Some Epidemiological Aspects of Lymphatic Filariasis and Its Prevention by Using Some Fish Predators

A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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DEDICATED

TO

MY PARENTS

AND

SPOUSE

DECLARATION

It is my greatest privilege to declare that the dissertation on "Some Epidemiological Aspects of Lymphatic Filariasis and Its Prevention by Using Some Fish Predators" carried out by me under supervision and guidance of professor Hamida Khanum, Ph.D., Parasitology Branch, Department of Zoology, University of Dhaka for fulfillment of the degree of Doctor of Philosophy under the University of Dhaka, Dhaka-1000, Bangladesh.

I have tried my level best to make the dissertation unique, informative and comprehensive one with the sincere co-operation and valuable guidance of my supervisors. In this regard, I would like to confirm that the research works documented and analyzed in this dissertation are original and had never been submitted for my other degree.

Sincerely,

Akond Mohammad Rafiqul Islam

CERTIFICATION

This is to certify that this thesis entitled "Some Epidemiological Aspects of Lymphatic Filariasis and Its Prevention by Using Some Fish Predators" submitted by Akond Mohammad Rafiqul Islam, for the degree of Doctor of Philosophy in Zoology of the University of Dhaka, Bangladesh, embodies the record of original investigations carried out by him under my supervision.

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ABSTRACT

The present study was carried out mainly in the two extreme poor prone zones like north and south zones of the country consisting 20 districts, among those, three districts like Gaibandha, Sylhet, Mymensingh are non-endemic area of filariasis. It was observed that, the factors which make the reduction of prevalence of lymphatic filariasisare the cost effective safe way control of the vector of lymphatic filariasis and also the effectiveness of predation by fish as a control measure of the vector of lymphatic filariasis. The availability and suitability for surviving the mosquito larvae and their predators in the same water bodies surrounding the lymphatic filariasis affected patient's house was also recorded.

On the basis of the above mentioned factors, different aspects of Lymphatic filariasis in Bangladesh including its epidemiological aspects, knowledge attitude and practices of the people and the scope of its prevention by using some fish predators were studied in the present study.

Out of 20 studied districts, Bagerhat, Gopalganj, Sylhet, Narail, Mymensingh and Norshindhi have no patients of filariasis. The highest frequency of patients found in Lalmonirhat (12.1%) and Thakurgaon (11.8%) followed by Gaibandha (10.2%). In the present study, 69.2% patients were found in north zone and 30.8% patients in south zone. 89.81% patients were found in endemic area (17 districts) and 10.18% patients were found in non-endemic area (3 districts). There was no patient in age group (0-10), the highest number of patients was found in age group (41-50) and gradually it is decreasing with the age. Filariasis affected most populated district is Lalmonirhat where only 35.3% household expenditure is above Tk. 4000/- per month and 11.8% house hold expenditure is below Tk. 1000/- per month. About 70.9% respondents of the study areas have no knowledge about filariasis. Till now 12.28% patients go to healer for treatment. 90.5% patients are suffering in leg swelling followed by hand swelling (7.6%). About 0.7% and 1.2% patients are suffering in breast and scrotum swelling respectively. The most patients of endemic districts are illiterate having knowledge gap than that of non-endemic district. The disease is also depended on

educational status/knowledge/awareness of the household's people. Very few patients of endemic district are used to go for treatment to the health complex.

Mosquito larvae and their predators were collected from three different types of habitat from the study areas. Ditch and abandoned ponds are abundant in south zone but the pit surrounding the tube well is the main breeding grounds in north zone, so the more effective breeding grounds for the vector of filariasis like-*Culex quinquefasciatus* is higher in north zone than that of south zone. Pit surrounding the tube well (domestic stagnant water) harbored the highest concentration (75.07%) of *Culex quinquefasciatus,* followed by abandoned pond (20.68%) and ditch (4.25%). There was a peak population of *Culex quinquefasciatus* from November to April. The maximum number of *Culex quinquefasciatus* larvae (12.07%) were collected in January followed by February (11.77%) and the least in June (4.67%).All together eight different predators werecollected ofwhich *Clarias batrachus* were found in most of the breeding grounds. The ditch is the more effective natural grounds for almost all of the predators of *Culex quinquefasciatus* followed by abandoned pond. In north zone, the more effective breeding grounds like Pit surrounding the tube well are abundant.

Fishes collected from mosquito breeding grounds were allowed to feed upon different instars of *Culex quinquefasciatus* to determine their predation capacity. Among the fishes *Clarias batrachus* consumed the highest number of larvae (24,372.76per day) followed by*Oreochromis mossambicus* (4,915.48 perday). All the three different sizes of guppy fish consumed mosquito larvae, the newly hatched fingerlings consuming 26.30first instar larvae per dayand an adult guppy fish consumed on an average 145.53 larvae per day.

It may be concluded that filariasis is mainly poor people disease because of their illiteracy and unhygienic-unhealthy living of standard. The lack of awareness, poor water-sanitation condition and living place surrounded by the mosquito breeding grounds are also responsible for endemism. The prevention mechanism of this disease should be predation of larvae by fish predators which will be safe for health and cost effective. So the study findings suggest for culturing suitable fish in the breeding grounds of mosquito larvae as a preventive measure against filariasis. Though the filariasis is a poor people disease, so poverty alleviation program should be expanded in every pocket of poverty stricken area. Poverty alleviation program for the poorest of the poor not only for upgrading their economic condition but also for upgrading their socio-cultural condition; increasing community participation in infrastructural condition;increasing awareness; changing attitude; providing health knowledge towards the causes, preventions and safe way control measures of filarial disease.

ABBREVIATIONS

1	ADL	Adenolymphangitis
2	AIDS	Acquired Immune Deficiency Syndrome
3	ALOS	Advanced Land Observing Satellite
4	CDC	Center for Disease Control
5	COMBI	Communication for Behavioral Impact
6	DALYs	Disability-Adjusted Life Years
7	DEC	Diethylcarbamazine
8	DEM	Digital ElevationModel
9	EDCR	Economic Development Corporation Report
10	EE	Elimination and Eradication
11	GAFLF	Global Alliance for the Elimination of Lymphatic Filariasis
12	GIS	Geographical Information System
13	HIV	Human Immune Deficiency Virus
14	ICDDRB	International Centre for Diarrheal Disease Research, Bangladesh
15	IEC	Information, Education and Communication
16	IU	Implementation Unit
17	IVM	In Vitro Maturation
18	JICA	Japan International Cooperation Agency
19	LF	Lymphatic Filariasis
20	LQAS	Lot Quality Assurance Sampling
21	MDA	Mass Drug Administration
22	MDGs	Millennium Development Goals
23	NGO	Non-Government Organization
24	NIPSOM	National Institute of Preventive and Social Medicine
25	NTD	Neglected Tropical Disease
26	PKDL	Post-Kala-Azar Dermal Leishmaniasis
27	PKSF	Palli Karma-Sahayak Foundation
28	SDGs	Sustainable Development Goals
29	SPSS	Statistical Package for the Social Sciences
30	TB	Tuberculosis
31	UNDP	United Nations Development Programme
32	USAID	United States Agency for International Development
33	WHO	World Health Organization

Chapter-1

INTRODUCTION

World Health Organization (WHO) ranked Lymphatic filariasis (LF) as the 4th leading cause of permanent disability (WHO, 1998). LF is the highest disease burden on any tropical disease except malaria which is one of the most disfiguring diseases and a major cause of clinical morbidity. Morbidity caused by chronic Lymphatic filariasis (LF) is mostly lifelong (WHO 1997a).

LF is a mosquito-borne parasitic disease which causes of physical deformation and disability mostly in tropical regions and poorer country of the world. LF takes a large toll on individuals both through physical disability and social stigmatization. It affects the people with genital disease and with lymphoedema. Young, unmarried women with LF are unable to abide by the standards set by society, due to limited marriage prospects (Wynd*et al.* 2009). Men with LF share similar sentiments, (Wynd*et al.* 2009). The disease impairs patient's educational and employment opportunities, marriage prospects, and sexual life.In Thailand and West Africa, there is a common perception that children born to LF-infected women will also inherit the genes for the disease (Wynd*et al.* 2009).

Although lymphatic filariasis is not associated with high mortality rate, chronic filarial infection causes enormous suffering. The socio-economic impact due to long term disability and deformity are extraordinarily are great. The determination of prevalence of the filarial infection in the community is important and necessary for public health program.Since the prevalence and intensity of infection are linked to poverty, its elimination can contribute to achieving the United Nations Millennium Development Goals (MDG) as well as Sustainable Development Goals (SDG: Post-MDG).

Filariasisis caused by thread-like filarial nematode worms in the superfamily Filarioidea, also known as "filariae". There are 9 known filarial nematodes which use humans as the definitive host. These are divided into 3 groups according to the niche within the body that they occupy: Lymphatic Filariasis, Subcutaneous Filariasis, and

Serous Cavity Filariasis. Lymphatic Filariasis (LF) is caused by species of nematode parasite-*Wuchereria bencrofti*, *Brugia malayi* and *Brugia timori* and is transmitted by mosquitoes (WHO 2002c).

The adults of*Wuchereria bancrofti*, *Brugiatimori* and *Brugia malayi* live within the lumen of lymphatic vessels.Subcutaneous frilariasis is caused by *Loa loa* (the African eye worm), *Mansonella streptocerca*, *Onchocerca volvulus*, and *Dracunculus medinensis* (the guinea worm). These worms occupy the subcutaneous layer of the skin, the fat layer. Serous cavity Filariasis is caused by the worms *Mansonella perstans* and *Mansonella ozzardi*, which occupy the serous cavity of the abdomen. Filariasis is a severely debilitating and stigmatizing disease caused by the parasite *Wuchereria bancrofti*, classic causative agents of this disease in humans.

In all cases, the transmitting vectors are either blood sucking insects (fly or mosquito) or copepod crustaceans in the case of *Dracunculu smedinensis*.Infection is usually acquired in childhood, but the painful and profoundly disfiguring visible manifestations of the disease occur later in life. Whereas acute episodes of the disease cause temporary disability, lymphatic filariasis leads to permanent disability.

The *Culex quinquefasciatus* species is the most common vector for bancroftian filariasis in Bangladesh. This domestic mosquito is known to thrive in impoverished urban areas and breed in stagnant, dirty water.Different works carried out by different scientist in Bangladesh also showed that this species is endophilic in nature i.e. it prefers to rest indoor (Ameen and Moizuddin, 1973; Ameen*et al*.1982, 1984; Ahmed *et al*., 1986, 1989, 1991).

Lymphatic filariasis: A neglected poor people disease of tropical world

Lymphatic filariasis considered globally as a neglected tropical disease of poor people and a devastating obstacle to socio-economic development because they debilitate, deform, blind and kill. Communities frequently shun and reject women and men disfigured by the disease. Affected people frequently are unable to work because of their disability, and this harms their families and their communities (CDC 2010).

Lymphatic filariasis affects the world’s poorest people, more than a billion people who subsist on less than $2 per day because the poor people are unaware, unhygienic as well as unable to buy mosquito curtain. They are illiterate and do not know why and how the disease occurs and spreads. They do not know how to control the disease. Moreover, neither the well-off society nor the government gives the proper and enough attention to them. So this disease is being neglected year after year. Lymphatic filariasis is primarily a disease of the poor in tropical countries (Molyneux*et al.* 2003).

It is more difficult to translate chronic disability and illness into a value that is readily understood by public health officials and health advocates in relation to their contribution to poverty. Rural to Urban Migration and increasing urbanization, both of which are occurring increasingly in low income countries, facilitate the spread of LF. This is mostly due to inadequate waste disposal and sanitation facilities, which increases the number of breeding sites for the mosquito vectors (Evan, *et al.*1993).According to JICA, about 70 million people are identified as endemic to filariasis mainly in North West area (relatively poor area) of Bangladesh.

Historical background

Lymphatic filariasis (LF) is commonly known as elephantiasis. The word “filarial” is derived from “filar” that means thread like, its ancient name was "Malabar leg". LF has been recognized for more than 4000 years. Patent microfilaremia is first detected in Children 5 to 10 years old who live in endemic regions.

Artifacts from ancient Egypt (2000 BC) and the civilization time of West Africa (500 BC) show possible elephantiasis symptoms. The first clear reference to the disease occurs in ancient Greek literature, where scholars differentiated the often similar symptoms of lymphatic filariasis from those of leprosy.

Cobbold, in 1877, wrote a description of the adult worm.The life cycle involving an arthropod vector was theorized by Mansonwho proceeded to demonstrate the presence of the worms in mosquitoes (Alexander, 1998).

In 1878, in China, Manson completed the description of the cycle while working in Amoy (now called Xiamen) along the Chinese coast in Fujian Province. Manson first demonstrated that mosquitoes were intermediate hosts for the parasite. For two decades, Manson maintained that infection was acquired when individuals drank the water contaminated with larvae released from dead or dying mosquitoes. Eventually, he came to accept the concept that larvae were transmitted by the bite of mosquitoes. Filariasis may, in fact, be a water-borne disease under some circumstances, since experimental infections can be induced by the oral route.

One of the most important developments in the history of LF control was the discovery by Chinese parasitologists during the 1970s and 1980s that it is possible to dramatically reduce the prevalence through simultaneous administration of the drug diethylcarbamazine (DEC) to infected populations. This was achieved primarily through medication of regional salt supplies with DEC.

Ironically, the LF life cycle was discovered in China and LF was first eliminated in China. The accomplishments of the Chinese provided proof-of-principle that it might be possible to eliminate LF worldwide through similar measures.Bruge discovered the microfilaria of *B. malayi* in Indonesia; Rao and Maplestone discovered the adults of *B.malayi* in India (Park, 2000).

Filarial situation-Global perspectives

The filariasis is endemic in 83 countries with more than a billion people at risk of infection and 120 million people clinically affected worldwide and40 million people have clinical manifestations of the disease including swelling of limbs, hydrocele, and acute adenolymphangitis (Ottesen 2000).

Current estimates indicate that LF is responsible for the loss of 4.6 million DALYs (Disability-Adjusted Life Years) per year. The vast majority of cases occur as a result of *W. bancrofti* infection. Of these, only about 10 to 20 million people are infected with *B. malayi*. *B. timori* affects large numbers of individuals living in endemic areas. The infection is widely distributed in the tropics, especially in South Asia, Africa (including Egypt) and tropical regions of the Americas. The endemic region extends from as far as western India to Korea in north-east. Periodic and sub-periodic forms of *W. bancrofti* are the most common in the filarial areas of Asia.

Nearly 60% of the LF problem is in the South East Asia region; 30% in the African region; 5% in the Eastern Mediterranean region; 4% in the Western Pacific region and 1% in the American region.India, Indonesia, Nigeria and Bangladesh account for nearly 70% of lymphatic filariasis cases.The 0.63 percent loss of gross national product is faced by India alone per year due to this disease.Case-control studies in India revealed that affected individuals are 27 percent less productive than their uninfected counterparts (Ramu*et al.*1998).

In the African region, *W.bancrofti* occurs in nocturnal periodic form in the hot humid sub-Saharan areas of the continent. In Europe, there is no known focus of human filariasis, although cases occur among immigrants (WHO, 1998). Lymphatic filariasis is also found in Central Africa, the Nile delta, Pakistan, Sri Lanka, Myanmar, Thailand, Malaysia, Southern China, the Pacific Islands, Haiti, the Dominican Republic, Guyana, Surinam, French Guiana, and Brazil (John *et al*. 2006).

In the pacific region, high incidence of filarial infection (mf rate> 15%) have been recorded. The infection occurs mostly in the flat low-lying areas. Only one species of human filarial parasite is present in the pacific area, namely *W. bancrofti.* It occurs in two forms-“periodic” and “sub-periodic” (WHO, 1998). Many endemic areas lack reliable data on the prevalence of LF, and estimates of the number infected may increase when more precise data become available from epidemiological mapping.

The major vectors are culicine mosquitoes in most urban and semi-urban areas, anopheline in rural areas of Africa and elsewhere, and *Aedes* species in the Pacific islands. *Mansonia* spp. also serves as vector, although anopheline mosquitoes are also sometimes involved in transmission. *B. malayi* infection, on the other hand, is a zoonosis, with both feline and monkey reservoirs.*Culex quinquefasciatus* is the major vector in Africa, Asia, and South America and transmits nocturnally periodic *W. bancrofti*. The *Culex* mosquito is known to thrive in impoverished urban areas and breed in stagnant, dirty water. Other mosquito species include *Anopheles* and *Aedes*for *W. Bancrofti* and *Mansonia* for *B. malayi.*

The 50th World Health Assembly in 1997 adopted a resolution calling on Member States to work towards elimination of LF as a public health problem by 2020, (Plate-1). Since then, with the formation of Global Alliance for the Elimination of Lymphatic Filariasis (GAELF) and the partnership of many Ministries of Health, NGOs and philanthropic foundations, efforts to eliminate this disease have scaled up in over 38countries.

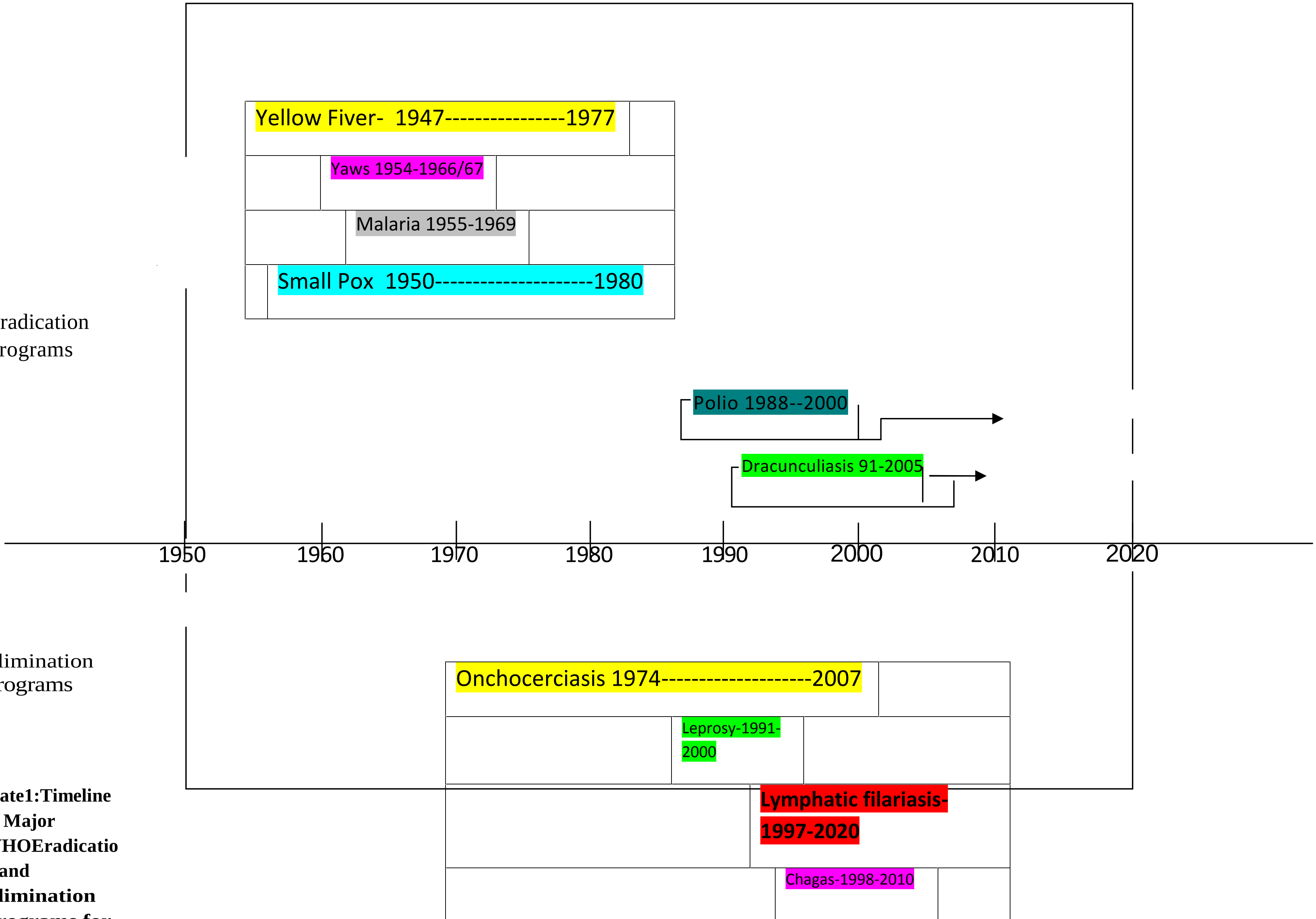
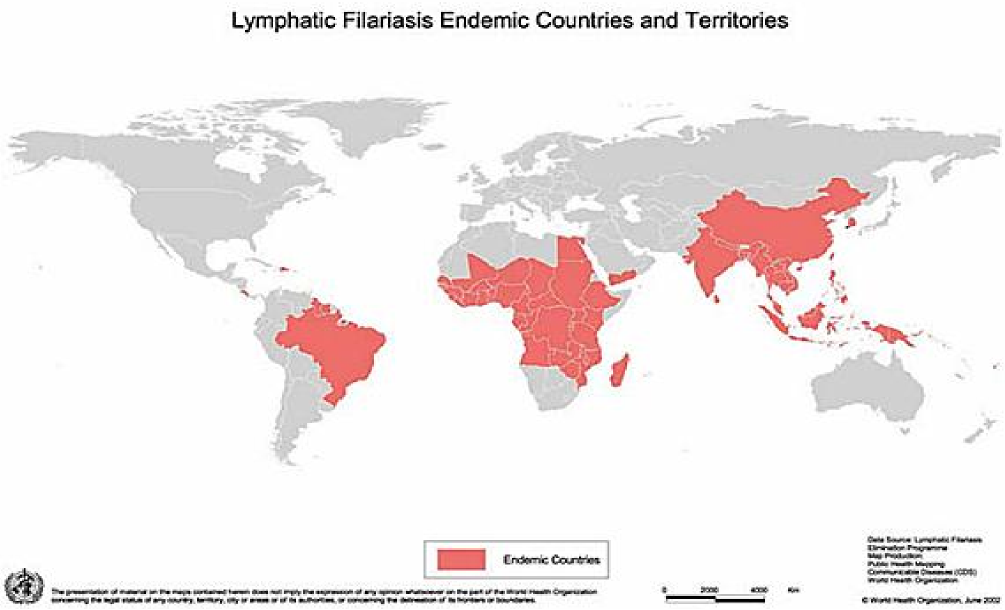


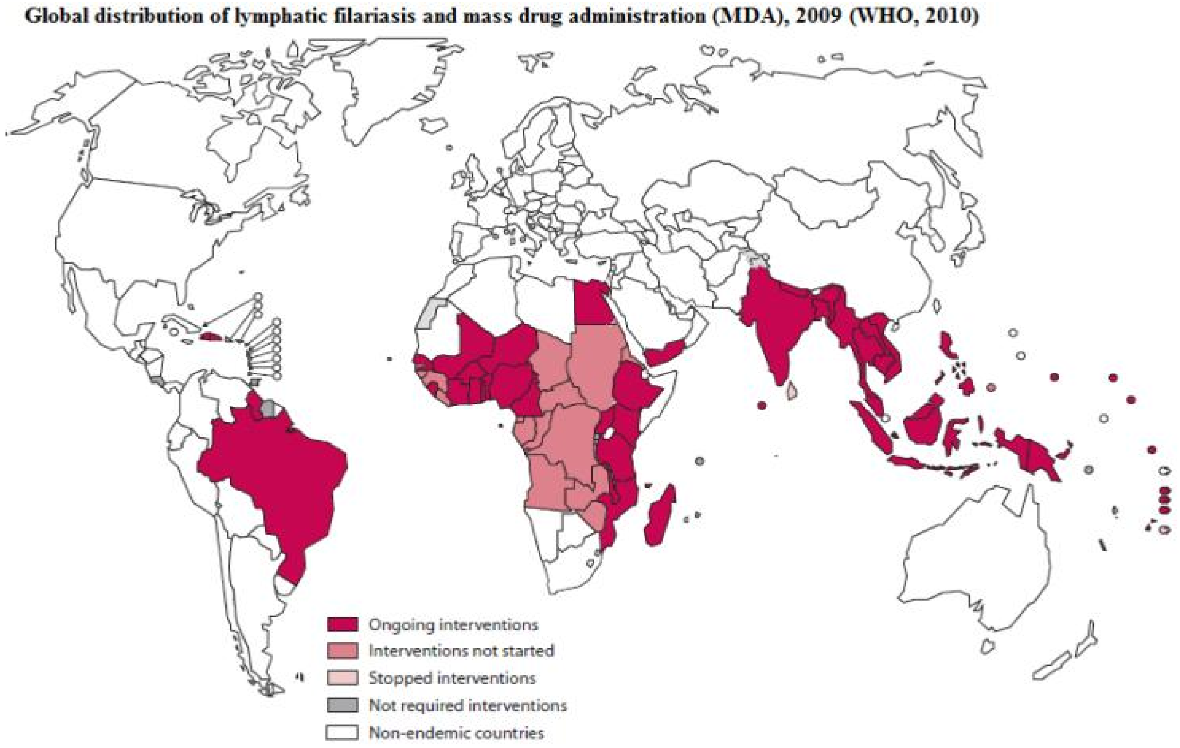
Plate1:Timeline of Major WHOEradication and Elimination Programs for LF

Historically, the public health approach to infectious disease control has been the creation of programs focusing on an individual disease with precise, epidemiologically driven strategies and disease reduction goals. A few of these disease-specific programs have been undertaken to eliminate or eradicate a disease. Disease eradication, the most definitive form of disease control, offers enormous potential for permanent, sustainable improvements in the health and well being of populations. For many practical, technical and financial reasons, global elimination and eradication (EE) efforts are vertically structured programs, with policy and strategy decisions made by organizations at the global level, not by individual nations (Barrette, 2004).

*W. bancrofti*is in endemic form in most of the tropical and subtropical regions of Asia, Africa, Latin America, Sri Lanka, Maldives and Pacific islands. *B. malayi*is found in Indonesia, Korea, costal area of China and India. Sub-periodic form of *B. malayi* occurs in Indonesia, Peninsular Malaysia, Thailand, South Vietnam, Sabah, Sarawak and Philippines (WHO, 1999). Timor microfilaria (*B. timori*) has been found only in Timor and neighboring Islands (Hawking, 1976). *B. malayi*is *also* found in African sub-continent viz. Egypt, Gambia, Ghana, Nigeria, Guinea, Rhodesia and Nyasaland and Comoro Island (Map-1).



Map-1 : The world map showing different endemic countries



Map-2: Globaldistribution of lymphatic filariasis and mass drug administration (MDA),2009(WHO,2010)

Regarding cost of filariasis in India, a mean annual expenditure became Rs. 72 (US $2.1). An estimate 8% of potential male labor input is lost due to the disease. Regression analyses revealed that lymphatic filariasis has a significant effect on work time allotted to economic activity but not absenteeism from work. Female patients spent less on domestic activity compared to their matches' controls. The results clearly show that the chronic form of lymphatic filariasis inflicts a considerable economic burden on affected individuals (Ramaiah *et al.*1999; Ottesen*et al*. 1992; Ottesen*et al*. 1998).As the severity of the disease becomes more apparent, social and economic stigma follow suit. Most females in India, East Africa, and Haiti, for example, are expected to nurture children (Wynd*et al*. 2007). However, young, unmarried women with LF are unable to abide by the standards set by society, due to limited marriage prospects (Wynd*et al*. 2009).In Thailand and West Africa, there is a common perception that children born to LF-infected women will also inherit the genes for the disease (Wynd*et al*. 2009).There are also significant economic implications that enforce the image of these infected LF women's being poor marriage prospects. In fact, a study on infected Haitian women by Coreil and colleagues found that many women were unable to "harvest the garden produce." These women thus struggle to find a partner and an identity in Haiti and coastal Ghana, where financial contributions to the family are essential aspects of social culture (Coreil *et al.*1998; Homeida *et al*. 2002).

Men with LF share similar sentiments, especially in regards to marriage and employment problems (Wynd*et al.*2009). Male sexual disability has not been significantly studied, but even so, it is believed that young men with hydrocele, another form of LF, struggle to "establish their sexual identity and their capacity to be reliable economic providers" (Coreil *et al*.1998).In South America, for example, researchers discovered that many marriages lacked sexual activity due to the painful intercourse resulting from LF (Wynd *et al.*2009).In Tanzania and Haiti, for example, men in the advanced stages of LF are considered socially "unacceptable" to the rest of society due to their inability to produce a child (Evan *et al*. 1993).Infected men and women are thus unable to and sometimes prohibited from selling garden produce in the market by the rest of society, and therefore cannot contribute to the household economy (Coreil *et al.*1998).This exclusion leaves these individuals seemingly helpless, with few options to alleviate their social and economic distress (Kazura, 1999; Kessel, 1957)

It is essential that we embrace an open mind when we encounter disability, and relay tolerance to others. Those who have LF are often excluded from society due to a dichotomy that exists between "us" (the uninfected) and "them" (the infected). These labels cause those who suffer from LF to fall to the bottom rung of the social ladder, contributing to a sense of subjugation and subordination. When most people encounter a description of LF or meet an individual with LF, they may tend to cringe back in horror and feel a sense of relief for not being infected. Coreil and colleagues describe how LF patients "received glances" and were subjected to rude remarks about their infected arms. The disgust and alienation that these patients received contributes to a striking decrease in their self-esteem. In fact, one women reported that she "hopes to die" because she has been living with the disease for such a long period of time

(Coreil *et al*.1998).It is this general attitude that needs to be upturned in order to truly combat LF and its implications.

