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REVIEW ARTICLE

AN OVERVIEW OF NEGLECTED TROPICAL DISEASES IN ETHIOPIA

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ABSTRACT: This review presents an overview of the neglected tropical diseases, the magnitude of the problem and the status of intervention in Ethiopia. Furthermore, the review attempts to identify gaps in information and the way forward. Thirteen poverty-promoting diseases have recently been designated as neglected tropical diseases (NTDs). These diseases include visceral leishmaniasis (VL), human African trypanosomiasis (HAT), Chagas disease, hookworm infection, ascariasis, trichuriasis, lymphatic filariasis, onchocerciasis, drancunculiasis, schistosomiasis, trachoma, leprosy (Hansen's disease), and Buruli ulcer. Except for Chaga's disease, all other officially designated NTDs occur in Ethiopia, with varying magnitude. Soil-transmitted helminthiasis (STHs) and schistosomiasis, the profiles of which have superficially been considered elsewhere, are the most prevalent and yet neglected diseases in Ethiopia. Leprosy, trachoma, onchocerciasis and dracunculiasis have drawn attention from the Ministry of Health and its partners, as well as their control is also on track. The Malaria and Other Vector-Borne Diseases Prevention and Control Team, in collaboration with other partners, has developed diagnosis and treatment guideline for VL to establish the control program. The distribution of Bancroftian filariasis is also being mapped to move towards institution of intervention. Human African trypanosomiasis (HAT) which used to be endemic in the southwestern parts of the country has not recently been reported from the same foci, perhaps due to dramatic ecological changes. Buruli ulcer is the other neglected tropical disease, only two cases of which have recently been reported in Ethiopia. Pediculosis, tungiasis and non-parasitic conditions such as podoconiosis and goiter are also presented as neglected diseases of public and socioeconomic importance in Ethiopia.

Key words/phrases: Ethiopia; Neglected tropical diseases; Non-parasitic conditions/diseases.

INTRODUCTION

Neglected tropical diseases (NTDs) are those diseases that have not received the attention and resources they deserve from governments and the

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pharmaceutical industries, because the populations they afflict are generally poor and marginalized, as well as they are not seen as a viable market for new treatments and control interventions (Chitsulo, 2005). In other words, NTDs are not prioritized as major public health burdens as compared to the "big three" diseases (malaria, HIV-AIDS and tuberculosis) and thus are not subject to compulsory reporting in most developing countries (Ehrenberg and Ault, 2005).

The most important neglected tropical diseases include three protozoan infections: visceral leishmaniasis (VL), human African trypanosomiasis (HAT), and Chagas disease; seven helminth infections: hookworm infection, ascariasis, trichuriasis, lymphatic filariasis, onchocerciasis, drancunculiasis, and schistosomiasis; three bacterial infections: trachoma, leprosy (Hansen's disease), and Buruli ulcer (Hotez *et al*., 2006). Cysticercosis, food-borne trematodiases, and some other parasitic infections could also be added to the list of NTDs (Pawlowski, 2006; Keiser and Utzinger, 2005; Lun *et al*., 2005).

Ethiopia is one of the tropical countries where NTDs are prevalent and widespread due to favorable climate and prevailing poverty under which disease agents and their vectors/intermediate hosts flourish best. Among the thirteen officially designated NTDs considered to be globally important (Hotez *et al*., 2006), only Chagas disease is not endemic in Ethiopia. The rest are known to occur with varying prevalence of infections. Furthermore, other parasitic diseases such as hydatidosis/echinococcosis due to *Echinococcus granulosus*, tungiasis due to *Tunga penetrans*, and pediculosis (louse infestation), as well as noninfectious conditions such as goiter and podoconiosis (non-filarial elephantiasis) can also be added to the list of NTDs in Ethiopia. Nevertheless, much has not been done to describe the epidemiological characteristics of most of these latter parasitic infestations, particularly of tungiasis and pediculosis, as well as non-infectious conditions.

