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LYMPHATIC FILARIASIS IN KENYA SINCE 1910, AND THE PROSPECTS FOR ITS ELIMINATION: A REVIEW
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LYMPHATIC FILARIASIS IN KENYA SINCE 1910, AND THE PROSPECTS FOR ITS ELIMINATION: A REVIEW

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ABSTRACT

Objectives: **To provide an overview of lymphatic filariasis in Kenya from the first time its prevalence was reported to the present day, with suggestions of issues that are yet to be resolved and to present the prospects for its elimination.**
Data sources: **Published and unpublished reports on filariasis studies in Kenya.**
Study selection: **Field-based epidemiological studies covering aspects of clinical, parasitology, entomology, social, economic, diagnosis and control of filariasis.**
Data extraction: **Review of published articles in scientific journals and communications, retrieval and review of published scientific articles from the Internet and personal communications.**
Data synthesis: **Re-organisation and pooling retrieved published data.**
Conclusions: **Almost one century after the first documented report of lymphatic filariasis in Kenya, no National Control Programme has been instituted. However, important findings that have implications on its control have been made and they should be utilised to implement a National Control Programme. On implementation of the National Control Programme, research should be focussed on the remaining unresolved issues and conducted within the framework of the Programme. The World Health Organisation has targeted lymphatic filariasis for global elimination by the year 2020. Kenya is well positioned to formulate her National Plan for Elimination of Lymphatic Filariasis (NPELF) and join other endemic countries worldwide, which have already launched their plans, in the global efforts to eliminate lymphatic filariasis as a public health problem.**

INTRODUCTION

Lymphatic filariasis is a major public health problem throughout the tropical and sub-tropical areas of Asia, Africa, the Western Pacific and some parts of the Americas(1). Over 120 million people in 73 countries worldwide are afflicted with lymphatic filariasis, which is a leading cause of disabling morbidity. Approximately one-third of people with this infection live in India while another third live in countries in Africa. Most of the remaining one-third of the infected population live in the remaining endemic regions. Over 1.1 billion people (20% of the world's population) live in areas where they are at risk of infection(2). Thus, lymphatic filariasis has been recognised as an important impediment to socio-economic development in many parts of Africa, Asia, the western Pacific and certain regions of the Americas due to the physical disabilities associated with it. A total of 44 million persons currently suffer from one or more clinical manifestations such as lymphoedema and elephantiasis of the limbs or genitals, hydrocele, chyluria, pneumonitis or recurrent infections associated with damaged lymphatics. The remainder of the 120 million infected have "pre-clinical" hidden damage of their lymphatic and renal systems(3). Added to this disease burden, there are the serious psychosocial consequences, the sexual/social dysfunction of men with hydroceles or other genital abnormalities and of young women with lymphoedema of the breasts or genitals(4,5). Among *Wuchereria bancrofti, Brugia malayi* and *B. timori*, the three aetiologic agents of lymphatic filariasis, *W. bancrofti* is the only known cause of infection in Africa where an estimated 564 million persons are either infected or have chronic disease(6). In Africa, including Kenya, the infection predominates in rural areas where access to health care is mostly inadequate. It is estimated that all persons living in endemic areas in coastal Kenya are at risk of infection as they are continuously exposed to infective mosquitoes (Mwandawiro, personal communication). Moreover, some of the people living in the Lake Region may also be infected (Githure, personal communication).

Though there have been some significant successes in the control of the disease, in most endemic countries the burden of lymphatic filariasis remains unaffected, or is even on the increase. However, the introduction in recent years of new drugs and improved diagnostic tools to

combat the disease prompted the International Task Force on Disease Eradication to identify lymphatic filariasis as one of the six potentially eradicable diseases(7). In 1997, the World Health Assembly passed a resolution on the elimination of lymphatic filariasis as a public health problem through mass chemotherapy of affected individuals and appropriate morbidity management of those presenting with clinical signs.

