Lesson 16 Other Non-Vectored Infectious

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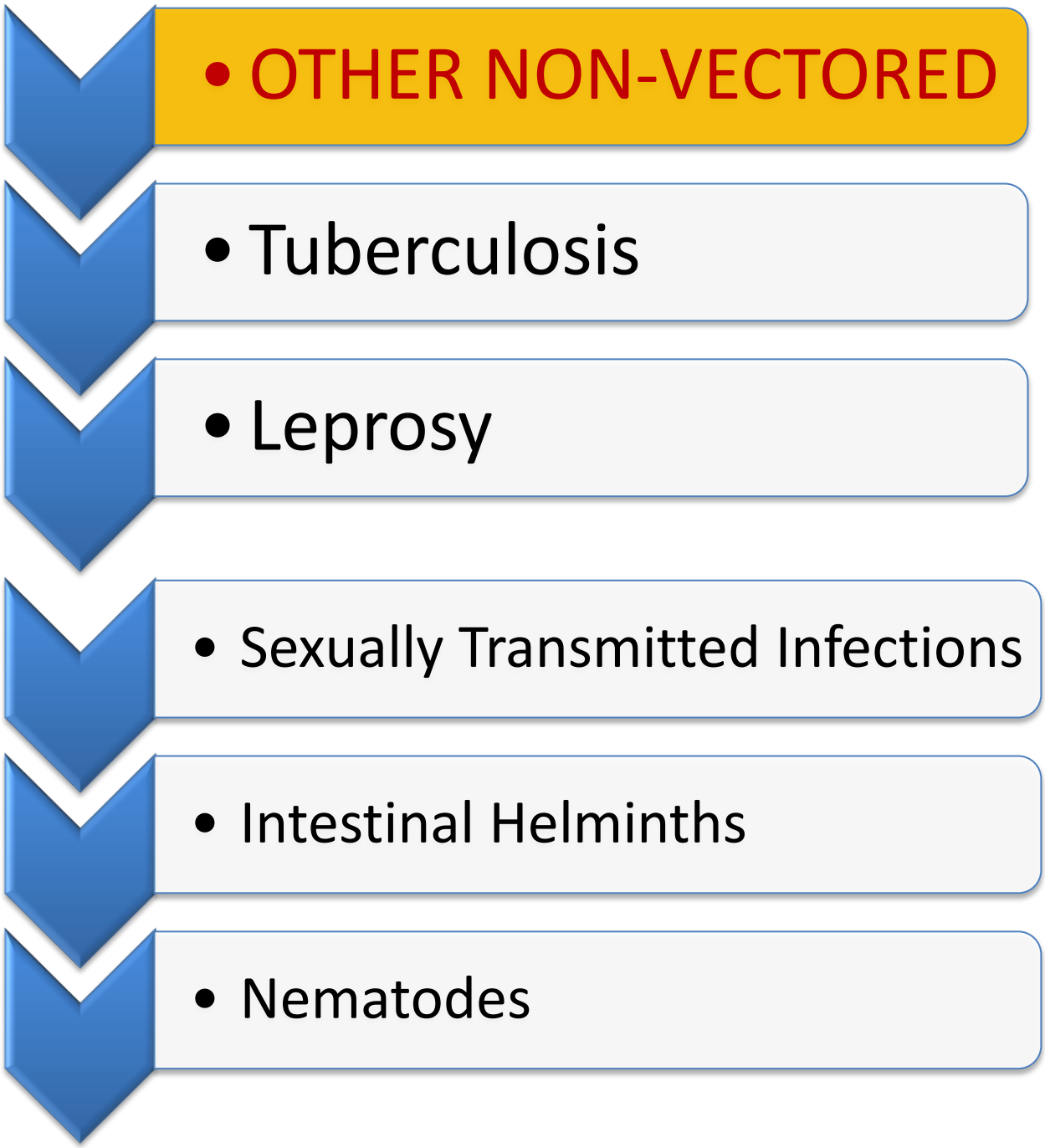
Learning Objectives



Non-vectored Infectious

Tuberculosis and others

Introduction

A USAID report places Ethiopia at number 8 among the top 22 countries with a high tuberculosis burden [1]. Another report places it among the top three in Africa [2]. It also quotes the World Health Organization's (WHO) *Global TB Report 200*s estimate of 267,000 active TB cases in 2004 "… with an estimated incidence rate of 353 cases per 100,000 people" [1].

The agency responsible for prevention and control of the disease - Ethiopia's TB and Leprosy Control Program (TLCP) – has been implementing Directly Observed Therapy, Short-Course (DOTS) in two experimental administrative zones since 1991. The DOTS coverage in the two zones was estimated at 70 percent in 2004 in areas where health services had adopted and implemented the strategy.

An estimated 40 percent of Ethiopians have access to health care, and the government has been trying to integrate TB treatment into general health services. Unfortunately, "the DOTS detection rate in 2004 was only 36 percent, compared with the WHO target of 70 percent detection". Moreover, "the treatment success rate is well below the 85 percent target set by WHO and declined from 80 percent in 2000 to 70 percent in 2003". The number of TB cases in Ethiopia is predicted to increase at a higher rate than in years past in response due to HIV/AIDS (nearly one-quarter of adult TB cases are HIV-positive), deepening poverty, and the high proportion of the latent infections (over a third of the population) [2].

A joint TB report gave Ethiopia a failing grade in its overall handling of the disease [3]. It estimated the number of Ethiopians dying of the illness at 56,000 a year. It based its dismal outlook on the contention that "Ethiopia's health facilities suffer from a high turnover of staff, resulting in a workforce that is not well trained in the principles of TB control".

The Disease

Tuberculosis (TB) is caused by a bacterial agent called *Mycobacterium tuberculosis*. The agent was first isolated in 1882 by a German physician named Robert Koch [4]. He received the Nobel Prize for this discovery. The disease most commonly affects the lungs but it can also attack almost any other organ of the body. The disease was once referred to as "consumption" because, without effective treatment, infected patients would often waste away. There are also a group of organisms which cause what is known as "atypical tuberculosis".

> "These involve other types of bacteria that are in the Mycobacterium family. Often, these organisms do not cause disease and are referred to a "colonizers," because they simply live alongside other bacteria in our bodies without causing damage. At times, these bacteria can cause an infection that is sometimes clinically like typical tuberculosis. When these atypical mycobacteria cause infection, they are often very difficult to cure. Often, drug therapy for these organisms must be administered for one and a half to two years and requires multiple medications." [4]

TB is spread when a person inhales minute particles of infected sputum from the air. The bacteria enter the air when an infected person "… coughs, sneezes, shouts, or spits (which is common in some cultures)". One can also contract atypical tuberculosis transmitted by drinking unpasteurized milk when cows get infected by a related bacteria called *Mycobacterium bovis*.