Published work on bacterial and parasitic diseases in Ethiopia is available in one form or another. Nevertheless, only few of these earlier works have addressed these diseases as neglected tropical diseases. We review here to provide highlights of epidemiological situations of neglected tropical diseases in Ethiopia, disease burden and the present control status so as to draw the attention of policy makers to consider intervention for NTDs that have not yet been addressed. Furthermore, the review also tries to indicate research questions, particularly for NTDs for which there is a dearth of

epidemiological information in Ethiopia.

EPIDEMIOLOGICAL CHARACTERISTICS, DISEASE BURDEN AND CONTROL STATUS

Protozoan infections

Visceral leishmaniasis (VL)

Visceral leishmaniasis (VL) and human African trypanosomiasis (HAT) are the protozoan neglected tropical diseases that are known to occur in Ethiopia. At present, it is only human VL that represents both public health and socio-economic significance in the country while HAT only exists as a risk.

VL is caused by *Leishmania donovani* complex and is transmitted by *Phlebotomus orientalis*, *P. martini*, and *P. celiae* (Asrat Hailu *et al*., 1995; MOH, 2006; Teshome Gebre-Michael and Lane, 1996). Since its first report in the 1940s in lower Omo plains of the southwestern Ethiopia (Coles *et al*., 1942; Anderson, 1943), VL has repeatedly been reported to be endemic in several lowland areas of the country, including Matema and Humera in the northwest, the Segen valley and its surroundings, Konso and the lower Omo plains, all in the southwest (Fuller *et al*., 1974; Fuller *et al*., 1979; Teklemariam Ayele *et al*., 1988; MOH, 2006).

In Aba Roba VL endemic focus, southwestern Ethiopia, the overall crude mortality rate due to VL was estimated to be 18.2/1000 (Ahmed Ali and Ashford, 1994) suggesting that mortality due to VL in the absence of treatment is very high. Nationwide, cases of VL are estimated at 4,500 – 5, 000 annually from at least 40 endemic foci (MOH, 2006). Considering the crude mortality rate estimated by Ahmed Ali and Ashford (1994) and assuming that the disease runs its course, the number of lives lost only due to VL would be estimated at 82 to 91 annually.

Although much has been known about the epidemiology of VL in Ethiopia, there are still gaps to be bridged in the epidemiology of the disease. For instance, the efforts to incriminate reservoir hosts have not so far been complete (Asrat Hailu *et al*., 2006) and the fact that new foci have continued to be reported shows the need for continued epidemiological studies.

VL seems to receive increased attention in Ethiopia, perhaps as a result of recent findings of the HIV-leishmaniasis co-infection (Nega Berhe *et al*., 1995; 1999; Dawit Wolday *et al*., 2001). Furthermore, severe complications of VL due to malaria have also been recognized (MOH, 2006). Be it for

these or other reasons, the Malaria and Vector-borne Diseases Prevention and Control Team of the Federal Ministry of Health, in collaboration with other partners, has recognized the disease and produced diagnosis and treatment guideline to establish control program. Thus, VL control and prevention has now been put in place and it is no longer neglected if the control effort by the national disease control program and technical and financial support by the partners are made sustainable.

Human African trypanosomiasis (HAT)

HAT due to *Trypanosoma brucei rhodesiense* for which *Glossina morsitans* serves as the major vector has been known to be endemic in Gambella area in the southwestern part of Ethiopia since the first reported case of the disease in 1967 from Maji area (Baker and McConnell, 1969). An outbreak of the disease recognized as sleeping sickness appeared from 1968 to 1970 along the Gilo River (McConnell *et al*., 1970; Hutchinson, 1971); sporadic cases were also reported from the same parts of the country in the 1970s but the disease has not since been spread to other parts of the country.

