 2005c), but to which

extent parasites perceive these variations and respond appropriately is unknown in a vast majority of species (Thomas *et al*., 2002; Poulin and Lefebvre, 2006).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area

3.1.1 Background and location

These studies were conducted at Bungoma District Hospital, in Bungoma County; Western Province of Kenya (Figure 3.1 and 3.2). It has an area of 2,069 km² and a population of 1,630,934 (Female 835, 339 and Male 795, 595) (K.N.B.S, 2009).

The Hospital is located in Bungoma town, a major transit town to Uganda. Important nearby Industries are Nzoia Sugar Company, 16 km to the east and Mumias Sugar Company 32 km to the south, thus contributing to high business activities. It is also an important agricultural centre, producing a wide variety of crops that support a large population. The town is linked by both Mombasa-Uganda Highway and Mombasa-Uganda railway line, hence a parking town for long distance drivers. The pre-survey data of HIV AND AIDS prevalence of those above 15 years are as shown in table 3.1 below.

Table 3.1: Shows HIV positive cases at Bungoma District Hospital from 2009-2011.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2009	89	82	57	51	96	114	113	151	78	56	81	81	1049
2010	73	61	52	72	75	89	62	50	44	63	66	78	785
2011	74	81	62	89									306

3.1.2 Climate

Weather patterns within the study area are strongly influenced by altitude and physical features (volcanic peaks). There is a considerable variation in the weather patterns throughout the year. The area has maximum temperature that varies over the

year between 18°C and 28°C with minimum temperature range of 8°C and 12°C. The mean temperature is 25^{o}C with the lowest temperature of 8.4^{o}C in September and the highest temperature of 28^{o}C in March (Survey of Kenya, 2004, Bungoma District Development Plan, 2002-2008).

The mean rainfall was over 1100 mm annually. Long rains fall between the months of March to September while November to February were the dry months, September to October were periods of short rains. Rainfall patterns recorded by the Kenya Meteorological Department, Bungoma District during the period of these studies indicated that higher rainfalls occurred between March to September 2010 while October 2010 marked the onset of dry season. November to December 2010 were periods of short rains while January to February 2011 were drier months.

3.1.3 Water and Sanitation

Bungoma County is endowed with long and short rain periods; therefore it has many permanent rivers and springs for both livestock and man. However pipe water supply to urban areas is inadequate with very poor sewage system in most towns in the County. Poor water and sewage has resulted to Typhoid fever, diarrhoea diseases having high morbidity in the County (KNDHS,2010).

Figure 3.1: Map of Kenya showing the location of Bungoma County (Source: Microsoft Encarta 2008)

3.1.4 Human activities

The main socio-economic activities in the study area include agriculture. Sugar cane is the major cash crop, while maize, forms a stable food crop in the area. The other food crops include cassava, groundnuts, sorghum, millet and vegetables. The residents here grow their own crops on the small farms available. Likewise, the inhabitants also keep livestock such as chicken, cattle, sheep and goats.

3.2 Research design

These studies adopted a cross sectional survey design which according to Kothari (2005), is an efficient method of collecting descriptive data regarding the characteristics of populations, current practices and conditions or needs. The cross-sectional survey design was adopted in these studies in order to capture data on epidemiology of intestinal parasitic infections from varied number of HIV and AIDS patients in Bungoma County.

3.3 Study population

The study participants were people living with HIV and AIDS aged 18 to 65 years inclusive and not on ART; and were attending CCC for the first time, during the period of June 2010 to February 2011, who had been referred from: Outpatient department (OPD), Health Centres, GK prison and Dispensaries within the County.

3.4 Sample size

Sample size was determined from the target population using Mugenda and Mugenda (1999) formula $n = z^2 (p\ q)/d^2$

n = the desired sample size

z = Standard normal deviation (at 95% = 1.96)

p = the proportion of parasitic infections among HIV AND AIDS in Kenya estimated at 19.4% (KNDHS, 2010)

q = 1-p = 80.6%

d = the acceptable error of margin (0.05)

n = 240

3.5 Sampling techniques

A convenience sampling technique was used to select HIV and AIDS patients and HIV –ve individuals attending the CCC.

3.6 Research tools and instruments of data collection

Questionnaires, interviews, observations and stool examination were used as main tools for data collection. Quantitative type of data was collected from 300 respondents at Bungoma District Hospital from June 2010 to February 2011. The selection of the above research tools was guided by the nature of the data that was to be collected as well as the objectives of the study.

3.6.1 Questionnaires

Patients' questionnaires were used to collect demographic and socio-economic information from 300 patients seeking treatment from Bungoma district hospital from June 2010 – February 2011 (Appendix I). The questionnaires were distributed to patients in presence of the medical practitioners working at the CCC. The respondents were asked to fill the questionnaires after giving stool sample and the Investigator interviewed those who could not read.

3.7 Pilot Study

The investigator undertook a pilot study in 2 hospitals in the neighbouring Mount Elgon District before the actual data collection. The pilot study helped to standardize /refine the data collection tool and methodologies. Mt. Elgon District borders Bungoma North District and share similar health environment. A total of 8 patients were included in the pilot study. Mugenda (1999) suggests that between 1% and 10% of the sample size is sufficient for piloting. More particularly: to test the questionnaires which were later used in the study, to get an impression of the healthcare problems in the research area and to help identify problems during the study and which could not have been seen during the planning stage.

3.8 Validity of the instruments

To determine the validity of the questionnaires, one lecturer in the Department of Biological Sciences, and one from School of Medicine in Moi University, one clinical officer identified during pilot study, examined the instruments and provided suggestions and comments, which were used as a basis to modify the research items and make them adaptable to the study. Based on the feedback offered by those who

were examined, the content of the questionnaire were modified and some items excluded completely.

3.9 Reliability of the instruments

According to Mugenda and Mugenda [1999], the reliability of an instrument is the measure of the degree to which a research instrument yields consistent results after repeated trials. In this study, test-retest method was used. The questionnaire was administered to the same subjects twice within an interval of two weeks. Then Pearson product moment correlation coefficient was calculated and a value of 0.7 or above was considered satisfactory (Kothari, 2005). The level of reliability in the current study was at a value of 0.8. The results obtained from the pilot study assisted the researcher to refine the questionnaire prior to the actual data collection.

3.10 Inclusion and exclusion criteria

The study subjects were 240 HIV AND AIDS and 60 HIV -ve who consented to the study. While those who were travelling, admitted in the ward, or those on ART, or those who had taken antibiotics or antihelminthic a week earlier; or those who could not give stool sample or declined to give consent were excluded.

3.11 Ethical Considerations:

These studies were conducted with the approval of the Institutional Research and Ethics Committee (IREC) of Moi University (Appendix II). Informed written consent was obtained from each study participant. Participants were also informed that they were free to withdraw consent any time; and that their stool specimens were examined by qualified persons. Moreover, all personal information of the participants was

treated with strict confidentiality. Study participants positive for intestinal parasites were treated free of charge using standard drugs at the Comprehensive Care Clinic (CCC-Bungoma District Hospital). The drugs were administered by clinicians working at the study site

3.12 Data collection

Participants, who consented to the study, gave their stool samples prior to filling the questionnaire on their social-demographic information, or before they were interviewed.

3.12.1 Stool collection and processing

A single fresh stool sample of (10-20gms) was collected from each study participant (n = 240) and (60 HIV-ve). One gram of the stool was preserved in 3mls of 10% formalin. Then stool specimens were examined by direct saline, iodine wet mount preparation and formol ether sedimentation methods following the standard procedure. Concentration technique and modified Ziehl Neelsen staining techniques were used for the detection of oocysts of several intestinal parasites including *Cryptosporidium parvum* and *Isospora belli* following the standard procedure (Cheesbrough, 1998). Two smears were prepared from each sample and one examined by experienced senior medical laboratory technician and the other by the Principal Investigator independently and then a consensus reached before recording.

3.12.1.1 Direct Microscopy (Wet mount*):*

Direct wet mount of stool in normal saline (0.85% Sodium Chloride (NaCl) solution was prepared at Bungoma district hospital and examined for the presence of motile intestinal parasites and trophozoites under light microscope (X10 , and X40 magnifications). Lugol's iodine staining was used to detect cysts of intestinal parasites.

3.12.1.2 Formal-ether concentration*:*

Using an applicator stick, about 5 gm of preserved stool sample were placed in a clean 15 ml conical centrifuge tube containing 7 ml of 10% formalin. The sample was dissolved and mixed thoroughly with applicator stick. The resulting suspension was filtered through a sieve (cotton gauze) into a beaker and the filtrate poured back into the same tube. The debris trapped on the sieve was discarded. After adding 3 ml of 99.5% diethyl ether to the mixture and hand shaking, the contents were centrifuged at 2000 rpm for 3 minutes. The supernatant was poured away and the tube placed in its rack. The sediments were stained with Iodine and put on slide and covered with cover slip. The entire area under the cover slip was examined using 40 × objective magnification (Gills, 1999). Microscopic examinations were done independently by experienced laboratory technicians; the determination and verification was finally made by the investigator.

3.12.1.3 Modified Zeihl-Neelsen Method*:*

Modified Zeihl-Neelsen staining; based on direct and concentration methods, for detection of oocysts of opportunistic coccidial intestinal parasite-*Cryptosporidium spp*, *Isospora belli*, *Cyclospora cayetanensis* were done. Fresh faecal samples were

collected and thin smears prepared, air-dried (modification), fixed with methanol for 5 minutes (modification) and stained by Zeihl-Neelsen technique at the CCC Laboratory Bungoma district hospital, and 2nd sample of every 10th patient send by CCC to KEMRI Nairobi as procedure for confirmation. Smears were prepared from the concentrated stool samples and were stained as described by Adegbola *et al.* (1994). In this technique, the slides were stained with carbol-fuchsine for 30 minutes (modification) and then washed with runnig tap water. The slides were decolorized in 1% HCl acid-alcohol for 1 minute and counter stained with 1% ethylene blue for another 1 minute. Finally, the stained smears were microscopically examined using 100x magnification (Endeshaw, *et al*., 2004).