Urbanization of vast areas of tropical Asia has resulted in a concomitant rise in the prevalence of both *W. Bancrofti* and *B.malayi* varieties of filariasis, carried by mosquitoes that breed in non symbiotic habitats. In 1997 the World Health assembly passed a resolution calling on its member states to undertake a global elimination program for Lymphatic Filariasis (LF). The major strategy for elimination is based on two principles: 1) to interrupt transmission of infection and 2) to alleviate and prevent the suffering and disability caused by LF (www.filariasis.org). To interrupt transmission, it is essential to reduce the levels of microfilariae in the blood for a sustainable period. This is achieved by administering a yearly, single dose, 2-drug regiment for most countries, the recommended drugs are DEC (6mg/kg) and albendazole (400 mg).

However, in many areas of Sub-Saharah, Africa (and Yeamen as well) where there is epidemiological overlap with loiasis and Onchocerciasis, the toxicities caused by DEC in people with these conditions necessitate substituting ivermectin. Such population would receive ivermectin and albendazole (Almeida, 1996).

A period of 5 years of annual treatments is currently recommended. To date, the number of serious adverse events from LF control means chemotherapy has been remarkably low. In some areas, a treatment require comprised of daily DEC-fortified salt is used. To alleviate suffering and decrease the disability caused by LF, the major strategy has been to decrease secondary bacterial and fungal infections of the affected limbs and genitals. This includes meticulous local hygiene, judicious use of antibiotics, physiotherapy and health education. Finally, there has been great interest in evaluating whether LF control practices that employ albendazole and ivermectin could have an impact on other Co-endemic helminth infections including Onchocerciasis and soil transmitted helminth infections. Such integrated proper strategies are attractive because of their economy of scale and cost effectiveness (Haddix *et al*. 1999; Rajendran *et al*. 2002; Webber, 1979; Taylor and Hoerauf, 2001).

The lymphatic system is vital to the elimination of pathogens and a blockage of the system causes an onset of secondary diseases that make it even more difficult for patients to live a normal lifestyle (Burril *et al*.1996). White (1926) studied the bionomics of *Culex quinquefasciatus* in India and found that it was very susceptible to climatic conditions and was not a hardy species.*Culex quinquefasciatus* preferred larger and more permanent areas of polluted water than domestic habitats of small household receptacles (Harris 1928). Belkin *et al*., (1945) worked onanophelene mosquitoes of the Solomon Island and New Hebrides. Benonson (1975) investigated the ways for control of communicable disease in man. Similarly, Bick (1951) studied the ecology of mosquito larvae of New Guinea pacific.Bram (1967) worked on the mosquito fauna of south East Asia.

The cyclopoid copepod *Mesocyclops thermocyclopoides*, a dominant invertebrate predator in many shallow ponds and temporary water bodies in northern India, feeds on cladocerans, rotifers, ciliates and when present, on mosquito larvae also, its prey selectivity with mosquito larvae in the presence of an alternate prey (the cladocerans- either *Moina macrocopa* or *Ceriodaphnia cornuta*) in different proportions. Costa and Fernando (1977) in Sri-Lanka supported the view that *Rasbora damiconias* acts as a good carnivore in the hilly areas. Gerberich (1971) has published a bibliography key word index on the control of mosquitoes by use of fish, covering the years 1901 to 1968.

Travis (1957) reported that fish can be used as predators of mosquito larvae because their population can be maneuvered by man, they are quite tolerant of a variety water conditions and they can be moved to water areas where they needed.

Global burden of filariasis: More than 120 million people are affected by lymphatic filariasis, including 25 million men who suffer from the genital swellings associated with the disease and 15 million people who suffer from severe lymphodema or elephantiasis of the leg (Nanduri and Kazura, 1989; Manson, 1978). The economic burden of lymphatic filariasis is tremendous. Patients who are heavily infected with lymphatic filariasis have a high risk of developing chronic symptoms, including lymphodema and elephantiasis. Such symptoms can result in a decrease in productivity, as they can lead to life-threatening infections if not properly cared for, as well as mobility and functionality problems. In nations that are endemic, the economic losses are often not calculated, but likely significant. Impact of the disease on Productivity is mentioned below:

- In Africa, LF causes more than $1 billion a year in losses. (Haddix *et al.* 1999). In African region, two freshwater breeding mosquitoes of *Anopheles gambia* complex namely *Anopheles arbinenses* and *Anopheles gambia* are known as the filarial vectors.
- In Haiti, women with lymph edema often are unable to participate in market trading, the major form of economic activity available to women (Coreil *et al.*1998).
- In Rufiji District, in 72.5% of the episodes, the affected individuals were incapacitated and unable to do their normal activities for an average duration of 3.7 days (Gasarasi *et al.* 2000).
- In Northern Ghana, 7% of potential male labor input may be lost due to chronic LF, (Gyapong*et al.* 1996). In some areas of Ghana incidence of acute adenolymphangitis (ADL) reach its peak during the rainy season, the time of peak agricultural activity, thus compounding productivity loss (Gyapong *et al.*,1996).
- Filariasis is transmitted by the infected mosquitoes. The severity of the disease is proportional to the intensity of biting by infected mosquitoes. In Africa, microfilaraemia rate was 45% in adult and the rate of exposure infective bites were 400% person per year.

- In Tanzania, the annual infective biting rate was 149% in the most highly endemic villages (microfilaraemia rate 28.5%).
- In India-
  - In India, LF causes almost $1 billion a year in lost productivity (Ramaiah*et al.*2000). *Mansonia annulifera* and *Mansonia uniformis* are vector of Brugian filariasis in India (WHO, 1998).
  - In India, 32 infective bites per person per year maintained a microfilaraemia rate of 16.7% (WHO, 1998, Hyma*et al*. 1989).
  - Cost of productivity loss to male weavers in India is estimated to be as high 27% (Ramu*et al.* 1998).
  - Chronic LF patients in Orissa, India lost a total of 68 days of work per year, equivalent to 19% of the total working time of the year. In addition, compared to the control group, which worked an average of 6.06 hours per day, the chronic LF group worked an average of 4.94 hours per day, a statistically significant difference *(Coreil et al*.1998).
  - Overall, an estimated 8% of potential male labor is lost to LF (Ramaiah *et al*. 1999).
  - Estimated average per capita loss to the endemic population due to LF per year is $2.00. The endemic population in India is 420 million people (Ramaiah *et al.* 2000).

Besides, the following vector-species are responsible for the filariasis in the following countries.

- In Libaria, *Anopheles nile* and *Anopheles hancock* have been incriminated as vector of filariasis.
- In Thailand, *Aedes niveus* and *Aedes poecilus* in Philippines have been incriminated as the vectors of *Brugia malayi.*

- *Anopheles danotities* and *Anopheles dirus* have been found to be responsible for filariasis in western pacific and in Southeast Asia respectively.
- *Anopheles barbirostris* has been reported as the vector of *Brugia timori* infection in Timor, Indonesia.
- *Culex quinquefasciatus* was found to be the only vector forbancroftianfilariasis of nocturnal periodicity in Bangladesh (Aslam, Khan and Wolfe, 1972; Ahmed *et al*. 1986).

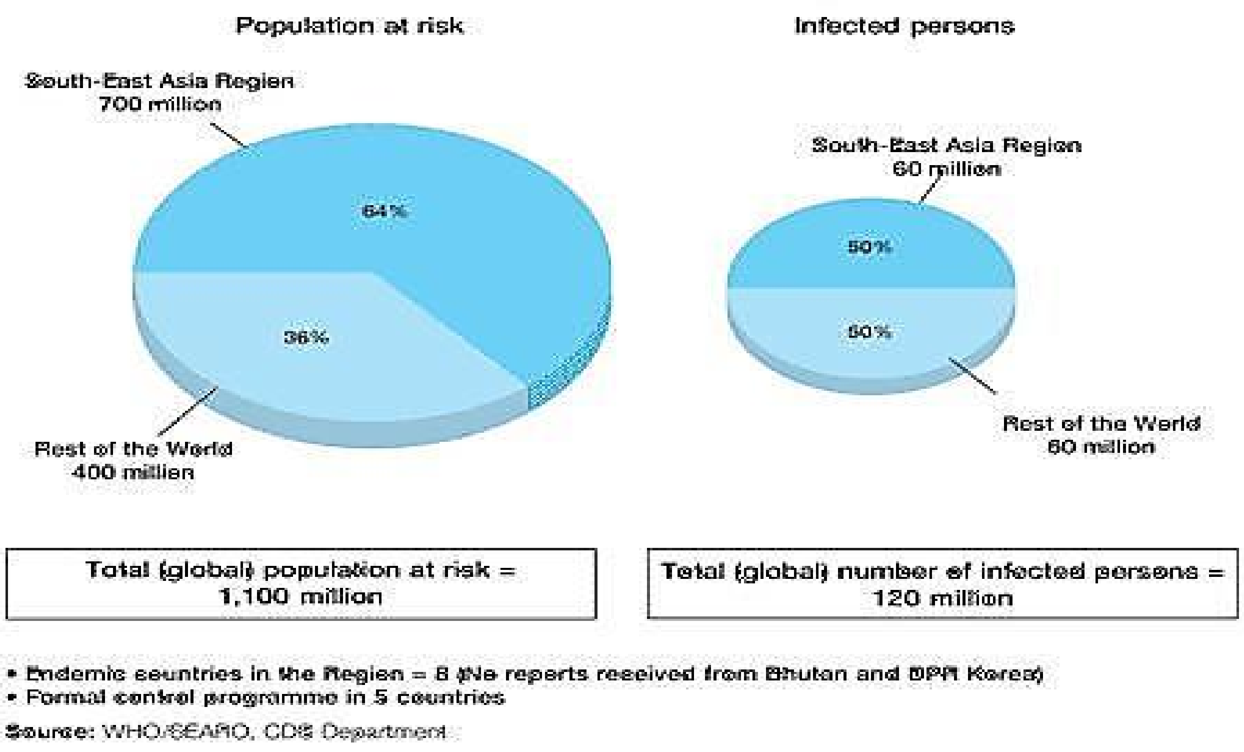


Plate-2: Global burden of lymphatic filariasis

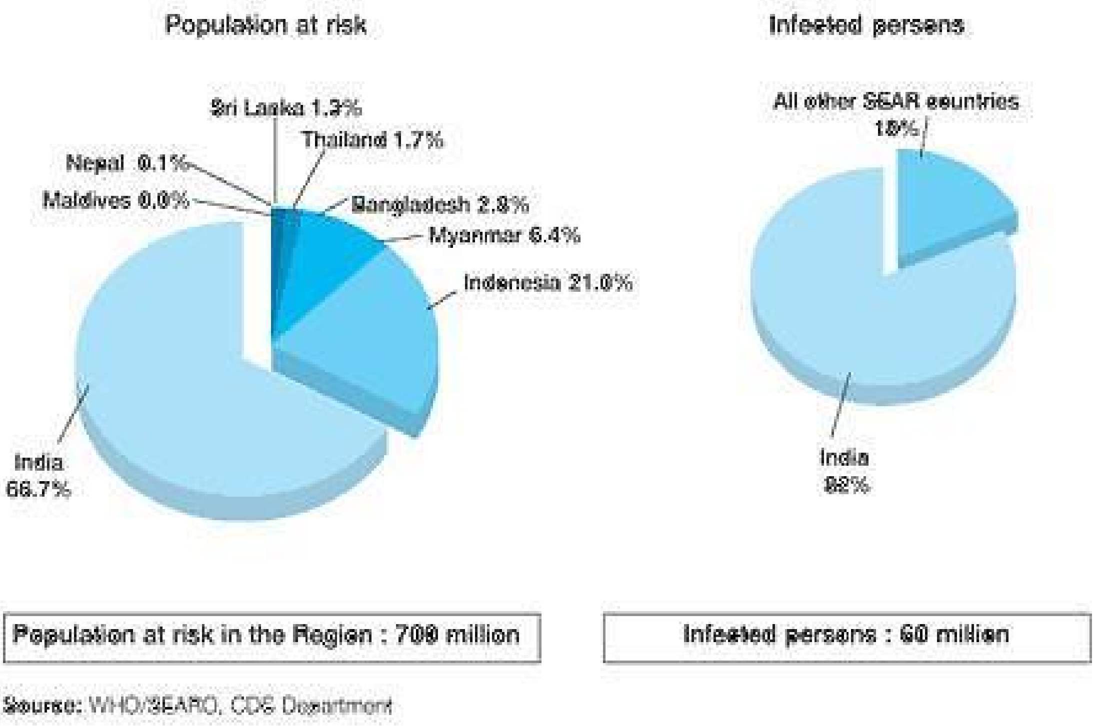


Plate-3: Filarial burden in South East Asia Region (SEAR)

Prevention and control measures situation of filariasis-Global perspective: Mosquitoes are still conspicuous vector and nuisance pest in the world. Important diseases caused by mosquito vectors are malaria, yellow fever, filariasis, dengue fever, elephantiasis, encephalitis etc. Not only anophelene mosquitoes but also Culicine mosquitoes have a good role in transmitting communicable disease. For each species of mosquito, there is a set of general ecological condition most favorable for development, and variations from these optimum environmental conditions are reflected in variation of the population density of the species (Bates, 1949; Gwadz, 1972; Hassan *et al*. 1997).

Culex quinquefasciatus lay eggs in domestic collection of water and such places as flooded open cement drains, flooded latrines, overflow water from houses, kitchens, ground pools, ditches, and shallow wells, rarely in tree holes or bamboos; not in jungle pools, stream pools if far from human habitations (Barraud, 1934;

DeMeillon,1968). DeMeillon (1967) worked on the duration of egg Larval and pupal stages of *Culex quinquefasciatus* in Yangon, Myanmar. Dhar (1968) reported the seasonal prevalence resting habits must preference and fillarial infection of *Culex* in Rajahmundry town Andhra Pradesh.

In several countries, effective control campaigns have greatly reduced the prevalence of lymphatic filariasis. Particularly, in China, India and Sri Lanka, the incidence of filariasis caused by *W. bancrofti* and *B. malayi* are decreasing due to effective control programme. Considerable success has been achieved in eliminating the parasites in the Southern Brazil, Japan, Republic of Korea and Turkey, where the filariasis transmission is seasonal. In some of these areas, there has also been a spontaneous decline in prevalence of filariasis, which was associated with improvement in economic status of the community and in sanitation and with effective mosquito control (WHO, 1998; Daniloya and Zubareva, 1932; Dealwis and Munasinghe, 1971; Michael *et al.* 1996; Molyneux *et al.* 2000; Baird *et al.* 1986; Southgate, 1992).

In view of the magnitude of the problem and of the differences between the various filariasis which make it impossible to control them all at the same time, and in view of their varying public health importance in different endemic areas, the world health organization has found it necessary to proceed gradually with a long term programme of activities for the control of this group of diseases. In this programme, priority has been given to that filariasis which constitutes major public health problems for many countries and in the control of which increasing interest has been shown as a result of recent advances in treatment and prevention (Carme and Laigret, 1979; Chow *et al.*1959; Chidester 1971; Nelson, 1979; Sabesan *et al.* 2000; Snow *et al.* 1999; Srtvidya *et al.* 2002).

Many endemic areas lack reliable data on the prevalence of LF, and estimates of the number infected may increase when more precise data become available from epidemiological mapping. Nationwide mapping in four neighboring countries in West

Africa showed that LF was endemic in a much wider area than expected, and the findings resulted in a dramatic increase in the estimated number infected (Gyapong *et al*. 2002, Genton *et al*. 1995; Linsday and Thomas, 2000; Nelson 1977).

Yet the appearances of pesticide resistance and adverse ecological effects have diminished our confidence in conventional chemical methods (Moore, 1967).The development of resistance in mosquitoes to insecticides, environmental pollution, the cost of operations due to short duration of action, newer insecticides and other reasons have given rise to a new thinking to find out other ways of mosquito control which refer to as “The Biological Control”. Larvivorous predators used on and off for many years in different parts of the world seems to be more practical among the various agents of biological control method (Gigliolo, 1960; Notestine, 1971).

Filarial situation in Bangladesh

According to Programme coverage in WHO LF database, there are 34 districts are endemic filariasis in Bangladesh. According to JICA, thirty-two out of a total 64 districts in Bangladesh with about 70 million people are identified as endemic to filariasis. Increased attention has been focused on disability management in Bangladesh. Bancroftianfilariasis is found in different parts of Bangladesh with high prevalence rate in northern districts (Bangladesh filariasis elimination programme 2002-2004).

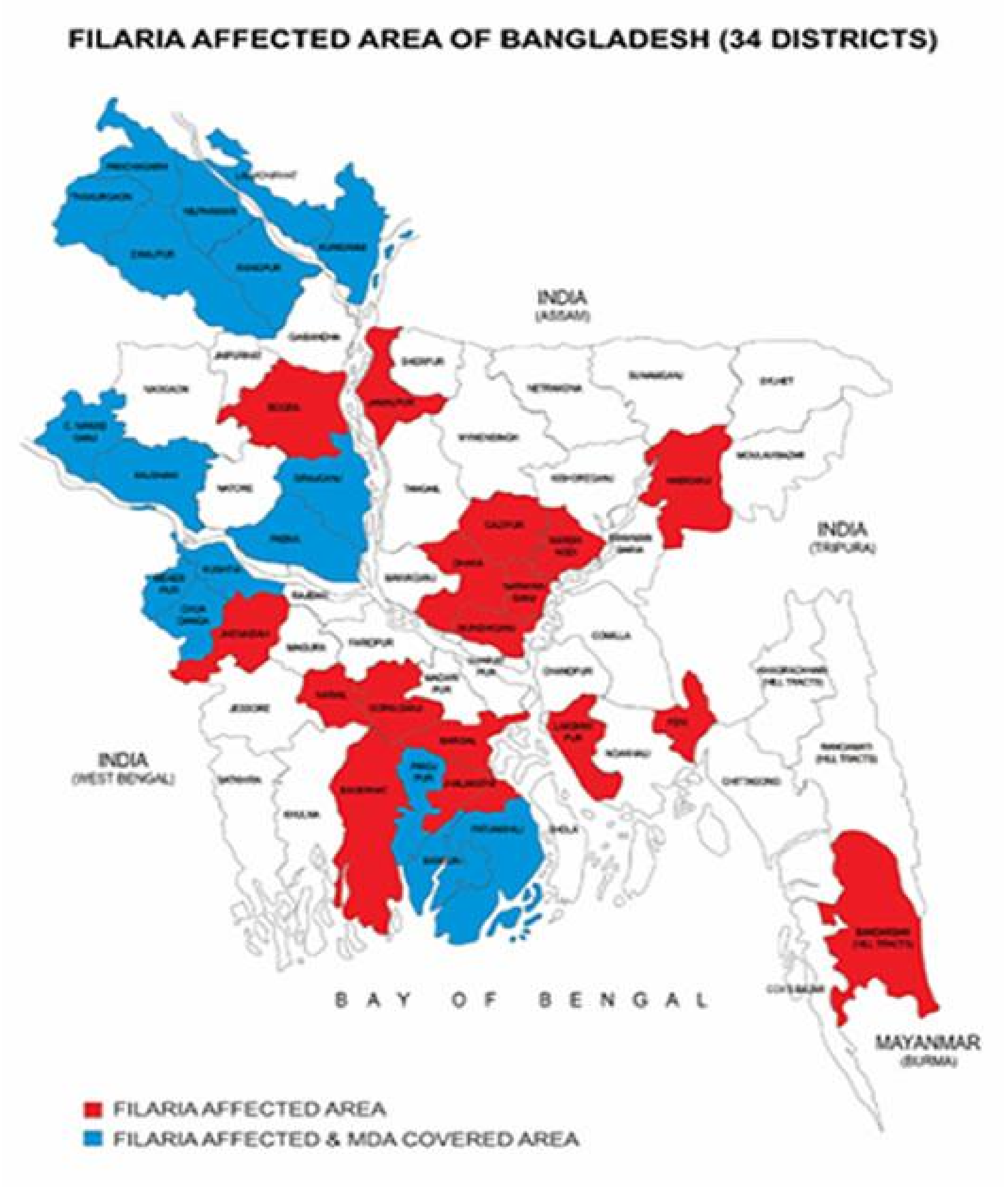
Bangladesh is surrounded by endemic areas of filariasis. It is surrounded by West Bengal, Bihar, and Assam states of India and Myanmar, where filariasis is endemic. Filariasis is prevalent in Bangladesh with different degree of endemism. The information regarding prevalence and epidemiology of filariasis in Bangladesh is inadequate due to lack of study, but few isolated survey have shown filariasis is prevalent in different parts of Bangladesh.

It has been showed that high numbers of cases were found in the greater district of Dinajpur, Pabna, Chittagong, Barisal, Rajshahi and Rangpur with the blood microfilaria positivity rate of 11.6%, 5.5%, 4.5%, 3.08%, 3.2% and 3.05% respectively. Lesser number of cases was found in the greater districts of Bogra, Faridpur, Comilla, and Sylhet with blood microfilaria positivity rate. No cases have been found in Noakhali (Wolfe and Khan, 1971).

Rahman *et al.* (2008) recorded most endemic villages for filariasis was Fokdonpur, Khankah and Gobindanagar in the Thakurgaon Sadar Thana. On an average 4.20% people were infected with filaiasis in those villages. The respondents had poor knowledge regarding the transmission of filariasis. Among the affected people, 55.67% were illiterate and 25% had primary education. Most of the respondents were unable to purchase mosquito net after maintaining their daily life expenses. The sanitation process of the study area was very poor.

An entomological investigation showed that the tropical house mosquito, *Culex quinquefasciatus* is the only vector of bancroftianfilariasis in Bangladesh. A study in Ache and Madarganj villages in Dinajpur district, recorded 35 mosquito species (11 species of *Culex*, 10 of *Anopheles*, 8 of *Aedes*, 3 of *Mansonia*, 2 of *Armigeres* and 1 of *Triptoroides*). Except few caseses of *B. malayi* all filarial cases in Bangladesh were due to *W. bancrofti* (Barry *et al*.1971).

According to programme coverage in WHO LF database, there are 34 districts, are endemic for filariasis in Bangladesh (Map-3).



Map-3: Filaria affected areas of Bangladesh (34 Districts).

[Source: WHO 2007. Global Programme to eliminate Lymphatic Filariasis. *Ann Rep Lym Fil.* **28**:7-8.]

Prevention and control measures situation in Bangladesh: Different works carried out by different scientist in Bangladesh also showed that this species is endophilic in nature i.e. it prefers to rest indoor (Ameen and Moizuddin, 1973; Ameen*et al.*1982, 1984; Ahmed *et al*.1986, 1989, 1991). The mosquito, *Culex quinquefasciatus* has been incriminated as vector of Bancroftian filariasis.The species have nocturnal periodicity (Ahmed *et al*.1986).Another study showed average microfilaria infection rate in mosquito was 4.5% in Thakurgaon and 1.6% in Dhaka (Chowdhury *et al*.1990a).

Culex quinquefasciatus was found endophagic and endophilic in nature i,e. it prefers to feed and rest indoor as observed by Ameen and Moizuddin (1973) and Ameen *et al.*(1982). Regarding vector, other two studies were conducted by Ahmed *et al*. (1989, 1991).

As filariasis is a chronic disease, diagnosis and treatments are cumbersome. More emphasis is to be given on vector control as the vector of filarial has domestic habit. Poor sanitation, rapid unhealthy and unplanned urbanization and industrialization of the towns of the country have made conditions ideal for transmission of *W. bancrofti* by mosquito (Ameen and Moizuddin, 1973; Malhotra *et al.* 1983).

Infestation by mosquitoes is a great problem for Dhaka city. With the expansion of the city, the manpower and other logistic supports of Dhaka Mosquito Control Scheme which was started in 1948 did not expand and the unplanned development of the city created more breeding sites for mosquitoes. Drainage system is not well developed. Sewerage system is expending very slowly with the development of the city. Maintenance of this system is also very poor. So the populations of various mosquitoes are increased day by day. So it is very much necessary to control mosquito of country.

In Bangladesh, filariasis control activities do not exit except very limited treatment of cases in the endemic zone with individual effort. In such places personal protection with impregnated bed net may help to control the disease. In the areas where malaria and filarial both are endemic.Use of insecticide-impregnated bed net may be a more fruitful method to control the diseases.

As filariasis is a chronic disease, it is really difficult to control by chemotherapy alone. As the disease is a vector borne one, some efforts to prevent man-vector contact would be more helpful to control the disease (Maxwell *et al.* 1990, 1999).Transplacental immunity and breast feeding may limit the intensity of infection in younger individuals. Babu *et al.* (2002) determined the economic loss due to treatment costs and work loss to individuals with chronic lymphatic filariasis in rural communities of Orissa, India. Babu and Kar (2004) worked on coverage, compliance and some operational issues of mass drug administration during the programme to eliminate lymphatic filariasis in Orissa, India.

Predation of the vectors of filariasisas an easier biological control-Bangladesh perspective: *Culex quinquefasciatus* breeds in large number of places both in polluted and clean water. The control of such huge breeding sources of this mosquito in Bangladeshis a great challenge. *Culex quinquefasciatus* behaved as an acidophilic, it more frequently preferred alkalinity, its principal breeding places as rules have a p^H 7.4-8.6 and the food suited to the larvae was most likely to occur in state of concentration.As filariasis is transmitted from one patient to another by the mosquito, so this disease would be controlled through controlling the mosquito breeding. *Culexquinquefasciatus*lay eggs in domestic collection of water and such places as flooded open cement drains, flooded latrines, overflow water from houses, kitchens, ground pools, ditches, and shallow wells, rarely in tree holes or bamboos; not in jungle pools, stream pools if far from human habitations (Barraud, 1934).

Hossain *et. al.* (1997) reported that among the larvae and their predators collected from Dhaka city, 75% of the total, was *Culex quinquefasciatus* Say. The other larvae found belonged to the genera *Culex, Aedes, Anopheles and Mansonia.* Domestic stagnant water harboured the highest concentration (29.2%) of *Culex quinquefasciatus,* followed by katcha drains (23.6%) and pucca drains (21.3%). There was a peak population of this species from November to April. Altogether 21 different predators were collected of which *Ranatra elongata* and *Naucoris s*p were found in most of the breeding grounds. Guppy fish, *Poecilia reticulata*, was common in the drains.

In addition to being a biting nuisance *Culex quinquefasciatus* is a vector of bancroftian filariasis (Begum *et al.* 1987).The permanent solutions of the filariasis problem will be to alleviate its vector. *Culex quinquefasciatus* is the vector of bancroftian filariasis in Dhaka city (Begum *et al.* 1987). The easier cost effective control of this vector will be the biological control like predation of vector's larvae by the aquatic predators. Vector control service, research and operations have been escalated especially since the end of World War II, where various control methods were developed. In recent years, many national vector control operations have been facing difficulties technically on account of the increases insecticide resistance in many vector species and operationally on higher cost of the alternate insecticides. Besides, chemical insecticides have a harmful effect on the environment. Moreover, resistance to DDT, Malathion and other organophosphate insecticides by the mosquitoes of Dhaka have already been reported (Pederson 1985). The chemical insecticides also kill non-target organisms including the natural predators of mosquito larvae (Mulla *et al.* 1975).On the other hand, mosquito control by using biological agents could be less expensive if applied judiciously. The use of fish predators could be a useful alternative against chemicals in controlling mosquito larvae. Some scientists have been tried against mosquito larvae in the laboratory in Bangladesh.

A number of insects and fishes have been tested in the laboratory to evaluate their predatory role against mosquito larvae. (Chakravertly *et al.*1976; Pasnicker and Rajagopalan, 1977; Sailer and Leink, 1954).

Huda and Rahman (1982) performed laboratory experiment in the University of Chittagong. Their study was undertaken to determine the larvicidal potential of eight indigenous fishes of Bangladesh. The fishes were *Amblypharyngodon mola* Ham, *Anabas testudineus* Bloch, *Apocheilus panchax* Ham, *Clarias batrachus L.*, *Colishafasciata* Bloch, *Channa* spp. Bloch, *Puntius ticto* Ham and *Rasbora daniconius* Ham. Hossain *et al. (*1997) performed laboratory experiment in the University of Dhaka. Their study was undertaken to determine the larvicidal potential of 20 aquatic species. Among those 20 species, six species were indigenous fishes of Bangladesh like *Anabas testudineus*, *Clarias batrachus*, *Colisha fasciata*, *Channa* spp, *Lebistus reticulaus*, *Oreochromis* spp. So the use of predators could be a useful alternative against chemicals in controlling mosquito larvae (Piessens and Partono, 1980; Piessens and Megreevy, 1980; Regis *et a*l. 1995).

The larval stages of mosquitoes live in aquatic environment. It is known that, as biological mosquito control agents, larvivorous fish have been singularly successful (Dixit *et al.*1981, Ahmed *et al*.1985). Hossain *et. al*. (1997) studied the orders Odonata and Hemiptera and some fishes collected from mosquito breeding grounds of Dhaka city were allowed to feed upon different larval instars of *Culex quenquefasciatus say* to determine their predation capacity. They observed that among the fishes *Clariasbatrachus* consumed the highest number of larvae (26,189.6 per day) followed by *Oreochromis nilotica* (4,770.5 per day). All the three different sizes of guppy fish consumed mosquito larvae, the newly hatched fingerlings consuming as many as 25.4 first instar mosquito larvae per day and an adult guppy consumed on an average 145.7 larvae per day.

Endemism and Epidemiological factors offilariasis

Endemism: The situation in which a species or other taxonomic group is restricted to a particular geographic region, due to factors such as isolation or response to soil or climate conditions. Such a taxon is said to be endemic to that region. The size of the region in this context will usually depend on the status of the taxon: thus a family will be endemic to a much larger area than a species, all other things being equal (Dictionary of Zoology, Michael Allaby, 2003).

Epidemiology: The word epidemiology comes from the Greek words *epi*, meaning on or upon, *demos*, meaning people, and *logos*, meaning the study of. In other words, the word epidemiology has its roots in the study of what befalls a population. Many definitions have been proposed, but the following definition captures the underlying principles and public health spirit of epidemiology.