Although animal trypanosomiasis causes tremendous livestock loss in Ethiopia, HAT is now believed to represent little or no public and socio-economic importance. Entomological and parasitological surveys carried out in the 1990s in Gambella area, southwestern Ethiopia, revealed that there was neither a single case of trypanosomiasis nor the major vector, *Glossina morsitans* in areas previously endemic for trypanosomiasis (Tekola Endeshaw *et al*., 1997). This was attributed to dramatic ecological changes that have taken place in the area over the last few decades. Nevertheless, active entomological and parasitological surveillances need to be proactively in place since the disease outbreak can occur with resumption of suitable transmission ecology. HAT surveillance can be linked with bovine trypanosomiasis intervention activities as considerable national control efforts are underway for the latter by governmental and nongovernmental organizations. Thus, there is a need for inter-sectoral collaboration between the Ministry of Agriculture and Rural Development and the Federal Ministry of Health for HAT surveillance.

Helminth infections

Helminthiasis constitutes the second causes of outpatient visit in Ethiopia (MOH, 2004a). This is particularly true for the most widespread and yet neglected schistosomiasis and soil-transmitted helminthiasis. Under helminthic infections, we have only considered lymphatic filariasis (LF) and

onchocerciasis among the major helminthic NTDs as well as hydatidosis as the rare NTD that chiefly affects the most neglected and marginalized pastoralist communities, and dracunculiasis as NTD targeted for elimination. STHs and schistosomiasis profiles have superficially been considered elsewhere (WHO, 2006).

Bancroftian filariasis

Bancroftian filariasis, lymphatic filariasis (LF) due to *Wuchereria bancrofti*, is known to be endemic in southwestern parts of Ethiopia since 1971 (McConnel and Schmidt, 1973). All parasitological surveys conducted to date have confirmed that the disease is endemic in southwestern parts of the country with varying prevalence of infections (McConnel and Schmidt, 1973; McConnel *et al*., 1976; Leykun Jemaneh and Dereje Kebede, 1995a, b), and the highest reported microfilaremia rate being as high as 80% (McConnel *et al*., 1976).

Bancroftian filariasis in Ethiopia, in its severest form, has been known to involve the lower extremities and genitalia thereby causing permanent and long-term disability (McConnel *et al*., 1976). On the other hand, Leykun Jemaneh and Dereje Kebede (1995b) observed only hydrocoele and enlargement of glands in the groin but did not find a case of elephantiasis in southwestern parts of Ethiopia, suggesting that bancroftian filariasis might be of recent phenomenon in the area. Such variations in disease manifestations may also result from genetic variations of the human hosts or the parasite *per se*, justifying molecular characterization of the parasite.

According to Leykun Jemaneh and Dereje Kebede (1995a, b), Bancroftian filariasis seems to be neglected in Ethiopia because of a belief that is linked to non-filarial elephantiasis. The speculation of these authors emanated from the fact that elephantiasis of the feet, which most investigators have attributed to soil origin or podoconiosis, is widespread in many regions of Ethiopia (McConnel *et al*., 1976; Hailu Birrie *et al*., 1997; Kelemu Destas *et al*., 2003). Nevertheless, recently, the Ministry of Health, in collaboration with the Carter Center and other collaborators, has planned to map the distribution of the disease towards institution of intervention.

Onchocerciasis

Onchocerciasis, also referred to as river blindness, is a disease caused by *Onchocerca volvulus*. In Ethiopia, the disease is transmitted mainly by *Simulium damnosum* complex in the main river valleys in western lowlands while *Simulium neavei* group (*S. woodi ethiopiense*) is a major vector in the

highlands (Oomen, 1969; Zein Ahmed, 1993; Teshome Gebre-Michael and Teferi Gemetchu, 1996; Seyoum Taticheff *et al*., 2006).