Upon entering the lungs the bacteria begins to multiply rapidly but is fought off by the immune system that forms a scar tissue around the site of infection thereby isolating it from the rest of the body. "Tuberculosis that occurs after initial exposure is often referred to as primary TB. If the body is able to form scar tissue (fibrosis) around the TB bacteria, then the infection is contained in an inactive state. Such an individual typically has no symptoms and cannot spread TB to other people." [4]. The scar tissue may eventually harden due to calcification and often appears on X-ray images – hence the use of X-ray in job, travel, and immigration-related TB tests. Sometimes, however, the body is unable to contain the infection and the bacteria break through the scar tissue causing a primary TB.

> "For example, the immune system can be weakened by old age, the development of another infection or a cancer, or certain medications such as cortisone, anticancer drugs, or certain medications used to treat arthritis or inflammatory bowel disease. The breakthrough of bacteria can result in a recurrence of the pneumonia and a spread of TB to other locations in the body. The kidneys, bone, and lining of the brain and spinal cord (meninges) are the most common sites affected by the spread of TB beyond the lungs." [4]

The symptoms include generalized tiredness or weakness, weight loss, fever, and night sweats. If the infection worsens or reaches advanced stages, chest pain and coughing-up of sputum and/or blood will ensue, together with shortness of breath. Other symptoms will follow if the infection spreads beyond the lungs to other sites depending on the site.

Treatment lasts many months and sometimes years. The patient's cooperation and diligence is essential for a successful outcome. This is referred to as compliance. Patient failure to take medications as prescribed is, in fact, the most important reason behind failure to cure the disease; hence, the introduction of DOTS as a method of insuring compliance. Four drugs are often prescribed for the initial two months to help kill the bacteria, and the number is reduced to two drugs for the remainder of the treatment period. "Streptomycin, a drug that is given by injection, may be used as well, particularly when the disease is extensive and/or patients do not take their oral medications reliably …." [4]

Meaza Demissie et. al. recently conducted an extensive literature review and analyses of Tuberculosis data for Ethiopia [5]. The following paragraphs are based on this study.

The actual magnitude of Tuberculosis as a public health problem in Ethiopia has not been determined accurately but hospital records show that it is the 3rd most important cause of in-patient admissions, and the number 1 cause of hospital deaths. About half a million Ethiopians were said to be positive for active TB in the 1960s and 800,000 in the 1970s. TB control in Ethiopia is structured hierarchically and DOTS (initially located in a single administrative Zone), was "…gradually expanded to 62 out of the total 69 zones (90%) of the country comprising a population of 62 million in 2002". Since the early 1990s co-infection with HIV has become a major challenge because "…TB is often the first opportunistic infection in HIV-infected persons, and active TB has been shown to induce viral replication, thus accelerating the progression from latent HIV-infection to clinical stages of AIDS."

> "In 1994, 44% of 450 TB patients in Shashemene (Oromiya Region) were HIV positive … and 22.4% of 107 cases with TB of the lymph nodes, confirmed by Fine Needle Aspiration (FNA) cytology and AFB smear examination, from August 1998 to December 2000 in Butajira (Southern Region) were HIV-positive … A cross sectional survey of smear-positive TB patients in Addis Ababa shows 45% coinfection … Of 125 consecutive culture-proven TB patients in Addis Ababa in 2000, 46% were HIV-positive … Data generated from various regions suggest that majority of hospitalized TB patients are HIV-positive (40-70% in Amhara Region). Like-wise, of 112 consecutive culture-positive TB cases diagnosed at the OPD of Tikur Anbassa Hospital in Addis Ababa, 65% were HIV positive …" [5]

As elsewhere in the developing world (or, even, developed world) drug resistance is a problem in Ethiopia. Various studies have reported resistance rates (to at least one drug) ranging from low single digits to nearly 16 percent as in the case of a 1994 Addis Ababa study a two-year period of organized TB control effort in the city. Non-compliance is a big problem in Ethiopia. It is thought that a default rate of up to 80% was possible in some communities where DOTS was not adopted due to lack of understanding of the need to complete the treatment regimen, poverty, and lack of social support. Better results and a compliance of up to 80% have been achieved under some DOTS programs in the last five years. This took place despite the widespread stigma against TB suffers which delays treatment and encourages default. Gender is an important variable as well. However, the role of gender in the control of tuberculosis has not been studied well [5]. A study from northern Ethiopia showed TB-related stigma toward female sufferers was stronger that stigma toward men (37). "This confirms the need to investigate the impact of gender at the various levels of tuberculosis control." [5]

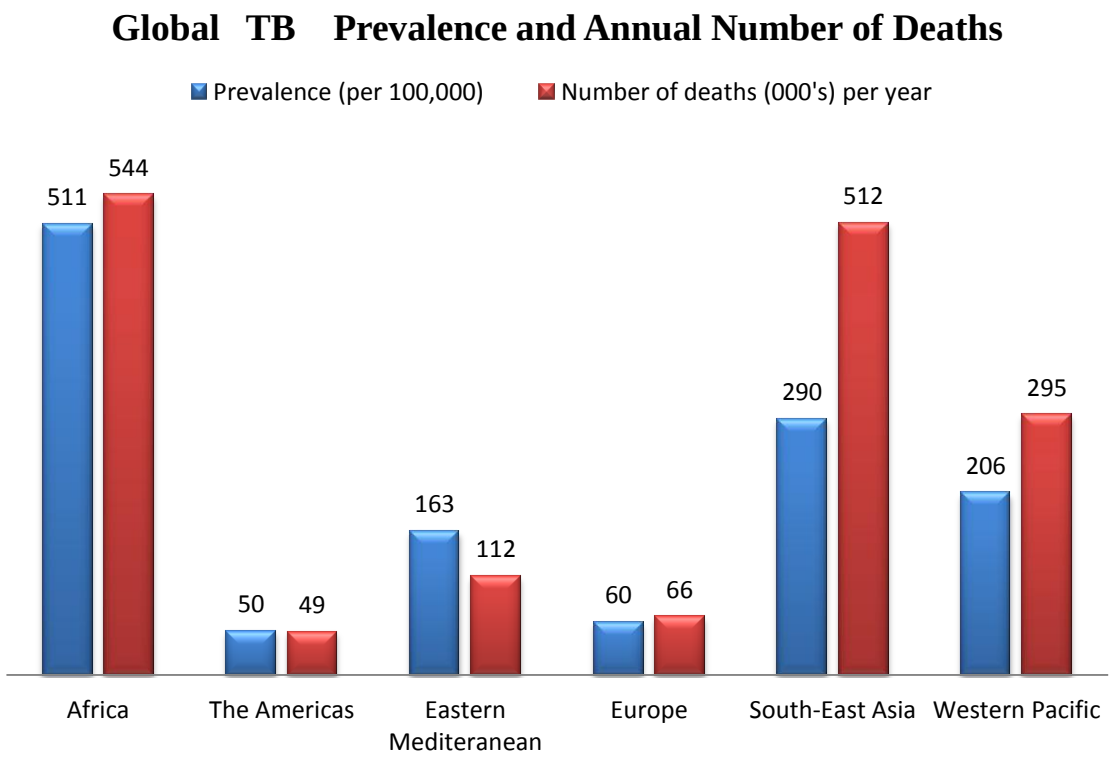
There has been a rising interest and increased funding among international donors in the country's efforts to control TB. In the last seven years the following institutions have shown interest and gave financial support to the control campaign [5]:

- The Dutch Embassy (RNE),
- German Leprosy Relief Association (GLRA),
- World Health Organization,
- United States Agency for International Development (USAID), and the
- Global Fund to Fight AIDS, TB and Malaria (GFATM).