3.12.1.4 Parasite identification

Parasite species were identified by their different morphological forms: cysts, oocysts flagellates, ciliates, larvae and eggs; with their characteristic identifying features (Cheesbrough, 1998), (Appendix III). The parasite intensities were calculated by counting the number of each adult parasite, ova, cyst or oocysts in the entire preparation, following formol ether, and ZN concentration technique, that gave the approximate number of each parasite per gram of faeces (Cheesbrough, 1998).

3.13 Data analyses

All data was entered and analyzed using SPSS Version 17. Data were summarized using frequency, means and standard deviation. Differences in proportion of prevalence were analyzed using Pearson Chi-square test while differences in mean intensity were analyzed using the student t-test. Significant factors causing observed differences in the prevalence and intensity of the parasites were analyzed using

multiple logistic regression. In all analyses, results were considered significant at $P \leq 0.05$.

CHAPTER FOUR

4.0 RESULTS

4.1. Background information of the respondents

Data collected to establish the background information of the respondents is presented in Table 4.1.

From the results, majority of the HIV and AIDS patients were female 138 (57.5%) while the HIV -ve were 33(55%). More than half of the HIV and AIDS 125 (56.2%) were aged between 36-50 years while 26 (43.3%) HIV -ve were of similar age-group. In both HIV and AIDS and HIV-ve, majority had secondary level of education 142 (59.2%) and 23 (38.3%) respectively. Similarly majority were married in both groups 187 (77.9%) and 44 (73.3%) for HIV and AIDS and HIV-ve respectively. With regard to occupation, 109 (45.4%) HIV and AIDS and 26 (43.3%) HIV -ve were self employed.

Table 4.1: The background information of the study respondents

		HIV positive		HIV negative	
Attribute	Characteristics	Frequency	%	Frequency	%
	Male	102	42.5	27	45
Gender	Female	138	57.5	33	55
	<18	15	6.3	7	11.7
	18-35 years	36	15.0	12	20
Age	36-50 years	135	56.2	26	43.3
	>50 years	54	22.5	15	25

Level of Education	None	13	5.4	6	10
	Primary	65	27.1	17	28.3
	Secondary	142	59.2	23	38.4
	Tertiary	20	8.3	14	23.3
Marital status	Married	187	77.9	44	73.3
	Single parents	33	13.7	12	20
	Divorced	9	3.8	3	5
	Widowed	11	4.6	1	1.7
Occupation	Unemployed	78	32.5	21	35
	Self-employed	109	45.4	26	43.3
	Formal employment	53	22.1	13	21.7

4.2 Prevalence of various intestinal parasitic infections among HIV and AIDS patients

The prevalence of intestinal parasitic infections among the HIV and AIDS patients was 33.4% while among the healthy individual was found to be 19.3%. The intestinal parasites identified were of two types, being protozoans and helminths as depicted in table 4.2

Table 4.2: Prevalence of various intestinal parasitic infections among the study subjects

Parasite	**Group**		**Chi-square**	***P*-value**
	Positive (cases)	Negative (control)		
Entamoeba histolytica	99 (41.2%)	7 (11.7%)	18.385	<0.001
Entamoeba coli	86 (35.8)	4 (6.7)	19.44	<0.001
Giardia lamblia	80 (33.3)	6 (13.3)	9.262	0.002
Cryptosporidium spp	30 (12.5)	1 (1.7)	6.080	0.014
Ascaris lumbricoides	33 (13.8)	3 (5)	3.480	0.062
Stronglyoides stercoralis	16 (6.7)	1 (1.7)	2.245	0.134
Ancylostoma duodenale	24 (10)	3 (5)	1.465	0.226
Trichuris trichura	28 (10.7)	1 (1.7)	4.245	0.017

Among the protozoa highest prevalence was reported for *E. histolytica* 99(41 .2%), followed in descending order by: *E. coli*, *G. lamblia* and Cryptosporidium spp. While *A. lumbricoides*, *T.* trichura, *A. duodenale* and *S. stercoralis* were the (Helminths). The prevalence of intestinal protozoa was significantly higher in the HIV and AIDS patients as compared to the non-infected patients ($P \leq 0.05$). All protozoan parasites among the HIV and AIDS patients were significantly higher than in the HIV-ve populations, however, there was no significant difference in the prevalence of intestinal helminths between the two groups ($P > 0.05$).

It was concluded from these observations that HIV patients were more afflicted by protozoan agents than helminthic.

4.3 Intensity of various intestinal parasitic infections

Table 4.3 presents data on mean intensities of various intestinal parasitic infections among HIV and AIDS and HIV-ve patients sampled at Bungoma District Hospital.

Table 4.3: Intensities of various intestinal parasitic infections among the respondents

Parasite	**Group**			
	Positive (cases)	**Neg (Control)**	**T-value**	***P*-value**
Entamoeba histolytica	61.8±13.3	9.7±3.8	26.307	**<0.001**
Entamoeba_coli	69±17.2	31.5±11.7	4.339	**<0.001**
Giardia lamblia	44.7±16.9	12.9±4.4	12.949	**<0.001**
Cryptosporidum spp	3.8±1.4	1.0±1.0	-	-
Ascaris_lumbricoides	6.8±2.0	2±1.0	7.090	**0.003**
Ancylostoma_duodanale	4.2±2.1	1.3±0.6	2.273	**0.032**
Trichuris trichura	4.1±2.2	1	-	-
Stronglyoides_stercoralis	3.2±1.4	1	-	-

The overall mean intensity of protozoans were found to be significantly *(P* ≤0.05) higher in the HIV and AIDS positive patients than the helminths among the HIV negative patients. It was clearly shown that the protozoan *E. coli*, was the more intense species accounting for most of the infections and followed in descending order by *E. histolytica*., *G. lamblia* and *Cryptosporidium* spp. Results further showed that helminths, although present accounted for lower intensities of infections led by *A.lumbricoides* and in descending order followed by *A. duodenale*, *T. trichura* and *S.*

stercoralis. It was therefore concluded from these observations that HIV patients had heavy loads of protozoa intestinal parasites than helminths.

4.4 Temporal variations in intestinal parasitic infections

Figure 4.1 shows temporal trends in the prevalence of IPI in patients at Bungoma District Hospital during the rainy and dry periods.

The observations in (Figure 4.1 and Figure 4.2) showed similar trends in both protozoans and helminths; highest prevalence occurred during the long rains (March-September 2010); followed by a general decline during the dry months (November 2010-February 2011).