Onchocerciasis is known to be limited to the southwestern, western and northwestern parts of Ethiopia where there are many rivers with vegetation that provide suitable breeding habitats for blackfly vectors (Zein Ahmed, 1993; Teshome Gebre-Michael and Teferi Gemetchu, 1996; Seyoum Taticheff *et al*., 2006). The recent Rapid Epidemiological Mapping of Onchocerciasis (REMO) also confirmed that onchocerciasis is endemic in villages found along the major rivers in the western parts of Ethiopia, i.e., Tekeze, Abay/Blue Nile, Baro, Omo, Rift Valley, and Ganale rivers (Desta Alamerew *et al*., 1999).

In almost all studies conducted so far, onchocerciasis is more common in males than in females and among adults of middle age than in children in Ethiopia (Seyoum Taticheff *et al*., 1987; Zein Ahmed, 1988), with peak infection rates in the age group 15 – 45 years (Seyoum Taticheff *et al*., 2006). This is attributed to more exposure of adult males to the bite of blackfly vectors as males are more involved in field work in the forest and savanna areas near rivers and streams (Wondimu Workneh *et al*., 1993; Seyoum Taticheff *et al*., 2006).

In the 1980s, it was estimated that about 1.4 million people were infected while about 7.3 million people were at risk of infection in endemic areas of about 200,000 sq. km. (Zein Ahmed, 1988), with the prevalence of infection ranging from 6.9% in Kuwara to 85.3% in Teppi, southwestern Ethiopia (Rasheed, 2007). The highest prevalence of the disease in the southwestern part could be due to the large number of rivers flowing in the forests, maintaining both high levels of transmission as well as intensity of the disease (Asrat Hailu *et al*., 2002). Considering the rapid population growth in Ethiopia and dramatic ecological changes associated with water resources development and re-settlement in deforested areas as well as global warming, the number of people that would be affected and at risk of having infection as well as the prevalence of the disease would be expected to be much greater than the earlier estimate.

Although high prevalence of onchocerciasis and microfilarial load reaching as high as 34 microfilariae per mg of skin (Amaha Kebede *et al*., 1993) were reported, the disease is rarely associated with blindness in Ethiopia. Nevertheless, onchocerciasis causes visual impairments and severe skin diseases such as debilitating and disfiguring onchodermatitis in a considerable number of infected people (Wondimu Workneh *et al*., 1993;

Asefa Aga *et al*., 1995; Genene Mengistu *et al*., 2002; Enk *et al*., 2003).

In Ethiopia, it appears that much is known about the distribution and magnitude of onchocerciasis. The disease has also been recognized as a major public health problem (Seyoum Taticheff *et al*., 2006) and ivermectin-based control is well underway. Nevertheless, studies on the ocular manifestations of the disease in different endemic regions of the country and the economic impacts caused by the disease are meager. Hence, further studies on ocular manifestations and socio-economic impacts of the disease are required. Furthermore, it is also proposed that the Ethiopian *Onchocerca* parasites be genetically characterized relative to the blinding parasites in West Africa.

Dracunculiasis

Dracunculiasis or "Guinea worm" infection is a painful and debilitating disease caused by the nematode *Dracunculus medinensis*. Humans catch the disease when freshwater cyclops infested with *Dracunculus* larvae are ingested in drinking water (King, 1993).

Information on the occurrence and distribution of dracunculiasis in Ethiopia remained very little and unreliable until the national dracunculiasis eradication program was initiated in the early nineties (Teshome Gebre *et al*., 2006). Although some investigators doubted the endemicity of dracunculiasis in Ethiopia (Kloos and Zein Ahmed, 1993), mainly due to the absence of systematic survey and active case detection, few reports made in the late 1980s and early 1990s proved beyond doubt that autochthonous transmission of the disease takes place in the southwestern part of the country (MOH, cited in Teshome Gebre *et al*., 2006; Leykun Jemaneh and Seyoum Taticheff, 1993).

