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Review Article

Epidemiology of elephantiasis with special emphasis on podoconiosis in Ethiopia: A literature review

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ABSTRACT

Elephantiasis is a symptom of a variety of diseases that is characterized by the thickening of the skin and underlying tissues, especially in the legs, male genitals and female breasts. Some conditions having this symptom include: Elephantiasis nostras, due to longstanding chronic lymphangitis; Elephantiasis tropica or lymphatic filariasis, caused by a number of parasitic worms, particularly *Wuchereria bancrofti*; non-filarial elephantiasis or podoconiosis, an immune disease caused by heavy metals affecting the lymph vessels; proteus syndrome, the genetic disorder of the so-called Elephant Man, *etc*. Podoconiosis is a type of lower limb tropical elephantiasis distinct from lymphatic filariasis. Lymphatic filariasis affects all population at risk, whereas podoconiosis predominantly affects barefoot subsistence farmers in areas with red volcanic soil. Ethiopia is one of the countries with the highest number of podoconiosis patients since many people are at risk to red-clay soil exposure in many parts of the country. The aim of this review was to know the current status and impact of podoconiosis and its relevance to elephantiasis in Ethiopia. To know the epidemiology and disease burden, the literatures published by different scholars were systematically reviewed. The distribution of the disease and knowledge about filarial elephantiasis and podoconiosis are not well known in Ethiopia. It is relatively well studied in southern Ethiopia but data from other parts of the country are limited. Moreover, programmes that focus on diagnosis, treatment, prevention and control of filarial elephantiasis and podoconiosis are also non-existent even in endemic areas. Furthermore, the disease mapping has not been carried out country-wide. Therefore, in order to address these gaps, Ethiopian Ministry of Health needs to take initiative for undertaking concrete research and mapping of the disease in collaboration with stakeholders.

Key words Elephantiasis; epidemiology; Ethiopia; lymphatic filariasis; podoconiosis

INTRODUCTION

Elephantiasis as a disease represents a major public health problem in tropical and subtropical regions of the world, which is characterized by the thickening of the skin and underlying subcutaneous tissues, especially in the legs and male genitals and female breasts, causing permanent disability. It is caused by filarial worms or non-filarial heavy metals[1].

In general, there are two forms of elephantiasis. Patients with massive edema of the lower extremities secondary to lymphatic obstruction by filariasis develop one form of elephantiasis. In this case, adult stage of the causative agents of filarial elephantiasis live in the lymph nodes of humans, and the female worms produce microfilariae that are found in the blood[2]. A similar clinical picture is also seen with non-filarial elephantiasis which is a non-communicable geochemical disease induced by the absorption of ultrafine silica particles from soil through the skin of the feet. But in this case the swelling is mostly involved below the knee[3-4]. Moreover, co-endemicity of LF and podoconiosis in Ethiopia is found in Illubabor and west Wellega zones[5].

Filarial elephantiasis

Filarial elephantiasis also called lymphatic filariasis (LF) is caused by three different types of thread-like parasitic worms: *Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori* that damage the human lymphatic system and transmitted by mosquitoes[3]. LF is the second most common vector-borne parasitic disease after malaria[6].

Currently, 1.23 billion people in 58 countries are living in areas where lymphatic filariasis is transmitted and are at risk of being infected. Globally, an estimated 25

million men suffer with genital disease and over 15 million people are afflicted with lymphoedema[2]. It is recognized as one of the world's most disabling disease and over 40 million persons show severe chronic manifestations of the disease[6]. It is also endemic in >39 countries in Africa[7]. In Ethiopia, the first case of LF was reported in 1971[8], and now 30 million people have been estimated to be at risk of LF, which would make Ethiopia the fourth highest burden (7.8% LF) country in sub-Saharan Africa[9]. The disease was endemic in Gambella, Benishangul-Gumuz, Southern Nations, Nationalities and Peoples' (SNNPR), Amhara and Oromia regions of Ethiopia[10].

It is poverty-related and predominantly affects the poor and marginalized people[11]. Chronic clinical manifestations associated with lymphoedema and hydrocele are debilitating, and account for nearly five million disability-adjusted life years. LF in Ethiopia has been known to involve the lower extremities and genitalia thereby causing permanent and long-term disability[12]. On the other hand, Jemaneh and Kebede *et al*[13] observed only hydrocele and enlargement of the glands in the groin but did not find a case of elephantiasis, suggesting that LF might be recent phenomenon in the area. Such variations of the disease may also result from genetic variations of the human host or the parasite, justifying molecular characteristics of the parasite[13]. The disease burden is not well studied in all over Ethiopia and data from endemic regions is limited though it is reported in the south-western lowlands.