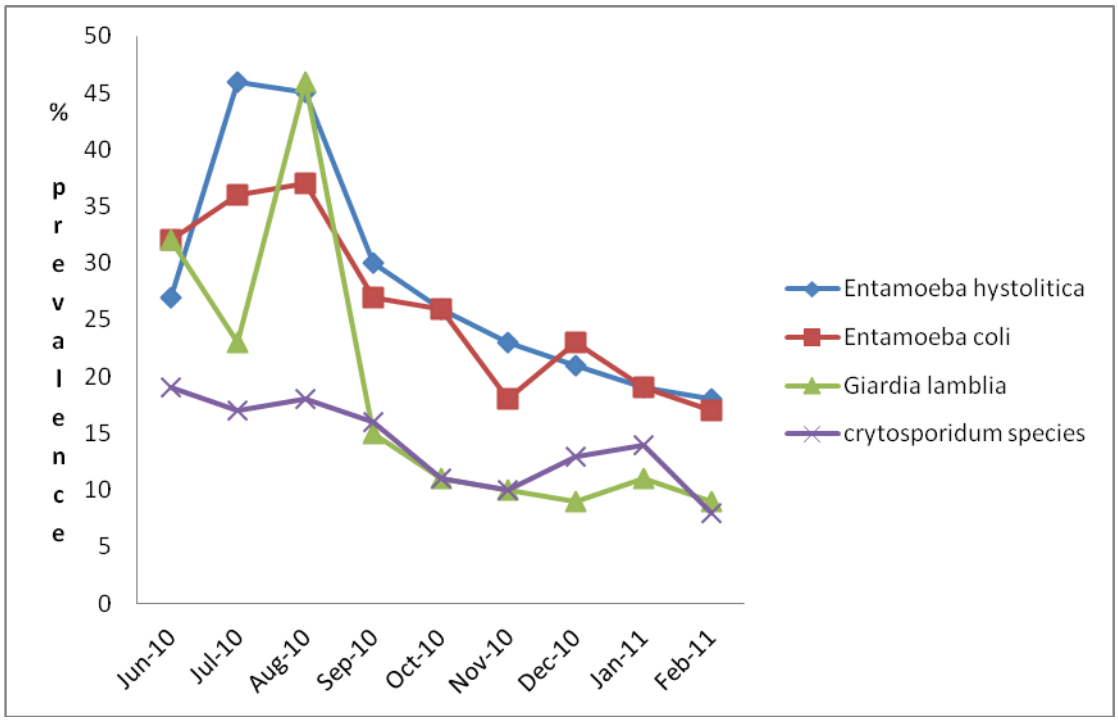

Figure 4.1: Temporal trends in the prevalence of intestinal protozoan parasites

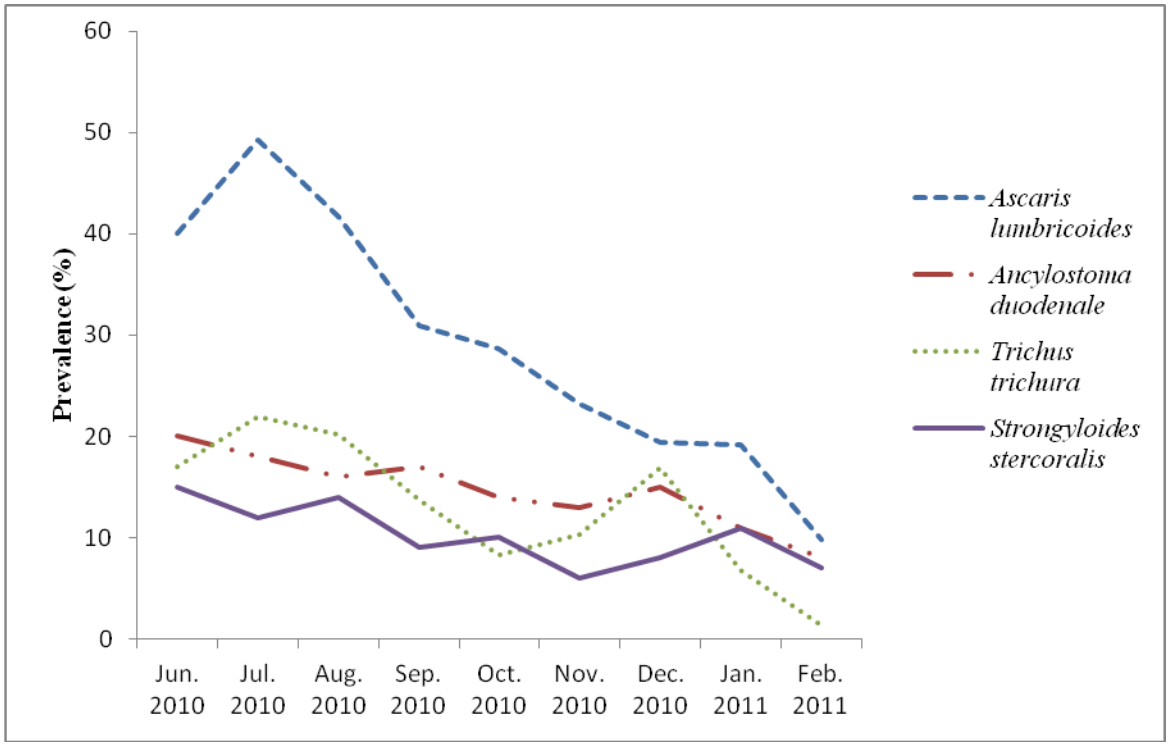

Figure 4.2 Temporal trends in the prevalence of intestinal helminthic parasites

In conclusion, Oscillations in seasonal frequencies were not dramatic in all the parasite species and all were present during both rainy and dry months.

4.4 Pre-disposing factors affecting the Prevalence of intestinal parasitic infections

Table 4.4: Pre-disposing factors affecting the prevalence of intestinal parasitic infections among HIV and AIDS patients at Bungoma District Hospital

Attributes	characteristic	Frequency	Prevalence of IPI	χ^2	P-value
Age	<18	26	17.8		
	18-35	23	36.9		
	36-55	19	39.7	19.443	<0.001
	> 55	12	51.6		
Gender	Male	63	22.8	21.311	<0.001
	Female	17	44.4		
Marital status	Married	19	34.5		
	Single	21	35.1		
	Divorced	21	32.3	0.811	0.623
	Widowed	19	32.7		
Levels of education	None	31	49.3		
	Primary	18	45.4		
	Secondary	13	33.9		
	College	14	24.2	25.442	<0.001
	University	4	13.2		
Income levels	< 1500	27	51.1		
	1501-5000	18	35.4		
	5001-10000	15	32.5		
	10001-20000	13	24.9	31.222	<0.001
	> 20001	7	22.4		
Smoking habits	Smoker	34	45.2	22.133	0.001
	Non-smoker	46	21.3		
Dietary habits	Eat fatty food	25	44.2	9.442	0.022
	Vegetarian	8	23.2		
	Eat at home	49	34.3		
	Eat in hotels	11	35.4		
Drinking habits	Drinker	33	27.5	19.233	0.001
	Non-drinker	47	39.3		

Data presented in table 4.4, showed that a total of 8 factors were likely to affect the prevalence of intestinal parasites in HIV and AIDS patients and these were: age, gender, marital status, levels of education, income levels, smoking habits, dietary habits and drinking habits. Out of the 8 factors, it was established that Marital status was insignificant factor. While the other 7 factors were independently responsible for the prevalence of intestinal parasitic infections among the HIV and AIDS patients. Prevalence of IPI increased significantly ($P < 0.05$) with increasing age of the patients. Significantly ($P < 0.05$) higher proportion of the females than males had IPI. The general trend in decline of the IPI with levels of education and income levels was also significant ($P < 0.05$). It was also noted that smokers had significantly ($P < 0.05$) higher prevalence of intestinal parasitic infections than the non-smokers. Patients who attested to eating more fatty food (meat) recorded higher prevalence of intestinal parasitic infections than vegetarians ($P < 0.05$). Finally, those who drink alcohol were found to have lower prevalence of intestinal parasitic infections than those who did not engage in the drinking.

We inferred that some attributes of man play an important role as host factors in the prevalence of IPI.

4.5 Multiple Logistic regression of factors influencing prevalence of intestinal parasitic infections among the HIV and AIDS patients

As indicated in table 4.5, the multiple logistic regression, controlling for all other factors, the main factors found to be affecting prevalence of intestinal parasitic infections in the study area were age, levels of education, income levels, smoking and drinking habits as well as dietary habits. The prevalence increased with increase in age and decreased with increase in level of education and income. Smokers and those

who regularly eat meat were likely to be infected while those who drink alcohol were less likely to be infected with the intestinal parasites.

We concluded that old age, low/poor social economic status and bad health practices greatly enhance the prevalence of IPI in man.

Table 4.5: Multiple Logistic regression of factors influencing prevalence of intestinal parasitic infections among the HIV AND AIDS patients

Factor	β	S.E	Wald	Sig	OR (95%CI)
Age (ref>18)					
<18	0.219	0.565	0.150	0.699	1.244(0.411-3.765)
18-35	0.879	0.595	2.184	0.139	2.409(0.751-7.730)
36-55	2.079	0.691	9.060	0.003	8.000(2.066-30.983)
Gender (Male)	0.203	0.534	0.159	0.169	0.808(0.625-1.078)
Education level (ref=none)					
Primary	0.327	0.378	0.751	0.386	8.904(0.191-12.262)
Secondary	1.235	0.632	3.823	0.051	3.438(0.997-11.859)
Tertiary	2.195	0.790	7.722	0.005	1.387(1.061-2.909)
Income level (ref<1500)					
Kshs1500-5000	-0.177	0.466	0.144	0.704	0.838(0.336-2.089)
Kshs 5001-10000	-0.623	0.472	1.748	0.186	0.536(0.213-1.351)
Kshs 10001-20000	-1.329	0.501	7.036	0.008	0.265(0.099-0.707)
Kshs >20001	-0.910	0.764	1.419	0.234	0.403(0.090-1.798)
Smoking habits (smoker)	0.304	0.926	3.108	0.034	0.738(0.365-0.958)
Drinking habits (drinking)	-0.404	0.300	8.908	0.007	1.513(1.369-8.106)
Dietary habits (Vegetarian)	-0.112	0.263	0.601	0.002	0.894(0.300-0.998)
Constant	4.709	3.41	4.251	0.006	4.181(2.093-7.083)

CHAPTER FIVE

5.0 DISCUSSION

5.1 Prevalence of various intestinal parasitic infections among HIV and AIDS patients

In the present study, the overall prevalence of intestinal parasitic infections (IPI) among HIV AND AIDS populations was (33.4%). It was higher than in other areas of Africa such as those reported in Senegal (15.3%) (Niang, 2008), Ivory Coast (17.9%) (Mamadou, 2010) and Zaire (19%) (Nzenga *et al*., 2009), and relatively much higher than in developed countries such as: Netherlands (0.9%), Germany (1.1%), USA (1.4%), and South Africa (3.2%) (WHO, 2010). However prevalence of (33.4%) were lower, compared to those reported in Nigeria (49%) (Awolaju and Morenikeji, 2009). This was probably due to all the species of parasites caused stress to the immune system and stimulated HIV to be more active and fatigue to be worse, coupled with low level of sanitation which increased infection rates (Ortega and Adam, 1997).

In addition, many African countries lack of access to anti-retroviral drugs which reduce the virulence of the HIV and therefore, the body systems are much weakened than the body of HIV and AIDS patients in developed countries where the antiretroviral drugs are easily available (Giannella, 2009).

Protozoan infections were more prevalent among the HIV and AIDS patients. The highest prevalence was reported for *E. histolytica* 99 (41 .2%), followed in descending order by: E. *coli (*35.8*%),* G. *lamblia (*33.3%*)* and *Cryptosporidium* spp (12.5%). Hayashi (2008) reported *E. histolytica*'s positive rates of 35.1% in

Machakos, 34.1% in Naivasha, almost similar to that reported in this study, but higher than 28.8% in Kitui, 31.4% in Nandi Hills and 27.9% in Taveta.

Hayashi (2008) also reported *E. coli* positive rates of 44.2% in Naivasha, 46.4% in Kitui, 63.3% in Taveta; which were higher than those reported in our study. It is possible that the human body already weakened by HIV and AIDS infection becomes an important site for parasitic infections. The resulting defects in cellular and humoral defense mechanism predispose the body to a spectrum of viral, fungal, bacterial and parasitic pathogens (Legesse and Erko, 2003).

Although helminthic infections were also present, they occurred in very low prevalence than the protozoan parasites perhaps because of their lower reproductive capabilities. Possibly some parasites were not detected in this study because not all techniques such as the water-ether sedimentation method for Microsporidia or adhesive tape or anal swab for Enterobius *vermicularis* were used. Therefore, the prevalence of intestinal parasites among the study participants may have been underestimated.

5.2 Intensity of various intestinal parasitic infections among HIV and AIDS patients in Bungoma County.

The mean intensity of protozoa was higher in the HIV positive patients than the helminths at Bungoma district hospital. Among the protozoans, *E. coli*, *E histolytic*, and *G. lamblia* all had higher mean intensity of greater than 50 ind/gm after slide examination. While *Cryptosporidium* spp. was found to be less than 10 ind/gm. The study findings concurred with studies reported from Thailand among HIV and AIDS

individuals who were found to contain higher mean intensity of protozoa intestinal parasites 150 ind/gm due to different immune status (Stringer *et al*., 2004). Higher intensities of intestinal parasitosis upto 1000 ind/gm of protozoan parasites were found in a study conducted in Tanzania among HIV and AIDS patients compared to the normal patients (Mlango, 2007). Yet in another survey conducted to determine the intensity of intestinal parasitic infections among HIV and AIDS affected school children in Igboora, a rural community of Oyo State, Nigeria, Awogun (2011) discovered that of 554 subjects examined, 50.4% harbored intestinal parasites, with mean intensity of 10 ind/gm to 300 ind/gm. The higher mean intensity of intestinal parasites among HIV and AIDS individuals in the current study could be associated with immuno-suppression, which may enhance parasite establishment and may thus increase parasite load.