Epidemiology is the study of the distribution and determinant**s** of health-related states or events in specified populations and the application of this study to the control of health problems. Epidemiology is a scientific discipline with sound methods of scientific inquiry at its foundation. Epidemiology is data-driven and relies on a systematic and unbiased approach to the collection, analysis, and interpretation of data. Basic epidemiologic methods tend to rely on careful observation and use of valid comparison groups to assess whether what was observed, such as the number of cases of disease in a particular area during a particular time period or the frequency of an exposure among persons with disease, differs from what might be expected. However, epidemiology also draws on methods from other scientific fields, including biostatistics and informatics, with biologic, economic, social, and behavioral sciences. In fact, epidemiology is often described as the basic science of public health, and for good reason.

First, epidemiology is a quantitative discipline that relies on a working knowledge of probability, statistics, and sound research methods.

Second, epidemiology is a method of causal reasoning based on developing and testing hypotheses grounded in such scientific fields as biology, behavioral sciences, physics, and ergonomics to explain health-related behaviors, states, and events (Hawking et al. 1966).

However, epidemiology is not just a research activity but an integral component of public health, providing the foundation for directing practical and appropriate public health action based on this science and causal reasoning (Report of United States Centers for Disease Control and Prevention -May’18, 2012).

The three components of filarial endemism and epidemiology consist of parasite, vector and host.One hundred and twenty million people in 83 countries of the world are infected with lymphatic filarial parasites, and it is estimated that 20% of the world's population are at risk of acquiring infection. Ninety percent of these infections are caused by *Wuchereria bancrofti*. For *W. bancrofti*, humans are the exclusive host, and even though certain strains of *B. malayi* can also infect some feline and monkey species, the life-cycles in humans and in these other animals generally remain epidemiologically distinct, so that little overlap exists. The major vectors for *W.*

bancrofti are culicine mosquitoes in most urban and semi-urban areas, anophelines in the more rural areas of Africa and elsewhere, and *Aedes* species in many of the endemic Pacific islands. For the Brugian parasites *Mansonia* species serve as the major vector, but in some areas anopheline mosquitoes are responsible for transmitting the infection. Brugian parasites are confined to areas of east and south Asia, especially India, Malaysia, Indonesia, the Philippines, and China.There are 34 districts, are endemic for filariasis in Bangladesh (According to Programme coverage in WHO, LF database, 2007).

Pathogenesis and Pathology

Lymphatic filariasis is a parasitic disease caused by microscopic, thread-like worms. Infection of humans occurs when a mosquito carrying the parasite deposits filarial larvae that are in the infective-stage on to the skin during a blood meal. Larvae penetrate the skin and accumulate in the lymphatic system where they develop and grow into adult worms that are sexually mature. This disease is manifested by enlargement of the limbs, scrotum, and other extremities, is not the initial effect but the result of long-standing infection. As worms block the lymph vessels, edema occurs, and in times the deposition of connective tissue cells and fibers contribute to elephantiasis (Thomas, 1986; Cheng, 1986; Ottesen and Nutman, 1992; Nelson and Hornsborourgh, 1988; Nelson, 1981; Pani and Uvaraj, 1995; Hotez and Remme, 2004)).

Most patients with LF tend to experience skin fold thickening and pigmentary changes to their skin. In these instances, the infected skin hardens and develops small bumps, such that even pressing cannot dent the skin. Furthermore, due to the dryness of the skin, soaking the patients' skin in water does not relieve the painful cracks that soon develop (Burril*et al.*1996; Evans *et al.*1993). Along with skin changes in the early stages of LF, infected persons also have to battle other infections (Rahman, 1992).

Swelling of body parts is a consequence of LF. Those who have swollen toes find it nearly impossible to wear shoes, which are vital for protection against the outside environment. The lack of shoes increases the chances of the patients' suffering from a secondary infection. Specifically, the swelling of the toes is accompanied with the tightening of skin cells, which facilitates further growth of bacteria and fungi. Because the toes have been greatly enlarged at this point, it is difficult to pry individual toes apart for removal of bacteria. In this way, infected persons become breeding grounds for further diseases (Burril*et al*.1996). The trauma of LF patients does not end here. Those who continue to experience progressive swelling are declared to have elephantiasis and are in for a life of painful disability.

The inflammatory response begins with the death of or damage to adult worms, which leads to host reaction and acute filarial lymphangitis. A heavy worm burden and the presence of worms in the scrotal area precipitate the development of hydrocele, chyluria, chylocele, and lymph scrotum. Lymphatic dysfunction caused by dilatation of the lymphatic vessels makes the patient more prone to repeated secondary bacterial infection, which precipitates lymphedema and elephantiasis. Microfilariae play an important role in the pathogenesis of tropical pulmonary eosinophilia (Dreyer et *al*. 2000).

The pathology associated with lymphatic filariasis results from a complex interplay of the pathogenic potential of the parasite, the immune response of the host, and external ('complicating') bacterial and fungal infections. While genital damage (particularly hydroceles) and lymphoedema/elephantiasis are the most recognizable clinical entities associated with lymphatic filarial infections, there are much earlier stages of lymphatic pathology and dysfunction whose recognition has only recently been made possible through ultrasonographic and lymphoscintigraphic techniques. For example, ultrasonography has identified massive lymphatic dilatation around and for several cm beyond adult filarial worms which, though they are in continuous vigorous motion, remain 'fixed' at characteristic sites within lymphatic vessels.

Asymptomatic Presentations

Of all the individuals with lymphatic filariasis less than half appear clinically asymptomatic, though they have microfilariae circulating in their blood and yet all have hidden damage to their lymphatic (as evidenced by lymphoscintigraphy) and/or renal systems (microscopic heamaturia and/or proteinuria). It is clear that this state of asymptomatic microfilaraemia is associated with a highly down-regulated immune system, but it is as yet unclear how, when or even whether these individuals will progress to develop one of the more overt clinical manifestations of filarial disease.

A second asymptomatic 'presentation' exists in individuals previously termed 'endemic normals'; their infections are defined not by microfilaraemia but by the presence of parasite antigen in the blood (which will disappear after appropriate treatment). It has only recently been possible to recognize this group of patients, and both their clinical features and infection remain to be defined (http://www.filariasis.org/disease.html).

Other syndromes

Other syndromes of uncertain relationship to lymphatic filariasis: A variety of syndromes co-existing with filariasis are found in filarial endemic regions, and because they show some evidence of therapeutic response to DEC, they have been suggested as possible manifestations of lymphatic filariasis. These include arthritis (typically monoarticular), endomyocardial fibrosis, tenosynovitis, thrombophlebitis, glomerulonephritis, lateral popliteal nerve palsy, and others. While future studies may strengthen our knowledge of the clinical presentation, such syndromes at present cannot confidently be attributed to filarial infection (http://www.filariasis.org/disease.html).

Expatriate Syndrome: Recently, a 'new' filarial syndrome has been described as one of clinical and immunologic hyper-responsiveness found in expatriate visitors to regions endemic for loiasis. This clinical syndrome is, of course, not new, nor is it limited to loiasis (tropical eye worm), as similar clinical descriptions of patients with onchocerciasis, lymphatic filariasis, and other filarial infections also have been recorded previously.

Instead of developing the commonly described chronic clinical manifestations of their filarial infections, individuals who have grown up outside endemic regions and then moved to these regions and acquired a filarial infection manifest prominent signs and symptoms of inflammatory (including allergic) reactions to the mature or maturing parasites.

In loiasis, these manifestations have included primarily calabar swellings, hives, rashes and occasionally asthma; and in bancroftian filariasis (when military personnel or other migrants to endemic areas have acquired these infections), symptoms have usually been lymphangitis, lymphadenitis, genital pain (from inflammation of the associated lymphatics), along with hives, rashes and other 'allergic-like' manifestations, including blood eosinophilia.

The reason for these different clinical presentations lies almost certainly in the different immunoregulatory responses to filarial antigens between those with long (including prenatal) exposure to these antigens and those meeting them for the first time (http://www.filariasis.org/disease.html).

Clinical Features

There are chronic, acute and 'asymptomatic' presentations of lymphatic filarial disease, as well as a number of syndromes associated with these infections that may or may or not be caused by the parasites.

Chronic manifestations: *Hydrocoele,* even though found only with *W. bancrofti* infections (i.e., not *Brugia* infections) is the most common clinical manifestation of lymphatic filariasis. It is uncommon in childhood but is seen more frequently post-puberty and with a progressive increase in prevalence with age. In some endemic communities 40-60% of all adult males have hydrocoele.

Thehydrocoeles can become massive but still occur without lymphoedema or elephantiasis developing in the penis and scrotum, since the lymphatic drainage of these tissues is separate and more superficial.

Whilelymphoedema, too, can develop in the absence of overt inflammatory reactions and in the early stages be associated with microfilaraemia, the development of elephantiasis (either of the limbs or the genitals) is most frequently associated with a history of recurrent inflammatory episodes.

Chyluria, another of the chronic filarial syndromes, is caused by the intermittent discharge of intestinal lymph (chyle) into the renal pelvis and subsequently into the urine.

There are 4 distinct acute manifestations of lymphatic filariasis, each with a different set of causal mechanisms and pathogenic implications.

Most important are the acute inflammatory episodes of the limbs or scrotum that are related to bacterial or fungal superinfection of tissues with already-compromised lymphatic function. In the past these were termed 'filarial fevers' and more recently 'adenolymphangitis' (ADL); it has been suggested, however, that a better description would be 'DLA' (dermatolymphangioadenitis) to indicate that they start peripherally, have features of cellulitis and drain centrally towards lymph nodes.

Confused with this picture in the past was another (second) type of 'filarial fever' in which the inflammation was initiated in the lymph node with 'retrograde' extension down the lymphatic tract and an accompanying 'cold' oedema.

A third acute filarial syndrome is tropical pulmonary eosinophilia, caused by an immunologic hyper-responsiveness to filarial infection. It is characterized by extremely high levels of peripheral blood eosinophilia, asthma-like symptoms, restrictive (and often obstructive) lung disease (Udwadia, 1993; WHO, 2000; Sarker *et al*. 1996; Sarker and Rahman, 1996).

The fourth (and least commonly recognized) form of acute inflammatory reaction caused by filarial infection is that seen early after infection particularly in expatriates exposed to, and acquiring, the infection for the first time, as when military missions have been sent to filariasis-endemic areas (Yangco *et al*. 1984)

Diagnosis of Lymphatic filariasis

Since lymphatic filariasis does not always result in clinical symptoms, the most accurate way to determine if someone is infected is a blood test. In most parts of the world, the parasites have a "nocturnal periodicity" that restricts their appearance in the blood to only the hours of 10pm - 2am. Besides "night blood films" taken at night can be tested by filtration or concentration techniques which are more sensitive as more blood can be taken.

However, an antigen-detection test that is simple, sensitive and specific is now available. This test can detect infection within minutes and unlike previous tests can be carried out at any time of day.

Management of Elimination of Lymphatic filariasis

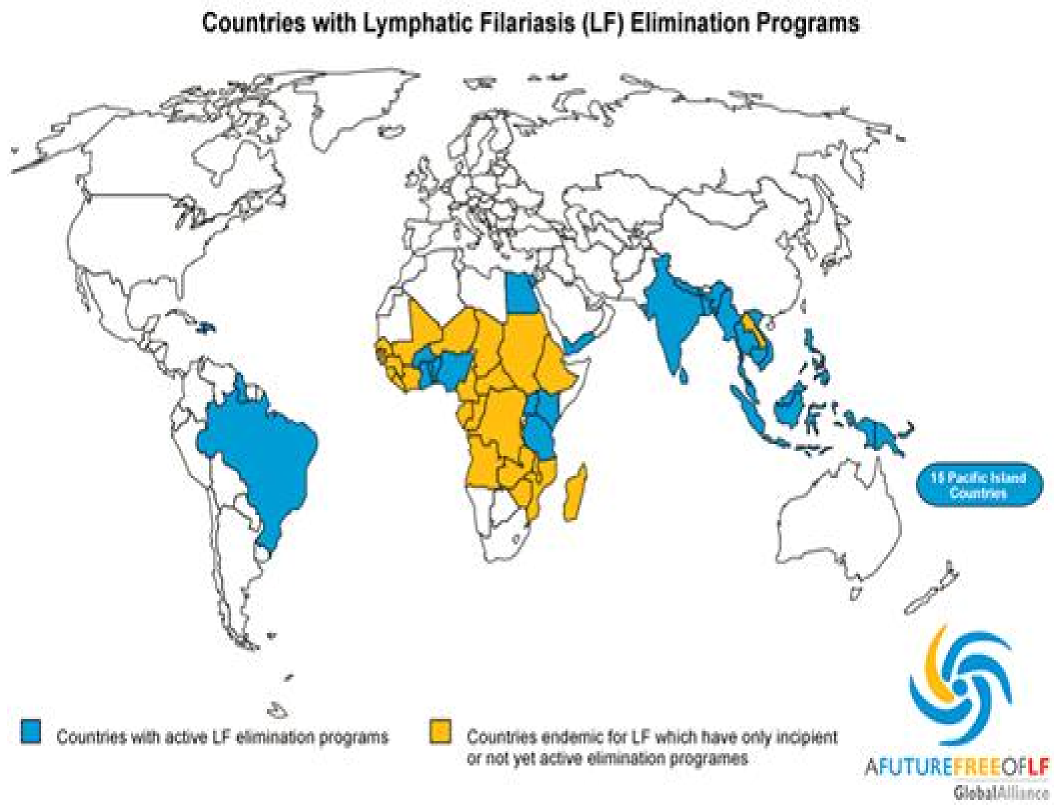
Because of the many different presentations of clinical disease related to LF, there is no single drug or treatment that is effective for all cases.However, for all patients, three issues should be considered:

1. anti-parasitic drug therapy
2. supportive clinical care
3. vector control management
4. patient education and counseling

To eliminate lymphatic filariasis (LF) as a public health problem, we must stop the transmission of infection. Levels of worm larvae (microfilaria) in the blood of infected persons must be reduced so that mosquitoes cannot transmit the worms from one human to another. The strategy for interrupting transmission is an annual single co-administration of two drugs for at least five years.

A major global effort is underway to eliminate LF over the next 10-20 years. The strategy for LF elimination relies on interrupting mosquito transmission. The GAELF (Global Alliance for the Elimination of Lymphatic Filariasis) currently recommends a dual strategy of prevention and treatment in order to achieve complete elimination. The prevention part of an elimination program involves the interruption of disease transmission through annual Mass Drug Administration's (MDAs) (Molyneux and Bradley, 2003). WHO recommends that for most mosquito vectors, the following are the major components of integrated vector control schemes: (1) environmental management and source reduction by draining, channeling and land filling improvement of water margins and water level management;(2) personal protection by the use of bed-nets or by the alternate use of insecticides other than DDT by impregnated bed nets, repellents etc. to reduce man vector contact; (3) the use of insecticides as adulticides and larvicides; (4) health education and training etc.

The permanent solutions of this problem will be to alleviate its vector. *Culex quinquefasciatus* is the vector of bancroftianfilariasis (Begum *et al*. 1987; Stolk *et al*. 2003).



Map-4: Countries with Lymphatic Filariasis Elimination Programs.

The approximately 40 countries that currently have elimination programmes have been particularly successful in creating an environment to set up successful programmes, establishing effective task forces to overseeprogramme activities, mapping LF to determine where endemic areas within the country are, deciding on mass drug administration strategy and finally, creatively developing ways to help those afflicted with LF.

Clinical Care

- Washing the affected parts twice daily with soap and clean, cool water, and drying carefully
- Raising the affected limb at night
- Exercising the limb regularly
- Keeping the nails and spaces between the toes clean
- Wearing comfortable shoes
- Using medicated creams or antibiotics to treat small wounds or abrasions

Through these methods, even the worst case of elephantiasis can be improved over time.

The objective of this study was to observe prevalence and epidemiological aspects of filariasis in accordance with age, sex and social economic factors of the population in Nilphamari district of Bangladesh. The list of these factors mentioned for lymphatic filariasis in various sources includes-

  - Biological risk (Mosquito bite)
  - Social risk (Ignorance, Poverty, Negligence of government)
  - International travel.
  - Developing countries. (poor infra-structure of the country)
  - Tropical climates.

Risk factors for lymphatic filariasis do not seem to be a direct cause of the disease, but seem to be associated with some way. Having a risk factor for lymphatic filariasis make the chances of getting a condition higher but does not always lead to lymphatic filariasis. Also the absence of any risk factors or having a protecting factor does not necessarily guard us against getting lymphatic filariasis (Udonsi, 1998; WHO, 2004; Wolfe and Khan, 1969).

Identification of causative organism of filariasis

The filarial parasite that are generally recognized as being distinct entities are (i) *Wuchereria bancrofti* (nocturnal periodic, sub periodic), (ii) *Brugia malayi* (nocturnal periodic, sub periodic) and (iii) *Brugia timori* (Only nocturnal periodic).The female produces microfilaria (mf), which circulates periodically in the peripheral blood either nocturnally or diurnally (WHO, 1984) diagnosis of lymphatic filariasis was based on the identification of mf in the peripheral blood. Night blood collection is the traditional method for detection of microfilaria in peripheral blood (Harinath, 1985).To avoid the inconvenience for the night blood collection, Udonsiused "provocative test" for collection of blood sample in daytime but unfortunately this yielded fewermicrofilaria than smear taken at night (Taylor *et al.*1992). Subsequently IFAT, ELISA, ICT etc. are used (Rao *et al.*1981).

Filarial vector

Mosquitoes are the only known vectors of lymphatic filariasis. *Culexquinquefasciatus* has been recognized as the vector of nocturnally periodic *W. bancrofti.Culex quinquefasciatus* was found to be the only vector for bancroftian filariasis of nocturnal periodicity in Bangladesh (Aslam, Khan and Wolfe, 1972; Ahmed *et al.*, 1986). In African region, two freshwater breeding mosquitoes of *Anopheles gambia* complex namely *Anopheles arbinenses* and *Anopheles gambia* are known as the filarial vectors.But in Libaria, *Anopheles nile* and *Anopheles hancock* have been incriminated as vector of filariasis.*Anopheles danotities* and *Anopheles dirus* have been found to be responsible for filariasis in western pacific and in Southeast Asia respectively.In Thailand, *Aedes niveus* and *Aedes poecilus* in Philippines have been incriminated as the vectors of *Brugia malayi. Anopheles barbirostris* has been reported as the vector of *Brugia timori* infection in Indonesia. *Mansonia annulifera* and *Mansonia uniformis*are vector of Brugian filariasisin India (WHO, 1998). Filariasis is transmitted by the infected mosquitoes. The severity of the disease is proportional to the intensity of biting by infected mosquitoes. In Africa, microfilaraemia rate was 45% in adult and the rate of exposure infective bites were 400% person per year.In

Tanzania, the annual infective biting rate was 149% in the most highly endemic villages (microfilaraemia rate 28.5%). In India, 32 infective bites per person per year maintained a microfilaraemia rate of 16.7% (WHO, 1998).

Filarial Host (Reservoir of infection)

Man acts as the host of filarial infection. Males are more affected. The disease is associated with zoogeography (generally tropical region), urbanization, industrialization, migration of people, illiteracy, poverty and poor sanitation. Variety of non- human primates such as gibbons, macaques, leaf monkey and orangutans are the important reservoir of zoonotic filariasis. They play an important role in epidemiology of human filariasis in endemic areas (Park, 2000).

Filariasis is a disease of the poor and underprivileged. Women suffer from lymphatic filariasis to a great extent but embarrassment, shame; Cultural constraints and social taboos are some of the reasons that refrain them from reporting problems and seeking help. Women are thus silently bearing the brunt of this disease (Bandyopadhyay*et al*., 1996).

In 1996, Mr. Ramaiahobserved that people were well aware of filariasis in their communities and recognized its different clinical manifestations. Only 9% of those with and 20% of those without the disease knew that filariasis was caused through mosquito bites; the rest attributed it to many other causes. People`s knowledge about transmission and prevention of filariasis was also very poor.

In another study, 104 residents of an endemic area in Haiti were interviewed by fewer than 50% of residents had heard of filariasis and only 6% knew that mosquitoes transmitted it. In contrast, all persons knew of the clinical conditions of hydrocele and elephantiasis. Hydrocele was thought to be caused by trauma or trapped gas, elephantiasis by walking bare foot on soil or water or by use of ceremonial powder that had been sprinkled on the ground. 76 respondents thought that hydrocele could be treated through surgery or a drug, respectively, whereas 86 respondents believed that either surgery or a drug could be used to treat elephantiasis (Eberhard *et al*.1996).

Acute Lymphadenitis (Elephantiasis) and Filarial Fevers

Death of the adult worm causes the next step in the progression of disease by producing an acute inflammatory response that is manifested as acute lymphadenitis.In endemic areas, this occurs frequently during the adolescent years and is manifested with fevers and painful swellings over the lymph nodes.This typically occur in the inguinal area. Episodes of painful swellings can last up to a week and commonly recur. Secondary bacterial infections may also result.Acute filariallymphadenitis is exacerbated by secondary bacterial infections.Some short-term travelers to endemic areas can also develop acute lymphadenitis, but the pathogenesis of this process occurs by a poorly understood process.This phenomenon was described in the 1940s among American troops returning from war in the Pacifictheatre.

A subset of patients with acute lymphangitis and filarial fevers will go on to develop lymphedema of the arms, legs, breasts and genitalia leading to elephantiasis. During these inflammatory processes, the skin becomes doughy and exhibits some degree of pitting.The inflammatory*W. Bancrofti* antigens have been developed.The assay, which recognizes a 200 kda antigen of adult worm origin, has a sensitivity of 96-100 percent and a specificity of 100percent.

The other assay is marketed as Trop-Ag-*W. bancrofti*, which is manufactured by Tropical Biotechnology Ltd (Townsville, Queensland, Australia).This assay also has a sensitivity of 100 percent in microfilaremic patients. For both assays, the circulating flarialantigen remains diurnally constant, so that blood for diagnosis can be collected during the day.

Increasingly, ultrasound has provided an important non invasive modality for monitoring the efficacy of anti-filarialdrugs. Ultrasound examination of the lymphatic vessels of the spermatic cord of infected person results in a distinctive sign is knownas the "filarial dance sign" reflective of nests of live worms in the lymphatics.

Justification of the study

The item wise justification of the study is given below.

(a)Economic importance:

Lymphatic filariasis is one of the most disfiguring diseases and a major cause of clinical morbidity. It is the world's second leading cause of permanent disability and a major impediment to socioeconomic development. The disease is endemic in 80 countries with more than a billion people at risk of infection and some 120 million people clinically affected worldwide. Thirty-two out of a total 64 districts in Bangladesh with about 70 million populations are identified as endemic to Filariasis.

Some other significance is given bellow.

- Social loss (lost or broken marriages, lost parenthood opportunities)
- Personal shame and injury (mental and physical)
- Lost / diminished economic productivity
- Sheer scale of treatment costs (that can bankrupt health service in resource poor developing countries where the disease is often at its worst.

(b) Remaining challenges: In the mean time, filariasis already has WHO adopted global strategy. WHO is working now towards elimination of lymphatic filariasis health problem by 2020. The research should be conducted to study the evident problems with community sensitization strategies and the lack of overall community involvement in the lymphatic filariasis eradication program.

Its claim as a community-directed program may hold truth, yet the more important question for integration is whether it is a community-supported program and if not, can support be revived for the program. The want of research for finding out the cost effective control measure of vectors of filariasis for ultimate eradication is significant. So this present challenge to be faced through this research.

(c)Lack of giving importance as a disease of the poor: Lymphatic filariasis affects the world's poorest people, 2.7 billion people who subsist on less than $2 per day because the poor people are illiterate, unaware, unhygienic as well as unable to buy mosquito net. They do not know how to treat, prevent and control the disease. Neither the well-off society nor the government gives the proper and enough attention to them. So this disease is being neglected year after year.

WHO estimated the number of people at risk from lymphatic filariasis is 49 million in mainly North West area (relatively poor area) of Bangladesh. So, this is a national problem of Bangladesh. It is expected that after this proposed research, a set of research findings will help to take proper action. In view of this, this topic has been selected.

(d) Lack of research work related to this disease: The lack of research work on this issueis remaining in Bangladesh, soit is expected to make original contribution in the area of alleviation of filariasis from Bangladesh through this research.

Objectives of the Study

1. To find out the prevalence and epidemiological aspects of lymphatic filariasis in different zones/districts of Bangladesh.
2. Determine the socio-economic characteristics and the infrastructural condition of the community for participation in prevention and elimination of this disease.
3. Asses the attitude and level of knowledge of the community towards the causes, preventions and control measures of filarial disease.
4. Find out the magnitude of negligence to lymphatic filariasis.
5. Find out the factors which make the growth prevalence of lymphatic filariasis.
6. Application of the cost effective and safe way control of the vectors of lymphatic filariasis.
7. Estimate the effectiveness of predation by fish as a control measure of the vector of lymphatic filariasis.
8. To find out the occurrence of the mosquito larvae and their predators in the same water bodies around the lymphatic filariasis affected patient's house.

Hypothesis

- Filariasis is neglected as a poor people disease in Bangladesh year after year.
- There is a need of education of the poor community people about the mode of transmission, prevention, treatment and cost effective safe way control of vectors of filariasis.
- As the patients are poor, they have no ability to use mosquito curtain.
- The government's anti-mosquito squad does not work at all.

- The unhygienic standard of living of the poor community people is a significant cause of filariasis in Bangladesh.
- There is a correlation between filariasis elimination and poverty alleviation.
- There are several factors related to the cause of prevalence of filariasis in Bangladesh.
- The predation is the cost effective safe way control of the vectors of Filariasis in Bangladesh.
- The ultimate eradication of filariasis will be ensured through the control of vectors of this disease.

Biology of the Parasite of filariasis

The worms, the pathogen of filariasis are ovoviviparous, and their larvae are called microfilariae. For *W. bancrofti*, humans are the exclusive host transmitted by the bite of mosquitoes. Infection occurs when filarial parasites are transmitted to humans through mosquitoes. When a mosquito with infective stage larvae takes a blood meal, the parasites are deposited on the person's skin, from where they enter the body through the skin. These larvae then migrate to the lymphatic vessels and develop into adult worms over a period of 6–12 months, causing damage to and dilatation of the lymphatic vessels.

The adult filariae live for several years in the human host. During this time, they produce millions of immature microfilariae that circulate in the peripheral blood and are ingested by mosquitoes that bite the infected human. The larval forms further develop inside the mosquito before becoming infectious to man. Thus, a cycle of transmission is established.

Classification of the parasite of filariasis :

Kingdom-Animalia

Sub-kingdom-Metazoa

Phylum – Nmatode

Class-Phasmidia,

Order-Spirurida

Super family- Filarioidea.

Family- Filariidae

Genus-*Wucherreria*

Species-*Wuchereria bancrofti*

Wuchereria malayi

Wuchereria timori

Characteristics of this organism:

- The adult males measure 40 mm in length by 0.1 mm in diameter, and the adult females measure 80-100 mm in length by 0.24-0.3 mm in diameter.
- These worms are found in the lymph glands and associated ducts of humans. The usually live in the blood but can appear in urine, where they were first discovered in 1866. It is presumed that they also occupy the adjacent subcutaneous tissues. Most commonly, they live in the lymphatics of the lower and upper extremities and male genitalia.
- After mating, the female worm can release 10,000 or more offspring per day. Instead of releasing eggs, the worms release first-stage larvae, which are known as microfilariae.

Plate-4 : Morphological structure of microfilaria

Plate-5: Microfilariae in blood stream

Plate-6: Microfilariae in blood stream

- Each microfilariameasuresapproximately 270 µm by 10 µm and contains nuclei that characteristically do not extend to the tip of the tail. The tail is not coiled.
- Another distinguishing feature is that themicrofilariais encased in a sheath comprised of chitin. The sheath is possibly a remnant of its eggshell.
- Microfilariae migrate from the lymphatic circulation into the bloodstream. However it shows nocturnal periodicity -that is, occurrence of microfilariae in the peripheral circulation at night. They are typically present in large numbers in the peripheral blood only at night (between 10 PM and 6 AM) in most

endemic by the continuous productionofmicrofilariaeisestimated at 5-8 years. Infections lasting 40 years have been reported.

- The adult and larval stages of*B. Malayi* resemble those of *W. bancrofti*. The life cycles of the two species of filariae are similar, although animal reservoirs occur for some members of the genus Brugia.The sub-periodic strain of *B. malayi* is a zoonosis acquired from forest monkeys and other wild animals, and transmitted through the bite of*Mansonia spp* mosquitoes.

Transmission cycle: *Wuchereria bancrofti* is transmitted by various species of *Culex, Anopheles* and *Aedes* mosquitoes and *Brugia malayi* by various species of *Mansonia, Anopheles* and *Aedes.* In the nocturnal periodic form, the microfilariae at night appear in the peripheral blood of the patient, reaching the maximum density at midnight. These cannot develop further unless taken up by a vector mosquito during her feasting blood meal. In the stomach of the vector the microfilariae loss its sheath, pass through the gut wall into the haemocoel and invades the thoracic muscles. Growth occurs with one or more molting. It then moves from the thorax forward, reaches the proboscis and enters the muscular labium in which it lies. It is the infective form and approximately 270 µmin size. This development depending on temperature and humidity, taken place between 10-14 days, after the mosquitoes have taken infected meal. It is important to note that there is multiplication of the larvae in the vector i.e. the microfilariae only develop and assume infective form within the vector without any increase in number.

At the time of next blood meal the larvae ruptures the proboscis, are deposited on the skin of the new host and enters the body through the breach on the skin made by the bite of the insect. Having penetrated the infective larvae migrates in to the lymph gland and lymphatics. In *W. Bancrofti* infection in course of 8-12 months and in *B. malayi* earliest by 2.5 months they become mature. As the pregnant female is in the lymphatics, the microfilariae after birth (viviparous) reach the blood vessels via thoracic and right lymphatic ducts. During the day time the microfilariae take shelter in the lungs and possibly in the internal blood vessels.