Dracunculiasis has been targeted for eradication from Ethiopia by the national guinea worm eradication programs and the Carter Center. According to CDC weekly report (CDC, 2007), there have been 29 cases in 2005, 1 case in 2006 and no case in 2007 from Ethiopia. Nevertheless, the fact that the Sudan reported 1,609 cases in 2007 may pose a threat to the eradication program in both countries. If there will be a security problem on the border and the disease control programs of the two countries do not work together in close collaboration towards achieving the same goal, infected individuals can cross the national boundary and the disease can be transmitted either way.

Hydatidosis

Human hydatidosis caused by *Echinococcus granulosus* has been known to occur in the southwestern part of Ethiopia (Fuller *et al*., 1974; Fuller, 1976; Fuller and Fuller, 1981; Lindtjorn *et al*., 1982). Based on the surveys involving 1,342 individuals in various regions of Ethiopia, Fuller and Fuller (1981) found 4.8% with palpable abdominal cysts and 15% with hepatomegaly in the Dassanetch and Nyangatom tribes in the lower Omo River Valley in the southwest. In another population-based study using ultrasound scanner among the Hamar of Ethiopia, Klungsoya *et al*. (1993) reported an overall prevalence of 0.7% (7/990), with higher rate among women (4.8%). The prevalence of hydatidosis among females in the Dassanetch and Nyangatom tribes and the Hamar of Ethiopia, which was 4.8% in both cases, is almost comparable to prevalence figures (5 to 10%) reported for the Turkana in Kenya, which has been considered to be the highest in the world (Fuller and Fuller, 1981; Nelson,1986; Klungsoya *et al*., 1993).

Since hydatidosis occurs in the most neglected and marginalized pastoralist communities in Ethiopia, only very little work has been done to describe the epidemiological characteristics of the disease. Consequently, available data on this disease is meager to show the magnitude of the problem and its distribution. Hence, it is suggested that further epidemiological studies using available modern diagnostic tools be carried out to generate baseline data and map the distribution of the disease for future intervention.

Bacterial infections

Trachoma

Trachoma, caused by *Chlamydia trachomatis*, is a contagious disease of the eye and represents one of the leading preventable causes of blindness worldwide. Factors that promote the transmission of trachoma, increase the frequency of re-infection and those that enhance the severity of the disease include overcrowding, low standards of hygiene, inadequate water supplies, illiteracy, poverty and low health services (Kusner, 1993; Wondu Alemayehu and Samson Bayu, 2006), as is common in most parts of Ethiopia.

In Ethiopia, trachoma is a public health problem and accounts for 35-50% of cases of blindness (Negussie Zerihun and Mabey, 1997; Mengiste Mesfin *et al*., 2006). Recent estimates showed that there are about 1.2 million blind people in Ethiopia, of which 87.4% is due to avoidable causes (Yemane

Berhane *et al*., 2006). Attributing 35-50% of the blindness to trachoma, it is estimated that there are about 420, 000 - 600,000 trachoma blind people in Ethiopia. The disease affects the most vulnerable members of the communities, particularly women and children (Wondu Alemayehu and Samson Bayu, 2006). The national prevalence of active trachoma in the age group 1-9 years is 40.1% (Yemane Berhane *et al*., 2006). Thus, the contribution of trachoma to poor health and low socio-economic development in Ethiopia is enormous.

Cognizant of the burden of global blindness, the World Health Assembly passed a resolution on the elimination of avoidable blindness globally, by urging the UN member states to commit themselves to supporting *VISION 2020: the Right to Sight*, the global initiative for the Elimination of Avoidable Blindness. In line with this, Ethiopia developed and implemented a National Five Year *VISION 2020: the Right to Sight* Strategic Plan (2001 - 2005). The Strategic Plan for Eye Care (2006 - 2010) developed as a second phase of *VISION 2020: the Right to Sight* is also being implemented.