Delay in seeking treatment is a major problem with significant impacts on recovery. A recent study compared treatment protocols between urban and rural inhabitants of Western Wellega [7]. The results showed less delay of service for patients in urban areas compared to rural patients. Delays were caused both by patient-related factors and health system-related factors. The latter are by far the bigger contributor to the delay in initiation of treatment.

A Global Look

Globally, an estimated 1.5 million people died of TB in 2006, and another 200,000 died due to co-infection with HIV [6]. "Both the highest number of deaths and the highest mortality per capita are in the Africa Region". [8] The TB epidemic grew rapidly in Africa during the 1990s but infection rates have leveled off somewhat, and have even started to decline in some parts of the continent. The number of cases is growing, however, due to population increase and lack of treatment of those already infected. More than twice as many people live in South-East Asia than in Africa but the graph below shows that the number of people dying of TB is Africa is higher than that in South-East Asia. The lowest prevalence rates (100,000) are in Europe and the Americas.



Source: Based on [8]

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Progress in Combating the Disease

The world health organization provided the following summary report regarding ongoing efforts to reduce the disease burden around the world [8].

- In 2005, an estimated 60% of new smear-positive cases were treated under DOTS – just short of the 70% target.
- Treatment success in the 2004 DOTS cohort of 2.1 million patients was 84% on average, close to the 85% target. However, cure rates in the African and European regions were only 74%.
- The 2007 WHO report Global TB Control concluded that both the 2005 targets were met by the Western Pacific Region, and by 26 individual countries (including 3 of the 22 high-burden countries: China, the Philippines and Viet Nam.
- The global TB incidence rate had probably peaked in 2005, and if the Stop TB Strategy is implemented as set out in the Global Plan, the resulting improvements in TB control should halve prevalence and death rates in all regions except Africa and Eastern Europe by 2015.

Still, drug-resistance remains a major challenge both in the developed and developing world due to the high cost of treating drug resistant TB. "A particularly dangerous form of drug-resistant TB is multidrug-resistant TB (MDR-TB), which is defined as the disease caused by TB bacilli resistant to at least isoniazid and rifampicin, the two most powerful anti-TB drugs." MDR-TB rates are especially high in some of the former Soviet Union countries and threaten to weaken ongoing TB control efforts there.

Strategies pursued by the World Health Organization to combat the spread of Tuberculosis around the world are based on the following six principles [8]:

1. **Expansion of high-quality DOTS:** This will require DOTS expansion to even the smallest and remotest areas. In the year 2004, a total of 183 countries (including all 22 of the high-burden countries which account for 80% of the world's TB cases) were putting in place DOTS services in at least part of the country.
2. **Stopping TB/HIV, co-infection and MDR-TB:** UN's Millennium Development Goal relating to TB (Goal 6; Target 8) seeks the tackling of issues relating to co-infection and drug resistance.
3. **National health system strengthening.** National efforts in financing, planning, management, information and supply systems and innovative service delivery need to be scaled-up.
4. **The role of care providers:** Duplicity in care involving a wide array of public, private, corporate and voluntary care givers provides the most efficient mechanism to reach the needy and ensure high-quality care.
5. **Empowerment of TB patients:** Respect for the rights of patients and empowerment through community involvement protects patients and helps combat stigma.

6. **Enabling and promoting research.** The history of human struggle against TB shows that progress in diagnostic and therapeutic practices and future success elimination will depend on the development of new diagnostics tools, more effective drugs, and vaccines.

Leprosy

The following paragraphs are based on a recent work on leprosy in Ethiopia by Fekadesillsie, Ahmed, and Betru [9]:

The naming of a patron guardian saint of the leper – Gebre Kristos – around the turn of the twentieth century marked the beginning of the recorded history of leprosy in Ethiopia. Patients congregated around Gebre Kristos church and were cared for by priests. A modern form of care dates back to 1932, and the establishment of Princess Zenebework hospital. In 1960, a French Catholic doctor named Dr. Feron founded a care facility near Harer and called it the St. Antonie Leprosy Home. A program was put in place in the 1950s to combat leprosy under the guidance of a National Leprosy Control Program office the Ministry of Health. "The German Leprosy Relief Association (GLRA) has been supporting the national leprosy control effort since then". Given the availability of a cure, and the relatively few number of leprosy sufferers in Ethiopia, its discussion here is more an acknowledgement of its place in the county's social history as one of the most feared diseases in the than a concern about its current impacts on public health.

The Disease

The World Health Organization (WHO) passed a resolution in 1991 to eliminate leprosy as a public health problem despite the recognition that the disease has been around since the start of the ancient civilizations of China, India and Egypt. The first known written mention of the disease dates back to 600 BC. The term "Elimination" (above) was defined as a reduction of the prevalence rate to less than one in 10,000. Reports indicate that this target was "… achieved on time"[10]. More than 14 million patients have been cured between 1991 and year 2000, and 4 million since 2000, and the prevalence rate has dropped by 90%. The disease has been eliminated from 113 countries (out of the original 122 endemic countries) between 1991 and year 2000 and an additional 13 countries achieved elimination since 2000. This has been facilitated by the absence of resistance to drugs used in treating leprosy.

Leprosy is a chronic disease caused by a bacillus agent, *Mycrobacterium leprae*, a bacteria that multiplies very slowly with symptoms taking as long as 20 years to develop. It is spread via droplets from the patient's mouth and nose during close and repeated contact with susceptible individuals. The bacterial agent attacks and damages the skin and nerves. The first drug breakthrough "occurred in the 1940s with the development of the drug dapsone, which arrested the disease. But the duration of the treatment of leprosy was many years, even a lifetime, making it difficult for patients to follow…" [10]. The WHO recommended multidrug therapy (MDT) in

1981 consisting of three drugs: dapsone, rifampicin, and clofazimine. As a result, leprosy is now a curable disease with little side-effects.

Leprosy in Ethiopia: Geographic Distribution

Historically, the occurrence of the disease in Ethiopia appears to have been limited to the highland regions of Oromiya, Amhara and SNNPR. The reason for the highland clustering is not clear but "…it has been noted that the low temperature at high altitudes encourages close person to person contact at night [for warmth]…." and may in fact allow the spread of the contagion. Exceptions to the highland foci have been occurrences in the low-lying Blue Nile tributary areas of Wellega.

An estimated 85,000 cases were being treated in Ethiopia (26 per 10,000 populations) in 815 treatment centers at the start of the MDT program in 1983. The success of the MDT treatment regime insured a substantial decline in active cases, so much so that there were only 5852 cases by 1995. However, the annual number of new infections has not shown a similar decline [9]. Moreover, "there are still 4 regions of the 11 regions, 17 zones and 1 special Wereda with prevalence rate greater than the leprosy elimination target set by WHO" [9].