After mating, each female worm produces several thousand offspring, microfilariae, during its lifetime. The microfilariae are found in humans' internal organs and appear in peripheral blood at times that coincide with the vector's biting activity. The biting mosquito ingests the microfilariae along with the blood meal. The adult parasites live 5 to 10 years, of which the fecund life span is 4 to 6 years. Several hundreds to thousands of infective mosquito bites are necessary to establish infection. Infected people can harbor microfilaremia without overt clinical manifestations.

The disease process is determined primarily by living adult worms, inflammatory responses caused by the death of adult worms, and secondary bacterial infections. Transplacental immunity and breast feeding may limit the intensity of infection in younger individuals. The prevalence of microscopically confirmed infection gradually increases up to the age of 30 to 40 years.

The adult worms only live in the human lymph system. The lymph system maintains the body's fluid balance and fights infections. Lymphatic filariasis is spread from person to person by mosquitoes. Filarial infection can cause a variety of clinical manifestations, including lymphoedema and elephantiasis, genital disease (hydrocele, chylocele, and swelling of the scrotum and penis) and recurrent acute attacks, which are extremely painful and are accompanied by fever.

The vast majority of infected people are asymptomatic, but virtually all of them have subclinical lymphatic damage and as many as 40% have kidney damage, with proteinuria and haematuria.

Life Cycle of *Wuchereriabancrofti:*

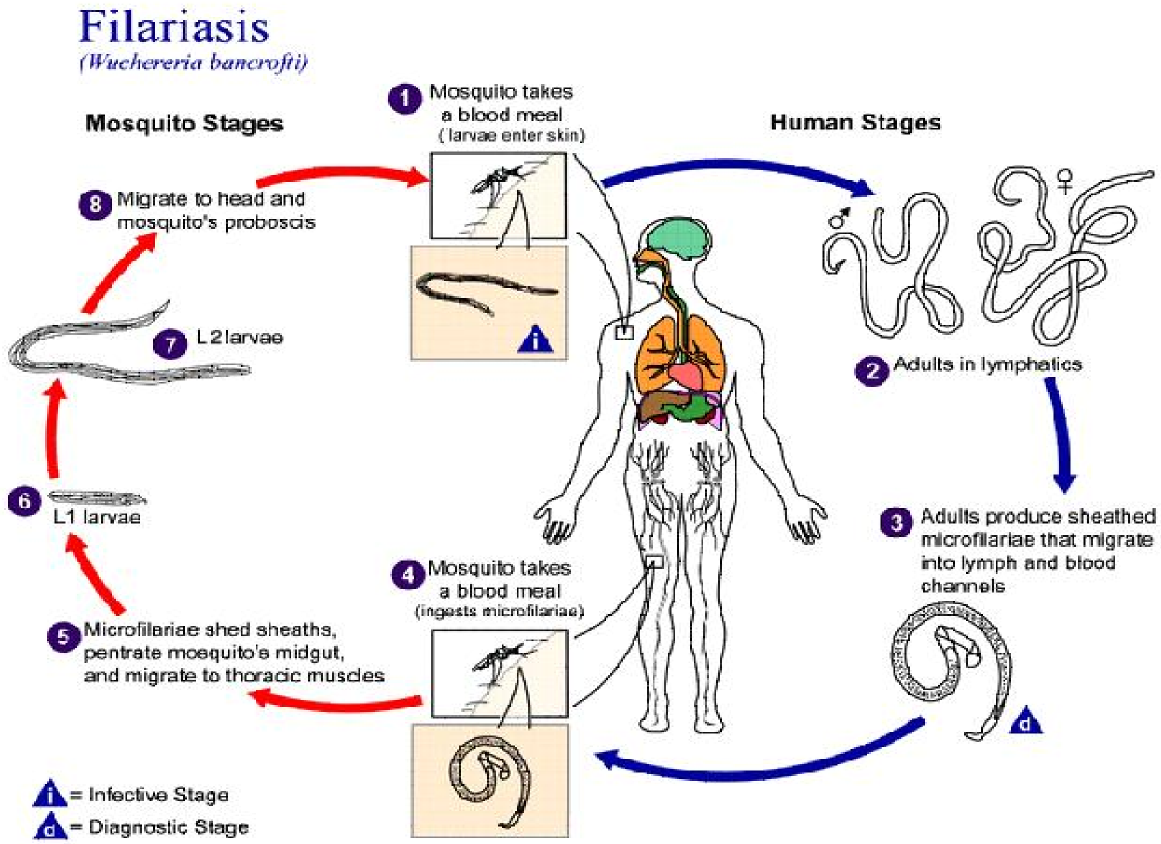


Plate-7: Life cycle of *W. bancrofti* (3,027 × 2,400 pixels, file size: 409 KB, type: image)

Hypothesis of nocturnal periodicity: There are several hypotheses have been contributed to explain nocturnal periodicity.

1. There is chemotactic attraction between the microfilariae and the saliva of mosquito hosts, which are more plentiful at night.
2. The relaxation of host during sleep induces the microfilariae to migrate into the peripheral circulation.
3. The migration results from a response to oxygen and carbon dioxide supply.

4. The microfilariae survive for only a short period and it is during the nocturnal period that they are most abundant and are readily found in the peripheral circulation.

During the day time the microfilariae are held in lungs by a 'retention factor' which is not operative or below its threshold at night. It has been suggested that the periodicity is related to a circadian rhythm in the host, and oxygen tension has been implicated. The biological advantage is that the microfilariae are present in the peripheral blood at the same time that the mosquito is feeding.

The periodicity may be thought of as an elaborate adaptation to escape from the host. It is an ecological adaptation to the feeding behaviour of the transmitting ct. (Croll, 1966).

Pathogenecity: Pathogenesis in filariasis is heavily influenced by the immune responses and the degree of inflammation. They are predominantly responses to the adult worms, primarily females. The clinical phases can be divided into the incubation, acute (or, inflammation), and obstructive stages.

The incubation phase**,** which is largely symptomless, but may include [transient lymphatic inflammation accompanied by mild fever and malaise, is initiated at the time of infection and lasts until the first microfilariae appear in the blood.

The acute phaseis initiated when the females reach maturity and commence to release microfilariae. This phase is characterized by intense lymphatic inflammation, usually in the Iower4 parts of the body. This is accompanied by chills, fever, and toxemia. The symptoms usually subside in a few days but commonly recur at frequent intervals.

The obstructive phase is manifested by a buildup of lymph. This increase in the amount of lymph results in chyluria, or lymph in urine. The obstructive phase eventually leads to elephantiasis.

Biology of the vector of filariasis

Mosquitoes are two-winged flies that belong to the family Culicidae in the order Diptera. There are approximately 3,500 species of mosquitoes. The family Culicidae is divided into three subfamilies: Toxorhynchitinae, Anophelinae, and Culicinae worldwide, there are 37 genera of mosquitoes. Mosquitoes live in humid tropics and subtropics, warm moist climates, temperate and cool zones- everywhere except areas that are permanently frozen. *Culex quinquefasciatus* is staying under the subfamily-Culicinae. Classification of the vector of lymphatic filariasis like *Culex quinquefasciatsu is* as follows*:*

Kingdom-Animalia
Sub-kingdom-Metazoa
Phylum – Arthropoda
Class-Insecta
Order-Diptera
Sub-order-Nematocera
Family-Culicidae
Sub-family-Culicinae
Genus-*Culex*
Species-*Culex quinquefasciatus*

The Mosquito Life Cycle: The mosquito has four distinct stages in its life cycle: egg**,** larva**,** pupa**,** and adult**.** The adult is an active flying insect, while the larvae and pupae are aquatic and occur only in water. Depending on the species, eggs are laid either on the surface of water or are deposited on moist soil or other objects that will often be flooded.

Plate-8: Mosquito Life Cycle Showing Habitat

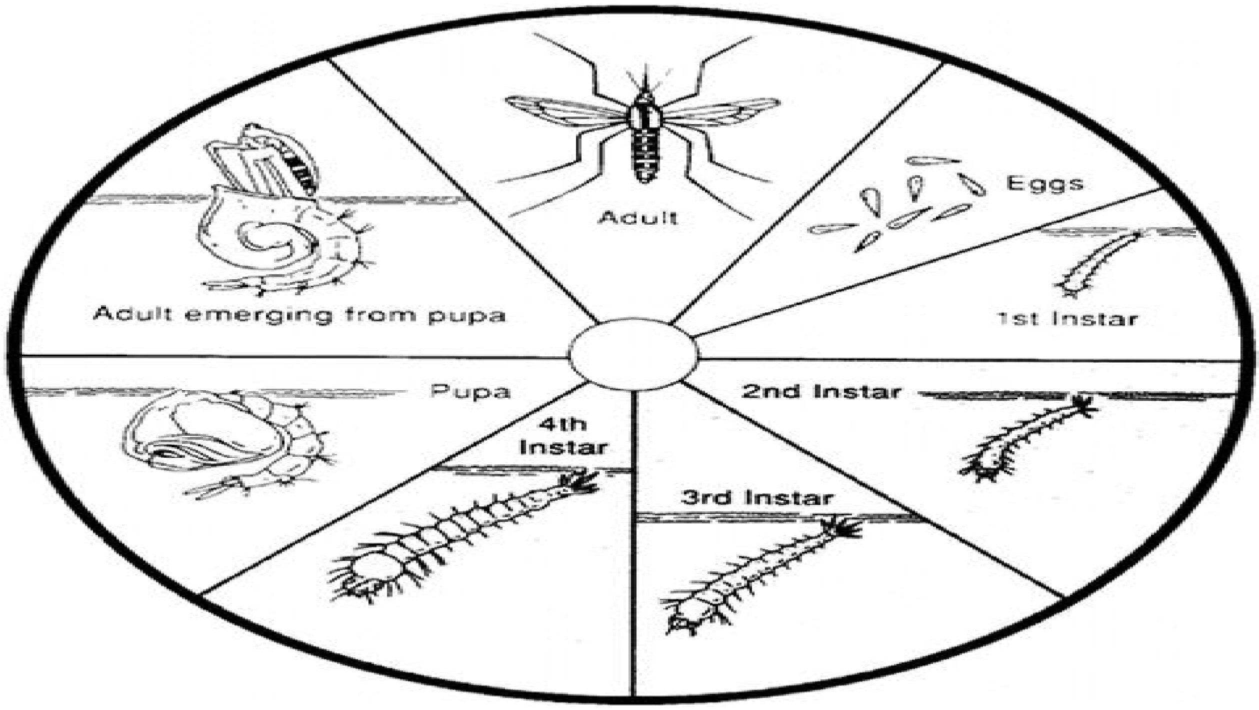


Plate-9: Mosquito Life Cycle showing all instars of larvae

The Egg Stage: One factor common to all mosquito species is that eggs are laid in association with free water or on a moist surface. Eggs are white when first deposited, darkening to a black or dark brown within 12-24 hours. Single eggs are about 1/50 inch (0.5mm) long, and those of most species appear similar when seen by the naked eye (one exception is the *Anopheles* spp. whose eggs have floats attached to each side of the egg). Eggs are laid singly by some species, and others lay eggs together in a raft form containing up to 300 eggs in one raft. The incubation period (time between when eggs are laid and when they hatch) may vary considerably among species. Eggs of permanent-water mosquitoes where eggs are deposited on the water surface may hatch in 1-3 days depending on temperature. Flood water species deposit their eggs on moist soil or another wet substrate and have a wide variation in incubation periods. These eggs will not hatch until submerged by rising water caused by rainfall, melting snow in the spring, or other floodwater. Depending on the species and conditions these eggs may hatch the next time they are flooded, as soon as ten days, or may not hatch until they are flooded a year or more later. Adult female mosquitoes lay mosquito eggs.

Plate-10:Eggs of *Culex* spp.

The eggs are laid:

1. Singly on the water surface – *Anopheles*, the malaria mosquito
2. Singly above the water line – *Aedes*, the floodwater mosquito
3. In groups, known as egg rafts, on the waters' surface – *Culex*, the house mosquito

The Larval Stage: The larvae (wigglers or wrigglers) of all mosquitoes live in water and have four developmental periods or instars. These are called 1st, 2nd, 3rd, and 4th instars with each succeeding stage larger than the last. At the end of each instar, the larva sheds its skin by a process called moltingand become larger. The larva is an active feeding stage. Larvae feed on particulate organic material in the water like detritus and microorganisms. The larvae of most species have a breathing tube at the rear of their bodies and must occasionally come to the surface of the water to get oxygen. The total length of time that larvae spend in the larval stage depends on the species and the water temperature. During the warm days of summer, larvae can complete development in five to seven days. Upon maturity the 4th instar larvae molts into the pupal stage.

Plate-11: Larva of *Culex* spp.

Development facts are given below:

- *Anopheles* larvae develop in permanent ponds and marshes
- *Aedes* larvae develop in temporary woodland pools and intermittently flooded ditches
- *Culex* larvae are found in catch basins and other natural and artificial containers; *Culex* prefer water that is stagnant or has a lot of organic material

The Pupal Stage: After completing the fourth instar, larvae shed their skin and become pupae. During the pupal stage, the mosquito undergoes final development into an adult. Unlike most other insects, the mosquito pupa is very active, and, like the larva, lives in water. It differs greatly from the larva in shape and appearance. The pupa has a comma-shaped body divisible into two distinct regions. The front region consists of the head and thorax (cephalothorax) and is greatly enlarged.

Plate-12: Pupa of *Culex* spp.

It bears a pair of respiratory trumpets on the upper surface. It must periodically come to the surface to get oxygen. Pupae, like larvae, breathe air but do not feed. The second region is the abdomen which has freely-movable segments with a pair of paddle-like appendages at the tip. The pupal stage only lasts for two to four days and is the stage when all the larval tissues change into the adult tissues. The adult emerges directly from the pupal case on the surface of the water.

The Adult Stage: After 15 to 20 minutes, the adult mosquito is ready for flight. The adult mosquito is entirely terrestrial and is capable of flying long distances. Generally, most adult mosquitoes do not fly further than one to four miles from where they emerge, but some species such as *Aedes vexans* can fly 20 miles if weather conditions are right.Both females and males feed on nectars which they use for energy. Males and females mate during the first 3 to 5 days after they have emerged. Females mate only once. Males generally live for only a week. Only the females feed on blood, which is occurring when they are biting. Males can't bite because they don't possess the specialized mouth parts required to do so. Females evidently gain little nourishment from blood meals but need them in order to develop eggs. Many mosquitoes feed on any warm-blooded bird or mammal. However, some prefer cold-blooded animals. Some species also prefer birds and seldom feed on mammals, which is the case with *Culex* spp. Mosquitoes. Unfortunately many species feed on a wide range of warm-blooded mammals and humans are also attacked. Once a female has completely engorged, she flies to a shaded environment until her eggs are completely developed, usually 3 to 5 days. Once the eggs are developed the female is called a gravid female and she begins to search for a desirable place to lay her eggs. If a female survives her egg laying activities, she will very soon start searching for another blood meal after which she will lay another batch of eggs. She does not need to mate a second time. Generally a female will only live long enough to lay 1 to 3 batches of eggs.

Plate-13: Adult stage of *Culex* spp.

Most mosquito species are actively searching for a blood meal in the evening hours from just before dark until 2 to 3 hours after dark. During the daytime the females normally rest in cooler vegetated areas where the humidity is higher and they are protected from drying out. Females will often bite in the daytime if humans or animals invade the wooded areas where they are resting.

Chapter-2

REVIEW OF LITERATURE

The word "filariasis" is derived from filar which means threadlike, its ancient name was"Malabar leg". Filariasis was the first disease proved to be transmitted by insects.In 1863, Demarquay found what is now known as the embryonic form of microfilaria *bancrofti* in hydrocele-fluid.

Lewis established the fact that the organism lives principally in the blood of man and consequently named it filarial *Sanguinis hominis* while Cobbold (1877) wrote a description of the adult worm and named filarial *bancrofti.* Lewis (1877) did the same in India, Manson (1878), completed the description of the cycle while working in Amoy (now called Xiamen) along the Chinese Coast in Fujian province. Today, lymphatic filariasis has been largely eradicated. Manson first demonstrated that mosquitoes were intermediate hosts for the parasite. For two decades, Manson maintained that infection was acquired when individuals drank water contaminated with larvae released from dead or dying mosquitoes. Eventually, he came to accept the concept that, larvae were transmitted by the bite of mosquitoes. Filariasis may, in fact, be a water-borne disease under some circumstances, since experimental infections can be induced by the oral route.

Manson in 1878 made the important observation that the mosquito served the parasite as intermediary host. Originally Manson proposed to call the embryonic form of *Wuchereria bancrofti,* in order to emphasize its nocturnal periodicity, filarial nocturnal, but in accordance with the rules governing Zoological Nomenclature, precedence was given to cobbold’s name for the adult form, the embryonic form is therefore referred to in this manual as microfilaria *bancrofti,* the other filaria of the blood are name microfilaria loa, microfilaria *malayi,* Microfilaria *volvulus,* Microfilaria *prestans,* the embryo of *Acanthoceilonema prestans.* Filarial *bancrofti* has been renamed *Wuchereria bancrofti* and an allied species *W. Malayi* has been discovered.*W. bancrofti* occurs indigenously in almost every tropical and sub-tropical country, from Charleston in the United States and Southern Spain in Europe and Brisbane in Australia. It is extremely common in India and South China, Samoa, and many of the pacific Islands, where fully 60 % of the inhabitants are affected. It is also found in the West Indies South Africa, Southern Sudan, West and central Africa.

In spite of the long history, no effective drug was found against filariasis till 1946. In 1947 after the Second World War, 1^{st} effective drug "diethyicarbamazine" Hotrazan was discovered by an American term. The look of a suitable experimental animal continues to be the main hurdle in research microfilaria in filariasis.

In 1955, the government of India launched a national programme against filariasis known as national filaria control programme. Filariasis is one of the major tropical diseases taken up by WHO/ UNDP in its "special programme for research and training in tropical disease in recent year (Park *et al.* 1985).

Filariasis is one of the most common diseases of developing countries. A significant amount of research work had been done for a long time and is still going on both international and national level. Review of literatures about those research works enable to know about many aspects of parasitic infestation which are relevant to this study (AbdulCader, 1971).

Barry *et al*., (1971) showed, except few cases of *B.malayi,* all filarial cases in Bangladesh were due to *W. bancrofti.*

Culex quinquefasciatus was found to be the only vector for bancroftian filariasis of nocturnal periodicity in Bangladesh (Khan and Wolfe, 1972; Ahmed *et al*. 1986).

Wolfe and Khan (1972) conducted entomological investigations and showed that the tropical house mosquito, *Culex quinquefasciatus* is the only vector of bancroftian filariasis in Bangladesh.

Khan and Wolfe (1972) collected 20,642 mosquitoes by all three types of collection methods:

i) Catches on human bait was made outside houses for 2 hours following dusk.

ii) Hand caught house resting collection were made in the mornings between 7 to 9 am.

iii) Cattle-biting collection was on cattle bait both in the open and in sheds, from 7 to 9 pm.

Each types of collection were made on three alternate nights per week in each village. Thirty five different mosquito species were identified, with only minor difference in the mosquito fauna of the two villages, which were about 5 miles apart. The most common mosquito collected in human habitation and while biting humans out-side of house was *Culex pipiens fatigans.* This species was never found biting cattle.A part from an unusually high infection rate in Madarganj village in November 1968 (based on the finding in 11 human biting mosquitoes of first and second stage *W. bancrofti larva),* infection rates were almost nil during the other colder drier winter months of December 1968 to February 1969 with the onset of the rains in March 1969, infection rate increased progressively and reached their peaks during the maximal rainy season in June and July 1969. Infective *Culex pipiens fatigans* than the other months of the rainy seasons March, April and May of 1969, higher percentage of infected and infective *Culex pipiens fatigans* were found house resting as opposed to human biting mosquitoes. Larvae of *Culex pipiens fatigans* were not found at all in ponds and other large permanent water collection. However, larvae of this species were found in small polluted domestic collection of water, in silage pits and open dirty drains, near individual habitation throughout the year. Fewest larvae were found in December 1968 and January 1969, correlating with the lowest infection and infectivity rates in adult mosquitoes.

The control measures against mosquitoes by the Dhaka city Corporation has so far been ineffective. Ameen and Moizuddin (1973) identified the main causes of this failure as:

- Sole dependence on chemical insecticides and the use of inappropriate insecticides,

- Untrained and inadequate manpower and
- Lack of proper equipment.

Mosquitoes are the only known vectors of lymphatic filariasis. *Culexquinquefasciatus* has been recognized as the vector of nocturnally periodic *W. bancrofti.* In African region, two freshwater breeding mosquitoes of Anopheles *gambia* complex namely *Anopheles arbinenses* and *Anopheles gambia* are known as the filarial vectors. But in Libaria, *Anopheles nile* and *Anopheles hancock* have been incriminated as vector of filariasis. *Anopheles danotities* and *Anopheles dirus* have been found to be responsible for filariasis in western pacific and in Southeast Asia respectively. In Thailand, *Aedesniveus*and *Aedespoecilus* in Philippines have been incriminated as the vectors of *Brugia malayi*. *Anopheles barbirostris* has been reported as the vector of *Brugia timori* in fection in Timor, Indonesia. *Mansonia* mosquitoes, *Mansonia annulifera* and *Mansonia uniformis* are vector of Brugian filariasis in India (WHO, 1998).

Ameen and Moizuddin (1973); Ameen*et al.* (1982, 1984) and Ahmed *et al.* (1986, 1989, 1991), *Culex quinquefasciatus*, the vector of Bancroftian filariasis in Bangladesh, is a domestic mosquito.

Different works carried out by different scientist in Bangladesh also showed that this species is endophilic in nature i.e. it prefers to rest indoor (Ameen and Moizuddin, 1973; Ameen*et al.*1982, 1984; Ahmed *et al.* 1986, 1989, 1991).

Pederson (1985) stated that chemical insecticides are expensive and have a harmful effect on the environment. Moreover, resistance to DDT, Malathion and other organophosphate insecticides by the mosquitoes of Dhaka has already been reported.

Begum *et al.* (1986) studied the population density of mosquito larvae and their ecology in Ramna lake of Dhaka city for a period of one year. A total of fourteen species belonging to three genera namely, *Anopheles, Culex, Mansonia* were collected. *Culex vishuni, C. quinquefasciatus, C. gelidus, C. tritaeniorhynchus, C. bitaeniorhyynchus, C. fascocephalus* and *C. whitemorei* constituted 98.77% of the total larvae. Population density of the larvae was higher in the sites of the lake with vegetation and dirty water than in the sites with less vegetation and clear water.

Mosquitoes are still conspicuous vector and nuisance pest in the world. Important diseases caused by mosquito vector are malaria, filariasis, yellow fever, Dengue fever, encephalitis etc. Not only anophelene mosquito but also Culicine mosquito has a good role in transmitting communicable disease (Islam, 1993, Chowdhury *et al*. 1990; Chidester, 1917).

According to Evan *et al.* (1996) most of the respondents were unable to purchase mosquito net after maintaining their daily life expenses. The sanitation process of the study area was very poor and it is an economic burden on the patients.

Hossain *et. al.* (1997) recorded that the highest density of mosquito larvae in derelict pond in Dhaka city.

Filariasis is transmitted by the infected mosquitoes. The severity of the disease is proportional to the intensity of biting by infected mosquitoes. In Africa, microfilaraemia rate was 45% in adult and the rate of exposure infective bites were 400% person per year. In Tanzania, the annual infective biting rate was 149% in the most highly endemic villages (microfilaraemia rate 28.5%). In India, 32 infective bites per person per year maintained a microfilaraemia rate of 16.7% (WHO, 1998).

Bogh, *et al.* (1998) studies the effects of Permethrin impregnated bed net on resting and feeding behavior of lymphatic filariasis vector mosquitoes in Kenya.

Bockarie *et al*. (1999) worked on mass treatment with ivermectin for filariasis control in Papua New Guinea and its impact on mosquito survival. He also reported the transmission dynamics of *Wuchereria bancrofti* in East Sepik Province, Papua New Guinea.

Beach *et al.* (1999) assessed the combined evermectin and albendazole for treatment of intestinal helminthes and *Wuchereria bancrofti* infection in Haitian school children.

As filariasis is a chronic disease, it is really difficult to control disease by chemotherapy alone. As the disease is a vector borne one, some efforts to prevent man-vector contact would be more helpful to control the disease (Ahorlu *et al.* 1999; Addiss and Dreyer, 2000).

40 million people have visible ailments, 120 million are infected in 80 countries and one billion live in risk of infection (Ottesen, 2000).

The estimated DALY (Disability Adjusted Life Years) burden is 5.5 million, second only to malaria within parasitic diseases (Molyneux and Zagaria 2002).

Lymphatic filariasis is one of the leading causes of physical deformation and disability in the world. It is primarily a disease of the poor in tropical countries and is caused by three species of nematodes which are transmitted to humans by several genera of mosquitoes (Molyneux and Zagaria 2003).

There are many, both biological and social risk factors are responsible for occurring this disease. The possible geo-environmental risk factors that are likely to influence the occurrence of lymphatic filariasis were identified. Their role (either directly or indirectly) in the transmission of filariasis was accessed (Brooker and Michael 2000).Accordingly, the Geo-environmental factors viz. Altitude, Temperature, Rainfall, Relative Humidity, Soil Type and the Land Use/ Land cover were considered for this study.

Predators of mosquito larvae

Prashad (1919) discussed the utility of fish as destroyers of mosquito larvae with special reference to their habits, their food under different conditions.

Southwall (1920) found the fish, *Channa* as a useful mosquito larvivore in East India.

Krumholy (1948) observed and mentioned that larvivorous fish which feed on the immature stages of mosquito larvae had shown better results than any other biological agents.

Hora and Mukherji (1953) reported various larvivorous fishes such as *Carassius* Linnaeus, *Lebistis reticulates, Gambusia affinities*, *Notopterus notopterus* Pallas, *Chela* Hamilton, *Damio* Hamilton, *Esomus* Swainson, *Puntius phuntunis* Hamilton, *Cirrhina mrigala* Hamilton, *Wallago* Bleeker, *Aplocheilus fanchax* Hamilton, *Oryzius* Jardon and Snyder, *Horaichthys setnai* Kulkarnia, *Aphanius* Nardo, *Channa* Bloch, *Colisa fasciata* Bloch, *Macropodus* Iacepede, *Etroplus suratensis* Block, *Etroplus maculates* Block, *Anabas testudineus* bloch, *Mugil* Iimaeus, *Ambassis ranga* Hamilton, *Ambassis nama* Hamilton, *Therapon jarbus* Forskal, *Badis* Blecker, *Glossogobius giuris* Hamilton, etc.

Travis (1957) reported that fish can be used as predators of mosquito larvae because their population can be maneuvered by man, they are quite tolerant of a variety water conditions and they can be moved to water areas where they needed.

Hildemann and Walford (1963) reported that annual fishes, Guppies, *Gambusia* spp. with their capacity to survive and multiply in impermanent waters have gone a long way to control their population.

Kalra, *et al.* (1967) reported *Lebistes reticulates* (peters) is an exotic fish in India introduced in 1910 to use against mosquito breeding under malaria control measure.

Gerberich (1971) has published a bibliography key word index on the control of mosquitoes by use of fish, covering the years 1901 to 1968.

The chemical insecticides also kill non-target organisms including the natural predators of mosquito larvae (Mulla *et al.* 1975).

Jhingram (1975) in India recognized the larvivorous potential of *Apolocheilus fanchax* Hamilton.

Chapman (1976) stated that the mosquito control agencies are presently using fish directly to suppress the mosquito population.

Chakravertly*et al.* 1976 suggested the use of predators could be a useful alternative against chemicals in controlling mosquito larvae. A number of insects and fishes have been tested in the laboratory to evaluate their predatory role against mosquito larvae.

Costa and Fernando (1977) in Sri Lanka supported the view that *Rasbora damiconius* acts as a good larvivore in the Hilly areas.

Begum *et al.*, (1977) reported that *Rhodothemis rufa* (Ramb.) is one of the common species of dragonfly found in the ponds, lakes and canals of Dhaka city and its subrubs throughout the year. They also added that in Bangladesh, *Neurothemis tullia tullia* is one of the common species around Dhaka city and its subrubs , and it is persistent throughout the year.They reported that *Urothemis signata* is one of the common species of dragonflies available in Dhaka city and other parts of Bangladesh.

Huda and Rahman (1982) have described that the studywas undertaken to determine the larvicidal potential of eight indigenous fishes of Bangladesh. The fishes were *Amblypharyngodon mola* Ham., *Anabus testudineus* Bloch, *Apocheilus panchax* Ham., *Clarias batrachus* L., *Colisa fasciata* Bloch, *Channa* sp. Bloch, *Puntius ticto* Ham. and *Rasbora daniconius* Ham. The tests were conducted in laboratory condition in the University of Chittagong in august 1981.

Ameen*et al.*(1982) have described four species of dragonfly larvae, namely *Pseudagrion subriceps* Selays, *Ischnura tercipata* Mortin, *Ceriyr incorm* and *elianum fabricus* and *Agriocnemis pygmeae* Ramber from Dhaka city and a key for their identification has been incorporated.

Ameen and Khairunnessa (1985) collected and identified twenty three species of aquatic Hemiptera belonging to 11 genera and seven families from ponds and lakes in and around Dhaka city. Preliminary identification keys based on their comparative study were also prepared for ready use by field workers and students.

Legovic (1989) in Yogoslavia, stated the predation in food webs, for the case when the specific predation is a hyperbolic function of prey concentration in one-predator one-prey systems, expressions are derived for predation rate in food webs for both nonselective and selective predation. These expressions can readily be applied to ecosystem model of food webs.

Hofbauer and Sigmund (1989) reported the stabilizing effect of predators and competitors on ecological communities. They stated that ecological communities can lose their permanence if a predator or a competitor is removed; the remaining species no longer exits.

Begum *et al*. (1990) reported the life history of dragonfly *Pantala flavescens* (Fab.) studied under the laboratory conditions at 30± 2 degree Celsius. There were 11 larval instars and it required 72.33 days in average to complete the development. Important external morphological characters of the larvae were noted instarswise. This species was found to breed from March to September.