Whilst Kenya is endemic for lymphatic filariasis, the disease remains of low priority in health circles although a good proportion of people living in the Coastal region are condemned to psychosocial, physical and reproductive disabilities due to filarial infection. This paper gives an overview of all the major research and control activities, on bancroftian filariasis in Kenya, from the time it was first documented in 1910 to the present time and also describes some of the on-going projects. Since there are unresolved issues still to be addressed, prospective studies in the field of lymphatic filariasis have been outlined in the last part of the paper. In recognition of Kenya's position in both lymphatic filariasis research and the focal (regional) endemicity of the disease, the formulation of the National Plan for Elimination of Lymphatic Filariasis (NPELF) is advocated.

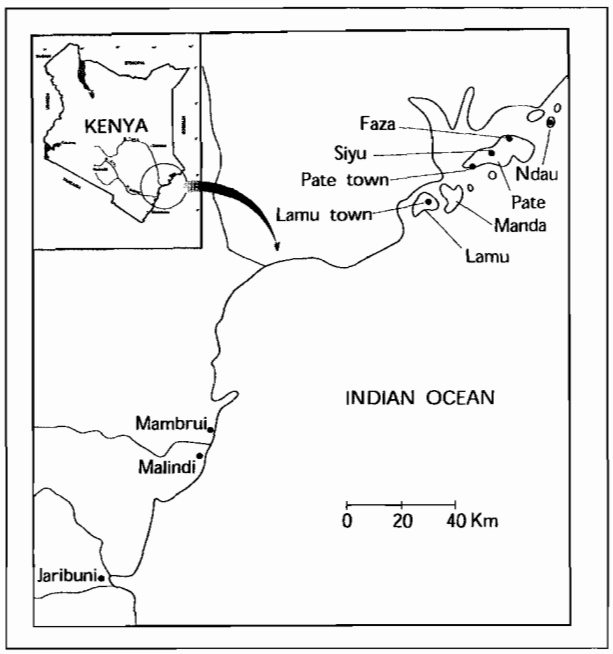
DOCUMENTED STUDIES

Parasitological and clinical investigations (Tables 1, 2 and 3): The only known type of lymphatic filariasis afflicting humans in Kenya is bancroftian filariasis, which is endemic along the Indian Ocean coastal districts of Kwale, Kilifi, Malindi, Tana River and Lamu. About three million people live in areas where transmission occurs. The disease causes severe morbidity, deformity and disability in infected persons. It has been known on Pate (Faza) Island, where pioneering epidemiological work began, since 1910. Documented epidemiological work(8) was conducted in 1921 in Pate Island and the Tana River area, during which 317 persons (285 males and 32 females) in endemic villages were examined. Out of these, 97 males and 15 females (35.33%) were microfilaraemic. This was followed by another survey by members of the Division of Insect-Borne Diseases in 1946 who found eight out of 34 persons examined in Siyu to have microfilariae in their blood. A human infection rate of 32 % was recorded from night blood samples in another study carried out in Pate Island, Figure 1(9). The highest parasite density was found in six to twenty-year age group, with the microfilarial densities being three times higher in males than in females, despite the latter living in closer contact with the vector.

A broader survey conducted in 1962 (10) covered 36 villages in the entire coastline from Vanga near the Tanzanian border to Pate Island on the northern coast. Microfilaria rates were found to vary from 25% in the north to 10 % in the south. Men were more heavily infected than women, with hydrocele being the commonest complication. The study however, examined only people aged 15 years and above and was mainly confined to the ten mile "coastal strip", the areas along the Tana and Sabaki Rivers, and the Mombasa-Nairobi road, excluding more inland areas (Figure 1).

Figure 1

Map of the Kenyan coast showing the towns and villages where DEC mass treatment was carried out (after Wijers and Kaleli, 1984)



The most extensive work was carried out in 1977 (11), which covered the same coastal length but extended deeper inland, examining only males over 14 years of age in the four districts of Kwale, Kilifi/Malindi, Tana River and Lamu bordering the sea (Figure 2). Prevalence in the wet, densely populated ten-mile wide coastal strip was generally low; it was much higher in the more sparsely populated, drier inland areas. Microfilaria rates and densities seemed to increase with age but levelled off at around the age of 50 years. Similarly, hydrocele and elephantiasis increased steadily with age. Elephantiasis was found to be more common in the north than the south, and occurred without the accompanying abnormalities of the genitals. However, the disease in males of the East African coast is generally characterised by a lack of severe or acute signs of lymph vessel inflammation compared to other parts of the world (12).