For full realization of the goal of *VISION 2020: the Right to Sight*, which is elimination of avoidable blindness, the Ministry of Health needs to sustain the lead it has already taken. To sustain the intervention program that has been put in place, the Ministry of Health needs to work in close collaboration with Regional Health Bureaus as well as national and international NGOs that are providing financial and technical support for the program. Now that more reliable data on trachoma is available at national level (Yemane Berhane *et al*., 2006), evaluation of the program using available data as a reference is indicated for further inputs and scaling up of the program.

Leprosy

Leprosy, caused by *Mycobacterium leprae*, is a chronic granulomatous disease that affects primarily the skin and peripheral nerves, and secondarily some internal organs such as the testis and the eye (Rojas-Espinosa and Lovik, 2001). The disease is transmitted via droplets, from the nose and mouth, during close and frequent contacts with untreated cases. Leprosy is a serious public health problem, owing to the permanent disabilities it causes, as well as its social consequences such as discrimination and stigma (WHO, 2000). Nevertheless, leprosy has not been the dreaded disease it used to be since the advent of multidrug therapy (MDT) in 1983 (Fekadesilassie Mikru *et al*., 2006).

In Ethiopia, the prevalence of registered leprosy cases were 80,927 in 1982 while the number of cases were reduced to 5,852 in 2002 (Fekadesilassie Mikru *et al*., 2006). Fekadesilassie Mikru and his co-workers also pointed out that child rate among new cases was 12.5% in 1993 and 5.8% in 2002. Although child rates are important indicators for active transmission, the decline evidently shows that leprosy transmission is gradually dwindling owing to intervention efforts that have been put in place by the national control program and the advent of MDT since the 1980s. Hence, the intervention efforts need to be sustained until the disease is eventually eliminated.

Buruli ulcer

Buruli ulcer is one of the chronic skin ulcers caused by *Mycobacterium ulcerans* (Thangaraj *et al*., 1999). Although the occurrence of chronic skin ulcers is known to be contained in lowland areas and accounts for 6.8% of all skin diseases in Ethiopia (Dagnatchew Shibeshi, 2000), only a single health facility based study was carried out to assess the occurrence of Buruli ulcer (Yonas Kassahun, 2003). In this study, 2 cases of ulcer were found to be due to *Mycobacterium ulcerans*. Based on only these two cases, it is very difficult to conclude that the disease is prevalent in Ethiopia. Hence, it is suggested that systematic survey of Buruli ulcer be carried out for active case detection in suspected lowland areas using the commonly used confirmatory methods.

Pediculosis and Tungiasis

Both pediculosis and tungiasis are ectoparasitic infestations due to arthropods. They are prevalent in the tropics where communities are the most deprived and personal hygiene leaves a lot to be desired. Infestation by these ectoparasites is extremely sensitive to the socioeconomic development and can be used as indicators of the socio-economic status of the endemic community.

Pediculosis refers to infestation with lice of the human body and it is prevalent worldwide. Lice are a nuisance in themselves and cause intense itching as well as they can cause embarrassment and concern for children, parents, and schools. Pediculosis is common among prisoners in jails, groups of soldiers under wartime condition, beggars and in other population groups in whom bathing and change of clothing are infrequent (Beaver *et al*., 1984).

Pediculosis represents a serious health risk in that lice are vectors

(transmitters) of disease etiologies as typhus and relapsing fever. In Ethiopia, pediculosis is highly prevalent, particularly in rural settings. Sholdt *et al*. (1979) extensively studied the epidemiology of human pediculosis in Ethiopia and showed that the body louse is commonly associated with major epidemics in the past. They also demonstrated that the causal organisms for typhus and relapsing fever reproduce in both the head and body lice. Other investigators have also described the endemicity of louse-borne relapsing fever (LBRF) in Ethiopia (Borgnolo *et al*., 1991; 1993). Infestation by lice is also responsible for the outbreak of epidemic typhus in Ethiopia (Pankhurst, 1976; Lakew Gebreselassie *et al*., 1990).