Sexually Transmitted Infections (STI)

Sexually transmitted infections (STIs) refer to a class of infections transmitted primarily through person-to-person sexual contact. The World Health Organization recognizes more than 30 such diseases with bacterial, viral, and parasitic agents. The most common infections are "…..gonorrhoea, chlamydial infection, syphilis, trichomoniasis, chancroid, genital herpes, genital warts, human immunodeficiency virus (HIV) infection, and hepatitis B infection" [11]. Illnesses such as HIV and syphilis can also be passed on from mother to child during pregnancy and childbirth, as well as during blood transfusions and tissue transfer.

The history of STI in Ethiopia has not been well documeted but "…it is likely that [the disease] became endemic first during the Middle Ages in the emperors' camps, or mobile capitals - one of the characteristic features of historic Ethiopia" [12]

STI researchers suspect that increasingly lax social standards and deteriorating cultural values, economic dislocations, and migrations have led to the acceleration of STI enabled by rampant promiscuity. Afework, Abebe and Kloos summarize the current state of affairs as follows:

> "The ecology of STI in Ethiopia has become more complex in recent years and reveals many characteristics of risk behavior and STI transmission reported from other endemic areas in developing countries. Not only has prostitution become more open and widespread but increasing poverty and resulting postponement of marriage, urbanization, sociocultural change resulting in sexual behavior, and increasing unemployment and streetism of youth have contributed to earlier and and often unprotected sex". [12]

Plorde DS who studied STI among the Amhara was more direct in his summary and gave a detailed background to the problem by focusing on marriage customs and the rather dramatic socioeconomic environment in recent years:

> "The high prevalence of all types of sexually transmitted diseases (STD) in Ethiopia, estimated in various field studies at 32-70%, led to analysis of the economic and psychosocial factors influencing the spread of these diseases. … Increases in migration and urbanization associated with the struggle toward economic development have weakened family and community relationships and encouraged sexual promiscuity, leading to an increase in STD incidence. The disruptive effects of sudden land nationalization caused many farmers to leave the land, forcing their wives to seek employment, which puts them at high risk of contracting the spreading STD. Moreover, there are far more women than men in the roadside and market villages, and STD are spread when men travel through or bring goods to market. Most marriages among the Amhara are temporary, with dissolution obtainable by mutual agreement. This custom provides women with opportunities for numerous transient sexual liaisons. Because of the limited employment opportunities available to women in Ethiopia, many select beer selling and prostitution as a way to earn an income. Thus, changes in the social structure, particularly in relation to the status of women, are contributing to the spread of STD. In general, neither health professionals nor the general population in Ethiopia understand the transmission process of STD, the serious nature of the problem, or how these diseases should be treated. Most treatment is provided by relatively untrained "dressers." Laboratory tests are often not performed, and penicillin is administered indiscriminately" [13].

Despite the epidemic nature of the problem few national studies exist on prevalence rates, the population at risk (other than the usual suspects – sex-workers, soldiers, truck drivers, etc), and regional variations. "STI are grossly underreported in Ethiopia, largely because these infections have traditionally been stigmatized, many infections are asymptomatic, and diagnostic and treatment facilities are scarce" [12].

Given the very high rates reported by small scale studies focusing of a subset of the population such as soldiers, high school students, commercial sex workers, women attending prenatal clinics, etc. the annual number of cases is likely to be in the millions. Published totals varied significantly year to year for the same administrative region due to reporting errors. For example, "…whereas Amhara Region reported five to 12 times as many cases as Tigray Region in 1992, 1993, and 1994 E.C. [Ethiopian calendar], Tigray reported more than twice as many cases in 1995 E.C. Similarly, Dire Dawa reported about 30 to 60 times more cases in 1993 than in 1992, 1994 and 1995 E.C."

A 1991 study of STI in Addis Ababa [14] focused on women attending family planning, gynecologic, and obstetric clinics and sought to "..correlate serological diagnosis of gonorrhea with clinical evidence of pelvic infection in order to define a reliable clinical diagnosis of gonorrhea..". A total of 1851 women, half of them symptomatic and half asymptomatic were tested using "…indirect haemagglutination test with gonococcal pilus antigen…". The gonococcal antibody test (GAT) seropositivity was also correlated with the patient's own history of sexually transmitted infections, age, clinic attended in the past, and "….the clinical evidence of infection in "gonococcal target organs" urethra, salpinges or Bartholin glands". [14] Study found widespread and disconcertingly high level of occurrence of gonorrhea among the women with a suggestion that similar results might be found in other urban areas of the country.

> "Fifty nine per cent of the study group were seropositive for the gonococcal antibody test, 22% with titres greater than or equal to 1/320, indicative of current, recent or recurrent infection. Seropositivity indicating past or present gonococcal infection was highest in those who gave a history of having had treated syphilis (85%), in women aged 40-49 (72%), and family planning attenders (EFGA) (66%) of whom 31% had titres greater than or equal to 1/320. Fifty per cent had clinical evidence of past or present infection in the urethra, salpinges or Bartholin glands. Gonococcal antibodies were present in 54% of women with no evidence of clinical infection, compared with 91% of those with pyosalpinx and 86% of those with triple infection of urethra, salpinges and Bartholin glands….The high prevalence of gonococcal antibodies in Ethiopian women, especially in asymptomatic clinic attenders must be of concern for all health workers especially those in gynaecology and obstetrics and the related disciplines of family planning and neonatal paediatrics. While seropositivity was highest in those giving a past history of syphilis, the patient's history of STD was unreliable, as of those who denied having any history of STD, fifty per cent were GAT seropositive. Despite a high correlation between GAT seropositivity with pyosalpinx and clinical evidence of infection in urethra, salpinges and bartholin glands, gonococcal antibodies were present in 54% of women with no clinical evidence of infection. Thus we were unable to define a diagnostic clinical picture of gonorrhoea in Ethiopian women." [14].

Abera Geyid (2002) studied a sample of 300 patients in three urban centers – Addis Ababa, Nazreth, and Awasa to learn about drug resistance. The results gave a clear picture in which "…only 12.3% were sensitive to all drugs while over 70% of the strains were resistant against more than two combined drugs and above 90% of these multi-drug resistant strains showed to be PPNGs [Penicilliniase-Producing Neisseria Gonorrhea]" [15]. A study in Gonder around the same time came up with identical results indicating the widespread nature of the problem, at least in urban Ethiopia. In a 2001 study involving 168 male subjects (no females) who volunteered to participate [16] by giving specimen:

> Multiple drug resistance was reported in 87.5% of isolates and only four isolates were sensitive to all antibiotics. One strain of N. gonorrheae was resistant to as many as eight antibiotics (tetracycline, penicillin, ampicillin, kanamicin, methicilin, carbenicillin, cotrimoxazole and ceftriaxone). More than eighty five per cent of the isolated strains were penicillinase-producing Neisseria gonorrhoeae (PPNG).