Begum *et al.* (1990) reported the life history of dragonfly *Rhodotheniu srufa* (Ramb.) studied around some temporary ponds in Dhaka, Bangladesh. It breeds from June to August. The life cycle (from oviposition to emergence) is completed in 130 days. There are 10 larval instars. The external morphological changes of each instar are described and illustrated in the report.They also reported the life history of *Neurothemis tullia tullia* (Drury) (Odonata: Libellulily) studied under laboratory conditions. There are nine larval instars. The life cycle, i.e., oviposition to adult emergence, was completed in about 81.5 days. Important external morphological characters of the various larval instars are also described and illustrated.

Begum *et al.* (1991) reported that *Urothemis signata signata* (Rambur) (Odonata: Libellulily) breeds from May to September. To study its biology, all the larval stages were reared in the laboratory at room temperature. There were 13 larval instars and the total time required to complete the life cycle was found to be about 157 days.

Dugatkin and Alfieri (1991) reported “Tit for tat” in guppies (*Poecilia reticulata*): the relative nature of co-operation and defection during predator inspection. The introduction of theoretical thinking into evolutionary biology has lain the ground work for a heuristic view of animal behavior in which individuals employ "strategies" that instruct them how to behave in a given circumstance to maximize relative fitness. Axlrod and Hamilton found that a strategy called "Tit for tat" (TFT) is one robust co-operative solution to the intreated prisoner`s dilemma game. There exists, however, little empirical evidence that animals employ TFT. Predator inspection in fish provides one ecological context in which to examine the use of the TFT strategy. Guppies were tested in multiple predator inspection trials. An individual was tested with its mirror image as well as a series of live conspacifies. Results indicates that guppies are capable of recognizing and remembering their partner`s behavior and seem to employ TFT like strategies over the course of many inspection visits. In addition, significant differences exist between individuals in the degree to which they will inspect a predator suggesting that "Co-operator" and defector may be relative terms rather than discrete categories of behavior.

Crowley and Johnson (1992) using 12 years of monthly sweep-net data from 9-12 permanent sampling stations evaluated the variability and stability of the dragonfly assemblage in Bays Mountain Lake (north eastern Tennessee, USA). To do this, they adopted the view that a stable (i.e. one capable of recovering quickly from disturbances) should have low variability (i.e. high persistence of taxa, relatively constant densities, and high rank concordance), except with disturbances more intense and frequent than those in this system. Moreover, a stable assemblage should contain population that exhibit during dependence and should tend to remain within a restricted range of densities, shifting toward a narrow density interval between generations (attraction). To test some specific predictions derived from these views, they analyzed 12-years sequences of larval population sizes just before the onset of emergence for the 13-dominant dragonfly taxa in the lake. Most but not all of the 13-dominant taxa persisted during the 12 years period. Variability's of taxon densities, measured as standard deviations across generations of log-transformed population sizes, were representative of the broad range for other invertebrate s but somewhat higher than those of terrestrial vertebrates. There were fewer than three significant abundance trends over the 12-year period, and rank concordance between generations was high. Density dependence was detected among some of the dragonfly density sequences by five different methods. Using techniques presented in the common paper, they found strong indications of both binding and attraction in the whole assemblage, they concluded tentatively that an assemblage consisting of at least 11 of the 13-dominant dragonfly taxa at Bays Mountain lake had low to moderate variability and is stable, but that the complete 29-species was probably not stable at the scale of this single lake. They emphasized the need for compiling such long-term descriptive analysis with studies for experimental disturbances.

Erlandsson (1992) studied the asymmetric interactions in semi aquatic insects. It was observed when the two species were starved for the same period of time, *Gerrissub straitus* Schumm (Hemiptera) was generally more successful at catching prey than either *Gerris* species, independent of prey size, when individuals from the formerly dominant species of the pair were less hungry (i.e., fed shortly before trials), their prey capture success decreased. Prey sharing and prey stealing were observed in trials with large prey and occurred both intra and inter specifically. The shift in dominance with differing hunger levels and the existence of prey and prey stealing may make theinter specific competition more symmetric allowing these species to coexist.

Hossain*et al.* (1997) studied the orders Odonata and Hemiptera and some fishes collected from mosquito breeding grounds of Dhaka city, were allowed to feed upon different larval instars of *Culex quenquefasciatus* say to determine their predation capacity. Among the hemipterans, *Naucoris* sp. consumed the highest number (an average of 18 larvae per day) and among the odonates, 11^{th} instar larvae of *Pantala* sp. consumed the highest number (60.5 mosquito larvae per day). Among the fishes *Clarias batrachus* consumed the highest number of larvae (26,189.6 per day) followed by *Oreochromis nilotica* (4,770.5 per day). All the three different sizes of guppy fish consumed mosquito larvae, the newly hatched fingerlings consuming as many as 2504 first instar mosquito larvae per day and an adult guppy consumed on an average 145.7 larvae per day.

Hossain *et al.* (1997) reported that among the larvae and their predators collected from Dhaka city, 75% of the total, was *Culex quinquefasciatus* Say. The other larvae found belonged to the genera *Culex, Aedes, Anopheles and Mansonia.* Domestic stagnant water harboured the highest concentration (29.2%) of *Culex quinquefasciatus*, followed by kutcha drains (23.6%) and pucca drains (21.3%). There was a peak population of this species from November to April. Altogether 21 different predators were collected of which *Ranatra elongate* and *Naucoris* sp were found in most of the breeding grounds. Guppy fish, *Poecilia reticulata,* was common in the drains.

Epidemiology and Clinical manifestations of Lymphatic Filariasis

Barry *et al.* (1971) surveyed Thakurgaon on area of 645km^2 in Dinajpur district, of Bangladesh to determine the prevalence and distribution of human filariasis. Emaciation of microfilariae and clinical manifestation was obtained from peripheral blood smears and physical examination of 9624 inhabitants. The microfilaria rate of 16.86 represented infection by *Wuchereria bancrofti* of natural periodicity. The clinical manifestation rate of 10% consisted primarily of genital hydrocele and elephantiasis of the scrotum in the male population. Lymphoderm and elephantiasis of the limbs were rarely observed in either sex. Microfilaria infection and clinical manifestation rates increased with ascending age group. An endemicity rate of 24.2% and a medium microfilaria density of 14.0 microfilariae per 20m^3 of peripheral blood indicated a moderately endemic focus of filariasis that serves as a reservoir of infection and constitutes a significant public health problem in Thakurgaon.

Wolfe and Khan, (1971) conducted a survey in some districts on the northwestern area of Bangladesh. It has been shown that high numbers of cases were found in the greater district of Dinajpur, Pabna, Chittagong, Barisal, Rajshahi and Rangpur with the blood microfilaria positivity rate of 11.6%, 5.2%, 4.5%, 3.08%, 3.2% and 2.5% respectively. Lesser number of cases was found in the greater districts of Bogra, Faridpur, Comilla and Sylhet and blood microfilaria positivity rates were also less. No case has been found in Noakhali.

An epidemiological survey on multistage stratified sampling scheme was carried out by the Malaria Institute of Pakistan through 1969-73 in the districts of Dinajpur and Rangpur to determine the prevalence and distribution of filariasis. In the districts of Dinajpur a total of 12426 examinations in different area results a microfilaria rate of total 14.18%. Similarly in the district of Rangpur a total examination of 6536 persons resulting a microfilaria rate of 7.92 % (IEDCR, 1977: unpublished document).

Freedman *et al.* (1994) worked on Lymphoscintigraphic analysis of lymphatic abnormalities in symptomatic and asymptomatic human flariasis.

This is a situation where large numbers of bacteria under the skin cause damage to the tiny lymphatic vessels and impair their ability to drain fluid. This in turn causes the limb to swell to an even greater size and become painfully inflamed and hot. Other symptoms of an ADL (which can last from 3 to 8 days) include fever, vomiting and nausea. Acute attacks are seen more often in higher stages of lymphedema and are the most common event to cause a patient to seek medical care 16. Patients in advanced stages of lymphedema and hydrocele have the added burden of social stigma attached to their condition. In many cultures around the world, the sight of the swollen legs or the hidden hydrocele is a source of shame to the patient (Dreyer *et al.* 1997, Coreil *et al.* 1998).

Lymphatic filariasis is caused by two species of nematodes: *Wuchereria bancrofti* or *Brugia malayi.* The former species is accountable for 90% of human infection and is found throughout the world. The *B. malayi*s is responsible for the remaining 10% of infection and is centered on Southeast Asia and the South Pacific (Ottesen, 2000).

There are several mosquito vectors for the parasite. The one most common for the *W. bancrofti* nematode is the *Culex quinquefasciatus* species of vector. This mosquito is known to thrive in impoverished urban areas and breed in stagnant, dirty water. Other mosquito species include *Anopheles* and *Aedes* for *W. Bancrofti* and *Mansonia* for *B. malayi.* Infection of humans occurs when a mosquito carrying the parasite deposits filarial larvae that are in the infective-stage on to the skin during a blood meal. Larvae penetrate the skin and accumulate in the lymphatic system where they develop and grow into adult worms that are sexually mature. These adult macrofilaria (which live from 5 to 10 years) begin to produce millions of tiny microfilaria which circulate through the body in the circulatory system. (Yamey, 2000; Dreyer *et al.*1997;Cobbold, 1977and Daggy, 1945).

Lymphedema and urogenital problems are the most common clinical manifestations of chronic LF. Lymphedema is characterized by swelling of the legs, arms, breasts, scrotum or penis and can occur from infection with both *W. bancrofti* and *B. malayi* parasites and in both genders (though lymphedema of the leg occurs predominantly in females). Hydrocele is a clinical manifestation of bancroftian infection in men where excess fluid causes massive swelling in the scrotal sac. It is thought that the pathology of this disease is caused by dysfunction and dilation of lymphatic vessels due to presence of the worm (Dreyer *et al.*2002).

Dreyer *etal.*2002 reported that patients with lymphedema are at risk from bacterial skin infections due to the breaks in the skin (called entry lesions) that develop due to poor lymphatic drainage, less resistance to fungal skin infections, and occlusion secondary to lymphedema. Moderate to severe edema cause folds in the skin to develop within which bacteria may flourish if proper hygiene is not carefully maintained. When bacteria are able to enter into the body through an entry lesion, they proliferate, leading to an episode of acute adenolymphangitis (ADL) also known as an acute attack.Though sub-clinical vessel damage has been observed through ultrasound imaging for nearly all infected individuals 15, only a small percentage of infected individuals (usually <5%) actually show overt manifestations of lymphedema; in contrast the prevalence of hydrocele in adult men is similar to the prevalence of microfilaria in the population. Lymphedema progresses through 7 stages of severity, with stage 1 being the least severe (Dreyer *et al.* 2002).

Ramaiah and Das (2004) worked extensively on Mass Drug Administration to Eliminate Lymphatic Filariasis in India.

In Bangladesh, filariasis control activities do not exit except very limited treatment of cases in the endemic zone with individual effort. In such places personal protection with impregnated bed net may help to control the disease. In the areas where malaria and filarial both are endemic, use of insecticide-impregnated bed net may be a more fruitful method to control the diseases. In Bangladesh, the disease is present all over the country with highest endemicity in Northern parts of the country. Out of 147 million people, about 20 million people in the area have been suffering from the disease, most of which are children. The exact figures of filariasis in Bangladesh are not known, but it is endemic in 33 districts out of 64 districts as reveled by ICT by Lot quality assurance sampling (LQAS), completed in 2002 and 2004. There is high endemicity of filarisis in Nilphamari, Thakurgaon, Dinajpur, Rangpur, Panchagarh, Kurigram, Gaibandha, Chapai Nawabganj, Rajshahi and Lalmonirhat. It is estimated that about 70 million are at risk of infection, while 10 million have various forms of clinical deformity and another 10 million are microfilaremics.

Khanum and Sarker (2006) worked on the epidemiological aspects of filariasis, occurrence and clinical manifestation of hydrocoel in the endemic northern districs of Bangladesh (Khanum *et al.*2013)

Rahman*et al.* (2008) recorded most endemic villages for filariasis was Fokdonpur, Khankah and Gobindanagar in the Thakurgaon Sadar Thana. On an average 4.20% people were infected with filaiasis in those villages. Sex was not a risk factor for this disease. The respondents had poor knowledge regarding the transmission of filariasis. Among the affected people, 55.67% were illiterate and 25% had primary education. Although lymphatic filariasis is not associated with high mortality rate, chronic filarial infection causes enormous suffering. The socio-economic impact due to long term disability and deformity are extraordinarily are great. The determination of prevalence of the filarial infection in the community is important and necessary for public health program. The effective control of communicable disease like filariasis depends on early detection of cases, monitoring and surveillance of the disease. Detection of microfilaria by thick film examination is currently practiced in Bangladesh, which is time consuming and tedious and difficult for handling large samples. Moreover, there is possibility of false negative result. It appears that development of serodiagnosis is highly relevant. Serological tests that identify the microfilaraemic individuals within populations in endemic areas without the need for night blood collection, identify actively infected individuals without microfilaria and quantify adult worm burdens following treatment would facilitate and constitute valuable tool for monitoring filariasis. As baseline information is not available, surveillance system has not been developed in the endemic region of Bangladesh. It is a real need to find out the real picture of filariasis in the country. Immunological methods like immune chrotographic test (ICT) filariasis, a rapid, simple and sensitive test may be more advantageous over the conventional parasitological examination.

A study (Khanum *et al*. 2013) was carried and compiled out in Nilphamari district to find out the prevalence and risk factors for filariasis. In the present study 258 infected persons were included out of 580 persons from 1112 families on 6 upzillas of 19 villages. In contacted through questionnaire, from this district NilphamariSadar and Paurasava, Sayedpur, Domar, Dimla, Joldhaka and Kishoreganj were selected and from each Union, three villagers were studied randomly. The current status of filariasis in Nilphamari Sadar and Paurasava was 3.76, Sayedpur 4.6, Domar 5.58, Dimla 6.79, Joldhaka 4.6 and Kishoreganj was 5.42%. It was found that 47.68% patients were males and 52.32% were females. This disease was more prevalent among the inhabitants in the age-group of 41-60 years. It was found that 47.5% patients were illiterate. The second highest infected people were primary and secondary educated (31.3 and 13.2% respectively). Illiteracy is one of the important social risk factors of this disease. It was also observed that only 19.38% patients used mosquito curtains while others cannot afford them for every member of the family. Poverty is also a major risk factor for this disease transmission.

Another study (Khanum and Islam, 2013,) was carried out in the Northern part of Bangladesh, especially in Kurigram, Lalmonirhat and Chapai Nawabgonj district; three villages were selected randomly from each sadar upazilla to find out the current status and risk factors for the disease filariasis. The present status of filariasis in Kurigram was 14.33%, in Chapai Nawabgonj was 4.11% and in Lalmonirhat it was 3.12%. It was found that 55.71% patients were male and 44.29% were female. So male were more susceptible host than female. The highest prevalence was found in the age of 31-40 years. Illiteracy is one of the important social risk factors of this disease. It was found that 56.27% patients were illiterate. The second and third highest infected people were maktab (18.38%) and primary educated (17.27). It was found that the highest number of infected people was unemployed (15.32%) and the second highest group was rickshaw puller (29.53%) and third highest group was others (beggar, children etc) (13.84%) and the fourth was day labour (12.48%). Most of the low incoming people are unhygienic and they are unable to buy mosquito curtain, aerosol, coil or others repellent. So poverty is another important social risk factor for this disease filariasis. Government initiative for prevention and control of filariasis in the study areas is not sufficient. It can be reveal that the endemicity offilariasis also due to the environmental conditions and climatic factors which are very much suitable for breeding of the vector.

Khanum H, JAbedin and M Hossain (2015) observed the application of technologies for diagnosis, treatment, prevention and control of malaria, kala-azar and filaria in endemic areas of Bangladesh**.**

A study was carried out by Anik *et al.* (2016) in Filaria Hospital of Nilphamari From Nilphamari district Nilphamari Sadar and Paurasava, Sayedpur, Domar, Dimla, Joldhaka and Kishoreganj were selected as study areas. The objectives of this study were to find out the current status of lymphatic filariasis (LF) in Nilphamari district: An endemic area for LF and non-endemic area in Bangladesh. The investigation was carried out among the inhabitants of the villages and the outdoor patients and hospitalized patients in Filaria Hospital. The current status of this disease in Nilphamari district was 4.43%, in Nilphamari Sadar and Paurasava was 3.25%, 4.10% in Sayedpur, 4.82% in Domar, 5.86% in Dimla, 3.85% in Joldhaka and 4.70% in Kishoreganj. It was found that 58.84% filarial patients were male and 41.16% female; highest prevalence of the disease was observed at the age group of 41-60 years; 45% patients were illiterate; Illiteracy and Poverty are the important social risk factors of this disease. Most of the infected patients were very poor and low income group. Only 40.5% patients knew about filariasis. Only 26.1% patients used mosquito curtains. During the study period in the Filaria Hospital of Nilphamari it was found that 66.15% hospitalized filarial patients were male and 33.85%

were female. The highest outdoor patients in Nilphamari Hospital were at the age group of 40-59 years and 76.22% patients had hydrocele.

Mobilization against Lymphatic Filariasis (LF)

The WHO formally launched a global program to eliminate lymphatic filariasis in 1998. Despite the staggering numbers of infected and at risk individuals, a goal has been set for eliminating the disease completely by 2020.There are three major reasons for the optimism behind this timeline is furnished below.

a) First, the biology of the disease makes it conducive to elimination. The parasite has no reservoirs other than humans; it is relatively inefficient at transmission and cannot reproduce within the mosquito vector.
b) Second, effective drugs have been developed that can kill microfilariae in the blood for up to one year with only a single dose.
c) Third, simple and accurate diagnostic techniques such as the finger prick antigen test have been recently developed. This allows for quick and easy monitoring of infection levels in endemic communities pre- and post-treatment with the drugs.

Global efforts since 1998 have scaled up rapidly such that elimination programs have begun in 38 of the 80 LF endemic countries and an estimated 90 million people have been reached. 350 million people are expected to be covered by the year 2005 and by the final year of elimination in 2020, the entire at-risk population of 1.1 billion people will have been covered by elimination programs. The GAELF recommends a two-pronged approach for eliminating the disease, 1. On the one hand, prevention of infection among the entire at-risk population is crucial to interrupting transmission. 2. On the other, treatment of individuals who already have the disease is central to gaining the legitimacy of the community, a necessary precondition for prevention activities. The activities are distinct but linked to each other.

Cox (2000),Ottesen *et al.* 1997 and WHO (1998) concluded that LF is one the major leading causes of disability worldwide with the WHO estimating the global burden of the disease to be 5,644,000 Disability Adjusted Life Years (DALYs). This is the highest disease burden of any tropical disease except malaria. The number of people infected with microfilaria has been estimated at approximately 120 million, with over 40 million individuals showing clinical symptoms. Nearly 1.1 billion or 20% of all people on the planet are at risk for being infected with parasite.

Economic Evaluations of LF Programs

A cost-effectiveness study in Tanzaniacomparing mass chemotherapy at different doses with DEC salt fortification was conducted in 1996 but contained methodological weaknesses and also did not calculate the costs of the morbidity control program. Information on the overall cost, financial sustainability, cost per patient treated and estimated use of resources has not previously been quantified for any LF prevention or treatment programs. There are currently very few studies conducted that have examined LF programs from an economic standpoint. Ramaiah *et al.* (1999) and Ramaiah *et al. (*2000) have pioneered work that focused on the economic burden of disease from the viewpoint of the patient, but have not done the same from the perspective of the LF program.

Chapter-3

MATERIALS AND METHODS

This research strategy provides the basis for a full range of social, economic and environmental factors in the development of an integrated disease control program. In order to achieve the aims, research was conducted within each domain of interest, which included the community, provider and program/policy domains, village/community members, Upazilla Health Officers. At the national level, the opinions of the managers and staff of specific disease control programs are were gathered in semi-structured interviews focusing on integration on their program.

Study design

The present study was designed on several key variables and modifying factors which are as follows:

Key variables: The study considered the following important variables:

- Age and sex of the respondents.
- Educational status of the respondents.
- Occupation of the respondents.
- Economic conditions of the respondents.
- Knowledge about filariasis, its cause, mode of transmission, prevention and control.
- Capability of the patient to take preventive measure.
- Suitability for living and breeding of mosquito larvae and their predators in the same water bodies surrounding the patient's house.
- Availability and condition or environment of breeding grounds of mosquito larvae surrounding the patients' house.
- Magnitude of relationship among host, parasite, vector and predators of the vectors.

Study period

The study period was during 2009 to 2013.

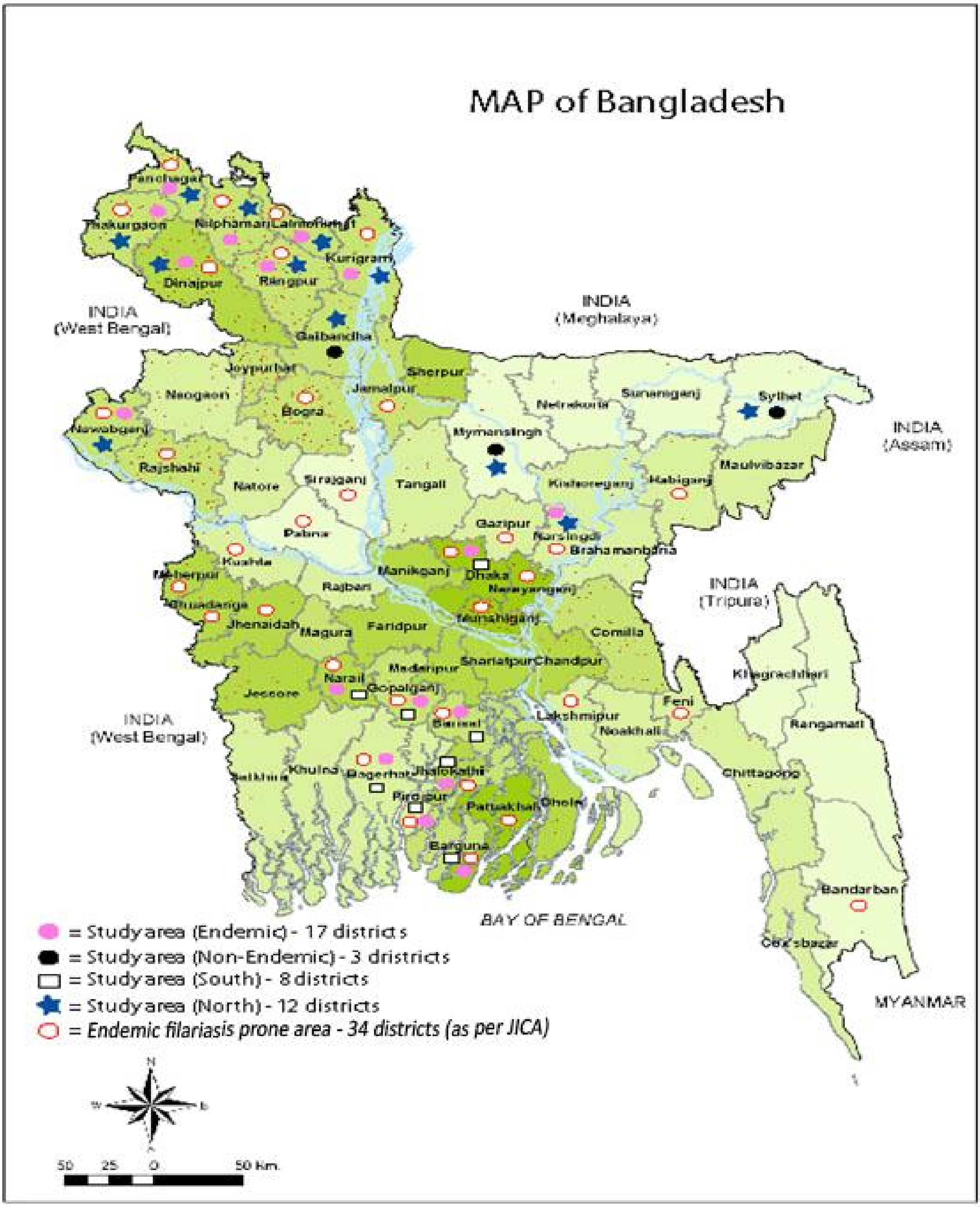
Study area

Out of 64 districts in Bangladesh, 12 districts of North zone and 8 districts of South zone of Bangladesh were selected as study sites. Out of 20 districts, 17 districts are endemic and 3 districts are non-endemic areas. The name of those endemic 17 districts are Panchagarh, Thakurgaon, Nilphamary, Lalmonirhat, Kurigram, Dinajpur, Rangpur, Chapainawabganj, Norshindhi, Dhaka, Narail, Gopalgonj, Barisal, Pirojpur, Bagerhat, Jhalakathi and Barguna. The other 3 non-endemic districts are Gaibandha, Sylhet and Mymensingh (Map-5).

The following study plan has been made before starting data collection for the present study:

1. Preparation of a map of the study area.
2. Identification of local leaders of the area.
3. Conduct meeting with local leaders for co-operation and co ordination.
4. Collection of relevant information of the study area.
5. Observation of the environment.
6. Completion of data.
7. Analysis and discussion.
8. Report writing.

The present study was carried out from door to door through direct observations and recording in the questionnaire. The research strategy provides the basis for a full range of social, economic and environmental factors in the development of an integrated disease control program. In order to achieve this aim, research was conducted within each domain of interest, which in this case includes the community, provider and program/policy domains. These include village/community members, Upazilla health Officers. At the national level, the opinions of the managers and staff of specific disease control programs are also gathered in semi-structured interviews focusing on integration and their program.



Map-5: Showing filaria affected districts in the map of Bangladesh in different way

Study population and selection of sampling sites

The present study multistage sampling designed with stages of selection at the following levels:

1. Districts
2. Sub-districts
3. Villages
4. Patient's house and
5. Water bodies surrounding the Patient's house.

District maps were used to select the sampling sites. Within selected sites, patients and their selected family members and selected community people, health institute, NGO-staff have been interviewed. Mosquito larvae and their predators were collected from different locations in selected districts. Mosquito larvae and their predators had been collected from different types of breeding grounds in the study areas.

Total 422 patients had been interviewed. Out of 422 patients, 292 patients were in north zone and 130 patients were in south zone. Out of 422 patients, 379 patients were in endemic areas and the rest 43 patients were in non-endemic areas. To select the districts, the following characteristics are taken into consideration.

North zone: Though the filariasis is a poor people disease, one of the poorest areas of Bangladesh like north zone was selected to observe the intensity of the disease in these areas. Besides, forknowing the effects of the specialized hospital for filariasis in Nilphamary district on the people, this area was selected too.

South zone: Recently south zone of Bangladesh is falling into vulnerable situation as because of disaster prone area like AILA-SIDR disaster. So, to address two extreme poorest zones in Bangladesh, south zone was selected along with north zone.

Endemic and non-endemic zone

Out of 20 study districts, 17 districts are endemic and 3 districts are non-endemic areas. To do comparative analysis between endemic and non-endemic zone, both the zones are selected. Notable that according to program coverage in WHO LF database, 2007, Gaibandha district is a non-endemic area (Map-5), but it had been observed that significant numbers of patients are existed in Gaibandha. No filarial patients were found in other two studied non endemic districts like Mymensingh and Sylhet. So for comparative study between non-endemic and endemic districts, only Gaibandha district was selected as a representative of non-endemic districts (as well as representative of north zone) and Barisal district (moderately affected) was selected as a representative of endemic districts as well asa representative of south zone.

Selection of breeding grounds of mosquito as well as the habitat of fish predators of mosquito larvae:

Though the number and type of breeding grounds of north area are lesser than that of south area but the breeding grounds found in north were suitable for *Culex* spp. mosquito round the year. Besides the breeding grounds in south area were dried in dry season but pit surrounding the tube well found in north area was watery in all seasons. The suitability of the habitat of more fishes was found in south zone but the more larvae consuming capable fishes habitat was found in north zone also. Main breeding grounds of *Culex spp*. found in the surrounding surveyed household in South zone of Bangladesh wereditch and abandoned pond but the main breeding grounds surrounding the surveyed household in North Zone of Bangladesh was the Pit surrounding the tube well which description is as follows.

Ditches: Ditches were human made excavation; it was contained by polluted water with high organic matter and was full of debris gained from drains and katcha latrines in or near ditches. Thickness of the debris at the bottom of the ditches varied from several inches to one foot. Water fluctuated with the season and generally it was varying 2 to7 feet. Water more or less polluted throughout the year but high pollution occurred in winter and gradually decreased in rainy season during to the heavy rainfall. The sampling ditches had water hyacinth and the margin for the ditches was caused with grasses and other weeds. Fish predators were found there throughout the year.

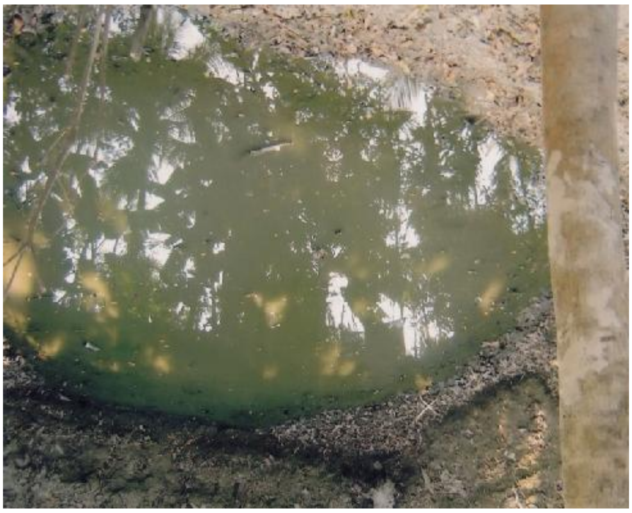


Plate-14: Picture of ditch

Plate-15 : Picture of ditch

Abandoned pond: There were many abandoned pond in south zone of Bangladesh. Those were also man-made excavations. These were rectangular in shape having depth of water varied from 3.5 to 8 feet. Those were longer in size in comparison to ditch. The water of those ponds was less polluted, those were partly covered with water hyacinth and other aquatic vegetation and many fish predators were found there.