Although pediculosis does not involve significant public health problem *per se*, entomological and disease surveillance mechanisms must be in place to proactively cope with disease outbreak. The health extension program of Ethiopia which is already in place is expected to play a significant role in prevention and control of pediculosis and associated disease outbreak in the rural communities. In order to prevent and control pediculosis under crowding conditions such as in schools and prisoners, the disease control program should work with the Ministry of Education and other respective institutions to prevent and control pediculosis and associated health risks.

Tungiasis is caused by infestation with the female jigger flea *Tunga penetrans*, also variously referred to as the chigoe flea, sand flea, or nigua. Human infestation with *Tunga penetrans* is usually acquired from contact with soil or sand contaminated by pigs or dogs, from whose feet the eggs drop to the ground, where the larvae, pupae, and unfed adults develop (Beaver *et al*., 1984). Although no specific disease is known to be transmitted by jigger flea (*Tunga penetrans*), the female jigger flea makes wounds in the leg and exposes it to other diseases such as lock-jaw due to bacterial superinfection, gangrene and as the result of the wound inflicted, abnormal posture of the leg is often seen (Beaver *et al*., 1984; Feldmeier *et al*., 2002; MOH, 2004b).

In Ethiopia, tungiasis prevails in an undetermined magnitude in various localities, posing a serious health problem in almost all parts of the country (Anonymous, 1961). Since tungiasis affects the poorest of the poor, particularly in the rural settings, it is not perceived as disease by the health authorities and personnel. Nevertheless, in areas where it is common, particularly in areas of sandy soil, multiple tungiasis results in loss of toenails and deformation of digits. Therefore, there is a need for undertaking of epidemiological and entomological studies by research institutes and

Ministry of Health to gauge the magnitude of the problem and recommend feasible interventions.

Non-parasitic conditions

Goiter

Generally, in Ethiopia, the occurrence of goiter is associated with low iodine intake, but several studies indicated goitrogens that are suspected to be consumed as the staple food by the affected communities to be also responsible (Hana Neka Tebeb, 1993; Cherinet Abuye *et al*., 1998). Studies in some parts of Ethiopia have also shown that goiter rates depend on community water sources, i.e., piped water users versus surface water users (Hanna Nekatebeb *et al*., 1993). Furthermore, there were also evidences that coliforms and *E. coli* isolated from drinking water contributed to the high incidence of endemic goiter other than iodine deficiency (Cherinet Abuye and Kelbessa Urga, 2000). In general, the low levels of iodine in water and normally consumed diets appear to be the most responsible cause for the development of goiter; in such communities, the low level of maternal daily iodine intake, in turn, may affect the iodine content and the nutritional status of breast milk for the nursing infant (Cherinet Abuye and Kelbessa Urga, 2000).

A number of surveys carried out in different parts of the country reported the widespread occurrence of goiter in Ethiopia, with varying rates of the incidence and a mean incidence of 25% (Hana Neka Tebeb, 1993). In a study conducted among schoolchildren of different regions in the country, the gross prevalence was 53.3% and it was higher in females (56.1%) than in males (50.8%) (Cherinet Abuye and Kelbessa Urga, 2000).

In Ethiopia, therefore, instituting a program for the control of goiter inherently needs to be based on the distribution of iodized salt in endemic communities (Hana Neka Tebeb, 1993; Cherinet Abuye and Kelbessa Urga, 2000). Hence, in view of the varied causes depending upon the region, goiter can be prevented by ensuring normal iodine nutrition through instituting ways that avail iodinated salt and by taking other locally appropriate measures.

Podoconiosis (endemic non-filarial elephantiasis)

Podoconiosis (endemic non-filarial elephantiasis) is a geochemical disease occurring in individuals exposed to red clay soil derived from alkalic volcanic rock (Davey *et al*., 2007). It is a chronic, debilitating disorder producing lymphoedema of the lower limbs and it is a considerable public

health problem in at least 10 Central American, Northern India and tropical Africa countries including Ethiopia (Davey, 2006). The continued exposure of unprotected feet to zirconium (Zr) and beryllium (Be), known for their ability to induce granuloma formation in the lymphoid tissue of man, and present in a clay rich in colloidal silica particle, is a factor involved in the development of lymph node sclerosis leading to elephantiasis (Frommel *et al*., 1993). Recent studies have also indicated that access to clean water and host genetic factors are important determinants of susceptibility to podoconiosis (Davey, 2006; Davey *et al*., 2007).