Moreover, the mean intensity of *Cryptosporidium*. spp. was also similar between the HIV and AIDS and HIV -ve individuals. Low mean intensity of *Cryptosporidium*. spp, in HIV and AIDS may be related to the widespread use of Trimethoprim-sulphamethoxazole; an inexpensive common antibiotic, prescribed for upper respiratory tract infections, and also it is given as a prophylactic measure against opportunistic infections in HIV and AIDS patients. The use of this antibiotic against bacterial infections may therefore have additional beneficial effects in curbing spread of some parasitic infections. Also low mean Intensity of *Cryptosporidium* spp in HIV-ve could be due to the fact that it is an opportunistic parasite that only becomes pathogenic in individuals with compromised immunity. The helminthic parasite load was low in both HIV and AIDS +ve and HIV –ve patients; possibly due the fact that helminths take long to be established in the host.

5.3 Temporal variations in prevalence of intestinal parasitic infections among HIV and AIDS in Bungoma County

In this study it was observed that there was an increase in the prevalence of intestinal parasites during the months of June to August. This was associated with increased amounts of rainfall, which brought conducive conditions for infection with these parasites: such as increased agricultural activities, increased food and water contamination. First, climatic conditions including ambient temperatures, by either reducing the life expectancy of the parasites host and/or increasing the growth rate of parasite, induces a higher level of most parasites kept under controlled conditions (Poulin, 2003). However, the overall seasonal data show low peak prevalence between December 2010 to February 2011, which were dry months.Variations in environmental conditions may influence endoparasite population dynamics either through their influence on host behaviour or nutritional condition (Adamu *et al.*, 2009). In turn, this may result in geographical or inter-annual variation in the dynamics both of the host-parasite associations and of any diseases for which endoparasites may occur.

It must be pointed out, that one of the less studied aspects of tropical parasite community patterns among the HIV and AIDS is whether or not these parasite communities experience temporal changes in response to seasonal variations in biotic and abiotic environmental factors (Anichebe, 2003). More importantly, the factors that cause variations in the prevalence of parasites community among HIV and AIDS patients were not clear yet. Therefore, the observed variations in prevalence of intestinal parasitic infections may be related to the changes in the environmental conditions but could also be possibly explained by internal host factors. The exact

nature or cause of the variation was however, subject to more detailed and controlled studies, which was not performed by the current study. Studies on temporal variations of intestinal parasitic infections are rare. It is therefore still a scientific challenge to understand seasonal changes in the epidemiology of these parasites, whether or not these communities experience temporal changes in structure and species composition in response to seasonal variations in biotic and abiotic environmental factors (Visser *et al*., 2008) determining the roles of different parasite species within a community, and if their infection levels are constant and predictable over time is vital to implement biological control methods in culture systems.

5.4 Pre-disposing factors affecting the prevalence of intestinal parasitic infections among HIV and AIDS patients in Bungoma County.

In this study, eight pre-disposing factors were used to determine the factors likely to influence the prevalence of the intestinal parasitic infections among the HIV and AIDS patients. Factors that were included in the study were age, gender, marital status, highest levels of education, income, smoking habits, dietary habits and drinking habits. First, it was established that prevalence of IPI increased with age. According to the results, HIV and AIDS patients aged 18 to 35 years had significantly lower prevalence of intestinal parasitic infections than those aged over 55 years. This observation is similar with that of Sarfati *et al*. (2006). The overall high infection rate with intestinal parasites recorded in the elderly could be due to reduced immunity as senescent sets in (George-Morris, 2004). Meanwhile significantly higher proportion of females had intestinal parasitic infections than their male counterparts. The higher prevalence of IPI among the females compared to males in these studies can be attributed to the fact that females in the study area engage in water and food

preparation for the family, thus leaving them more exposed to infective agents of IPI than men. It is also possible that females received repeated high doses of the HIV in unprotected sex, leaving them with a more degraded immunity than males thus more vulnerable to various infections. Alternatively it is also possible that more females visited the hospital not only for medical treatment but also for other services such as antenatal services and family planning in the study area. This is contrary to (Awogun 2011) observation that reported opposing trend and attributed it to the fact that males have fewer restrictions than females.

The findings that parasite infections declined with increased level education of the study participants indicated the overall improvement of hygienic conditions and sanitation with knowledge of self deworming. Another study by Bern *et al*. (2000) had shown such a relation between increase in educational level and lower prevalence of intestinal parasite infection. Higher income levels was also found to result in reduced prevalence of IPI mainly because, people with high income have ability to afford drugs that will reduce the prevalence of IPI than those without any disposable income.

Smoking and poor dietary habits were all found to increase the prevalence of IPI among the HIV and AIDS patients. These are similar to findings by (Zander, 2004). Smoking, poor dietary habits and excess drinking have been associated with reduced immune response and increased pathogens in the body (Foudraine *et al*., 1998) and can presumably explain the high prevalence of these pathogens among the patients who smoked non-vegeterians or consumed less alcohol.

Numerous studies have shown that multiple factors can each influence the proportion of parasites infections. Also habitat characteristics are known to greatly influence parasite and host distributions (Krist *et al*., 2000). This study support the value of standard faecal examinations in HIV and AIDS individuals, since these examinations can be easily performed with low costs allowing initiation of provision of the therapeutic approaches.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSION

Based on the findings from the study, the following conclusions were made:-

1). The prevalence of intestinal parasitic infections (both protozoa and helminthes) were significantly ($P < 0.05$) high in both in HIV and AIDS and HIV -ve. (33.4% and 19.3%) respectively.

2). The mean intensity of IPI (both protozoa and helminthes) were significantly ($P< 0.05$) higher in HIV and AIDS than in the Controls

3). IPI are more prevalent during the rainy period than the dry periods.

4). Factors associated with prevalence of IPI were: age, gender, level of education, level of income, cigarette smoking and meat eating habits.

6.2 Recommendations

Based on the findings from the study, the following recommendations were made:-

1). IPI exist in both HIV and AIDS and seronegative populations, therefore specific anti-protozoa drugs such as (Metronindazole; Albendazole) be incorporated in the management models of HIV and AIDS.

2). More efforts should be put in controlling intestinal parasites during rainy seasons to reduce the parasite burden among the populations.

3). Health education programmes on sanitation, personal hygiene, safe drinking water and change of risky life style be advocated for.

4). Special care programmers' targeting vulnerable groups: females, low income, self-employed, married couples and those with risky life styles: alcoholics and smokers, also nutrion and women empowerment be part of management of HIV and AIDS.

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APPENDICES

Appendix 1: Questionnaire for the patients/healthy individuals

Instructions

I am Fredrick Wabwile Wanyama. Currently; I am collecting data on the "***Epidemiology of intestinal parasitic infections among HIV infected population in Bungoma County, Kenya".*** Your answers to these questions are part of an educational research project. There is no right or wrong answer. Please be as honest as possible when responding to these statements. DO NOT WRITE YOUR NAME ANYWHERE ON THIS PAPER. Responses are strictly confidential.

If you accept you can sign, or tick in the box shown (if your signature bears your name)

I accept to participate in the study,

Signature……. / …… [ ].

Before you answer the questions below we require your stool sample for laboratory test.

Section a: Biographical form

Residence (Division) _____

Tick only one answer.

2. Age < 18 yrs [ ] 18-35yrs [ ] 36-50 yrs [ ] > 50 yrs [ ]

3. Gender Male [ ] Female [ ]

4. Highest levels of education None [ ] Primary [ ]

Secondary [ ] Tertiary [ ] University [ ]

5. Marital status Married [ ] Single [ ] Divorced/Divorcee [ ]
   Widow [ ] Widower [ ]
6. Occupation_____
7. Your approximate in-come [< 1,500] [1,500-5,000] [5,001-10,000]
   [10,001-20,000] [>20,001].