Podoconiosis

The term podoconiosis was coined by Ernest Price, derived from the Greek words *podos* and *konos*, which mean foot and dust, respectively, and imply that the disease is caused by exposure of feet to irritant clay soil[14-15]. Podoconiosis is non-filarial elephantiasis that predominantly affects barefoot subsistence farmers in areas with red volcanic soil[16-17]. It is a chronic and debilitating geochemical disease occurring in individuals exposed to red clay soil derived from alkalic volcanic rock[18]. The disease is characterised by bilateral swelling of the lower legs with mossy and nodular changes to the skin, and causes considerable disability[17] as shown in Fig. 1.

Even though, the aetiology is not fully understood, current evidence suggests that mineral particles from irritant volcanic soils have a role, with some families having an additional genetic susceptibility to the condition[19-20]. Studies have also documented the association of the disease with irritant red clay soils, generated in areas at >1500 m above sea level (masl), with >1000 mm annual rainfall and maximum temperatures of >20°C[21]. Chemicals from the soil are transmitted through the soles of the feet and it is believed that these mineral particles cause an immune system response eventually resulting in the formation of inflammatory masses of nodules (granulomas) in the lymph vessels of the feet and leg[17-18]. Recent studies have also indicated that access to clean water and host genetic factors are important determinants of susceptibility to podoconiosis[20-22].

Fig. 1: Bilateral swelling of podoconiosis (*Source: http://www.washethiopiamovement.com/images/stories/podo01.jpg).*

Due to its public health importance, the World Health Organization (WHO) added podoconiosis to the lists of neglected tropical diseases (NTDs). Hence, it has been now identified as an important NTD in East Africa, South America and Asia[15-16]. In endemic areas, it causes severe social stigma, physical disability and huge economic burden to patients and affected families[17-18, 23]. If disability is detected and correctly managed early, the negative economic and psychosocial consequences may be averted[24]. Identification of the suspected case, physical examination of cases, differentiation of filarial type of elephantiasis from non-filarial elephantiasis through parasitological and serological examination are the most appropriate diagnostic approaches that should be adopted[25].

Considering podoconiosis epidemiology and burden, we systematically reviewed its present scenario, epidemiology, prevention and control in Ethiopia. Extensive research in Ethiopia and in the eastern African region on the aetiology, natural history, distribution, and management of non-filarial elephantiasis had been conducted by Ernest Price, in the early 1970s[26]. In his pioneering work, he identified the possible association between the disease and exposure to red clay soil. Finally, in 2002, Davey[3] was first introduced to the problem of podoconiosis in

one of the southern districts of Ethiopia. Since then, she has led podoconiosis research using a multi-disciplinary approach which included epidemiology, immunology, mineralogy, genetics, bioethics, social sciences, and economics, to describe the disease and its impacts[27-28].

Little information is available about how different communities incorporate elephantiasis, its origin and impact into local knowledge. Hence, strategies responsive to communities' sociocultural understandings will have key roles in reversing this trend and in addressing the disability burden that is currently only superficially understood in affected communities.

Ethiopia is one of the countries with the highest number of podoconiosis patients. It is estimated that around 0.5 to 1 million people are affected and an additional 19.2 million people (22–24% of the population) are at risk through exposure to red-clay soil[23, 26, 29] as compared to 30 million of LF (Table 1)[30]. Moreover, prevalence estimates from 56 market counts ranged from 0.4 to 3.7%[27], are probably underestimated and attributable to reduced mobility of patients and stigma. More recent studies in Ethiopia estimated a prevalence of 5.5% in southern Ethiopia[3], 5.2% in western Ethiopia[14], 7.4% in central Ethiopia[15] and 3.3% in northern Ethiopia[28]. It is noted that the presence of significant geographical variation in the prevalence of podoconiosis in Ethiopia suggested the existence of spatial patterns to disease distribution.

In Ethiopia, podoconiosis is prevalent 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 southeastern lowlands[16, 22]. However, studies have also indicated that it is distributed in Gulliso district, west Ethiopia[31], Midakegn district, central Ethiopia[32], Bedele Zuria district, west Ethiopia[33], Ocholo, southwest Ethiopia[34], Gera and Didessa, western Ethiopia[35], east and west Gojjam and northwest Ethiopia[36]. Despite this distribution, it is relatively well studied in southern Ethiopia but data from other parts of the country are limited or lacking[37]. Moreover, programmes that focus on prevention and treatment of podoconiosis are also nonexistent even in endemic areas[33]. This showed that still the distribution and knowledge of podoconiosis is not well known. Furthermore, the disease mapping has not been carried out country-wide, since filarial elephantiasis has been reported in the southwestern lowlands[38]. Therefore, Ethiopian Ministry of Health needs to take initiative for undertaking concrete research and mapping of the disease in collaboration with stakeholders.