Plate-16 : Picture of abandoned pond

Plate-17 : Picture of abandoned pond

Pit surrounding the tube well: Maximum households have used tube well rather than ponds for domestic purposes in north zone of Bangladesh due to scarcity of ground water in those areas. So domestically used water through the pipe line of tube well and rain water were stagnant regularly in hole called pit which were sometime katcha or sometime puccawhich were also man-made. And the water in those pitswas polluted in nature. Pucca concrete pits were constructed by bricks and cement which were uncovered and were more or less square in shape. The average size of pits was 3feet x 3feet but it varies according to the number of users. Households used those pits for the culture of fishes like- *Clarias batrachus* (Linnaeus, 1758), *Oreochromis mossambicus* (Peters, 1852) and *Anabas testudineus* (Bloch, 1792).

Plate-18 : Pit surrounding the tube well

Plate-19 : Pit surrounding the tube well

Collection and transportation of samples

Collection of samples: Patients of filariasis are found in 14 districts among the 20 study districts. Accordingly, the Mosquito larvae and their predators were collected from the same breeding grounds of the study area of 14 districts where patients were found. The collections were usually done in the morning in between 9 a.m. and 10 a.m. with a standard ladle. The inner side of the container was white to facilitate detection of larvae. The handle of the ladle was made of bamboo.

Plate-20 : Collection of mosquito larvae and their predators

Plate-21 : collection of mosquito larvae and their predators

The ladle was lowered and dipped slowly and carefully into the water at the breeding site without disturbing the water surface. Within a moment the ladle was full of water along with the larvae and pupae of mosquitoes and their small predators such as small fish, fingerlings of fish and other insect.

Mosquito larvae were picked up with the help of a fine pipette and kept into the glass bottle with sufficient amount of water. The small predators which were collected along with mosquito larvae were picked up with the help of a fine forceps and kept into a kettle. One dip of the ladle was collected in each sample. All those larvae collected in one dip were kept in one bottle and all the predators were kept into one kettle.

A part of the bottle was kept empty with sufficient air inside to ensure sufficient supply of oxygen to the larvae for respiration. Bottles were tightly corked and marked. All the predators were kept into a kettle which had a spout for entering air to facilitate the breathing of the predators. The mouth of the kettle was properly covered by its lid.

During collection, bottom debris at each breeding site was also observed and recorded. Water color, nature of water such as polluted or non polluted or clean water, weather condition, vegetation and predators in the breeding sites were recorded. Besides these, the big predators were collected by using a hand sweep net which was fine meshed (mesh size 2mm). One sweep of the sweep net was used for each sample. All the big predators collected in one sweep were kept in the kettle.

Transportation of samples:A small box was used to transport the samples from the field to the laboratory with great care. The box was divided into several compartments in accordance with the size of the bottles. Pieces of papers were used in the compartments to minimize collision and shaking of the bottles. Thus breaking of the bottles was avoided. Much care was taken in carrying the predators of mosquito larvae in the kettle to minimize the shake.

Methods for rearing of *Culexquinquefasciatus*in the Laboratory

For identification, colonization and continuous supply of mosquito larvae, the mosquitoes were reared in the laboratory. Larvae collected from the breeding grounds surrounding the patient's house and adult mosquitoes collected from the patient's house were reared in the laboratory.

The larvae were reared in a plastic bowl containing tap water. The larvae were supplied with powdered glucose and yeast. After pupation the pupae were transferred to a beaker, which was then kept inside, and adult rearing cage for emergence. The cages for rearing adults were made of iron frame (30 cubic centimeters) lined with thick mesh mosquito netting.

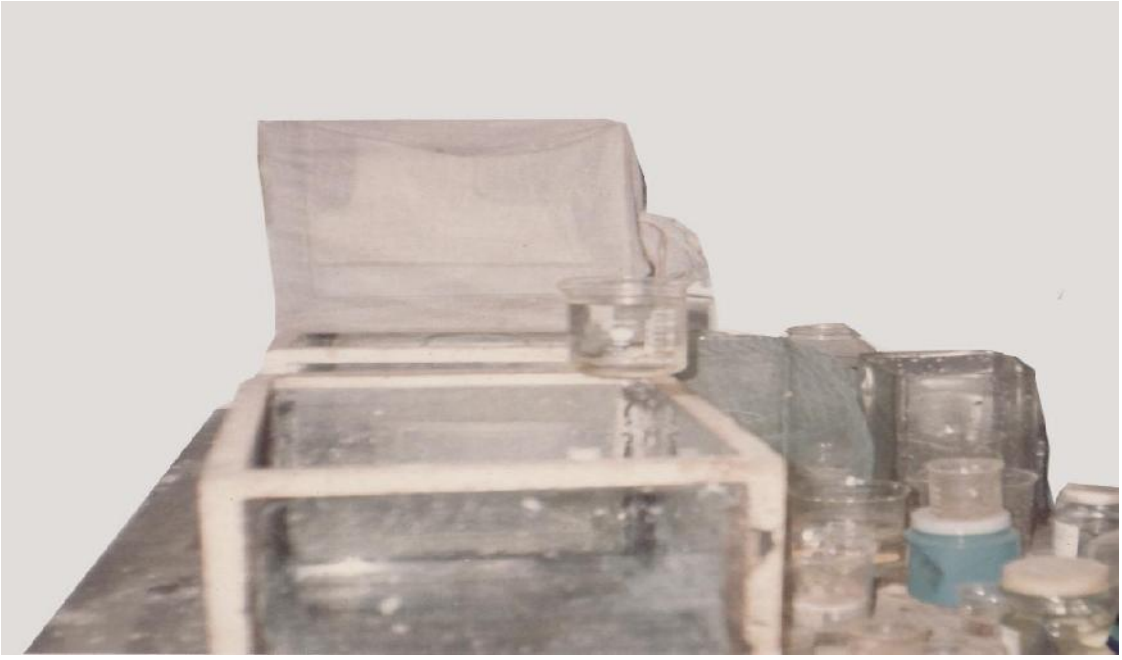


Plate-22: Mosquito rearing

There was an opening at one side of the cage which was provided with a long sleeve made of mosquito netting, through which beaker, bowls, pigeon and other necessary materials could be taken in and out of the cage without letting a mosquito to escape. The sleeve was tied with a cord when not in use.

After emergence of adults, they were fed with glucose water soaked in a wool pad kept in a Petridish inside the cage. After a pre-oviposition period of 2-3 days the females were given blood meal from a pigeon. The feathers of the breast region of the pigeon were removed. The wings and legs of the pigeon were also tied with a piece of thread to prevent its movement. Then it was placed inside the cage exposing its naked breast so that the female mosquitoes could suck blood. *Culex quinquefasciatus* is nocturnal in feeding habits, so blood meal was given at night time.The supply of glucose solution for the males was continued. The adult mosquitoes could not survive at low humidity, so the cage was moistened with a wet cloth.

About two days after a blood meal, the females oviposited. A beaker, two third filled with water, was kept inside the cage for oviposition. After oviposition, the eggs were transferred to a new beaker containing tap water.

The water of the rearing beaker was changed on alternate days and fresh tap water was given to avoid microbial contamination and formation of scum. Overcrowding of hatched larvae was avoided by separating the larvae into different beakers to get healthy individuals. Colonies were maintained in the laboratory at room temperature. The adult mosquitoes collected from the patient's housewere reared for producing larvae in the laboratory following above mentioned methods and maintain life cycle of mosquito for both identification and continuous supply for research work.

Measurement of predators

The collected predators were brought to the laboratory.The size of each predator fish in the jar was measured by general geometrical scale. The predator was taken into a clean petridish, they were placed on the measuring scale.The size was measured in centimeter from the top of the head to the base of caudal organ of the predator. Thelength and width of the fish were measured with care and transferred immediately into the jar.

Plate-23: Predation of larvae by fish

Plate-24: Counting of larvae for determining the consume capacity of the fish predator

Predation of larvae by fish

Several glass-jars (average measurement of the jar : 15cmx 13cm x 30 cm)were used to observe the predation of mosquito larvae. The predators were kept in the jars in tap water in the laboratory. The one-fourth of the Jar was full of water. Counted numbers of larvae of different instars were introduced into the jars containing a single predator. The mosquito larvae of each instar (1-4) offered for five consecutive days. Exception method was followed for the fish *Clarias batrachus* (Linnaeus, 1758) and *Oreochromis mossambicus* (Peters, 1852). In these two cases, the predation was allowed for only two hours in each day and found number multiply by 12 for determining the consumption rate of those fishes in a day because counting the larvae of 24 hours at a time was difficult.

Then after 24 hours, numbers of uneaten larvae were counted and were taken out of the jar and then found out the number of larvae eaten by a single fish predator and the capacity of predation of the selected fish predator was determined.

Fresh supplies of larvae were introduced thereafter. The fishes which were namely *Clarias batrachus* (Linnaeus, 1758), *Oreochromis mossambicus* (Peters, 1852), *Anabas testudineus* (Bloch, 1792), *Colisa fasciata* (Bloch and Schneider, 1801), *Channa striata* (Bloch, 1793), *Channa orientalis* (Bloch and Schneider, 1801), *Channa punctata* (Bloch, 1793) and *Poecilia reticulata* (Peters, 1859) selected as predators for laboratory experiment.

Data collection

The following methods were followed for data collection:

1. Filling the Questionnaire.
2. Collection of mosquito larvae and their predators from the same water bodies surrounding the patients' house.
3. Alive adult mosquito collection and then rearing those for producing more larvae in the laboratory for research use and identification purpose.

Before base line data collection, we introduced with the civil surgeon of concerned district through the department of Zoology, University of Dhaka. Concerned civil surgeons helped us through the local upazila health inspector and previous report. Then we introduced with local community leaders, influential persons and discussed with them about the purpose of the study. They were pleased and expressed their willingness to co-operate and help in all positive ways and they actually helped us in various ways. The patients were asked a series of questions in various angles.

Data Analysis

Data were analyzed for different parameters. The schedule for data collection consists of respondents demographic socio-economic information and the variables are age, sex, weight, educational qualification, economic condition, knowledge about disease, attitude and practice towards the prevention and control of the disease; spatial frequency, endemism of filariasis, frequency of breeding grounds, sanitation, treatment, sign-symptom of the disease, NGO involvement, predation capacity of the predators and comparison between different aspects.

After collecting of data, all the data were computed and maintained by using Microsoft Excel software regularly. After completion of data entry all files were converted to specializedsoftware such as Statistical Package for the Social Sciences (SPSS) verified and analyzed. After analyzing by SPSS, raw tables were formatted in Microsoft Excel to convert final tables and graphs in presentable ways.

Chapter-4

OBSERVATIONS AND RESULTS

According to the objectives of the present study, the prevalence and epidemiological aspects of lymphatic filariasis (LF) in different zones/districts of Bangladesh, the socio-economic characteristics and the infrastructural condition of the community for participation in prevention and elimination of this disease, to asses the attitude and level of knowledge of the community towards the causes, preventions and control measures of filarial disease, the magnitude of negligence to lymphatic filariasis, the factors which make the growth prevalence of lymphatic filariasis were observed.Along the above objectives, the cost effective and safe way control of the vectors of lymphatic filariasis, the effectiveness of predation by fish as a control measure of the vector of lymphatic filariasis and the occurrence of the mosquito larvae and their predators in the same water bodies around the lymphatic filariasis affected patient's house were also investigated.

Thestudy was carried out among the people of the 12 districts of North zone and 8 districts of South zone of Bangladesh. Out of those 20 districts, 17 districts were endemic and 3 districts were non-endemic areas (according to JICA, 2004 and WHO, 2007). According to JICA and WHO, Gaibandha was non-endemic district but in thepresent study, the patientswere identified in Gaibandha. Besides, out of those 20 districts, patients were found in 14 districts and were not found in other 6 districts. District maps were used to select the sampling sites. Within selected sites, patients and their selected family members and selected community people, health institute, NGO-staff have been interviewed. Mosquito larvae and their predators had been collected from different types of breeding grounds around the patients' house in the study areas. Total 422 patients had been interviewed. Out of 422 patients, 292 patients were in north zone and 130 patients were in south zone. On the other hand, out of 422 patients, 379 patients were in endemic areas and the rest 43 patients in non-endemic areas.

Prevalence of LF in different districts of Bangladesh

Preliminary LF eliminated 10 districts declared in 2011& 2012 by Filariasis Elimination Programme, in which 5 districts (Rajshahi, Dinajpur, Meherpur, Patuakhali and Barguna) are decleared in 2011 and 5 districts (Pabna, Sirajganj, Kushtia, Chuadanga and Pirojpur) are decleared in 2012. But this study found patients inBarguna, Pirojpur and Dinajpur. It is mentionable that Rajshahi, Meherpur, Patuakhali, Pabna, Sirajganj, Kushtia and Chuadanga district were not included in the presenent study (Table-1).

Table-1: Prevalence of Filariasis in different districts as per the information of different sources

According to JICA 2004	According to WHO LF database, 2007	The surveyed districts in present study		Preliminary LF eliminated 10 districts declared in 2011& 2012 by Filariasis Elimination Programme
		Patients Found	Patients not Found	
Barisal Division				
Barguna	Barguna	Barguna		Barguna
Barisal	Barisal	Barisal		
Jhalokathi	Jhalokathi	Jhalokathi		
Pirojpur	Pirojpur	Pirojpur		Pirojpur
Patuakhali	Patuakhali			Patuakhali
Chittagong Division				
Loxmipur	Loxmipur			
Feni	Feni			
	Bandarbon			
Dhaka Division				
Dhaka	Dhaka	Dhaka		
Munshiganj	Munshiganj			
Narsingdi	Narsingdi		Narsingdi	
Gazipur	Gazipur			
Gopalganj	Gopalganj		Gopalganj	
Narayanganj	Narayanganj			
Jamalpur	Jamalpur			
			Mymensingh	
Khulna Division				
Kushtia	Kushtia			Kushtia
Chuadanga	Chuadanga			Chuadanga
Meherpur	Meherpur			Meherpur

Bagerhat	Bagerhat		Bagerhat	
Norail	Norail		Norail	
Jhenidah	Jhenidah			
Rajshahi Division				
Pabna	Pabna			Pabna
Rajshahi	Rajshahi			Rajshahi
Chapainawabganj	Chapainawabganj	Chapainawabganj		
	Sirajganj			Sirajganj
Bogra	Bogra			
Rangpur Division				
Kurigram	Kurigram	Kurigram		
Rangpur	Rangpur	Rangpur		
Thakurgaon	Thakurgaon	Thakurgaon		
Panchagarh	Panchagarh	Panchagarh		
Lalmonirhat	Lalmonirhat	Lalmonirhat		
Nilphamari	Nilphamari	Nilphamari		
Dinajpur	Dinajpur	Dinajpur		Dinajpur
		Gaibandha		
Sylhet Division				
Hobiganj	Hobiganj			
			Sylhet	
Total=32 districts	34 districts	14 districts	6 districts	10 districts

Table-2: Prevalence of LF in different studied districts

Sl. No	Name of Districts	Frequency of Patients	Percentage (%)
1.	Panchagarh	30	7.1
2.	Dinajpur	20	4.7
3.	Thakurgaon	50	11.8
4.	Pirojpur	30	7.1
5.	Barisal	27	6.4
6.	Jhalokathi	26	6.2
7.	Barguna	31	7.3
8.	Rangpur	25	5.9
9.	Kurigram	27	6.4
10.	Gaibandha	43	10.2
11.	Lalmonirhat	51	12.1
12.	Nilphamari	31	7.3
13.	Dhaka	16	3.8
14.	Chapainawabganj	15	3.6
15.	Bagerhat	0	0
16.	Gopalganj	0	0
17.	Sylhet	0	0
18.	Narail	0	0
19.	Mymensingh	0	0
20.	Norshindhi	0	0
	Total	422	100

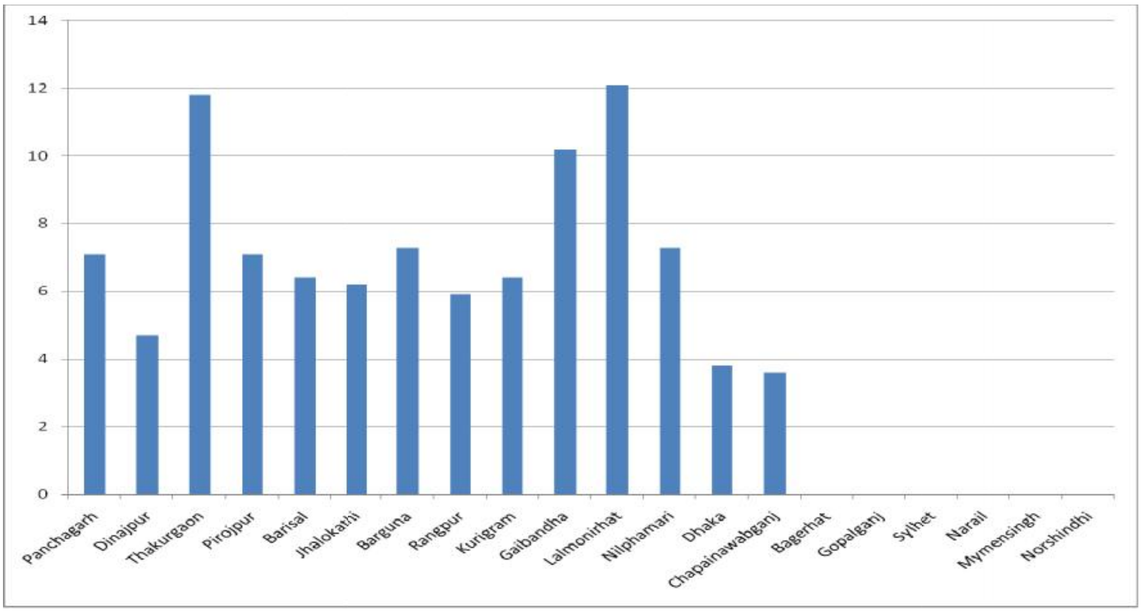


Figure-1: Prevalence of LF in different studied districts

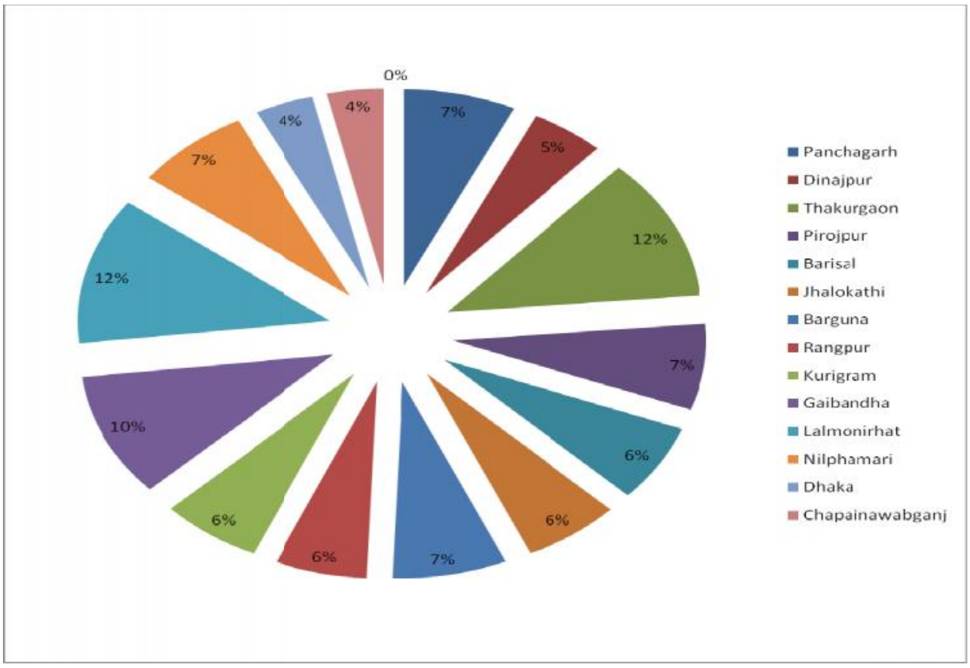


Figure-2: District wise prevalence of LF (showing through pie chart)

Bagerhat, Gopalganj, Sylhet, Narail, Mymensingh and Norshindhi have no filarial patients as per information provided by the concerned cevil surgeons' office. The highest frequency of patients found in Lalmonirhat and Thakurgaon followed by Gaibandha.

Frequency of patients found in endemic and non endemic zone (Endemic-non endemic declared byWHO):

Among 20 studied districts 17 districts were endemic and 3 districts named Sylhet, Gaibandha, and Mymensing were non-endemic districts and the 89.81% patients were found in endemic area and 10.18% patients were found in nonendemic area(Table-3, Figure-3).

Table-3:Frequency of patients found in endemic and non endemic zone

Sl. No	Name of Districts		Frequency of Patients	Percentage (%)
	Non Endemic Districts	Endemic Districts		
1.		Panchagarh	30	89.81
2.		Dinajpur	20	
3.		Thakurgaon	50	
4.		Pirojpur	30	
5.		Barisal	27	
6.		Jhalokathi	26	
7.		Barguna	31	
8.		Rangpur	25	
9.		Kurigram	27	
10.		Lalmonirhat	51	
11.		Nilphamari	31	
12.		Dhaka	16	
13.		Chapainawabganj	15	
14.		Bagerhat	0	
15.		Gopalganj	0	
16.		Norshindhi	0	
17.		Narail	0	
Sub total			379	
18.	Sylhet		0	10.18
19.	Gaibandha		43	
20.	Mymensingh		0	
Sub total			43	
Grand total	3	17	422	100

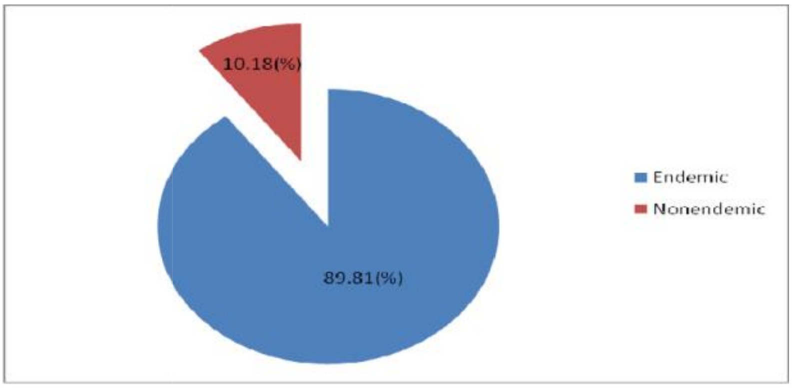


Figure-3: Frequency of patients found in endemic and non endemic zone

Distribution of patients in different zones: Considering Dhaka City Corporation as a centre of the country, the south side of Dhaka City Corporation was treated as south zone and the north side of the Dhaka City Corporation was treated as north zone. These zonewise distributions of patients are shown in the following table and figure (Table-4 and Figure-4).

Table-4: Zone wise distribution of filarial patients

Sl. No	Name of Districts		Frequency of Patients	Percentage (%)
	North Zone	South Zone		
1.	Panchagarh		30	69.2
2.	Dinajpur		20	
3.	Thakurgaon		50	
4.	Rangpur		25	
5.	Kurigram		27	
6.	Lalmonirhat		51	
7.	Nilphamari		31	
8.	Chapainawabganj		15	
9.	Sylhet		0	
10.	Gaibandha		43	
11.	Mymensingh		0	
Sub total			292	
12.		Pirojpur	30	30.8
13.		Barisal	27	
14.		Jhalokathi	26	
15.		Barguna	31	
16.		Dhaka	16	
17.		Bagerhat	0	
18.		Gopalganj	0	
19.		Norshindhi	0	
20.		Narail	0	
Sub total			130	
Grand total	11	9	422	100

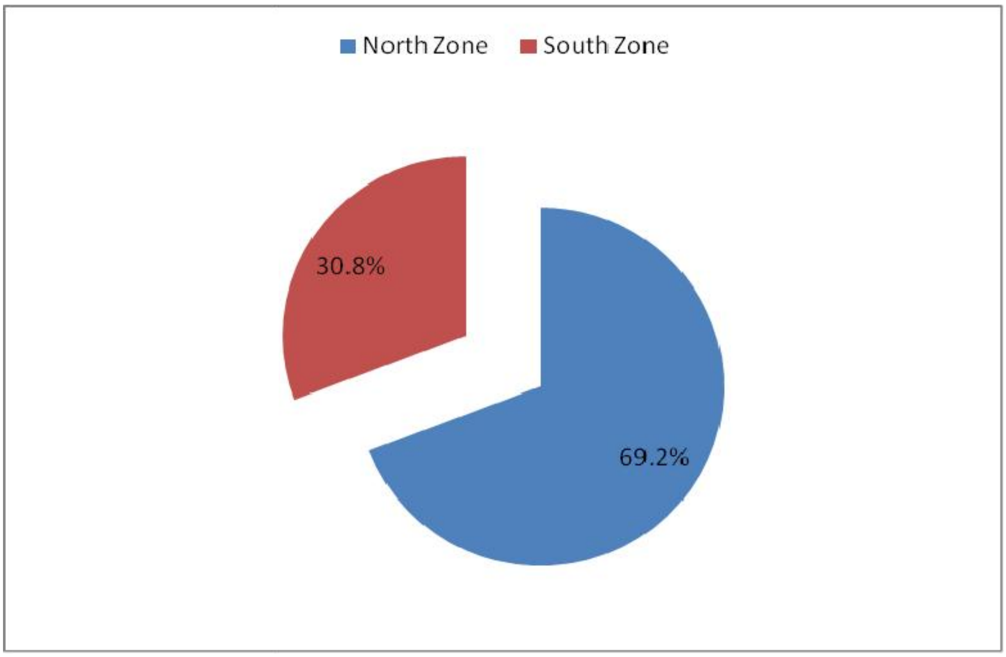


Figure-4: Zone wise (North and south) frequency of patients under the study area

Among 20 studied districts 12 districts are located in north zone and 8 districts are located in south zone in Bangladesh and the 69.2% patients were found in north zone and 30.8% patients were found in south zone (Table-4 and Figure-4).

Distribution of patients according to various aspects

Distribution of patients according to their sex: Male-female patients' distribution is as follows (Table-5, Figure-5&6). Higher percentage of female patients was found in Kurigram (77.8%), Lalmonirhat (72.5%), Thakurgaon (72%), Dinajpur (70%), Chapainawbganj (66.7%), and Panchgarh (56.7%). Border areas as well as insolvent areas'females were more affected than that of central areas.

Table-5: Sex of the respondent-patients

Name of Districts	Sex of the respondents patients				Total	
	Male		Female			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequenc y	Percentage (%)
Panchgarh	13	43.3	17	56.7	30	100
Dinajpur	6	30.0	14	70.0	20	100
Thakurgaon	14	28.0	36	72.0	50	100
Pirojpur	20	66.7	10	33.3	30	100
Barisal	18	66.7	9	33.3	27	100
Jhalokathi	17	65.4	9	34.6	26	100
Barguna	20	64.5	11	35.5	31	100
Rangpur	17	68.0	8	32.0	25	100
Kurigram	6	22.2	21	77.8	27	100
Gaibandha	19	44.2	24	55.8	43	100
Lalmonirhat	14	27.5	37	72.5	51	100
Nilphamari	17	54.8	14	45.2	31	100
Dhaka	10	62.5	6	37.5	16	100
Chapainawabganj	5	33.3	10	66.7	15	100
Total	196	46.4	226	53.6	422	100

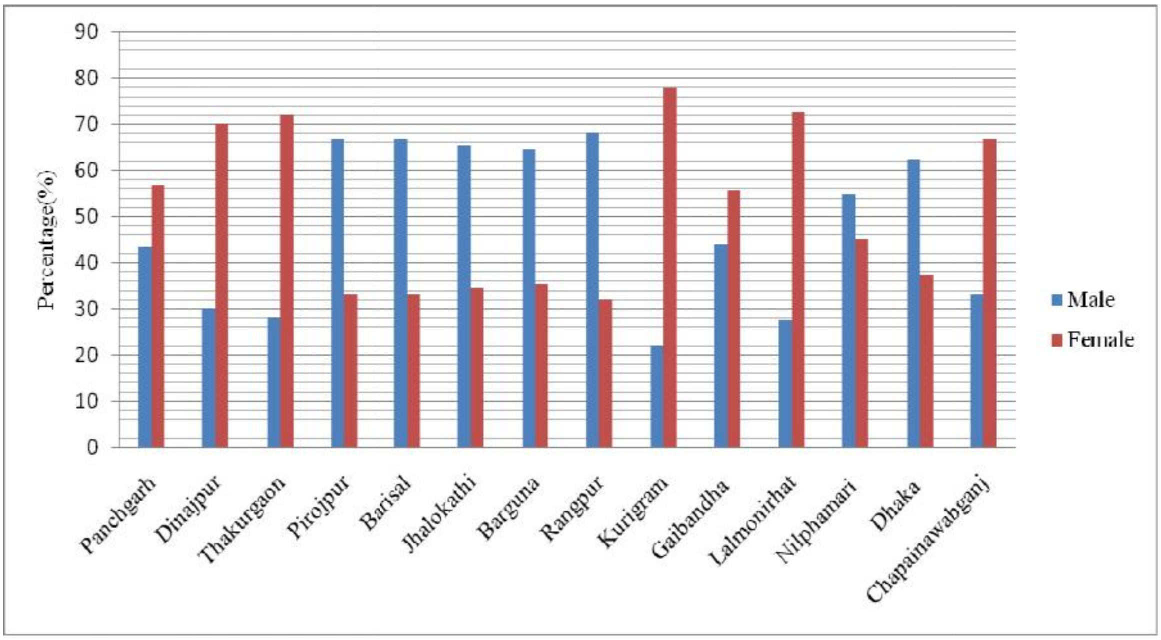


Figure-5: Distribution of respondent-patients according to sex (District wise)

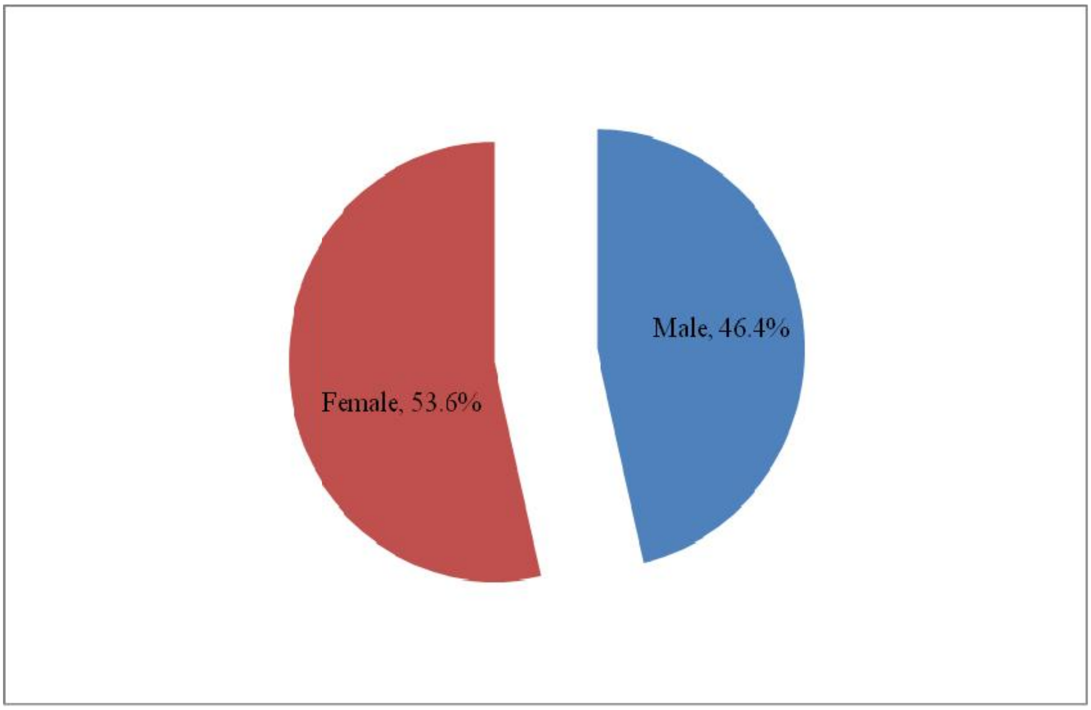


Figure-6: Distribution of patients according to sex (overall).