In Ethiopia, podoconiosis is present in surface areas covering over one fifth of the country, but spares most of Tigray, the Blue Nile basin, the Rift Valley, the Awash Valley and the south-eastern lowlands (Price, 1976). Although systematic surveys have not been carried out at national level to provide the overall population affected, the prevalence of podoconiosis ranging from 0.42 to 9.1% have been reported in the affected communities (Oomen, 1969; Kelemu Destas *et al*., 2003).

In addition to its public health impact, elephantiasis due to podoconiosis represents tremendous social and economic impacts. Victims of elephantiasis are turned out of their families and resort to begging and the association between the diseases and begging is therefore one of reverse causality (Davey, 2006). Because of deformity, the affected people are ostracized from the communities and denied intermarriage. The economic loss of the country due to elephantiasis of soil origin is also very huge. In a limited study carried out in Woliata zone, Fasil Tekola *et al*. (2006) estimated total direct costs of podoconiosis at US$ 143 per patient per year and the total productivity loss for a patient at 45% of the total working days per year, causing a monetary loss equivalent to US$ 63. The investigators also estimated that the overall cost of podoconiosis exceeds US$ 16 million per year (only for this zone). Hence, assessment of economic loss at a national level is very pressing as the relative contribution of elephantiasis due to podoconiosis alone to the country's economic loss can be very huge.

Doubtlessly, elephantiasis due to podoconiosis represents considerable public health, social and economic problem in Ethiopia. The Ministry of Health needs to take initiative for intervention and put elephantiasis on the list of health problems that also need due attention for the fulfillment of the Millennium Development Goals. For the control of this geochemical condition, a simple preventive measures, such as use of robust footwear, is generally considered effective (Fasil Tekola *et al*., 2006).

CONCLUSIONS AND THE WAY FORWARD

In Ethiopia, as in other economically developing tropical countries, some NTDs have neither been addressed by health authorities nor by NGOs due to, among other factors, the top priority given to the biggest health challenges, i.e., the "big three" diseases. However, that situation has now been changing, mainly because of recognition of the synergistic relationships between NTDs, and the big three by renowned parasitologists, researchers as well as WHO. Consequently, global partnerships and initiatives have emerged to address the major NTDs and inexpensive or donated drugs for preventive chemotherapy of seven diseases are available.

For the control of NTDs, innovative and continued efforts should be mounted in order to link or integrate NTDs with the diseases of major challenges to humans (Molyneux and Nantulya, 2004; Hotez *et al*., 2006). Additionally, creative rethinking is needed in order to maximize the use of available resources for the overall success of disease control programs in humans. On the other hand, when the actual disease or similar diseases control programs exist elsewhere, then the strategy should be to solicit and attract international or multinational acceptance and support so as to extend and widen the benefits of the existing control efforts (Molyneux and Nantulya, 2004; Hotez *et al*., 2006). Such approaches will be instrumental to get the necessary assistances in terms of funding and personnel, while assuring the supporter that allocation of the resources is solely for the work on the control of NTDs.

For those NTDs that lack existing programs, because of the probable endemic nature of the diseases, further activity on advocacy and soliciting supportive responses from the global partnership for health and non-governmental organizations needs to be pursued. In brief, the way forward for the control of NTDs should be aimed to focus on the development of appropriate control strategies consisting of interventions such as chemotherapy and prevention through achieving access to clean water, clean surroundings and personal hygiene, and the use of simple footwear, control of insect vectors, public education and last, but not least, the access to basic health care.

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