Differences in the epidemiology of lymphatic filariasis were observed between a small compact Moslem town (Mambrui) and an inland rural area (Jaribuni) where people over one year old were examined(13). In Mambrui, microfilaria rates and densities were lower in the richer people living in better quality houses and higher in the poor individuals living in poor quality and less-lit houses. In Jaribuni, however, the type of housing did not matter as much as the distance from the Jaribuni River, which was the main breeding site for *Anopheles funestus* (the principal vector in that area).

Table 1

Parasitological and clinical surveys of bancroftian filariasis in Lamu and Tana River districts in coastal Kenya, 1921-1984

Area	Mf (%)	Mf den	Hc rate	El rate	Ref. No.*
Pate Island	40.0	–	–	–	8
Pate Island	32.0	9.4	–	11.0	9
Lamu area	23.9	24.0	–	–	10
Faza	15.1	7.6	–	11.8	11
Faza	5.9	–	–	–	31
Takwa	20.6	17.3	–	0.0	11
Pate	10.9	–	–	–	11
Siyu	9.9	–	–	–	11
Ndau	16.4	–	–	–	11
Kipini and Witu	16.4	17.1	–	–	10
Tana River	14.7	10.9	–	–	10
Mororo	2.3	13.0	–	0.0	11
Bura	0.0	0.0	–	0.0	11
Hola	10.8	1.5	–	0.0	11
Wenje	18.9	10.0	–	1.6	11
Wema	4.6	2.7	–	3.1	11
Garsen	4.5	3.5	18.1	12.0	11
Idsowe	8.7	17.0	30.7	5.9	11
Ngao	13.7	9.3	30.9	18.4	11
Semikaro	0.0	0.0	–	0.0	11
Kipini	28.1	27.7	–	1.9	11
Pandanguo	15.9	4.8	-	0.0	11
Mapenya	4.8	18.0	–	0.0	11
Bargoni	8.6	2.0	–	0.0	11
Hola	11.0	–	28.0	–	14
Wenje	19.0	–	15.0	–	14
Wema	5.0	–	27.0	–	14
Garsen	4.0	–	22.0	–	14
Idsowe	12.0	–	38.0	–	14
Ngao	13.0	–	34.0	–	14
Semikaro	0.0	–	10.0	–	14

Mf (%) = percentage of the population with microfilariae; Mf den = microfilarial density (no.mf/ml)
Hc rate = hydrocele rate; El rate = elephantiasis rate; *numbers correspond to references cited in text

Table 2

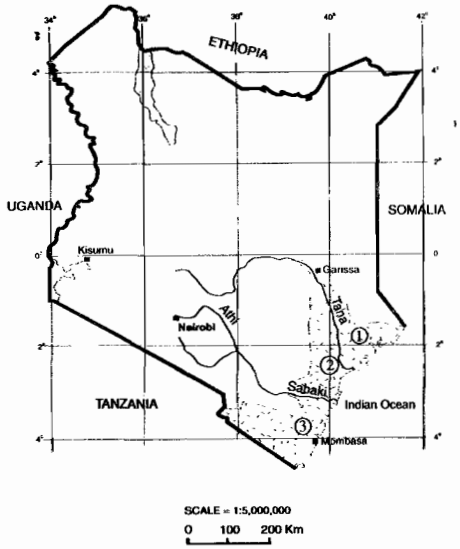
Parasitological and clinical surveys of bancroftian filariasis in Kilifi and Malindi districts in coastal Kenya, 1962-1984

Area	Mf (%)	Mf den	Hc rate	El rate	Ref. No.*
Mambrui	17.8	11.4	–	–	10
Kakoneni	26.3	24.9	–	–	10
Kilifi area	13.1	23.9	–	–	10
Mariakani	>30.0	>40.0	–	–	12
Ganze	>30.0	>40.0	–	–	12
Kakoneni	>30.0	>40.0	–	–	12
Mambrui	21.7	–	15.4	–	13
Jaribuni-Magogoni	22.0	–	17.0	–	13
Malindi area	10.0	–	17.0	–	14
Takaungu	8.0	–	15.0	–	14
Rabai	6.0	–	19.0	–	14
Chakama	40.0	18.7	51.0	–	14
Jaribuni	40.0	17.0	48.0	–	14
Jomvu	38.0	10.6	50.0	–	14
Kadunguni	44.0	26.1	37.0	–	14
Nasibu	56.0	20.4	42.0	–	14
Ndigiria	39.0	19.9	30.0	–	14
Mabuani	2.0	–	16.0	–	14
Mutsara	35.0	22.1	24.0	–	14
Mambrui	21.1	–	–	–	31
Jaribuni	22.0	–	–	–	31
Mwangatini	27.8	–	–	–	32
Masheheni	15.9	–	–	–	32