A 2002 publication of a study featuring 561 young males and females (aged 15 – 20) in Addis Ababa measured the gonorrhea and chlamedia prevalence rate. One-third of the study subjects self-reported having had sexual intercourse. A among the conclusions of the study was that "…while 7/52 (13.5%) of the sexually active females were found to … have STDs, only 2/136 (1.5%) of the males had an STD…" [16] Suggesting that the females were perhaps being infected by older males outside of their age group.

The following summary excerpts are obtained from the work by Afework, Abebe and Kloos [12] by way of concluding this part of the non-vectored infectious illnesses in Ethiopia:

- The symptoms often recorded in STI research (the 1994/95 Adami Tulu study, for example) and in surveillance systems, include urethral discharge in males, vaginal discharge in females, genital ulcer in both sexes, and abdominal pain in females.
- Failure to diagnose illnesses early leads to serious life-long health consequences, and a positive status (especially among women) often leads to a spousal beatings and family break-up/divorce.

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- Treatment and the purchase of drugs constitute a huge financial burden.
- "Antimicrobial resistance of several sexually transmitted pathogens has been increasing in Ethiopia and most parts of the world and this has rendered some low-cost regimens ineffective."
- A collaborative study by the Ministry of Health, Ethiopian Nutrition Institute, the US Center for Disease Control, and Medicine Sans Frontiere in Addis Ababa and SNNPR showed that "…where as N. gonorrhea was the leading pathogene that caused uretheral discharge in males as compared to females with vaginal discharge, bacterial vaginiosis was the common cause of VDS [vaginal discharges] in females".
- "According to the review of the Ethiopian literature regarding the interaction of STIs and HIV infections …, the prevalence of genital discharge syndrome, syphilis, genital warts, pelvic abscesses in females, genital chlamydial infections, herpes simplex type 2 infection were [all] associated with HIV"

Intestinal Parasitism

Almost all illnesses in Ethiopia are under-reported, often by a significant margin. The apparent exception is the prevalence of intestinal parasitism which is often over-reported due to a narrow focus on a specific vulnerable group - school children. These tend to carry the causative agents at much higher rate than the general public [18].

A 2001 cross-sectional study of 415 school children [19] found nine species of parasites with overall prevalence of 27 percent. Hymenolepis nana was the most common parasite found in this study followed by hookworm. Hymenolepis nana is a dwarf tapeworm "… diagnosed in children, in persons living in institutional settings, and in people who live in areas where sanitation and personal hygiene is inadequate" [20]. The other study results are as follows:

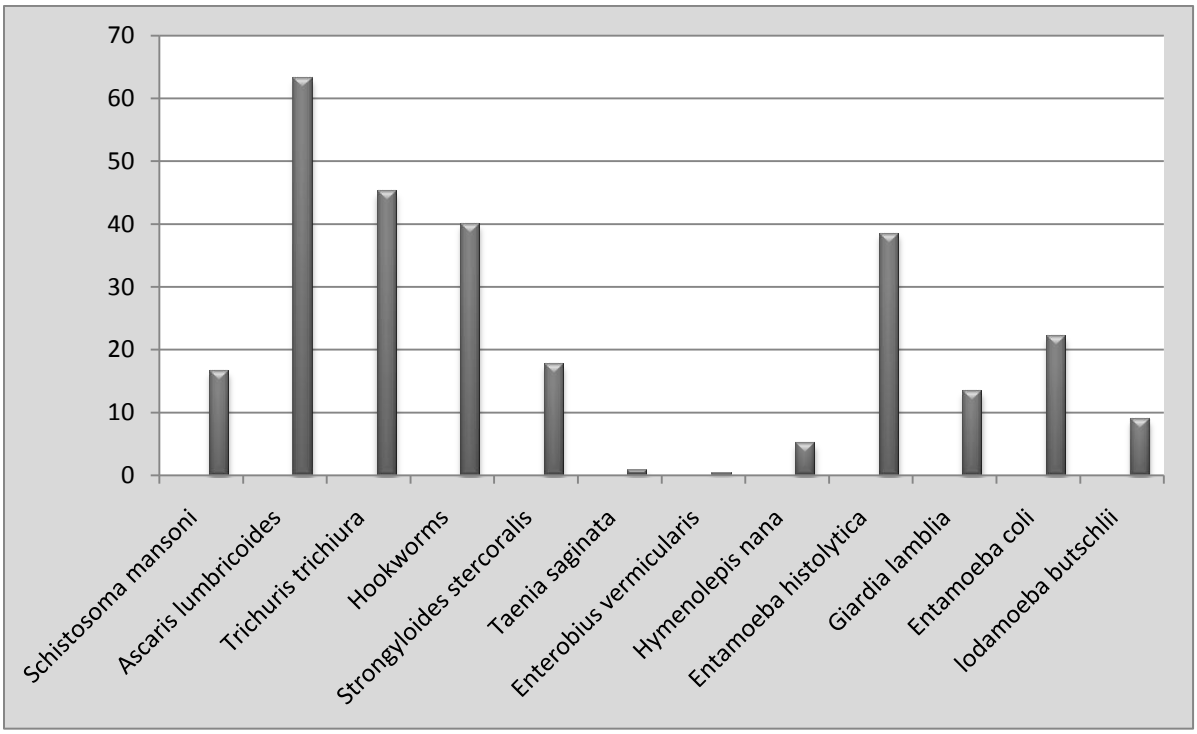
> "Prevalence of intestinal helminthic infections was not related to the availability, type and usage of latrines ($p>0.05$). A higher prevalence of H. nana was found among children with poor personal hygiene ($p<0.05$). Prevalence of hookworm infection rate was significantly lower in children who wore shoes regularly ($p<0.05$). It seems that children who eat food items sold on the street had a higher prevalence of Ascaris lumbricoides and Trichuris trichiura infections than those who didn't ($p=0.05$). Children with stunted growth had higher infection rate of with H. nana than children who are properly nourished ($p<0.05$). Conclusion: Intervention programs should emphasise proper personal and environmental hygiene practices." [19]

A different result was found in a 2003 study of 259 school children [21] southeast of Lake Langano because "of the 259 students surveyed for intestinal parasites, 217(83.8%) had one or more parasites". In this study, the "prevalence of hookworm was the highest (60.2%), followed by *Schistosoma mansoni* (21.2%), *Trichuris trichuria* (14.7%), *Taenia* spp. (13.9%), *Entamoeba histolytica/dispar* (12.7%), *Ascaris lumbricoides* (6.2%), *Giardia duodenalis* (6.2%) and *Strongyloides stercoralis* (5.8%), in that order. An association was not found between hookworm infection and low haematocrit value of the study subjects." [21]

In a 1993 study of children in Bahir " out of 528 children examined by formolether concentration method over 95 % were found to harbour one or more intestinal behaviour parasites…", the most

common ones being "… geohelminths, faeco-orally transmitted amoebae and water-related schistosome parasites". [22] Most children were found to harbor more than one parasite, and "it appears that double infections by A. umbricoides and T. trichiura are most common". The list of parasites, and the disease burden as measured by the percentage of children carrying it is given as follows:

Percentage of children in a 1993 Bahir Dar Study with a Given Parasitic Infection



Source: Based on [22]

Even though double infection is common, infection with three parasites was also found to be a common occurrence as can be learned from the study results cited above. Up to six parasites were found per child.