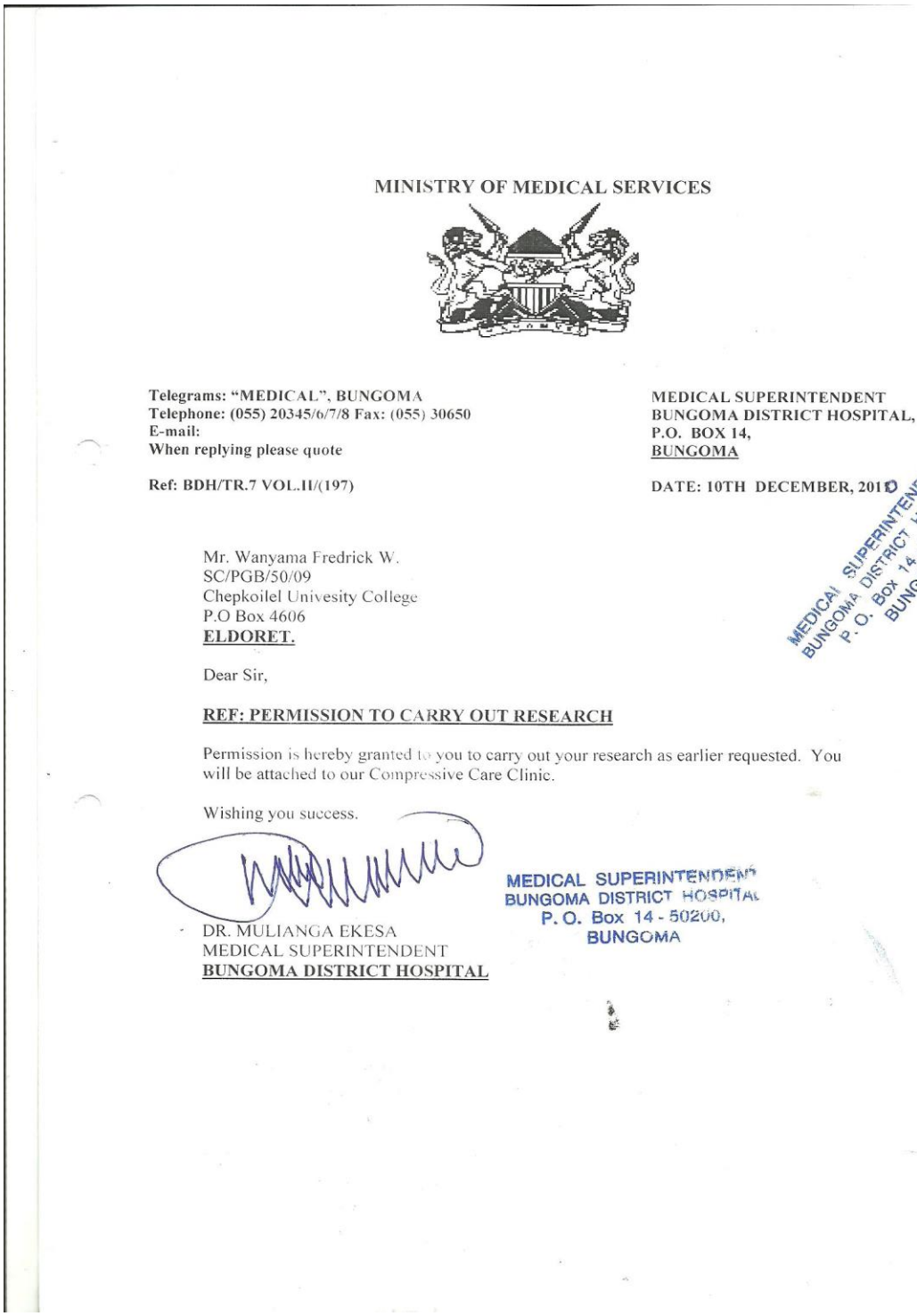
Personal habits

1. Smoking: Cigarette Smoker [ ] Non-smoker [ ]
2. Eat fatty: food (meat) daily [ ] Eat vegetable diets [ ]
3. Drinking habits: Alcohol drinker (beer, spirits or local brew-busa) [ ]
   Non-drinker [ ]

Thank you for your cooperation

Appendix II: Approval letters**:**

Approval Letter from Medical Superintendent Bungoma District Hospital.



MINISTRY OF MEDICAL SERVICES

Telegrams: "MEDICAL", BUNGOMA
Telephone: (055) 20345/6/7/8 Fax: (055) 30650
E-mail:
When replying please quote

Ref: BDH/TR.7 VOL.II/(197)

MEDICAL SUPERINTENDENT
BUNGOMA DISTRICT HOSPITAL,
P.O. BOX 14,
BUNGOMA

DATE: 10TH DECEMBER, 2010

MEDICAL SUPERINTENDENT
BUNGOMA DISTRICT HOSPITAL
P. O. Box 14 - 50200,
BUNGOMA

Mr. Wanyama Fredrick W.
SC/PGB/50/09
Chepkoilel Univesity College
P.O Box 4606
ELDORET.

Dear Sir,

REF: PERMISSION TO CARRY OUT RESEARCH

Permission is hereby granted to you to carry out your research as earlier requested. You will be attached to our Compressive Care Clinic.

Wishing you success.

DR. MULIANGA EKESA
MEDICAL SUPERINTENDENT
BUNGOMA DISTRICT HOSPITAL

MEDICAL SUPERINTENDENT
BUNGOMA DISTRICT HOSPITAL
P. O. Box 14 - 50200,
BUNGOMA

Certificate of approval to carry out the research from IREC.

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2011/52

28th July, 2011

Approval Number: 000668

Fredrick Wanyama
Chepkoilel University College
P. O. Box 1125 -00100
ELDORET - KENYA

Dear Mr. Wanyama

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee have reviewed your research proposal titled:

"Epidemiology of intestinal parasitic infection among HIV infected population in Bungoma District."

Your proposal has been granted a Formal Approval Number: **FAN: IREC 000668** on 28th July, 2011. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 27th July, 2012. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Yours Sincerely,

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
APPROVED
28 JUL 2011
P. O. Box 4606 ELDORET

29/07/2011

DR. W. ARUASA
AG. CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc: Director - MTRH
Dean - SOM
Dean - SPH
Dean - SOD

Appendix III: Bar chart showing the demographic and social information

Chart 4.1: Gender trends

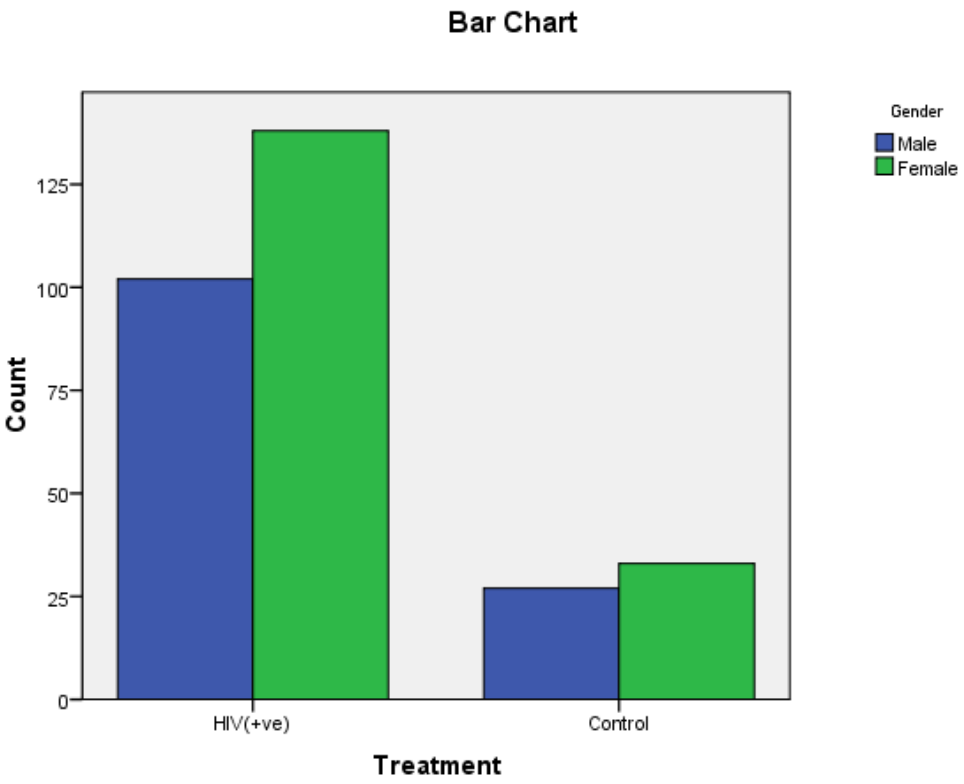


Chart 4.2: Trends in Age Groups of Respondents

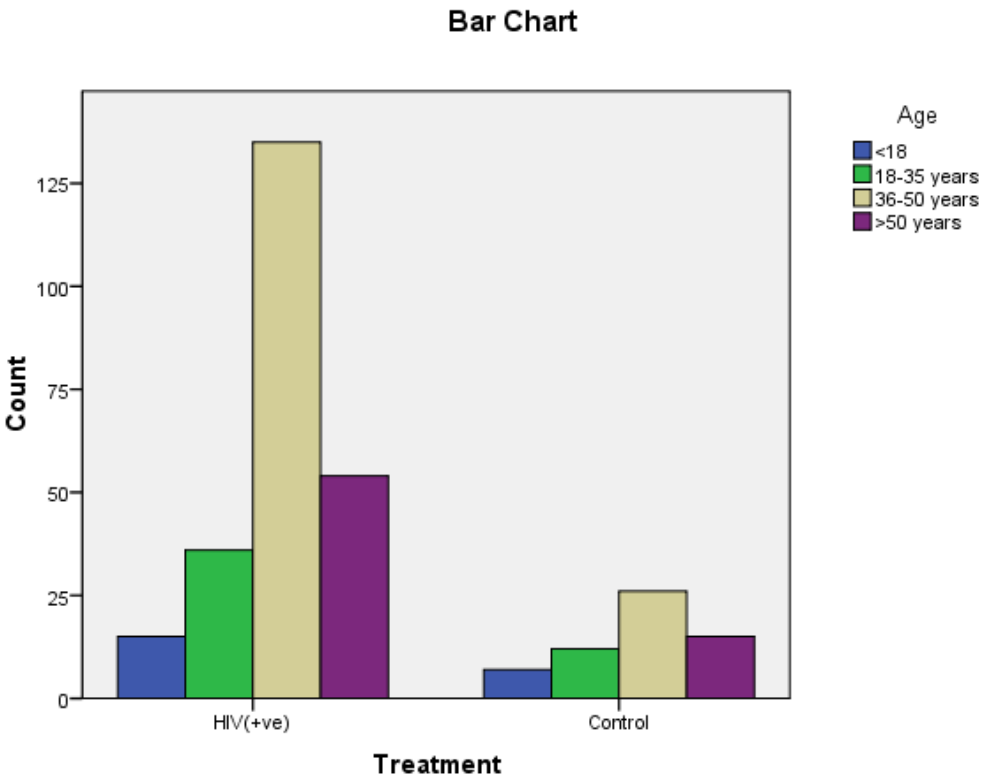
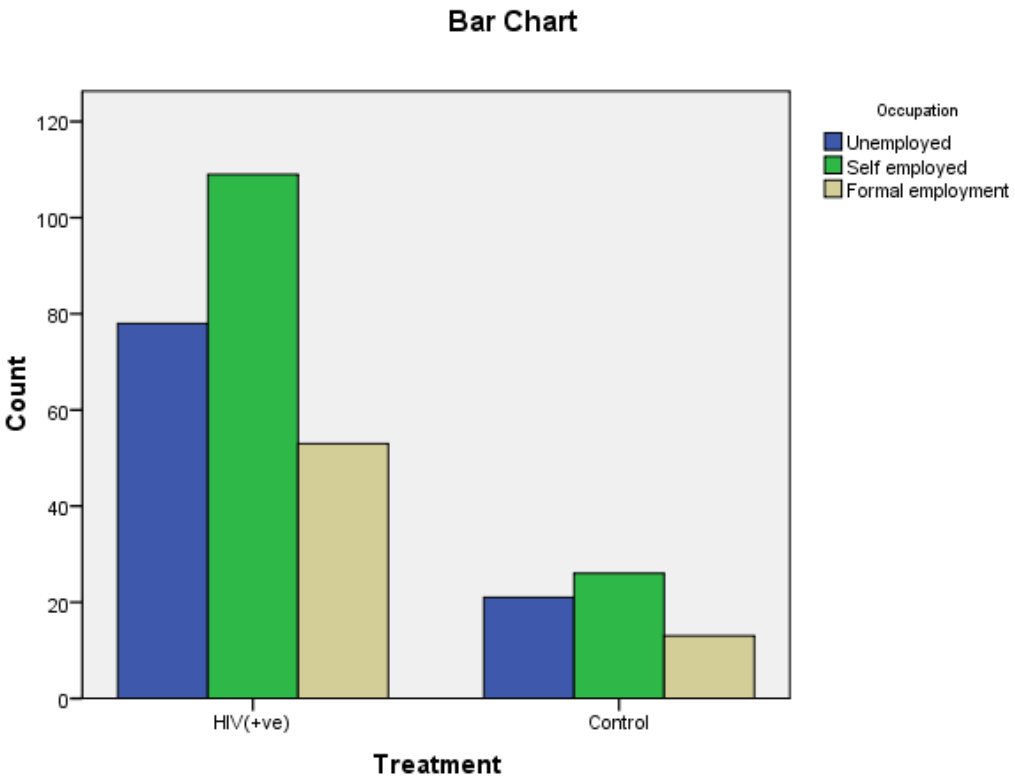