Mf (%) = percentage of the population with microfilariae; Mf den = microfilarial density (no.mf/ml); Hc rate = hydrocele rate
El rate = elephantiasis rate; *numbers correspond to references cited in text

Figure 2

Bancroftian filariasis endemic areas, Coast Province, Kenya



1. *Lamu/Tana River*	2. *Kilifi/Malindi*	3. *Kwale/Mombasa*
Bargoni	Chakama	Chwake
Bura	Ganze	Dzivani
Faza	Jaribuni	Gandini
Garsen	Jomvu	Gazi
Hola	Kadunguni	Kinango
Idsowe	Kakoneni	Lunga-Lunga
Kipini	Kilifi	Lutsangani
Lamu	Mabuani	Mailinane
Mapenya	Malindi	Mariakani
Mororo	Mambrui	Milafenyi
Ndau	Mashekeni	Mobasa
Ngao	Mariakani	Mrima
Pandanguo	Mutsara	Msambweni
Pate	Mwangatini	Muhaka
Semikaro	Nasibu	Mwena
Siyu	Ndigiria	Nguluku
Takwa	Rabai	Shirazi
Wema	Takaungu	Vanga
Wenje		
Witu		

One of the studies by Wijers (14) indicated that in some rural areas on the Kenyan coast, where *Anopheles* transmitted filariasis occurred, transmission levels tremendously increased during and immediately after the rains but declined considerably during the drier months, resulting in interrupted transmission. This led to the hypothesis that interrupted transmission tends to promote the development of microfilaraemia while a more continuous transmission leads more readily to the development of the clinical signs, in areas with equal yearly transmission. Before this observation, it had earlier been suggested that continuous transmission is necessary if a high incidence of *W. bancrofti* infection is to be found in man(10).

Other epidemiological studies in the later years were even more localised, covering very small areas, some of which were conducted for academic purposes by students pursuing higher-degree courses. These studies were, therefore, more intensive than extensive in approach compared to the earlier ones. One of such studies(15) examined 1129 persons in Vanga (Lunga-Lunga location), Kwale District and found elephantiasis and hydrocele to increase with age. Another study(16) was conducted in Maili Nane in Mwachinga village of Kinango location (Kwale), serum samples from all microfilaraemic persons were positive for circulating filarial antigen, as were 15% of samples from amicrofilaraemic and asymptomatic persons. Later in Muhaka village also in Kwale District(17), it was shown that prevalence increased with age and was focal as both microfilaraemia prevalence and density were significantly higher in Kilore than Mvumoni, two adjacent villages. The final survey(18) covered Gandini, Dzivani and Lutsangani villages in Kinango division in which microfilarial densities were significantly higher in males than females but surprisingly elephantiasis was significantly higher in females than males, possibly because the main clinical manifestation in males is hydrocele. In this study(18), it was also shown that the infection was generally higher in males than females. However, when this observation was re-evaluated by age groups, it was shown that the significance remained only in men compared to women of childbearing age as previously reported in Muhaka(17).

Entomological investigations (Table 4): Initially, *Aedes pembaensis* was erroneously incriminated as an important vector transmitting bancroftian filariasis in Pate Island due to its abundance. This was compounded by the fact that the species had infection rates of six per cent and 6.3%, from collections made in the houses and the bush respectively, carrying unidentified filariae larvae that were presumed to be bancroftian(19). Other species in the houses were *Aedes aegypti* and *Culex fatigans* with infection rates of seven and fourteen per cent, respectively. Thus, it was concluded that the epidemiological pattern of bancroftian filariasis for the coastal regions of East Africa was quite different from that on the islands in Lake Victoria where *Anopheles gambiae* and *Anopheles funestus* were the principal vectors(19).