> "In polyparasitism, infection with three parasites is the most common (29.0 %), followed by infection with 2 parasites (27.5 %), 4 parasites (17.2 %), 5 parasites (6.1 %) and 6 parasites (3.3 %). Triple infection was mainly caused by A, lumbricoides, T. trichiura and hookworms." [22]

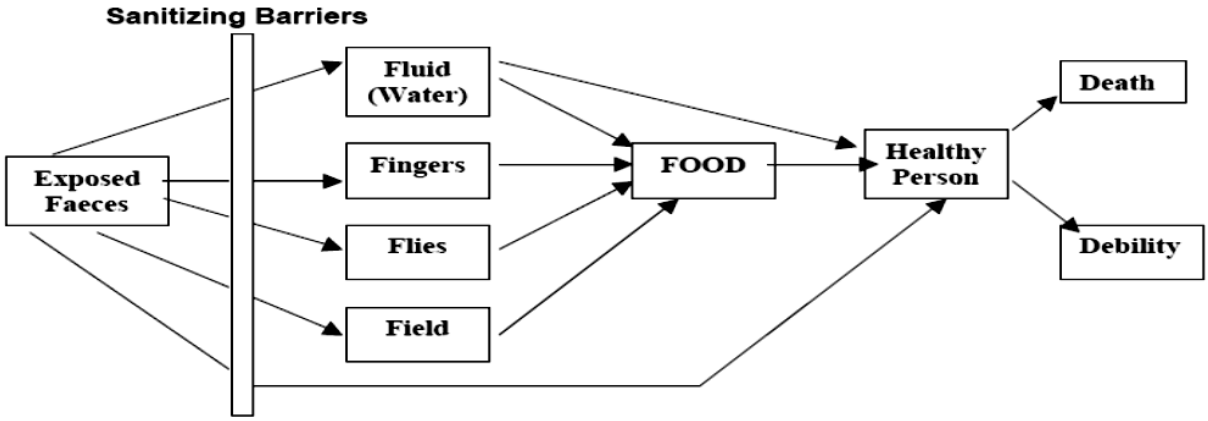
The authors gave the following graphic account of the risk factors:

> The majority of the residents had pit or pour-flush latrines. The platforms of many latrines, especially of the pit types, were not neat. When this observation was made during the dry season there was a shortage of water in the town and the majority of pourflash latrines were also not functional. Be it for this reason or for convenience, many children and few adults were observed deafecating in the fields and street sides, more commonly in the early morning and late afternoon. Vegetables are grown in plots along the lake shore during the dry season or little rains. These plots were areas of land exposed as the lake water receded. The vegetables were watered with water retained by temporary

> pockets. Many people owned vegetable plots and some owners worked in the plots bare-footed. Children accompanying their parents to the vegetable plots defecated in the plots. Vegetable leaves (both cabbage and lettuce) and water from the temporary pockets examined for parasites were found to contain amoebae cysts and Ascaris ova. Unidentified rhabditiform larvae were encountered in the soil samples. [22]

It is was difficult to establish a direct link between human waste disposal, or lack thereof, and parasitic infections. A government report [23] on this matter estimated latrine coverage in Ethiopia at 49.7 percent for urban areas and a dismal 3.9 percent in rural areas. The report also addressed the direct links mentioned above by focusing on "the Five Fs" – faeces, fluid, finger, flies, field (see below).

Figure 1 :- Mode of Transmission of excreta Borne Diseases.



This Diagram, known as Five "F" Shows Transmission routes (Five "F") of excreta Borne Diseases.

Source: [23]

The following summary is based on a recent work on intestinal parasitism in Ethiopia by Habtamu Belete and Helmut Kloos [18].

Intestinal Protozoa

Amebiasis:

Amebiasis is an illness caused by protozoa knows as *Entamoeba histolytica*.

> "This is a single celled parasitic animal, i.e., a protozoa, that infects predominantly humans and other primates. Diverse mammals such as dogs and cats can become infected but usually do not shed cysts (the environmental survival form of the organism) with their feces, thus do not contribute significantly to transmission. The active (trophozoite) stage exists only in the host and in fresh feces; cysts survive outside the host in water and soils and on

foods, especially under moist conditions on the latter. When swallowed they cause infections by excysting (to the trophozoite stage) in the digestive tract. [24]

This is one of the most commonly reported parasitic infections in Ethiopia. Average rates as high as 19% were found in a survey of 1850 children in 50 rural schools; 15% in a survey of 12,457 persons in 97 study communities; 12% in Jijiga; 14% in Metehara Sugar Estate; 12% among 698 school children in 17 rural communities in Shewa; 16% among highland migrant farm workers in the Awash Valley; 21.9% in Asendabo in Jimma Zone; and 4.2% around lake Tana. "Significantly, more females than males were infected "…indicating that transmission levels are either higher in the domestic domain or reflect lowered immune response during pregnancy" [18]. As in most other countries, the infection rate declines with age. Recent studies have also noted a co-infection involving *Entamoeba histolytica* and the HIV virus. "Among 147 AIDS patients with diarrhea-associated parasitic infections, 8.2% had *E. histolytica* infections [18].

Giardiasis

Studies on giardiasis in Ethiopia are less common but it seems that this parasitic infection is not as widespread as amebiasis. Giardiasis "…is a diarrheal illness caused by a one-celled, microscopic parasite, *Giardia intestinalis* (also known as *Giardia lamblia*). Once an animal or person has been infected with *Giardia intestinalis*, the parasite lives in the intestine and is passed in the stool" [25] A co-infection with HIV had been noted in Addis Ababa where 4.1% AIDS patients were found to be in this category [18].

Intestinal Helminths

Cestodes:

"Cestodes are tapeworms…, specialized flatworms, looking very much like a narrow piece of adhesive tape. Tapeworms are the largest, and among the oldest, of the intestinal parasites that have plagued humans and other animals since time began." [26]. The most important cestodes affecting humans and animals in Ethiopia are *Taenia saginata* and *Hymenolepsis nana*, the former due to the custom of eating raw meat and the later due to unhygienic food consumption with contaminated hands and fingers that allows the ingestion of eggs from the faeces of an infected person. [18] "At the regional level, the highest rates of taeniasis were reported from towns in the eastern highlands, and the lowest rates from the western lowlands, where there are few cattle due to trypanosomiasis" [18]. Taenia infections are underreported in Ethiopia due to the custom of self-medication that discourages visits to modern health care services.