Chart 4.3: Trends in The Occupation Of Respondents



Appendix IV: Some photographs from the survey

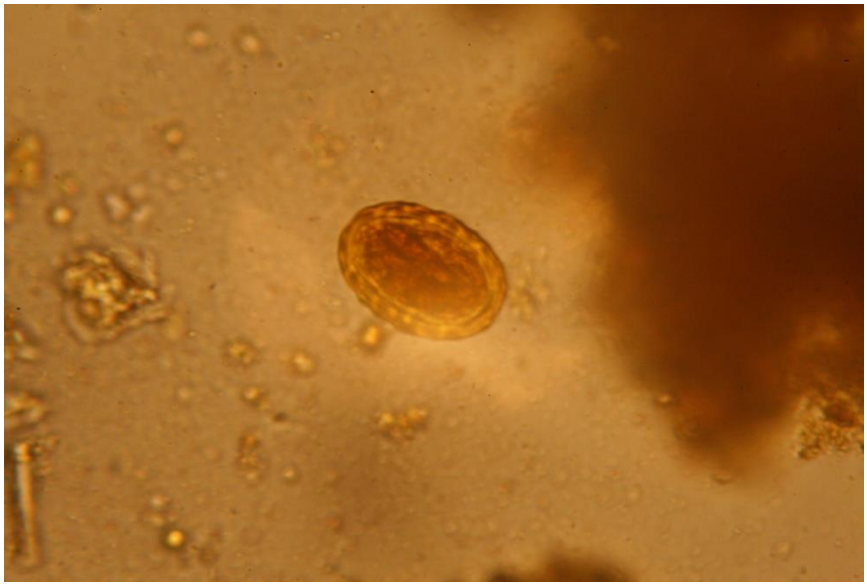


Plate 1: Fertilized Ova of A. *lumbricoides* x40.