In a later survey, *Ae. pembaensis* was found to feed on domestic and wild animals as well as man without discrimination(9) but seemed not to transmit human filariasis. This is because after DEC treatment, infection rate fell only in *Culex quinquefasciatus* (from 25 to 6.6%) but remained the same in other mosquito species including *Ae. pembaensis.* It was therefore confirmed that *Cx. quinquefasciatus* was the chief vector transmitting bancroftian filariasis in Pate and that *Ae. pembaensis* transmitted an animal filarial worm, *Brugia patei,* recovered in cats, dogs and genet cats in Pate Island(20). The presence of *B. patei* in Pate Island has been reported in other epidemiological studies(9, 10) and in Lamu Island during a screening of domestic cats(21). However, an attempt to find the infection in humans and mosquitoes was unsuccessful(22).

Another extensive survey(10) documented *Cx. quinquefasciatus, An. gambiae* and *An. funestus* as the main vectors of bancroftian filariasis in Kenya, suggesting

Table 3

Parasitological and clinical surveys of bancroftian filariasis in Kwale and Mombasa districts in coastal Kenya, 1962-2000

Area	Mf (%)	Mf den	Hc rate	El rate	Ref No.*
Mombasa	2.6	7.1	–	–	10
Mombasa-Mariakani	16.3	8.7	–	–	10
Mombasa-Gazi	9.6	6.2	–	–	10
Msambweni-Vanga	9.1	4.8	–	–	10
Lunga-Lunga	>30.0	>40.0	–	–	12
Kinango	>30.0	>40.0	–	–	12
Milafenyi	15.0	–	45.0	–	14
Nguluku	15.0	–	28.0	–	14
Chwake	26.0	4.6	7.0	–	14
Mwena	26.0	8.3	48.0	–	14
Shirazi	40.0	7.6	21.0	–	14
Mrima	40.0	6.8	31.0	–	14
Muhaka	41.0	11.2	54.0	–	14
Vanga	13.7	233.0	16.5	2.4	25
Mailinane	17.8	–	11.1	8.9	16
Muhaka-Mvumoni	6.3	–	5.6	1.4	17
Muhaka-Kilore	24.0	–	30.0	4.6	17
Gandini	12.1	75.1	–	–	18
Dzivani	12.6	30.1	–	–	18
Lutsangani	24.9	108.6	–	–	18

Mf (%) = percentage of the population with microfilariae
Mf den = microfilarial density (no.mf/ml)
Hc rate = hydrocele rate
El rate = elephantiasis rate
*numbers correspond to references cited in text

Table 4

Entomological surveys on vectors of bancroftian filariasis in coastal Kenya, 1959-1997

Area	*Culex quinquefasciatus*		*Anopheles gambiae*		*Anopheles funestus*		Ref. No.*
	a	b	a	b	a	b	
Pate/Faza Island	154	11 (7.1)	–	–	–	–	9
Kenyan Coast	2,800	47	1,020	6	925	9	9
Lamu area	3,695	56 (1.5)	56	0	0	0	10
Kipini and Witu	3,772	32 (0.8)	483	1 (0.2)	0	0	10
Tana River	129	–	738	0	0	0	10
Malindi and Mambrui	1,404	10 (0.7)	0	0	0	0	10
Malindi-Kakoneni	367	3 (0.8)	3,510	28 (0.8)	2,304	27 (1.2)	10
Kilifi area	449	0	791	2 (0.3)	178	1 (0.6)	10
Mombasa	1,571	0	0	0	0	0	10
Mombasa-Mariakani	1,770	5 (0.3)	55	2 (3.6)	49	1 (2.0)	10
Mombasa-Gazi	333	1 (0.3)	469	2 (0.4)	134	0	10
Msambweni-Vanga	663	4 (0.6)	1,466	4 (0.3)	264	0	10
Mambrui	3,823	37 (0.97)	0	0	0	0	24
Jaribuni	0	0	629	7 (1.1)	11,603	104 (0.99)	24
Spray-catch:							
Lutsangani	236	0	201	4 (2.0)	358	0	23
Dzivani	157	0	139	2 (1.4)	13	0	23
Gandini	98	0	369	3 (0.8)	32	1 (3.1)	23
Human bait:							
Lutsangani	163	1 (0.6)	165	2 (1.2)	176	2 (1.1)	23
Dzivani	251	3 (1.2)	19	0	3	0	23
Gandini	98	0	12	0	1	0	23