Among the total patients, 53.6% were female and 46.4% were male, the female were comparatively less educated than male so the number of female patients were little bit higher than that of male.

Distribution of patients according to age group: In the present investigation, the patients were divided into nine categories based on age group for determining the age wise magnitude of the prevalence of filariasis. The patients' distribution according to different age group was follows (Table-6, Figure-7&8).

Table-6:Districtwise patients' distribution according to different age group

District		Age of the respondents(Years)									Total
		0-10	11-20	21-30	31-40	41-50	51-60	61-70	70-80	81-90	
Panchgarh	Person	0	0	0	8	8	12	2	0	0	30
	%	0	0	0	26.7	26.7	40.0	6.7	0	0	100
Dinajpur	Person	0	0	0	3	10	4	3	0	0	20
	%	0	0	0	15.0	50.0	20.0	15.0	0	0	100
Thakurgaon	Person	0	0	1	6	17	19	6	0	1	50
	%	0	0	2	12	34	38	12	0	2	100
Pirojpur	Person	0	0	3	9	8	7	3	0	0	30
	%	0	0	10	30	26.7	26.7	10	0	0	100
Barisal	Person	0	0	0	5	10	10	2	0	0	27
	%	0	0	0	18.5	37.0	37.0	7.4	0	0	100
Jhalokathi	Person	0	0	0	5	13	7	1	0	0	26
	%	0	0	0	19.2	50.0	26.9	3.8	0	0	100
Barguna	Person	0	0	0	5	15	11	0	0	0	31
	%	0	0	0	16.1	48.4	35.5	0	0	0	100
Rangpur	Person	0	0	0	6	13	6	0	0	0	25
	%	0	0	0	24.0	52.0	24.0	0	0	0	100
Kurigram	Person	0	1	1	6	7	9	2	1	0	27
	%	0	3.7	3.7	22.2	25.9	33.3	7.4	3.7	0	100
Gaibandha	Person	0	0	1	9	15	14	4	0	0	43
	%	0	0	2.3	20.9	34.9	32.6	9.3	0	0	100
Lalmonirhat	Person	0	0	0	11	18	16	6	0	0	51
	%	0	0	0	21.6	35.3	31.4	11.8	0	0	100
Nilphamari	Person	0	6	4	8	6	3	4	0	0	31
	%	0	19.4	12.9	25.8	19.4	9.7	12.9	0	0	100
Dhaka	Person	0	2	8	1	2	2	0	1	0	16
	%	0	12.5	50	6.2	12.5	12.5	0	6.2	0	100
Chapai nawabganj	Person	0	2	3	3	3	4	0	0	0	15
	%	0	13.3	20	20	20	26.7	0	0	0	100
Total	Person	0	11	21	85	145	124	33	2	1	422
	%	0	2.6	5	20.1	34.4	29.4	7.8	0.5	0.2	100

In the present study, filariasis was not found in tender aged children (0-10 years)in the study area. 31-60 years old patient were found in every district. Older aged (81-90 years) patients were not found except in Thakurgaon district.

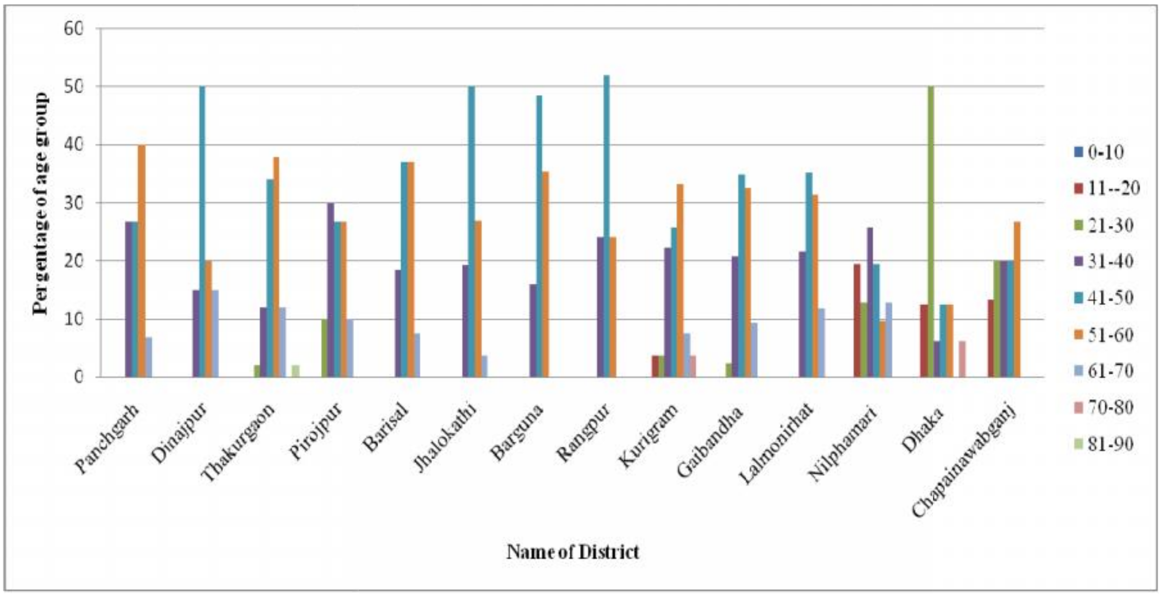


Figure -7: Distribution of patients according to age group (District wise)

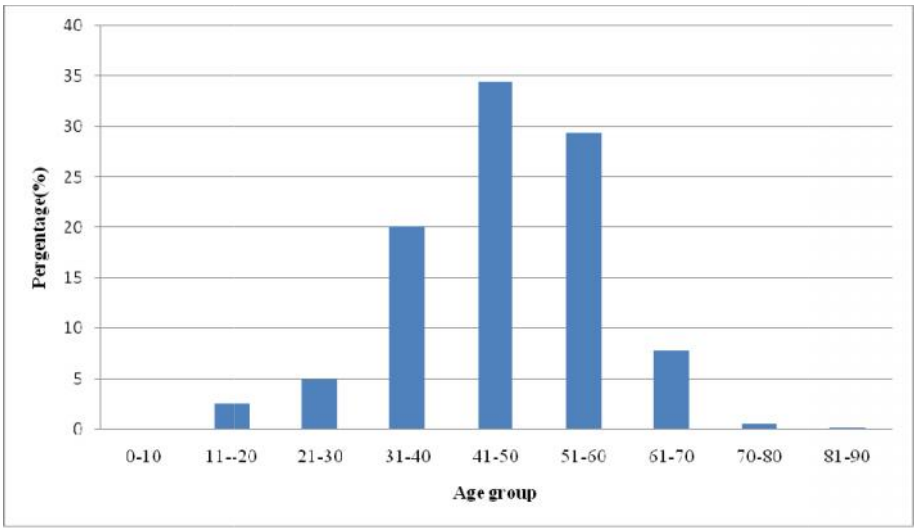


Figure-8: Distribution of patients according to age group (overall)

There was no patient in age group (0-10), the highest number of patients was found in age group `41years-50years' (34.4%). The patients of this age group were foundmore or less in every study-district. It was also observed that this disease is gradually increasing/visual upto the age of 50 years and then it is gradually decreasing with the upper age and ultimately the older patients are not alive, so only one patient is found in age group:`81years-90years'.

Observation of patients based on body weight: In the present observation, the patients were categorized into six categories based on weight-group for determining the weightwise magnitude of the prevalence of filariasis. Patients' distribution according to different weight of the patients is as follows (Table-7; Figure-9)

Table-7:Districtwise patients' distribution according to different weight-group

District		Weight of the respondents						Total
		<30	31-40	41-50	51-60	61-70	71-80	
Panchgarh	Frequency	0	1	13	5	10	1	30
	%	0	3.3	43.3	16.7	33.3	3.3	100
Dinajpur	Frequency	0	0	10	6	1	3	20
	%	0	0	50.0	30.0	5.0	15.0	100
Thakurgaon	Frequency	0	4	28	15	2	1	50
	%	0	8.0	56.0	30.0	4.0	2.0	100
Pirojpur	Frequency	0	0	1	8	17	4	30
	%	0	0	3.3	26.7	56.7	13.3	100
Barisal	Frequency	0	0	12	8	7	0	27
	%	0	0	44.4	29.6	25.9	0	100
Jhalokathi	Frequency	0	0	7	8	10	1	26
	%	0	0	26.9	30.8	38.5	3.8	100
Barguna	Frequency	0	0	8	13	9	1	31
	%	0	0	25.8	41.9	29.0	3.2	100
Rangpur	Frequency	0	0	7	6	10	2	25
	%	0	0	28.0	24.0	40.0	8.0	100
Kurigram	Frequency	0	1	10	11	5	0	27
	%	0	3.7	37.0	40.7	18.5	0	100
Gaibandha	Frequency	0	1	20	16	4	2	43
	%	0	2.3	46.5	37.2	9.3	4.7	100
Lalmonirhat	Frequency	0	7	24	18	2	0	51
	%	0	13.7	47.1	35.3	3.9	0	100
Nilphamari	Frequency	0	6	16	9	0	0	31
	%	0	19.4	51.6	29.0	0	0	100
Dhaka	Frequency	0	0	10	6	0	0	16
	%	0	0	62.5	37.5	0	0	100
Chapai nawabganj	Frequency	1	0	7	7	0	0	15
	%	6.7	0	46.7	46.7	0	0	100
Total	Frequency	1	20	178	138	71	14	422
	%	0.2	4.7	42.2	32.7	16.8	3.3	100

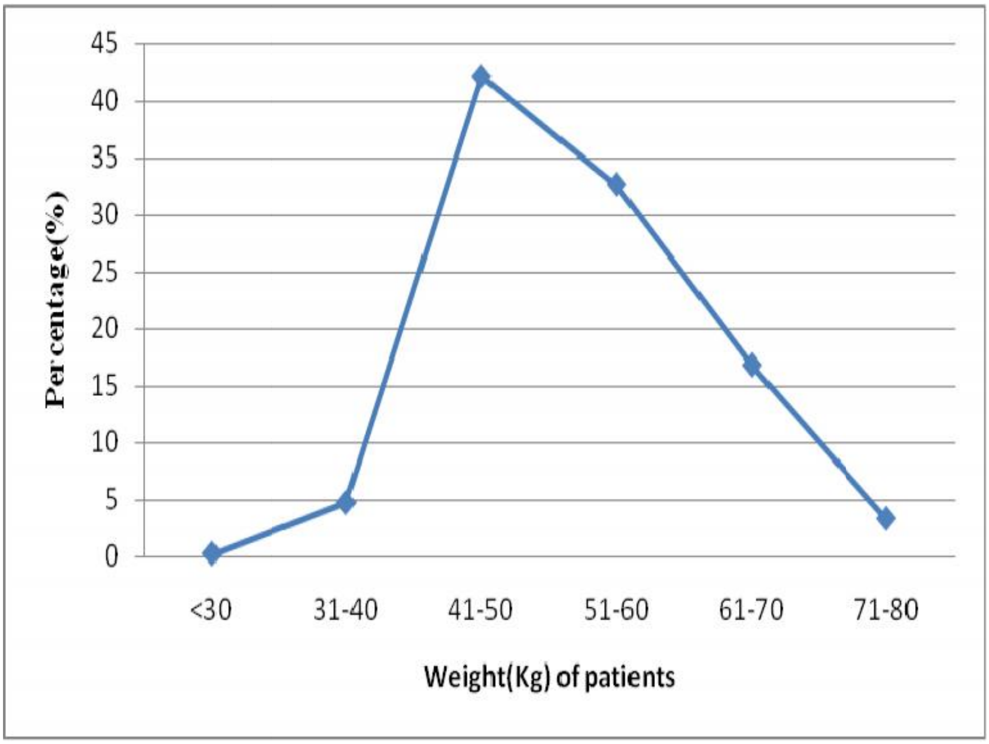


Figure-9: Distribution offilarial patients according to body weight.

Most of the patients were positioned in the weight-range of 41kg-50kg (42.2%). People' belonging the below weight of 41 kg and upper weight of 50kg was less affected by filariasis. The middle weight group of people was more affected in filariasis. That means the magnitude of prevalence of the disease is gradually decreasing with the lesser (lessrthan 41kg) and upper (higher than 50kg) weight of group.

Distribution of patients according to their educational status: Education is one of the most important factors of spread out of the disease. In the present investigation, the patients were divided into four categories based on educational status for determining the importance of education to prevent or cure from the disease as the following tables and figures (Table-8&Figure-10-11).

Table-8: Districtwise patients' distribution based on their educational status

District		Educational status				Total
		Illiterate	Can sign only	Up to Primary level	Above Primary level	
Panchgarh	Frequency	21	6	3	0	30
	%	70.0	20.0	10.0	0	100
Dinajpur	Frequency	12	3	5	0	20
	%	60.0	15.0	25.0	0	100
Thakurgaon	Frequency	23	24	2	1	50
	%	46.0	48.0	4.0	2.0	100
Pirojpur	Frequency	19	7	3	1	30
	%	63.3	23.3	10.0	3.3	100
Barisal	Frequency	21	3	3	0	27
	%	77.8	11.1	11.1	0	100
Jhalokathi	Frequency	16	2	6	2	26
	%	61.5	7.7	23.1	7.7	100
Barguna	Frequency	19	6	6	0	31
	%	61.3	19.4	19.4	0	100
Rangpur	Frequency	17	5	3	0	25
	%	68.0	20.0	12.0	0	100
Kurigram	Frequency	21	2	4	0	27
	%	77.8	7.4	14.8	0	100
Gaibandha	Frequency	25	12	6	0	43
	%	58.1	27.9	14.0	0	100
Lalmonirhat	Frequency	35	7	9	0	51
	%	68.6	13.7	17.6	0	100
Nilphamari	Frequency	24	3	4	0	31
	%	77.4	9.7	12.9	0	100
Dhaka	Frequency	0	0	2	14	16
	%	0	0	12.5	87.5	100
Chapainawabganj	Frequency	2	6	7	0	15
	%	13.3	40	46.7	0	100
Total	Frequency	254	86	60	22	422
	%	60.2	20.4	14.2	5.2	100

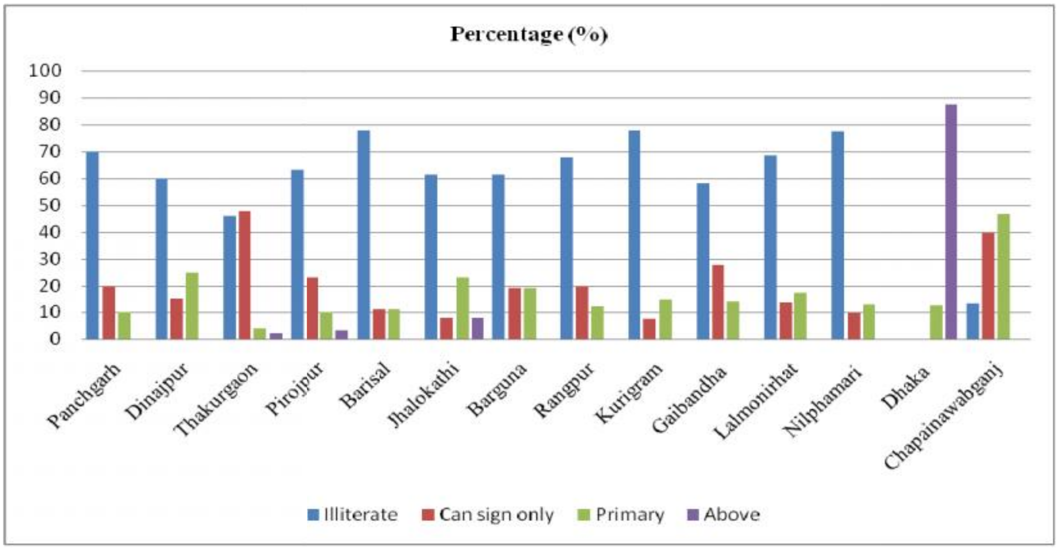


Figure-10: Districtwise distribution of patients according to their educational status

There were no patients who were educated above primary level in 10 districts. The highest frequency of illiterate patients was in every district except one district like Dhaka. The prevalence of filariasis is depending on uneducational status.

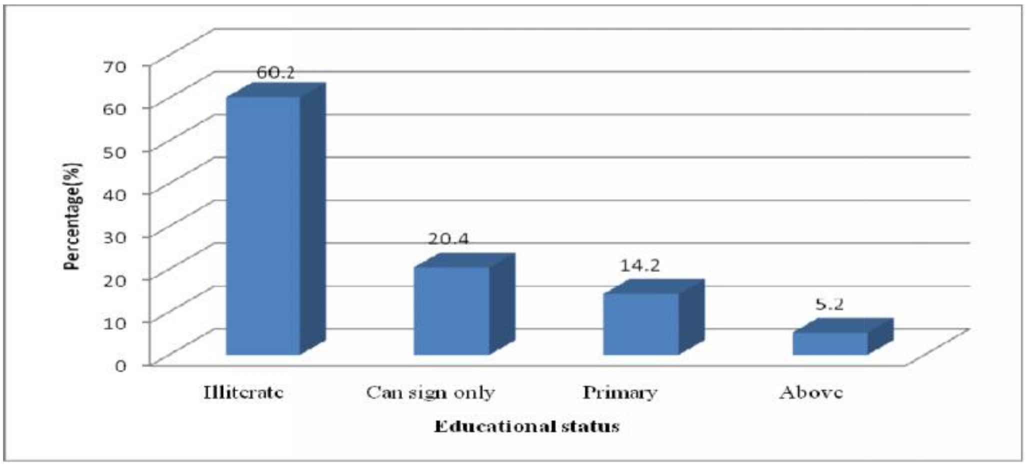


Figure-11: Distribution of patients according to their educational status

The patients were mostly illiterate (60.2%) followed by the patients who can signonly (20.4%). 5.2% patientswere above the primary level. It is observed that the filarisisis occurred in the illeterate people and the prevalence is decreasing with the higher educational status.

Pattern of latrine used by the patients: Four types of latrines were found in the study areas which weresanitaryLatrine; Pit latrine,Hanging latrine and Open field (used as latrine). Distributions of Patients according to their behaviors regarding use of different types of latrines are shown in Table: 9 and Figure: 12-13.

Table-9: Type of latrine use by the patients in different districts

District		Type of latrine				Total
		Sanitary latrine	Pit latrine	Hanging latrine	No latrine (Open field)	
Panchgarh	Frequency	22	3	4	1	30
	%	73.3	10	13.3	3.3	100
Dinajpur	Frequency	15	2	2	1	20
	%	75	10	10	5	100
Thakurgaon	Frequency	40	3	5	2	50
	%	80	6	10	4	100
Pirojpur	Frequency	22	2	4	2	30
	%	23.3	6.7	13.3	6.7	100
Barisal	Frequency	17	4	4	2	27
	%	63	14.8	14.8	7.4	100
Jhalokathi	Frequency	17	3	4	2	26
	%	65.4	11.5	15.4	7.7	100
Barguna	Frequency	21	3	4	3	31
	%	67.7	9.7	12.9	9.7	100
Rangpur	Frequency	19	3	2	1	25
	%	76	12	8	4	100
Kurigram	Frequency	20	3	3	1	27
	%	74.1	11.1	11.1	3.7	100
Gaibandha	Frequency	31	4	7	1	43
	%	72.1	9.3	16.3	2.3	100
Lalmonirhat	Frequency	38	6	3	4	51
	%	74.5	11.8	5.9	7.8	100
Nilphamari	Frequency	20	6	2	3	31
	%	64.5	19.4	6.5	9.7	100
Dhaka	Frequency	16	0	0	0	16
	%	100	0	0	0	100
Chapainawabganj	Frequency	13	1	1	0	15
	%	86.7	6.7	6.7	0	100
Total	Frequency	311	43	45	23	422
	%	73.7	10.2	10.7	5.5	100

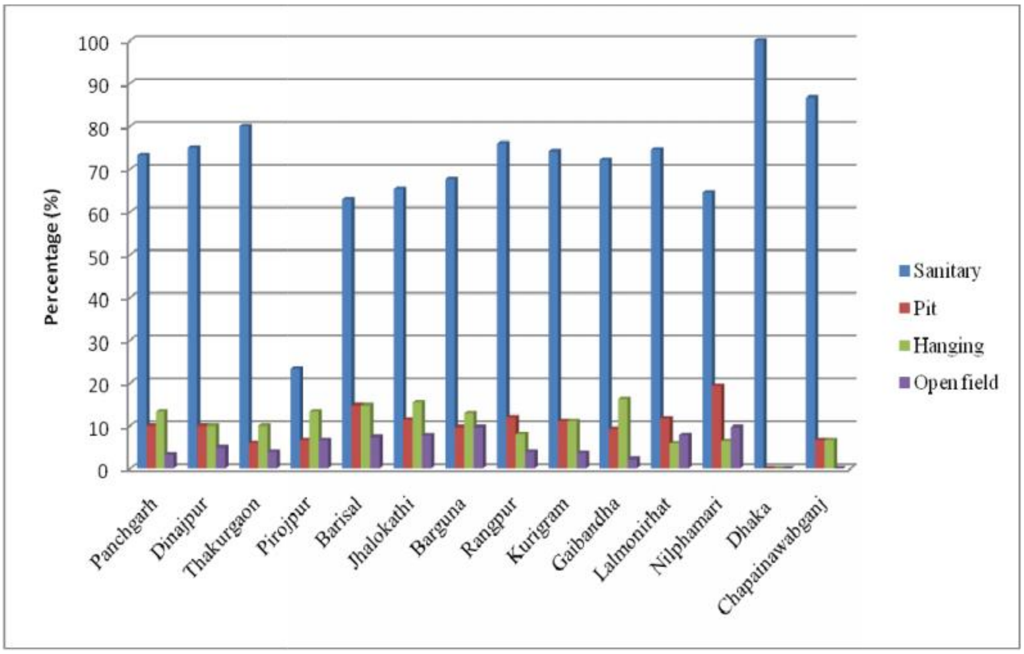


Figure-12: Type of latrine use by the patients

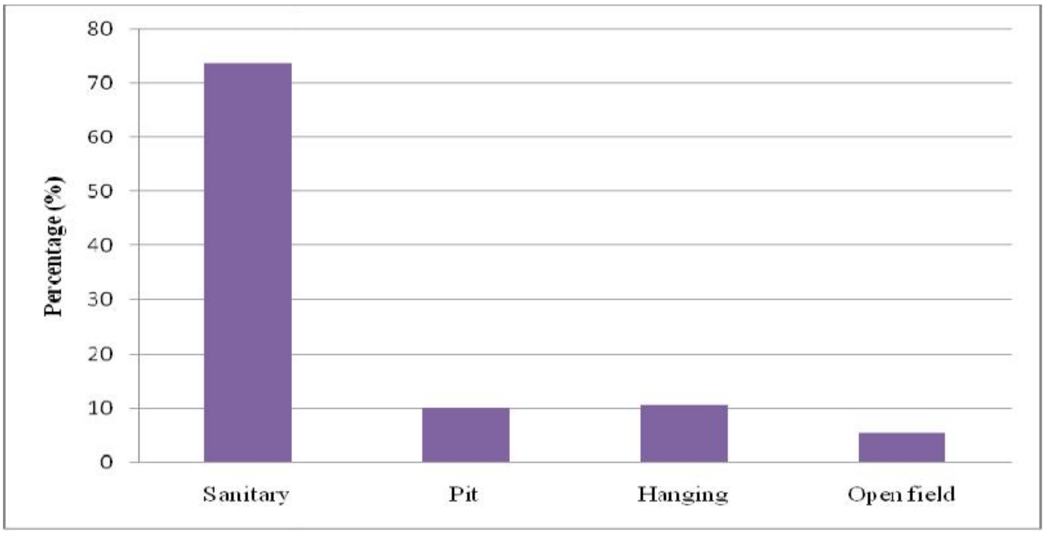


Figure-13: Percentage of the pattern of latrine use by the patients in studied districts

Some patients of almost all districts use hanging latrine and open field for sanitation purpose which is suitable for disease transmission. It was observed that, still about 26.3% patients' family used pit, hanging latrine and open field for sanitation purpose which transmit the disease.

Hand washing elements used after defecation by the patients (district wise): Four types of practice of using hand washing elements after defecation by the patients were found in the study areas which were 'Soap and water', 'Ash and water', 'Soil and water' and 'Water only'. Distributions of Patients according to their behaviors regarding use of different types of hand washing elements are shown in Table: 10 and Figure: 14-15.