Hymenolepsis nana, the dwarf tapeworm, is probably the most common human tapeworm in the world. Humans acquire the infection by ingestion of ova. The ova, found in the stool of infected persons, have polar filaments (arrow) and are about 35 µm in diameter. The scolex of ***H. nana*** has four suckers and a short rostellum with hooks. ***H. nana*** is the only human tapeworm that does not require an intermediate host. Eggs passed in the stool are readily infective for humans, and autoinfections can occur. [27]

In Ethiopia prevalence rates as high as 61% were reported for *H. nana* (Kemisie, South Wello Zone) and 78% "…among students in 50 communities in central and northern highland" [18]

Nematodes

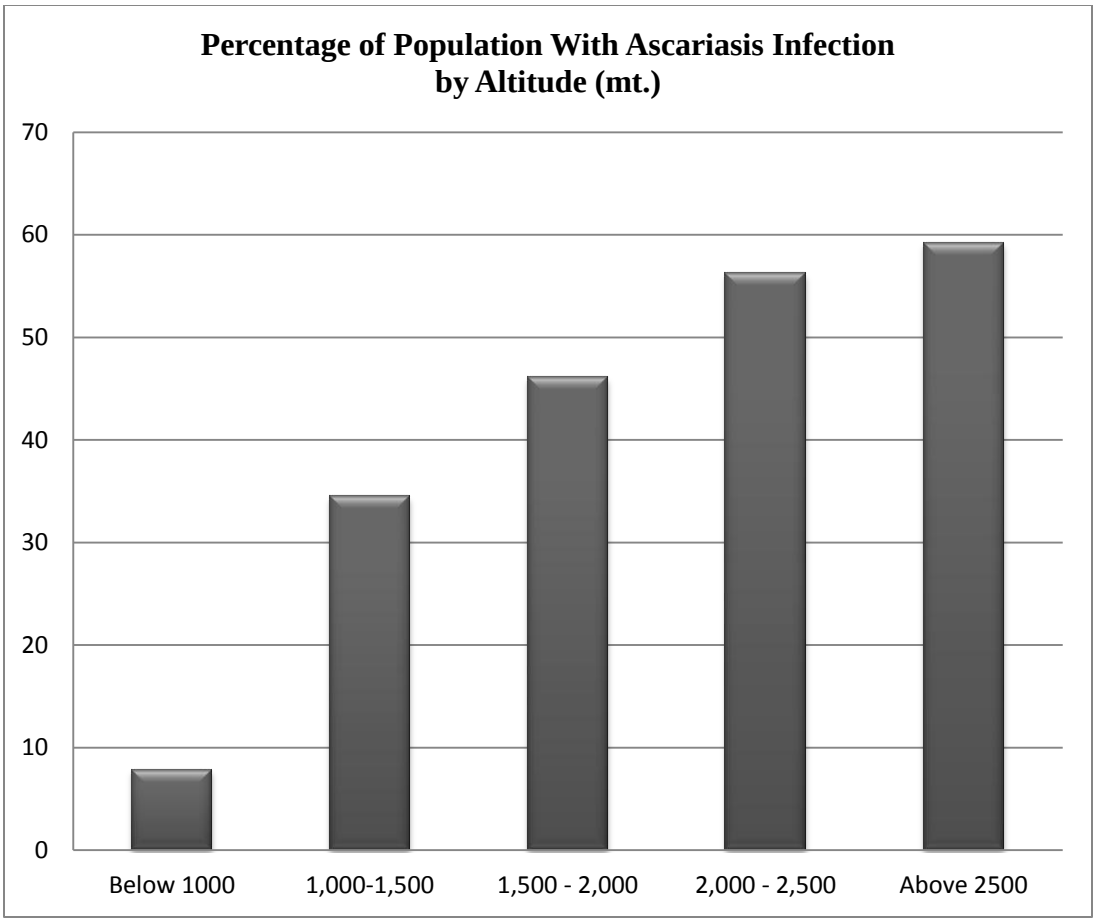
"Parasitic nematodes are major challenges to human health and agriculture. Parasitic nematodes, including whipworm, Ascaris, hookworm, and filarial worms, currently infect about 3 billion people." [27].

Ascariasis

Ascariasis is caused by the parasitic round worm *A. lumbricoids*, and found among literally all segments of the Ethiopian society. Of all the parasitic illnesses infecting adults and children in Ethiopia this is "…probably the most common parasitic disease, particularly in the malaria-free highlands" [18]. The most comprehensive study on ascariasis in Ethiopia was conducted between 1979 – 82 involving over 32,000 persons with an astonishing prevalence rate of 44% among the study participants two-thirds of whom were children. Infection rates as high as 59% percent were noted for some highland study sites above 2500 meters (see graph below), with low laying elevations (below 1000 meters) burdened to a much lesser degree (7.8%) [18]. Arid climates are unfavorable for the survival of the parasite's eggs. Re-infection after de-worming is also very common in Ethiopia. A study in the late 70's sought to show the link, if any, between ascariasis and malnutrition among Ethiopian children living in urban areas. It assumed a prevalence rate of "…. about 10% in infants, 28% in children 1-2 years old, and 62% in children over 3 years" [28]. The double-blind study found no effect of ascariasis on the nutritional status of children.

Indoor and outdoor biotic contamination of the living due to improper disposal of human waste and close proximity of humans and animals (especially in rural Ethiopia) accounts for the epidemic nature of parasitic infections. An epidemiological survey of a rural peasant association in southwestern Ethiopia gave the following results regarding ascariasis and the risk factors:

> "Over 90% of the households had domestic animals (dogs, cattle, goat, chickens, etc.) roaming freely within the same house, and all households had problems with insects and other vermin such as flies, lice, bedbugs, and rats. With regard to the degree of ventilation and illumination of the huts, only 10% of households had windows, while just over 20% had dual egresses. More than half of all households inspected were in need of significant maintenance, such as leaky roofs and damaged walls…. At the time of the survey, the two-week period prevalence for any childhood illness was 32.6%, with diarrheal disease representing the most frequent cause…. Diarrheal illnesses were described by mothers as watery (54%), mucoid (26%), or bloody (20%)…. Stool samples from 103 randomly chosen individuals in the kebele were examined and 94 (91.2%) were found to be positive for either a single or multiple parasitic infection (Table 5). Infection with Ascaris lumbricoides was most prevalent (76 cases), followed by hookworm (28 cases), Trichuris trichura (8 cases), and Entamoeba histolytica (3 cases). Single parasitic infection was by far the most common finding, representing 79.7% of all positive cases. Concomitant infection with two and three parasites were observed in 18.1% and 2.1%, respectively." [29]



Source: [Based on 18]

Ascariasis: A Global Perspectives:

There are over 1.5 billion cases of ascariasis in the world, and 3million children die of enteric diseases, mostly in the Asian and African continents, every year. "Although the infection is often asymptomatic, its effects may contribute substantially to child morbidity when associated with malnutrition, pneumonia, enteric diseases and vitamin A deficiency" [30]. The reasons for the high prevalence include the ability of infective eggs to survive in harsh environments, the very high number of eggs produced by the female parasite, lack of protection conferred by a prior infection, and unsanitary conditions surrounding most dwellings in developing counties [31].