a = number of mosquitoes examined; b = number of mosquitoes infective (%); * numbers correspond to references cited in text

that *Cx. quinquefasciatus* was the main vector in the coastal towns and villages, but in inland villages the anophelines were more important. However, *Cx. quinquefasciatus* was also seen to play an equally important role in some rural settings(23). The three species are all vectors of lymphatic filariasis but their importance varies from place to place(9,23,24) depending on the local ecological conditions. For example, it was shown that *Cx. quinquefasciatus* was the only vector in Mambrui, a coastal town with wet pit latrines for breeding, while *An. funestus*

was the main vector in Jaribuni, an inland village with a river serving as the breeding site(24). Peak transmission in Mambrui was from June to July whereas in Jaribuni it was from December to January, just after the short rains.

Immunological studies: Immunological studies have been carried out only in Kwale District where it has been shown that filarial specific IgG4 was significantly higher in microfilaraemic groups than in amicrofilaraemic ones(17,25,26). These studies also showed that the mean level of filarial specific IgGI was significantly higher in amicrofilaraemic, symptomatic cases than in microfilaraemic, symptomatic ones. Use of antifilarial IgG4 or circulating filarial antigen (Og4C3) has been shown to be useful in identifying persons with filariasis(16,17). In one of the studies(17), antigenaemia increased gradually, peaking in the age group 21-40 years. Individuals from an endemic area had higher levels of the total and filarial-specific IgE than in persons from a non-endemic area(26). However, the concentration of total IgE was higher in individuals who had microfilaraemia than in those that did not, while the reverse was the case with filarial-specific IgE. A new method for diagnosis of filariasis using detection of circulating filarial antigen is now available. A multi-country study was conducted in Kenya to validate the Immunochromatographic Card Test (ICT). When comparing ICT sensitivity to those of standard parasitological detection of microfilariae it was found to be more sensitive than microfilaria detection, simple, rapid and convenient in field settings(27).

Recent studies in the same district have shown that the human foetus develops cytokine production patterns similar to those observed in adults and that prenatal exposure to helminthes (schistosomiasis/filariasis) may not lead to tolerance or altered foetal immunity(28). It has further been demonstrated that helminth-specific immune responses acquired during gestation persist into childhood. This prenatal sensitisation biases T- cell immunity induced by BCG vaccination away from type 1 T- cell IFN-γ responses associated with protection against mycobacterial infection(29). Furthermore, the human foetus of helminth-infected mothers can be sensitised in-utero to produce helminth-specific B cells and that neonatal B cells are intrinsically capable of IgE and IgG production (30).

Control efforts (chemotherapy using diethylcarbamazine): Although prevalence surveys have been carried out in Kenya, very little has been done to control the disease as a public health problem. As early as the 1950s diethylcarbamazine (DEC) has been used to treat lymphatic filariasis cases in Kenya despite the side effects some patients present with. Initially mass chemotherapy was conducted in the late 1950s in Pate Island where adults received 2.2g, children above five years 1.1g and those below five years 0.55g of DEC spread over six days. A fortnight later, human infection rates fell from 32% to 25% and microfilarial densities from 10.3 to 1.5 mf/20mm^3. Eight months later, infection rates fell to 16% and microfilarial densities to 1.1 mf/20mm^3(9).

The second mass treatment covered a much larger area(31) during which the local people distributed the drug and also treated the side effects. DEC was administered for 13 days to all persons above one year in Mambrui, Jaribuni and the villages off the north coast of Kenya (Lamu, Pate, Siyu, Faza and Ndau) with a population of 20,000. Two years later, microfilaria rates in Mambrui had dropped by 75%. In Jaribuni, a reduction of 75% was recorded in men, but in women it was only 48%. Spectacular reductions were also achieved in Island villages to the north. It was concluded that it was possible and cheap to control bancroftian filariasis on the East African coast by mass treatment campaigns(31). Moreover, prophylaxis trials in Burangi, Mwangatini and Masheheni in Kilifi District(32) suggested that DEC could be used as a prophylaxis against bancroftian filariasis if given annually or bi-annually.