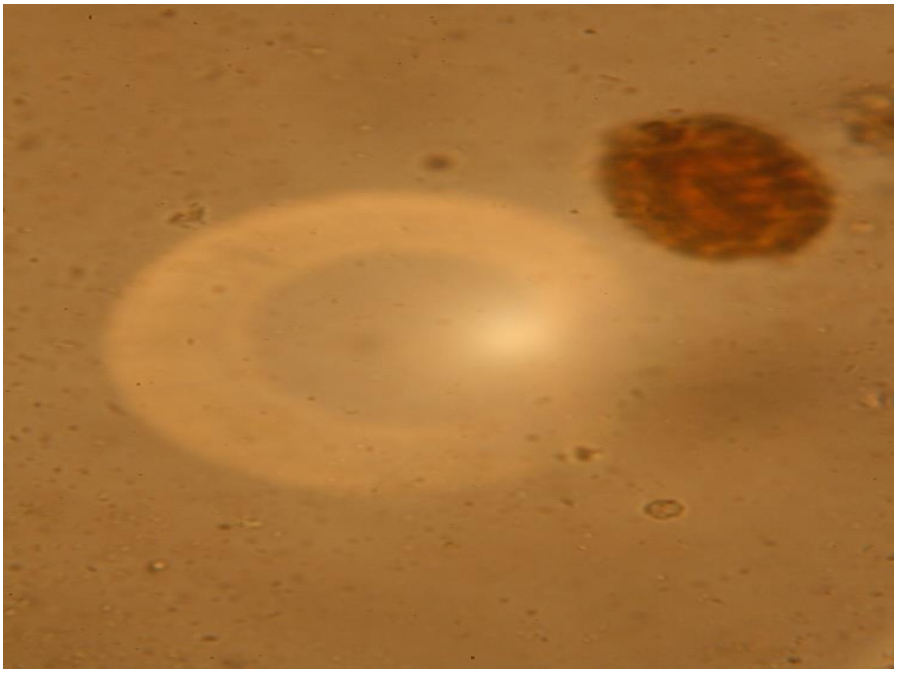


Plate 2: Ova of unfertilised *A. lumbricoides*

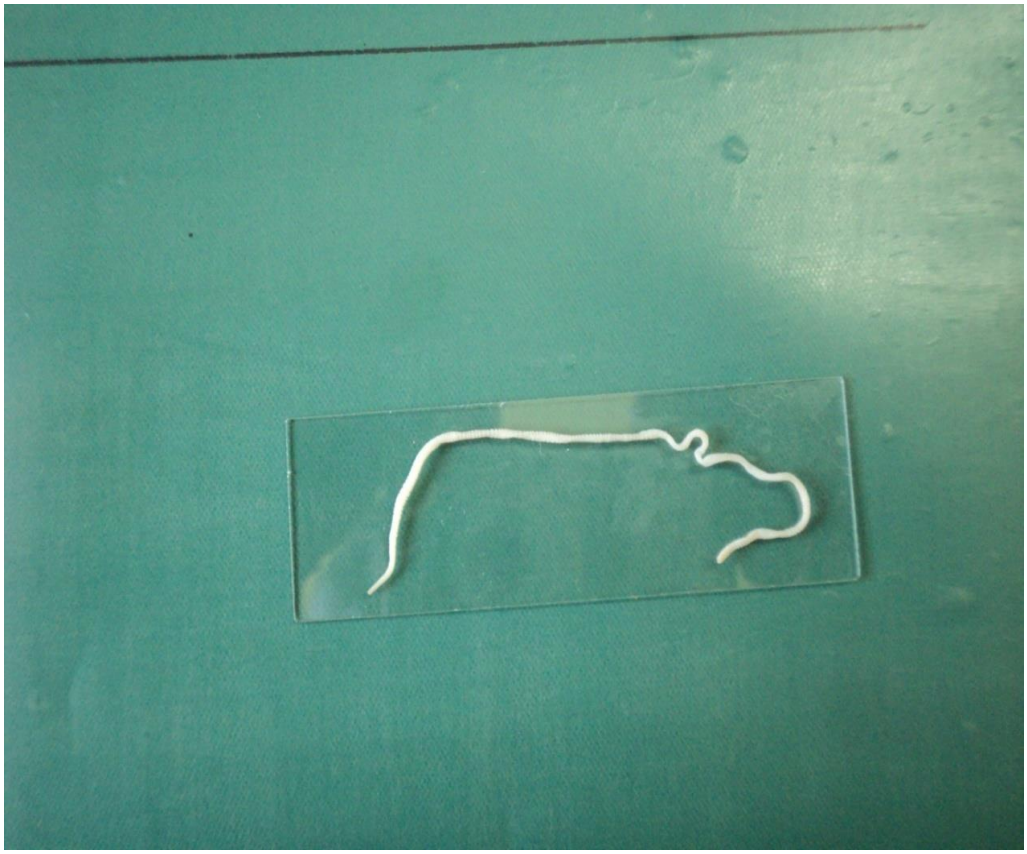


Plate 3: Adult of *A. lumbricoides*

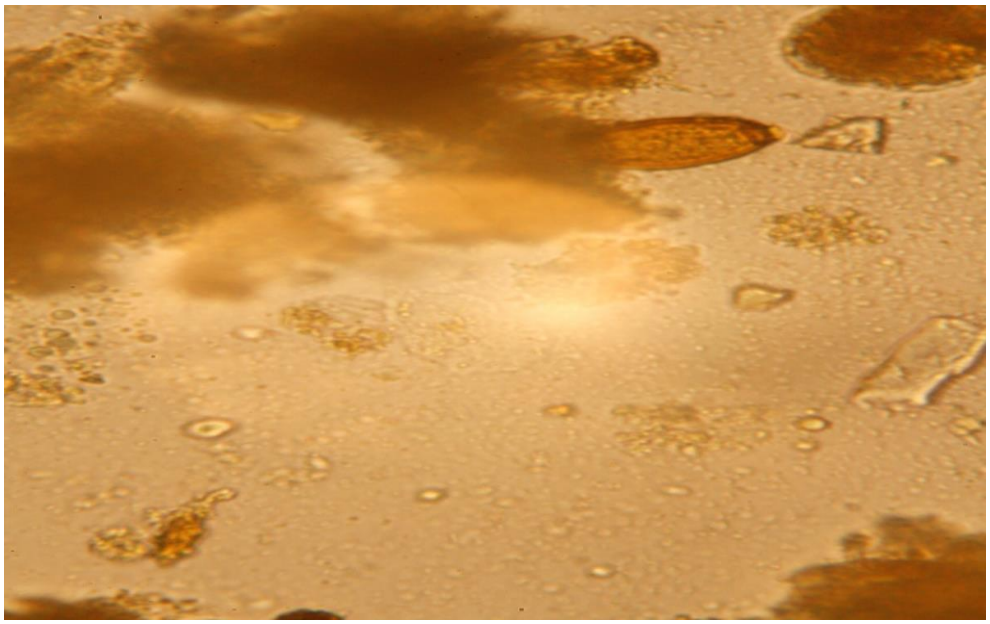


Plate 4: Ova of *Trichuria trichuris x40*

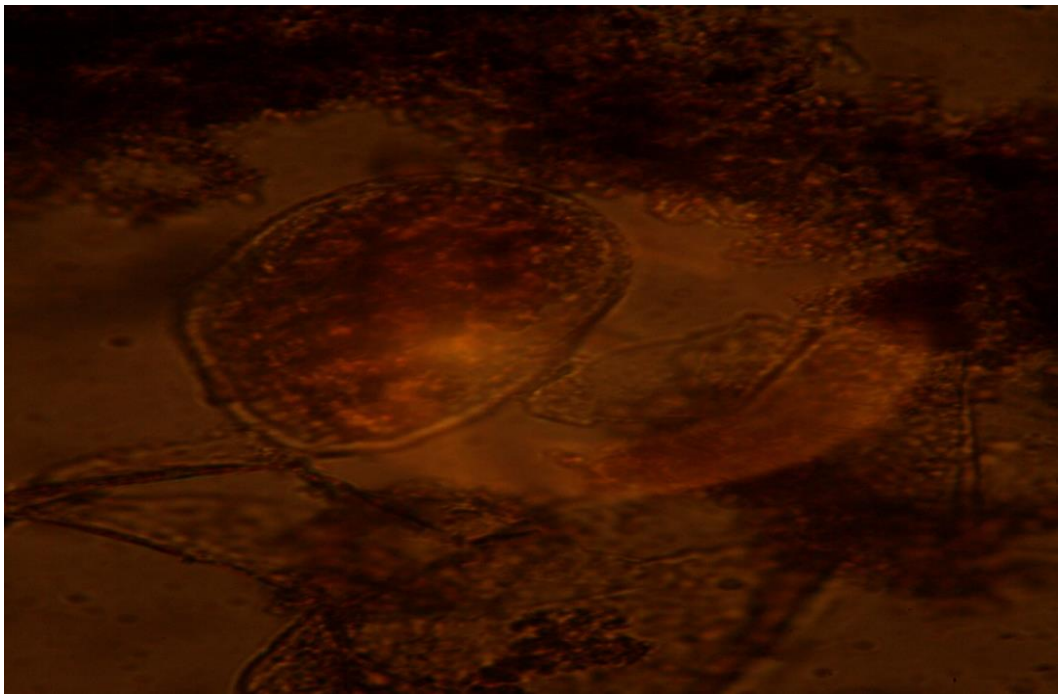


Plate 5: Ova of Hookworm x10 *(A. duodenale).*

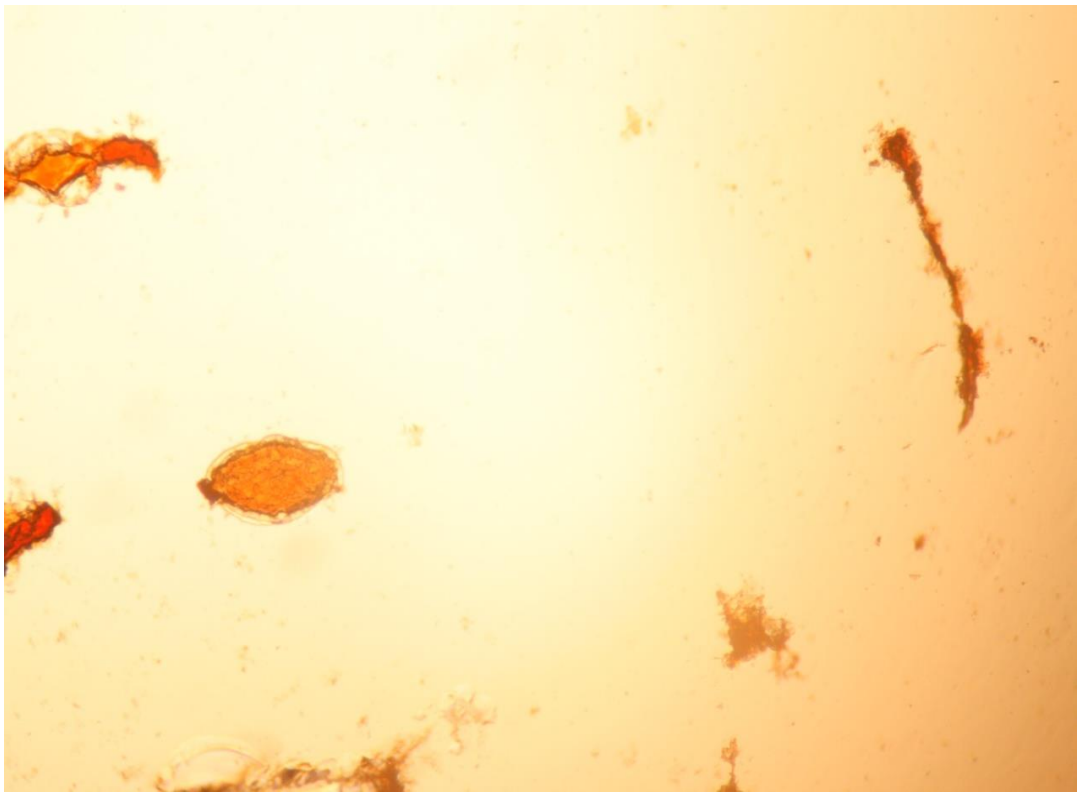


Plate 6: Ova of Hook worm x40 (*A. duodenale*).