Table 1. Distribution and populations at risk for LF and podoconiosis in Ethiopia

Disease	Geographical distribution (Endemic regions)	Estimated No. of total population at risk (in million)	Proportion of sub-Saharan Africa prevalence (%)
Lymphatic filariasis	Gambella, Benishangul-Gumuz, SNNPR, Amhara and Oromia	30	6–9
Podoconiosis	One fifth of the surface of Ethiopia	19.2	7.8

Impact on lifestyle and economic opportunities: In addition to its public health impact, elephantiasis due to podoconiosis represents tremendous social and economic impacts. Victims of the disease are turned out of their families and resort to begging and the association between podoconiosis and begging, is therefore, one of the reverse causality[39]. Because of deformity, the affected people are ostracized from the communities and denied intermarriage. Moreover, cross-sectional studies in southern Ethiopia found that more than one-half of respondents showed stigmatizing attitudes towards social interactions with podoconiosis patients[40]. Even though, the economic loss of the country due to elephantiasis of soil origin is also very huge, there has been limited study so far to determine its impact on economic output. However, in a study by Tekola *et al*[29], it was found that affected individuals lose 45% of their total productive work days, costing a single zone of 1.5 million people in Ethiopia >16 million US$ annually. This showed the enormous economic impact of non-filarial elephantiasis in affected area.

Believes about the disease causality and transmission: Podoconiosis has been present for centuries in Ethiopia, yet has received little attention from policy makers despite high prevalence and serious associated debility. This may be either because the disease is not an immediate threat to life or because of the absence of information on the socioeconomic impact of the problem[29, 41]. For instance, a study conducted in southern Ethiopia showed that the proportion of respondents holding at least one misconception about causation was 93.4%. Similarly, 55.8% showed stigmatising attitudes towards social interactions with podoconiosis patients and 63.8% had unfavourable attitudes towards the condition[42]. Moreover, studies conducted in East and West Gojjam Zones of northern Ethiopia showed that only 37.5% of the study

subjects believed podoconiosis could be prevented and 41.3% did not know the cause of podoconiosis[36].

Furthermore, other studies have also indicated that accesses to clean water and host genetic factors are important determinants of susceptibility to podoconiosis[20, 22]. On top of this, according to another qualitative study, people believed that it is hereditary. Anyone who has the disease in the bloodline of the family can pass it on to the children born to that person[14]. This showed that the communities' knowledge and attitude towards podoconiosis were gloomy and unfavourable. Therefore, sincere efforts are required towards the communities for awareness, prevention and control of podoconiosis.

Efforts in Ethiopia

Towards the control of LF, the Ethiopian Ministry of Health in collaboration with Addis Ababa University, Carter centre-Ethiopia and WHO-Ethiopia initiated the mapping of lymphatic filariasis in the country in the following five regions: Benishangul-Gumuz, Gambella, SNNPR (Keffa, Sheka, and Bench Maji), Oromia (west Wollega, Jimma, and Illubabor), and Amhara (north Gondar)[8]. Despite this, the full extent of endemicity for LF in other regions is still unknown[10].

As far as podoconiosis is concerned, treatment of the early stages of disease is relatively straightforward, and comprises daily washing with soap and dilute bleach, topical ointment, elastic bandages where swelling is predominant, and routine use of socks and shoes[42]. Although podoconiosis is preventable and at least partially treatable, providing appropriate and sustainable care is a major challenge in Ethiopia due to resource-poor settings. Currently, nationwide podoconiosis mapping is underway. At present, only one organization in Ethiopia, the Mossy Foot Treatment and Prevention Association (MFTPA) provides prevention, treatment and rehabilitation for people with podoconiosis, despite an estimated disease burden of one million. The MFTPA is a non-governmental, community-based organization that encourages community ownership of the problem of podoconiosis and transforms patients into community care agents[43]. WHO recommended community-based treatment and control strategies for cases consisted of foot hygiene, use of shoes, wound care, *etc* in few endemic places of the country[44].

CONCLUSION

The epidemiology and the knowledge about disease burden of podoconiosis are limited in Ethiopia. There is little information regarding it impact, and programmes that focus on prevention and treatment of podoconiosis are also non-existent even in endemic areas. Moreover, the disease mapping has not been carried out country-wide, since filarial elephantiasis has been reported in the southwestern lowlands with overlapping distribution. Similarly for LF, delays in drug availability in areas where intervention has already started, absence of a morbidity management and appropriate guidelines, and weak collaboration with other disease control programmes makes the disease control more difficult. Therefore, the Ethiopian health ministry should launch a strategic plan on podoconiosis as well as LF disease mapping, increase knowledge on epidemiology, diagnosis, management, prevention and control of podoconiosis and LF in collaboration with stakeholders.

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