Mass treatment with DEC(31) was speculated to be the main factor resulting in the low infection rates obtained in five villages of Lamu and Pate Island(21). Out of 814 persons examined, only 24 (17 males and 7 females) were infected, majority of whom (19 out of 183) came from Ndau where mass treatment campaign had not been effectively carried out(31).

Social- economic studies: In an effort to investigate community perceptions regarding chronic disease manifestations, Amuyunzu(5) conducted a study among the Duruma community in Lutsangani village in Kwale District. Interviews with patients with chronic filariasis revealed that deformity was reported as the worst outcome of the disease. The patients also identified intermittent pain with chronic manifestations as a major problem. These episodic pains caused patients to become bed-ridden and dependent on members of their households for cure and care. The community reactions towards victims of chronic filariasis were varied. People who had patients in their households expressed sympathy and understanding, whereas those who had no relationship with victims joked and laughed about it. Out of the 65 patients interviewed, only one reported that mosquitoes were associated with filariasis. The majority of the patients said that the disease was caused by witchcraft, sexual transgression and consumption of bad food. Most (over 90%) of the patients believed the disease was incurable.

In a study confined to Msambweni Hospital, Kwale District, Mwobobia *et al*(33), revealed that hydrocelectomy accounted for 9.7% and 7.6% of major surgery operation time and bed-days, respectively. The corresponding proportions of the costs of supplies used in theatre and of recuperative drugs were 9.4% and 11.2%, respectively.

Rapid assessment studies: Hydrocele, a common, chronic condition associated with lymphatic filariasis causes physical, psychological, social and economic distress. In Kenya, hydrocelectomy is very common and is a leading cause of elective surgery in Kinango Hospital, Kwale District (MOH, unpublished data). A study to assess the value of hydrocelectomy as a proxy for the prevalence of lymphatic filariasis was conducted in five hospitals in coastal Kenya(33). The age distribution pattern

of hydrocelectomy patients paralleled that of hydrocele cases observed by Wijers(11) in the surrounding area. This study also showed that hydrocelectomies form a significantly high proportion of major operations performed in Kwale District than in Kilifi District (including Malindi).

The foregoing section has briefly reviewed already published work, which is also summarised in the accompanying Tables and Figures. A lot of studies in the field of lymphatic filariasis, results of which are yet to be published, have been going on from the late 1990s to the present time, and these are outlined in the following section.

ON-GOING STUDIES

Clinical trials: A clinical study comparing the efficacy of single dose DEC, albendazole alone and their combination is nearing the conclusion of its second year(34). The study is being conducted in Muhaka, Kwale District and has shown that a combination of DEC/albendazole is significantly more effective in reducing pre-treatment microfilaraemia prevalence (82.5%) than a single drug of DEC (54.5%), twelve months after treatment. Use of DEC/albendazole was also useful in clearing intestinal helminths (hookworm, *Ascaris lumbricoides* and *Trichuris trichiura).* Although data at 24 months have not been analysed, this study appears to suggest that a combination of DEC/albendazole should be used for integrated control of bancroftian filariasis and geohelminths in areas with multiple helminthic infections. Because of the high concurrent endemicity of *Schistosoma haematobium* with bancroftian filariasis and geohelminths and the high priority given by the affected communities in places similar to Muhaka, the possibility of including a schistosomacidal drug to the DEC/albendazole combination should be explored(35).

Control studies: use of impregnated bed-nets: A study conducted in Kwale district(36) showed that although permethrin impregnated bed-nets only marginally reduced the mosquito biting densities, they exerted a very strong suppressive effect on the actual transmission of lymphatic filariasis.

Mass drug administration (community-directed treatment): In a multi-country study that has just been completed(37), treatment coverage by two methods of mass drug administration of ivermectin using the regular health service (HST) and the community (Com-DT) was compared in Malindi and Kilifi Districts. Treatment coverage by the community was significantly higher (88%) than by the health service (46.5%), $p < 0.001$. The Com-DT arm attained a coverage level compatible with what is recommended (80% and above) for the global elimination of lymphatic filariasis.