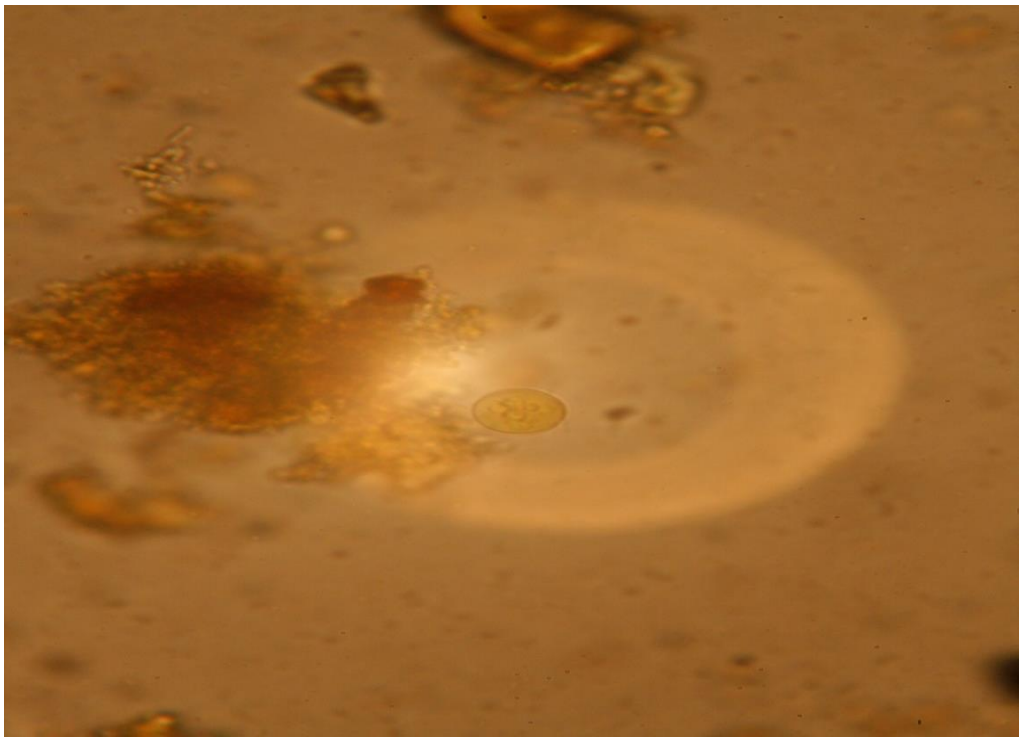


Plate 7: Cyst of *E. histolytica* x100

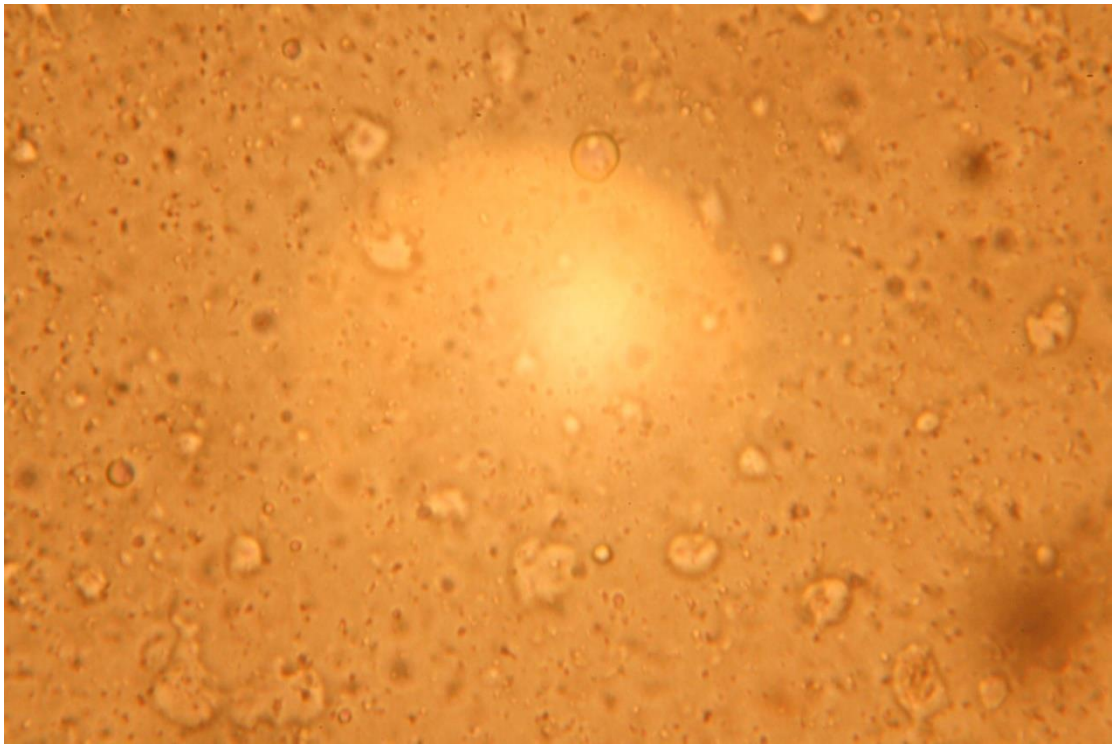


Plate 8: Cysts of *E. histolytica* x100

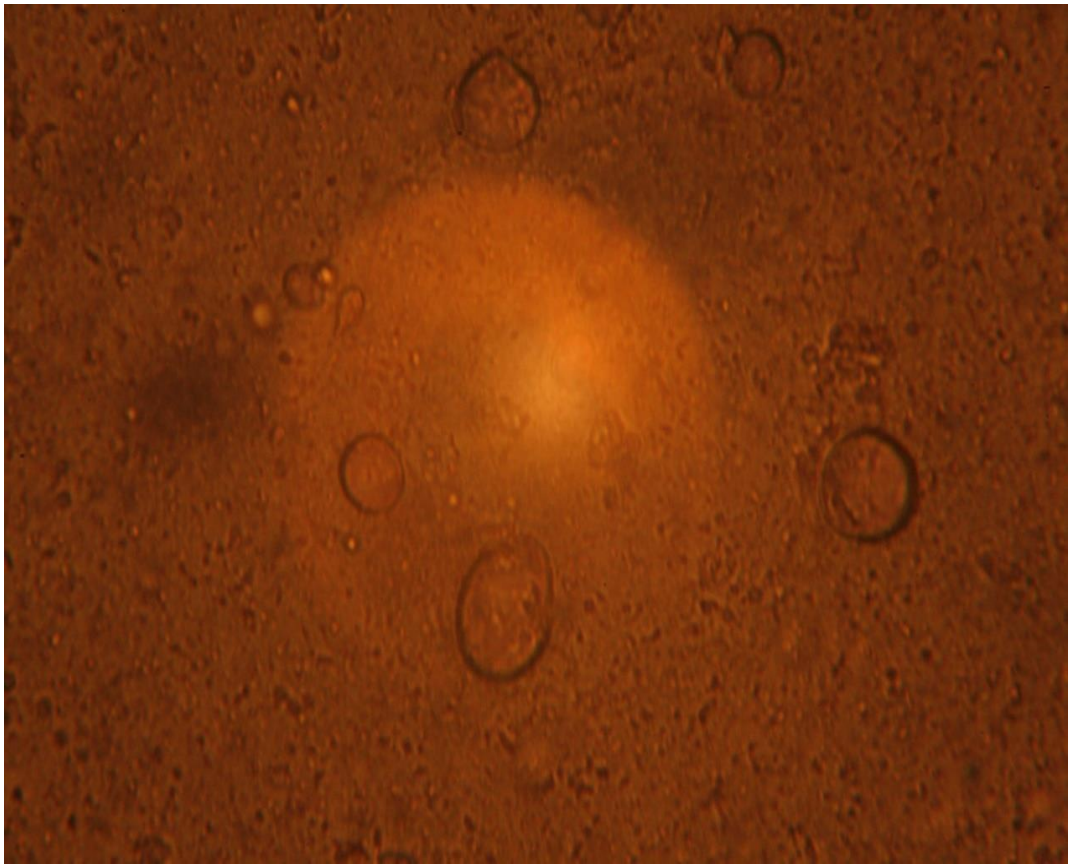


Plate 9: Cysts of: *E. coli* x *100*

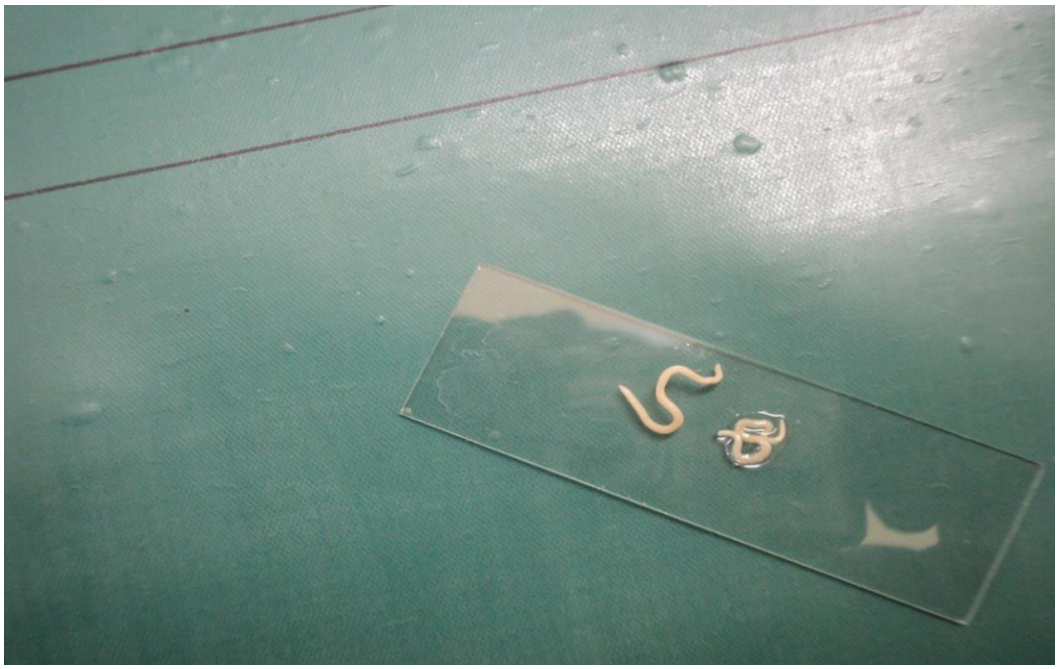


Plate 10: Adult Hook worm: (Ancylostoma *duodenale*)

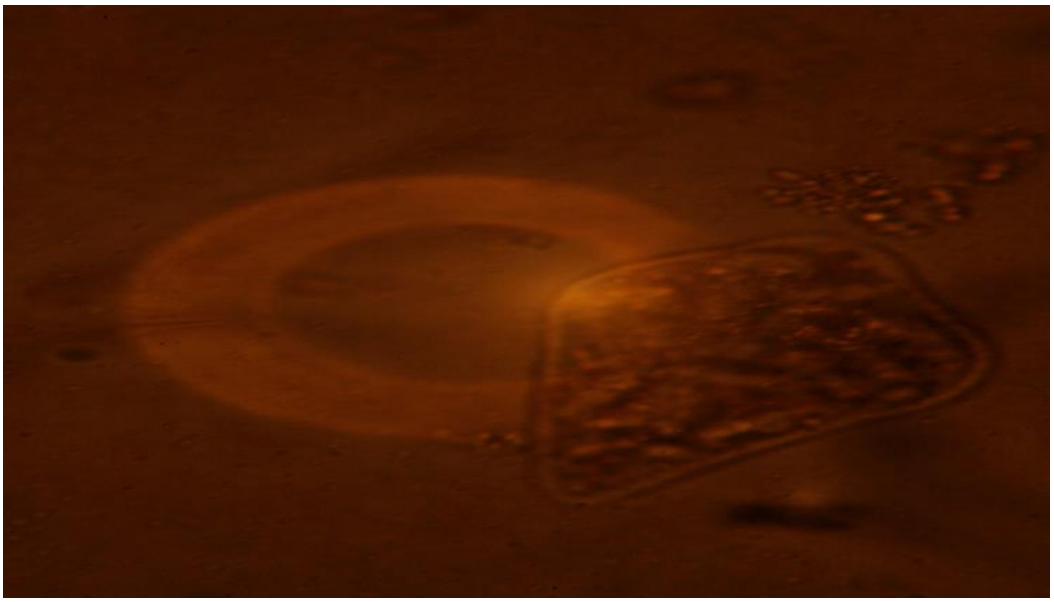


Plate 11: Trophozoite of Giardia *lamblia* x40

Note: Flagella were note visible, probably due to damage during trasportation from Bungoma to UoE laboratory for photographs to be taken.

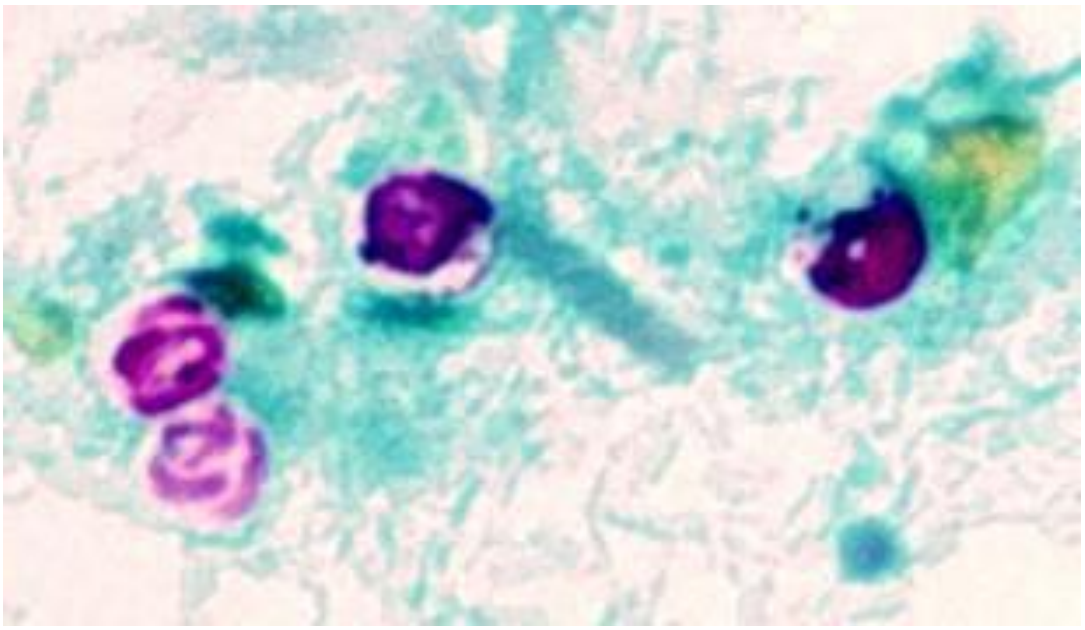


Plate 12: Oocyst of Cryptosporidium parvum x100