> "The highest prevalence of ascariasis occurs in tropical countries where warm, wet climates provide environmental conditions that favor year-round transmission of infection. This contrasts to the situation in dry areas where transmission is seasonal, occurring predominantly during the rainy months … The prevalence is also greatest in areas where suboptimal sanitation practices lead to increased contamination of soil and water. The majority of people with ascariasis live in Asia (73 percent), Africa (12 percent) and South America (8 percent), where some populations have infection rates as high as 95 percent …."[31]

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Epidemiology of the Agent

Of all infective nematodes, A. lumbricoides is the largest intestinal nematode of man. "The female worms are larger than the males and can measure 40 cm in length and 6 mm in diameter" [31]. The illness occurs at all ages but 2 to 10 year-olds are most affected with prevalence decreasing after age 15. "Infections tend to cluster in families, and worm burden correlates with the number of people living in a home" [31]. This is a hardy parasite with ova that can survive for up to 10 years in the environment under prolonged conditions of warm, shady, and moist surroundings. Infection often occurs during the consumption of contaminated food or water, or when handling food or eating with contaminated hands. Then the following happens:

> " Larvae usually reach the lungs by four days after ingestion of eggs. Within the alveoli of the lungs, the larvae mature over a period of approximately 10 days, then pass up via bronchi and the trachea, and are subsequently swallowed. Once back in the intestine, they mature into adult worms. Although the majority of worms are found in the jejunum, they may be found anywhere from the esophagus to the rectum. After approximately two to three months, gravid females will begin to produce ova which, when excreted, complete the cycle. Adult worms inhabit the lumen of the small intestine, usually in the jejunum or ileum. They have a life span of 10 months to 2 years and then are passed in the stool. When both female and male worms are present in the intestine, each female worm produces approximately 200,000 fertilized ova per day. When infections with only female worms occurs, infertile eggs that do not develop into the infectious stage are produced. With male-only worm infections, no eggs are formed. The ova are oval, have a thick shell, a mamillated outer coat, and measure 45 to 70 µm by 35 to 50 µm. The ova are passed out in the feces, and embryos develop into infective second-stage larvae in the environment in two to four weeks (depending upon environmental conditions). When ingested by humans, the ova hatch in the small intestine and release larvae, which penetrate the intestinal wall and migrate hematogenously or via lymphatics to the heart and lungs. Occasionally, larvae migrate to sites other than the lungs, including to the kidney or brain." [31]

Trichuriasis:

Trichuriasis is a parasitic infection caused by soil-borne *Trichuris trichura*. Its etiology follows the same course as *Ascaris* "…but there is no pulmonary migration of the larvae; the worms develop in the large intestine". There are very few studies in Ethiopia regarding this disease but a recent literature review has shown that Triachuriasis incidences tend to follow the same pattern as Asicasiasi, including the altitudinal pattern. "On the central and northern plateau *T. trichuria* was found in more than 90% of 50 communities [surveyed], with a mean prevalence of 49%" [18]. Like Ascariasts the illness mostly infects children.

Epidemiology:

Trichuris trichura is the third most common round worm of humans. It occurs worldwide, with infections more frequent in the hot tropics, in places with poor sanitation and among children. With the estimated infection of 800 million people, mostly in Asia and Africa, the global burden of this diseases is enormous.

> The adult worms (approximately 4 cm in length) live in the cecum and ascending colon (the first part of the large intestine). Female worms in the cecum shed between 3,000 and 20,000 eggs per day. The unembryonated eggs are passed with the stool. In the soil they embryonate and become infective in 15 to 30 days. After ingestion (soil-

contaminated hands or food), the eggs hatch in the small intestine, and release larvae that mature and establish themselves as dults in the colon. The adult worms are fixed in that location, with the anterior portions threaded into the mucosa (the lining) of the intestine. The females begin to oviposit (lay eggs) 60 to 70 days after infection. The life span of the adults is about 1 year" [32]

Hookworms

Due to poverty, improper human waste disposal, and the custom of walking bare-feet, hookworm infection is widespred in Ethiopia especially among the adult agricultural population. The following summary regarding hookworm infections in Ethiopia are excerpts from Habtamu Belete and Helmut Kloos's literature review on the subject [18]:

- "The hookworms which most commonly infect humans are *Ancylostoma duodenal* and *Necator americanos*, but in Ethiopia the later is significantly more common…"
- The survey of 5,506 school children in 10 provinces in 1983 showed the attitudinal rage of high hookworm prevalence to be between 800 and 1200 meters. This was expected because of optimal rainfall requirement (over 1200mm), and temperature requirement (26-32 degrees Celsius) of the ovum.
- Significant variations in infection rates were noted. Results for 10 school-age populations in the lowlands of Gonder showed infection rates ranging from 7% to 67%, and among 16 villages in western Abaya from 4% to 75%, and by age group in Melka Sedi plantation from 70% in the 15 – 34 age group (females) to 80% in the 5 – 14 age group (males).
- Favorable conditions also exist around irrigation schemes. "Settlers from the northern highlands [have] the same high hookworm infection rates as indigenous farmers within 3 to 4 years of moving to western Ethiopia…Thus, a large increase in hookworm prevalence may have taken place as a result of the 1984/85 settlement program".
- Another example comes from the arid lowland of the Awash Valley where indigenous pastoral nomads with unaltered cultural/economic life show far fewer signs of infection with hookworm. Population movements and shifts from pastoralism to farming creates environment that favor parasite survival, transmission and spread. These ecological changes are also anticipated to take place in several other areas set aside for future irrigation farming.
- Soil type is important with *N. americanus* infections more common in flat areas with sandy soils and *A. duodenale* in "…well drained sandy loams on slopes…"
- Prevalence is high in endemic areas among all ages (slightly higher among males), partly due to re-infection and lack of shoes.

A Global Perspective

"Hookworms are thought to infect 800 million people worldwide". [33]. People become infected by direct contact with contaminated soils, usually by walking barefoot, or swallowing contaminated soil accidentally or with food. Hookworms suck blood voraciously and cause iron deficiency anemia thereby adding to the long list of agents responsible for diseases burdens in the developing world, especially among children, pregnant women, and nursing mothers. In children, this worm infestation adds to the risk factors for intellectual, cognitive, and growth retardation. It also contributes to "…. intrauterine growth retardation, prematurity, and low birth weight among newborns born to infected mothers" [33]. The disease is rarely fatal, however.

> Hookworms have a complex life cycle that begins and ends in the small intestine. Hookworm eggs require warm, moist, shaded soil to hatch into larvae. These barely visible larvae penetrate the skin (often through bare feet), are carried to the lungs, go through the respiratory tract to the mouth, are swallowed, and eventually reach the small intestine. This journey takes about a week. In the small intestine, the larvae develop into half-inch-long worms, attach themselves to the intestinal wall, and suck blood. The adult worms produce thousands of eggs. These eggs are passed in the feces (stool). If the eggs contaminate soil and if conditions are right, they will hatch, molt, and develop into infective larvae again after 5 to 10 days. [34]

> "The symptoms can be linked to inflammation in the gut stimulated by feeding hookworms, such as nausea, abdominal pain and intermittent diarrhea, and to progressive anemia in prolonged disease: capricious appetite, pica (or dirt-eating), obstinate constipation followed by diarrhea, palpitations, thready pulse, coldness of the skin, pallor of the mucous membranes, fatigue and weakness, shortness of breath and in cases running a fatal course, dysentery, haemorrhages and oedema." [33]

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