Entomological studies: A study to determine the individual contribution of the three vectors of lymphatic filariasis was conducted in Kwale District(38). *Anopheles funestus* overwhelmingly dominated the other two vectors in the main indices of transmission Annual Biting Rate, Annual Infective Biting Rate and Annual Transmission Potential (ABR, AIBR, ATP), indicating that it was the main vector, followed by *An. gambiae* with *Cx. quinquefasciatus* playing a minor role. It has also been indicated that infectivity rates of bancroftian filariasis vectors vary significantly between the wet and dry season (39).

UNRESOLVED ISSUES

While Kenya is well positioned to formulate its National Plan for Elimination of Lymphatic Filariasis (NPELF), there are several research issues in the field of filariasis that need to be addressed alongside the elimination activities. Such issues, in order of importance, include the following:

- Presence of bancroftian filariasis has recently been detected by PCR around Lake Victoria (Githure, personal communication). Entomological and parasitological surveys to establish the current filarial situation in that area and all other suspect areas should be conducted. Such activities would contribute to mapping of filariasis as a pre-requisite for up-scaling the NPELF.
- Tools for certification of lymphatic filariasis elimination need to be established. Entomological investigations are very important in filariasis surveys and seem to be more acceptable to the communities than the rather invasive parasitological and clinical examinations.
  - Studies are currently underway to evaluate the usefulness of testing the vector as a tool for monitoring transmission trends during mass treatment to eliminate filariasis.
- While mass treatment targets the parasites, it offers very little help to alleviate morbidity of patients suffering lymphoedema and adenolymphangitis (ADL). Studies to show the most effective methods for management of lymphoedema and ADL are urgently required. The issue of non-filarial elephantiasis, or podoconiosis also known variously as "Nyeri leg" or "Meru leg" according to geographical locality, should be addressed with a view to defining its prevention and management.
- Whereas female genital filariasis has been reported in other parts of the world, it is not documented in Kenya. Investigations on hidden pathology (kidney and lymphatic vessels) as well as female genital filariasis and their clinical management are necessary.
- There is new evidence to support the speculation that infection takes place very early in small children. In a paediatric population at Kilifi District Hospital, circulating filarial antigen was detected and filarial infection was thought to be responsible for fevers that could not be explained by malaria (Peshu, personal communication). In this regard, more intensive studies in young children, with a view to putting intervention

in place in order to prevent filarial morbidity later on in life, are essential.

- Concurrent infection with both malaria and lymphatic filariasis has been documented in India and other countries. Since *An. gambiae* transmits both diseases on the Kenyan coast, studies to establish whether there is concurrent infection with these two parasites in mosquitoes and humans, and the immunological implications are needed.
- While control of lymphatic filariasis is encouraged, methods of multiple drug delivery for integrated control of helminths should be explored.
- *Brugia patei* is morphologically quite similar to *B. malayi*, an infection of humans and animals; and *B. pahangi*, an animal parasite with a potential to infect humans. Studies to find out whether *B. patei* still exists in Kenya and whether it plays any role in human filariasis in Kenya are needed.
- In previous studies we have recovered filarial parasites from non-human primates. It is speculated that some of these zoonoses are of public health importance, for example, *Meningonema peruzzii* which we recovered from a vervet monkey can cause neurological disorders in humans. Exploration and biology of zoonotic filariae with public health implications is important.

A lot of research in the field of lymphatic filariasis has been done in Kenya. Although continued research to fill the remaining gaps is encouraged more efforts should now be focussed on the elimination of this horrendous disease. WHO has targeted lymphatic filariasis for elimination by the year 2020, and is supporting endemic countries to initiate National Elimination Plans. Kenya needs to quickly take advantage of her unique position: (i) focal endemicity of filariasis; (ii) highly qualified and experienced personnel in the area of lymphatic filariasis; (iii) good infrastructure; (iv) endemic communities who are very supportive of elimination activities; (v) availability of effective drugs (Merck is donating ivermectin, SmithKline is donating albendazole and WHO through its Product Development Unit, has negotiated manufacturing of affordable DEC) and; (vi) multinationals who are eager to support filariasis elimination activities, and form her National Task Force and National Elimination Plan for Elimination of Lymphatic Filariasis. Some of the countries in the region have already implemented their elimination activities and Kenya should not wait any longer.

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