Table-10:Districtwisepractice of using hand washing elements after defecation by the patients

District	Hand washing elements used after defecation								Total	
	Soap and water		Ash and water		Soil and water		Water only			
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Panchgarh	7	23.3	12	40.0	7	23.3	4	13.3	30	100
Dinajpur	5	25.0	7	35.0	5	25.0	3	15.0	20	100
Thakurgaon	14	28.0	16	32.0	16	32.0	4	8.0	50	100
Pirojpur	6	20.0	10	33.3	11	36.7	3	10.0	30	100
Barisal	4	14.8	5	18.5	15	55.6	3	11.1	27	100
Jhalokathi	6	23.1	5	19.2	14	53.8	1	3.8	26	100
Barguna	3	9.7	10	32.3	16	51.6	2	6.5	31	100
Rangpur	4	16.0	10	40.0	8	32.0	3	12.0	25	100
Kurigram	3	11.1	16	59.3	6	22.2	2	7.4	27	100
Gaibandha	11	25.6	12	27.9	16	37.2	4	9.3	43	100
Lalmonirhat	11	21.6	21	41.2	7	13.7	12	23.5	51	100
Nilphamari	6	19.4	11	35.5	4	12.9	10	32.3	31	100
Dhaka	14	87.5	0	0	0	0	2	12.5	16	100
Chapai nawabganj	3	20.0	1	7.0	3	20	8	53	15	100
Total	97	23	136	32.2	128	30.3	61	14.5	422	100

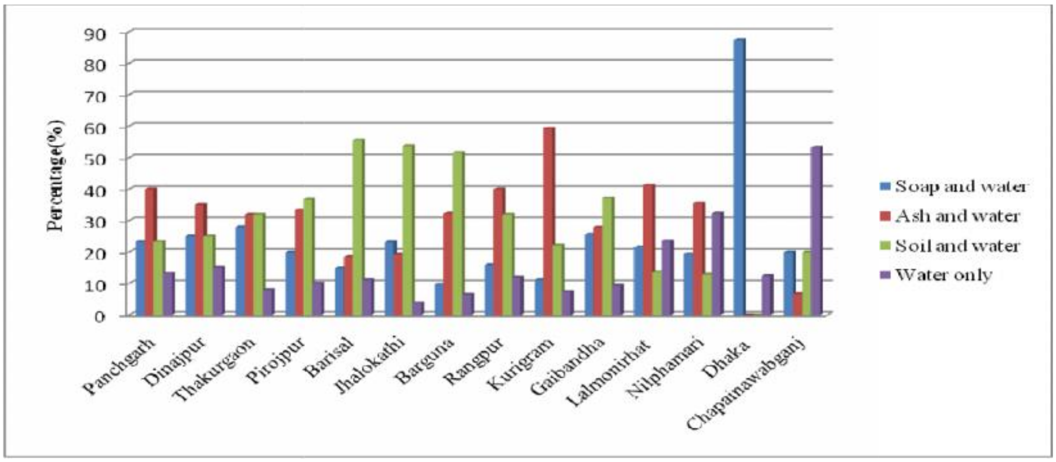


Figure-14: Hand washing elements used after defecation by the patients (Districtwise)

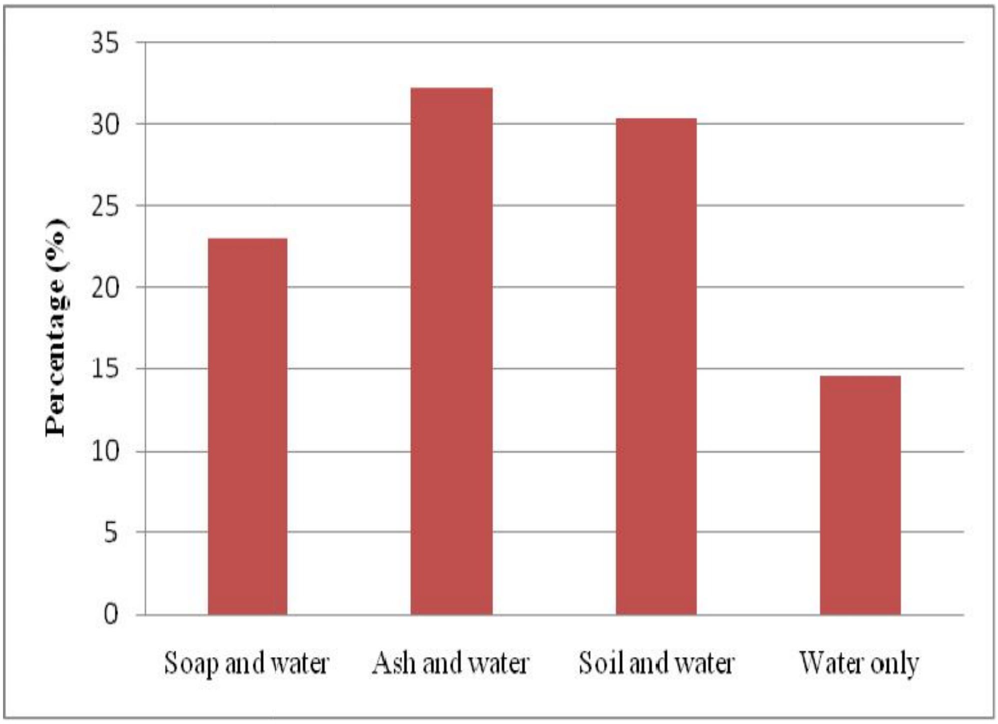


Figure-15: Hand washing elements used after defecation by the patients

Even now some patients of all districts use only water for hand washing after defecation which was one of the causes of disease transmission. Around 14.5% patients of all over the study area use only water for hand washing after defecation is an unhygenic living status which was one of the causes of transmission of disease.

Uses of bed net by the patients: Use of bed net is one of the most important prevention factors which make anticipation of free from mosquito bite and then stop/dicrease the disease. So it was observed that whether the patients used bed net or not (Table-11& Figure -16).

Table-11: Use of bed net practice by the patients in different study areas

District	Use of bed net				Total	
	Yes		No			
	Frequency	%	Frequency	%	Frequency	%
Panchgarh	25	83.3	5	16.7	30	100
Dinajpur	17	85.0	3	15.0	20	100
Thakurgaon	42	84.0	8	16.0	50	100
Pirojpur	26	86.7	4	13.3	30	100
Barisal	23	85.2	4	14.8	27	100
Jhalokathi	22	84.6	4	15.4	26	100
Barguna	26	83.9	5	16.1	31	100
Rangpur	21	84.0	4	16.0	25	100
Kurigram	25	92.6	2	7.4	27	100
Gaibandha	36	83.7	7	16.3	43	100
Lalmonirhat	50	98.0	1	2.0	51	100
Nilphamari	30	96.8	1	3.2	31	100
Dhaka	15	93.8	1	6.2	16	100
Chapainawabganj	13	86.7	2	13.3	15	100
Total	371	87.91	51	12.09	422	100

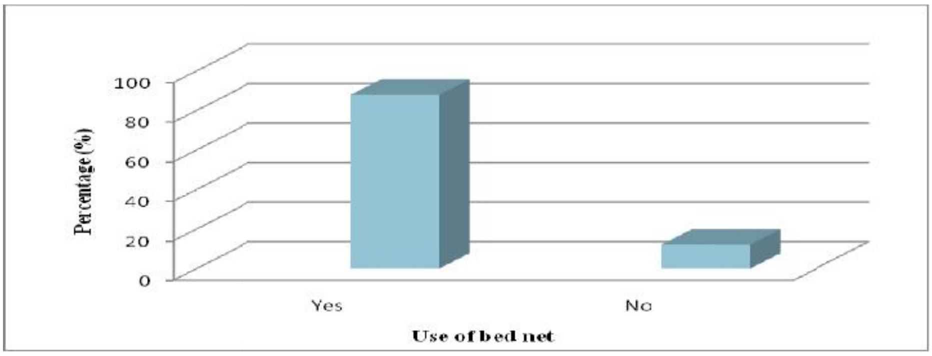


Figure -16: Use of bed net practice by the patients

The present study revealed that, 12.09 % patients' don't use bed net. Though 87.91 % patients' use bed net but they are actually protected only more or less 6 hours during night time, sothey are not safe from the mosquito during the rest of the 18 hours. They are mostly attacked during the use of latrine because in and around the latrines are more suitable area for breeding and resting of mosquitoes.

Sign and symptoms of filarisis: Sign and symptoms of filarisis of the respondents were observed. Distribution of respondents according to sign and symptoms of filariasis are as follows (Table: 12&Figure: 17-18).

Table-12: Sign and symptoms among the patients of filarisis

District		Signs and symptoms				Total
		Swelling with pain and fever	Pain with fever	Swelling with pain	Pain with irritation	
Panchgarh	Frequency	16	5	6	3	30
	%	53.3	16.7	20	10	100
Dinajpur	Frequency	11	0	9	0	20
	%	55	0	45	0	100
Thakurgaon	Frequency	31	16	3	0	50
	%	62	32	6	0	100
Pirojpur	Frequency	4	2	20	4	30
	%	13.3	6.7	66.7	13.3	100
Barisal	Frequency	9	9	6	3	27
	%	33.3	33.3	22.2	11.1	100
Jhalokathi	Frequency	6	8	12	0	26
	%	23.1	30.8	46.2	0	100
Barguna	Frequency	16	11	3	1	31
	%	51.6	35.5	9.7	3.2	100
Rangpur	Frequency	7	4	14	0	25
	%	28	16	56	0	100
Kurigram	Frequency	11	7	6	3	27
	%	40.7	25.9	22.2	11.1	100
Gaibandha	Frequency	19	10	13	1	43
	%	44.2	23.3	30.2	2.3	100
Lalmonirhat	Frequency	44	2	2	3	51
	%	86.3	3.9	3.9	5.9	100
Nilphamari	Frequency	4	3	6	18	100
	%	12.9	9.7	19.4	58.1	100
Dhaka	Frequency	3	1	11	1	16
	%	18.8	6.2	68.8	6.2	100
Chapainawabganj	Frequency	1	0	11	20	15
	%	6.7	0	73.3	20	100
Total	Frequency	141	78	122	81	422
	%	33.4	18.5	28.9	19.2	100

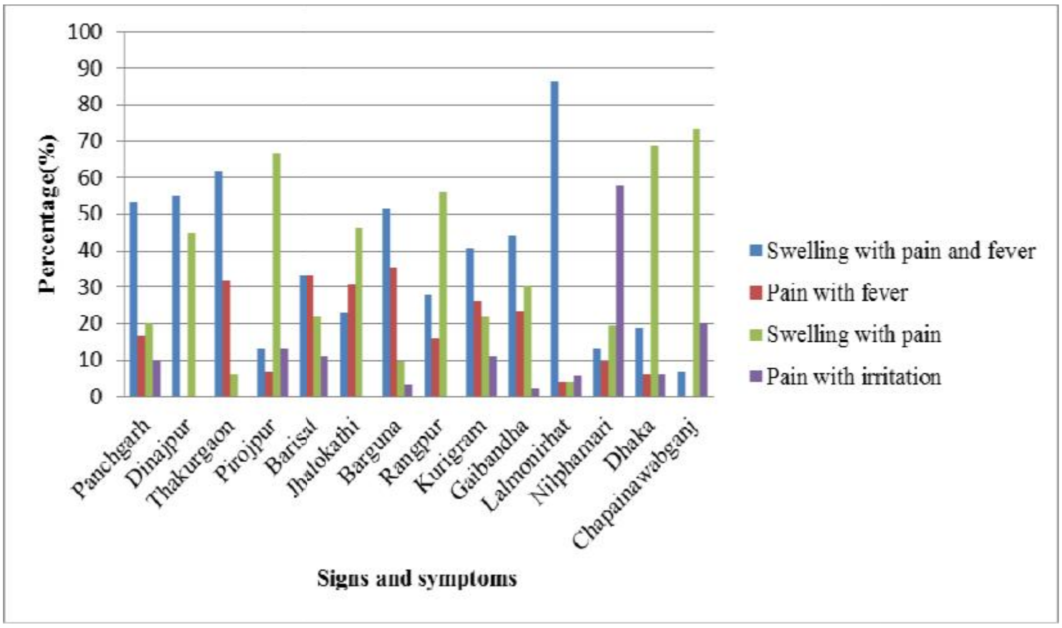


Figure-17: Sign and symptoms of filarisis among the patients

The highest percentage of patients was severely attacked by filariasis in Lalmonirhat (86.3%) followed by Thakurgaon (62%). And these two districts have highest number of patients according to this study.

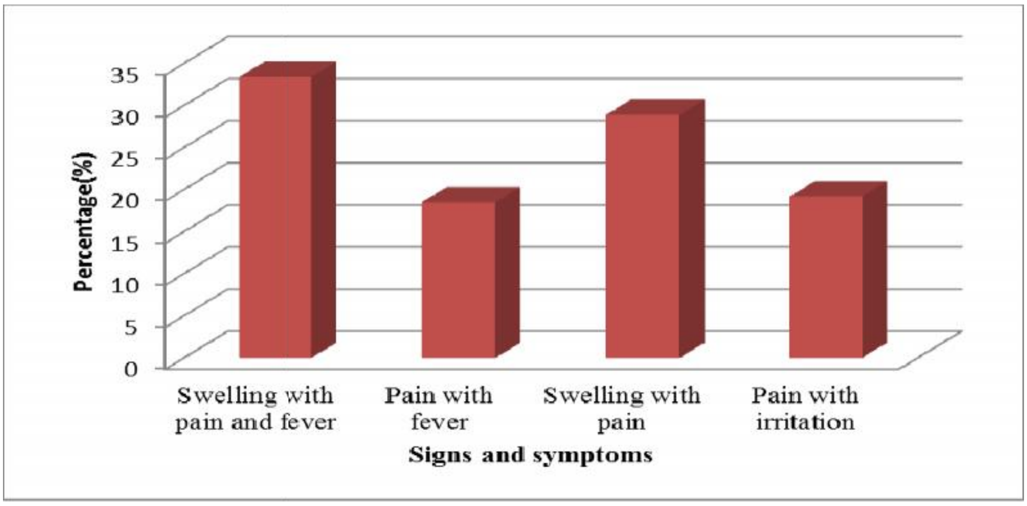


Figure-18: Sign and symptoms of filarisis among the patients

The symptom 'swelling with pain and fever' was found in most percentage (33.4%) of the patients followed by 'swelling with pain' (28.9%). The initial sign and symptom like 'pain with fever' and 'pain with irritation' were found in the less percentage of the repodents which were 18.5 % and 19.2% respectively. It is notable that the initial sign and symptom are not so visible, so that these sign and symptoms were found less.

Swelling of organs or parts of the body due tofilariasis: Swelling of organs or parts of the body due to filariasis of the respondents was observed. Distributions of respondents according to swelling organ due to filariasis are as follows (Table: 13& Figure: 19-20).

Table-13: Distributions of respondents according to swelling organ due to filariasis

District	Swelling organ								Total	
	Leg		Hand		Breast		Scrotum			
	frequency	%	frequency	%	frequency	%	frequency	%	frequency	%
Panchgarh	23	76.7	7	23.3	0	0			30	100
Dinajpur	20	100	0	0	0	0			20	100
Thakurgaon	46	92.0	4	8.0	0	0			50	100
Pirojpur	24	80.0	3	10.0	1	3.3	2	6.7	30	100
Barisal	23	85.2	2	7.4	1	3.7	1	3.7	27	100
Jhalokathi	23	88.5	2	7.7	0	0	1	3.8	26	100
Barguna	28	90.3	3	9.7	0	0			31	100
Rangpur	23	92.0	2	8.0	0	0			25	100
Kurigram	25	92.6	1	3.7	0	0	1	3.7	27	100
Gaibandha	41	95.3	2	4.7	0	0			43	100
Lalmonirhat	51	100	0	0	0	0			51	100
Nilphamari	26	83.9	5	16.1	0	0			31	100
Dhaka	16	100	0	0	0	0			16	100
Chapai nawabganj	15	100	0	0	0	0			15	100
Total	384	91	31	7.35	2	.5	5	1.18	422	100

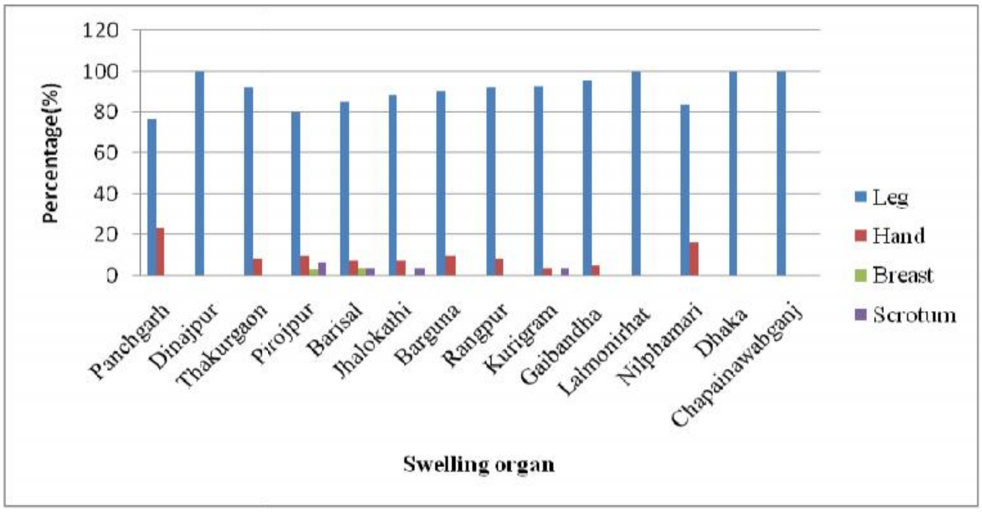


Figure -19: Percentage of respondents according to affected organs/partsdue to filariasis

Leg is the most swelling organ of the patients in every district (Table 13). Some districts have some patients with hand swelling. Breast and scrotum swelling were found less because of the patients' shame; the patients may not be splled out about their sensitive organs.

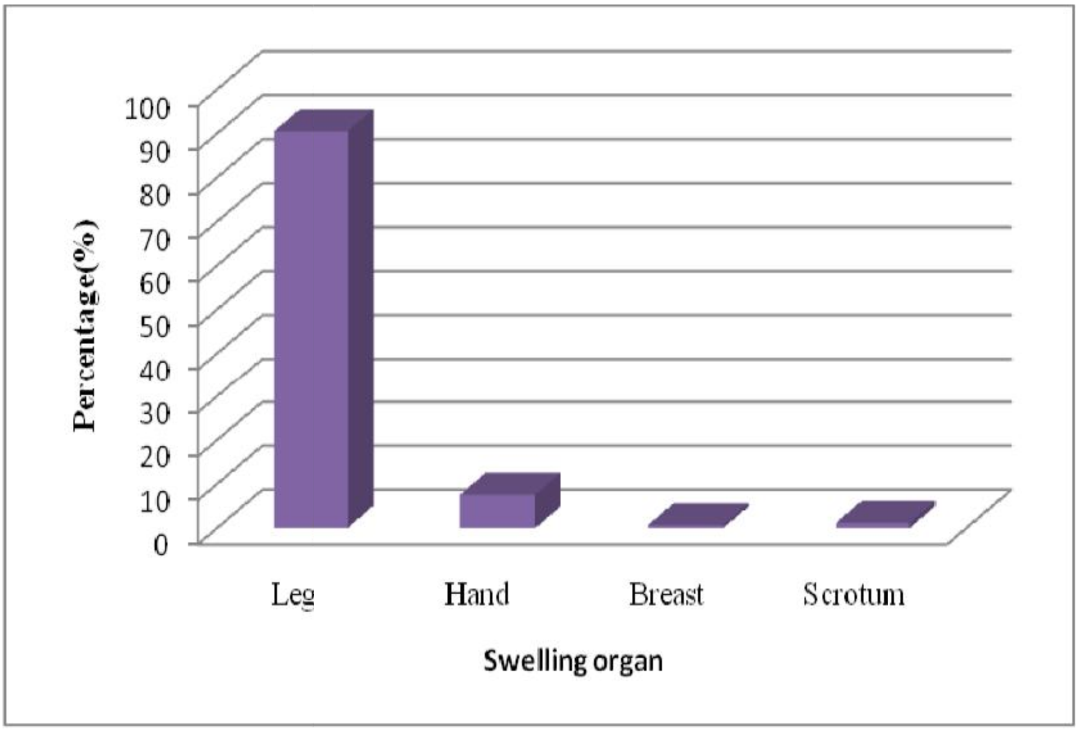


Figure-20: Overall status of the swelling of affected organs of the respondents

In the present study, 91 % patients were suffering from leg swelling followed by hand swelling (7.35%). 0.5% and 1.18% patients were suffering from breast and scrotum swelling respectively. Perhaps the patients may not be splled out about their sensitive organ because of shame (Figure- 20).

Treatment for filariasis: Distribution of respondents according to their treatment attitudes of the disease was observed (Table: 14&Figure: 21-22).

Table-14. Awareness among the patients for seeking treatment of filariasis

District	Treatment of filariasis				Total	
	Yes		No			
	frequency	%	frequency	%	frequency	%
Panchgarh	30	100	0	0	30	100
Dinajpur	20	100	0	0	20	100
Thakurgaon	50	100	0	0	50	100
Pirojpur	30	100	0	0	30	100
Barisal	27	100	0	0	27	100
Jhalokathi	26	100	0	0	26	100
Barguna	31	100	0	0	31	100
Rangpur	25	100	0	0	25	100
Kurigram	27	100	0	0	27	100
Gaibandha	43	100	0	0	43	100
Lalmonirhat	27	53	24	47	51	100
Nilphamari	25	80.6	6	19.4	31	100
Dhaka	16	100	0	0	16	100
Chapainawabganj	14	92.8	1	7.2	15	100
Total	391	92.7	31	7.3	422	100

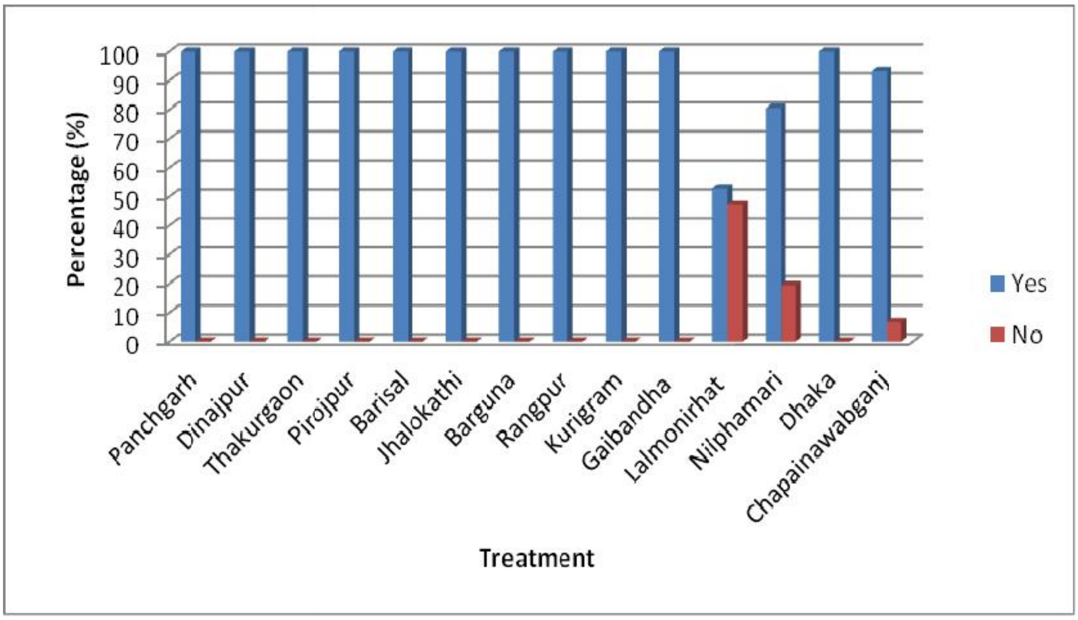


Figure -21: Awareness for seeking treatment of filariasis

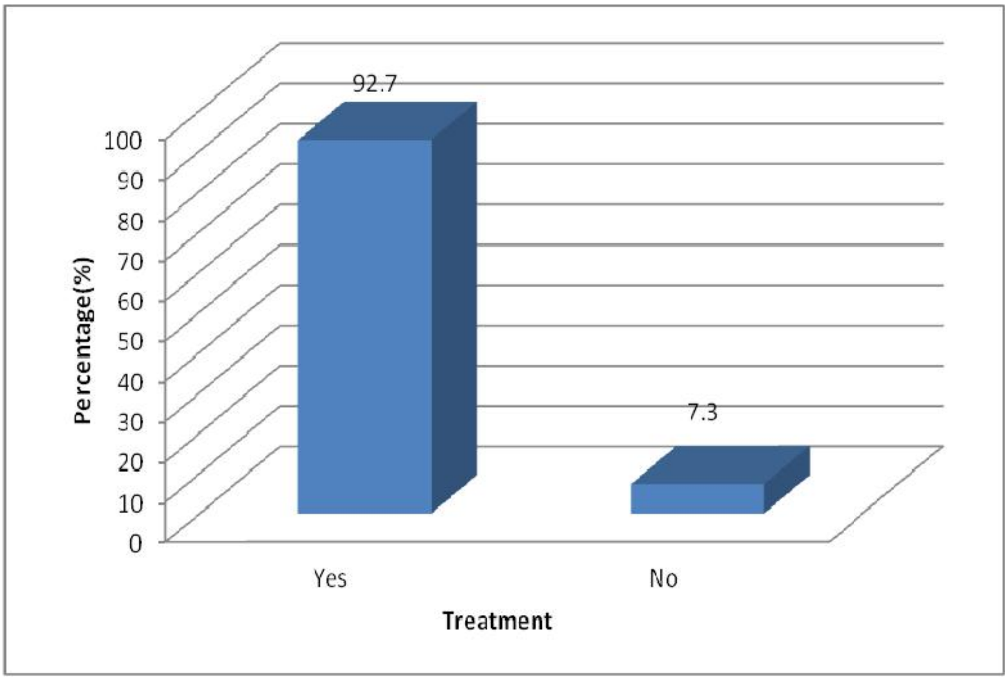


Figure –22: Percentage of patients goes for treatment of filariasis

About 7.3% patients never went for any treatment. It is due to lack of awareness. Some of the patients of three districts: Lalmonirhat, Nilphamary and Chapainawabganj never went for treatment and the frequency of the patients of those districts was also high. So there is a correlation between treatment and frequency of patients.

Place of treatment for filariasis: The knowledge, attitude and practice of treatment for filarisis were also determined through observation of giving importance by the patients for selection of place of treatment (Table: 15& Figure: 23-24).

It is notable that the highest number of patients who goes to healer was found in Lalmonirhat district and the highest frequency of patients were also found in Lalmonirhat among 20 studied districts.

Table-15: Selection of place for treatment by the patient who take treatment only

District	Place of treatment						Total	
	Healer		Doctor		Health complex			
	frequency	%	frequency	%	frequency	%	frequency	%
Panchgarh	3	10.0	9	30.0	18	60.0	30	100
Dinajpur	2	10.0	6	30.0	12	60.0	20	100
Thakurgaon	5	10.0	14	28.0	31	62.0	50	100
Pirojpur	2	6.7	10	33.3	18	60.0	30	100
Barisal	4	14.8	7	25.9	16	59.3	27	100
Jhalokathi	2	7.7	7	26.9	17	65.4	26	100
Barguna	3	9.7	10	32.3	18	58.1	31	100
Rangpur	2	8.0	7	28.0	16	64.0	25	100
Kurigram	2	7.4	9	33.3	16	59.3	27	100
Gaibandha	3	7.0	14	32.6	26	60.5	43	100
Lalmonirhat	19	70.4	5	18.5	3	11.1	51	100
Nilphamari	1	3.2	16	51.6	8	25.8	31	100
Dhaka	0	0	2	12.5	14	87.5	16	100
Chapainawabganj	0	0	1	6.7	13	86.7	15	100
Total	48	12.28	117	29.92	226	57.80	422	100

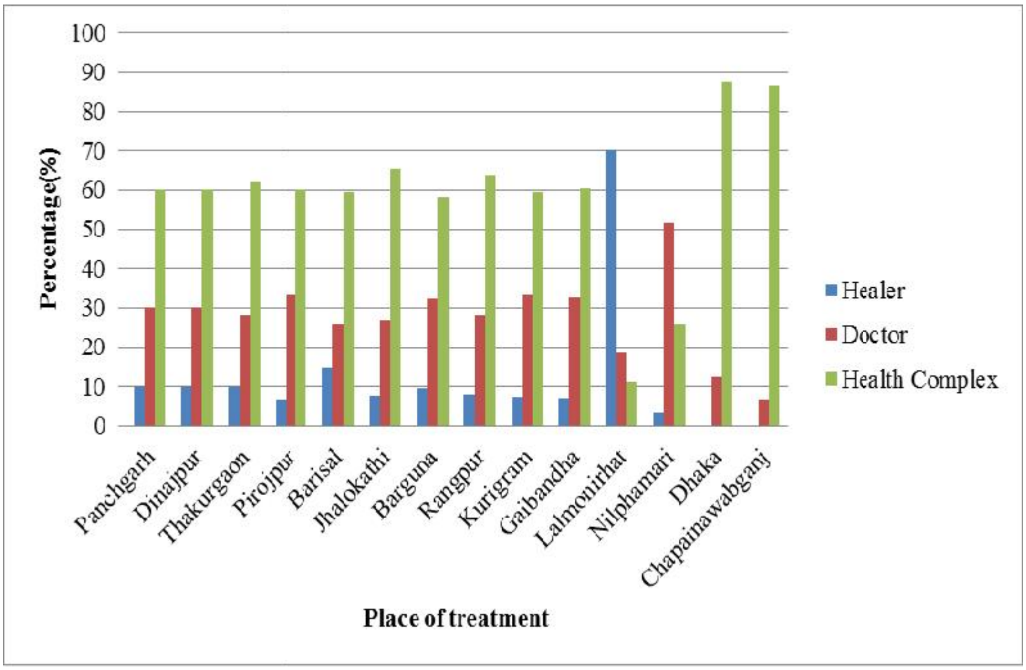


Figure -23: Place of seeking treatment for filariasis

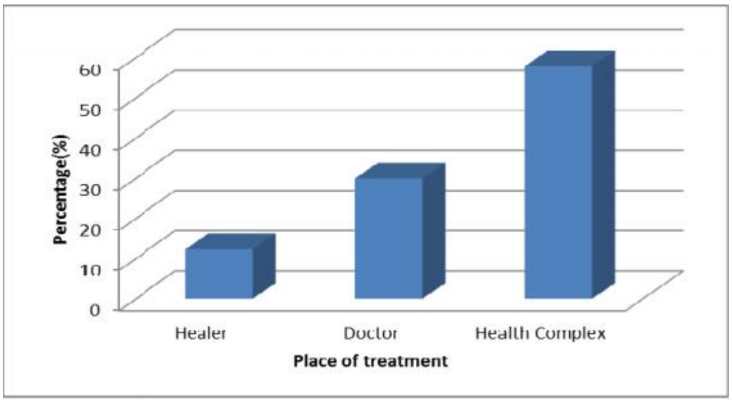


Figure-24: Seeking place for treatment offilariasis.

Though the maximum patients go to health complex followed by doctor but till now some patients (12.28%) go to healer for treatment. The knowledge, attitude and practice of patients for selection of place of treatment were not fully satisfactory. The lack of awareness persists.

Enrollment of the patients in community health complex in different districts: The knowledge and eggerness for treatment of the patients were observed through determining the distribution of respondents according to their enrollment in community health coplex (Table: 16 & Figure: 25).

Table-16:Enrollment of the patients of filarisis in community health complex

District	Enrollment in community health complex				Total	
	Yes		No			
	Frequency	%	Frequency	%	Frequency	%
Panchgarh	21	70.0	9	30.0	30	100
Dinajpur	19	95.0	1	5.0	20	100
Thakurgaon	39	78.0	11	22.0	50	100
Pirojpur	22	73.3	8	26.7	30	100
Barisal	17	63.0	10	37.0	27	100
Jhalokathi	15	57.7	11	42.3	26	100
Barguna	21	67.7	10	32.3	31	100
Rangpur	10	40.0	15	60.0	25	100
Kurigram	13	48.1	14	51.9	27	100
Gaibandha	35	81.4	8	18.6	43	100
Lalmonirhat	4	7.8	47	92.2	51	100
Nilphamari	5	16.1	26	83.9	31	100
Dhaka	0	0	16	100	16	100
Chapainawabganj	5	33.3	10	66.7	15	100
Total	227	53.8	195	46.2	422	100

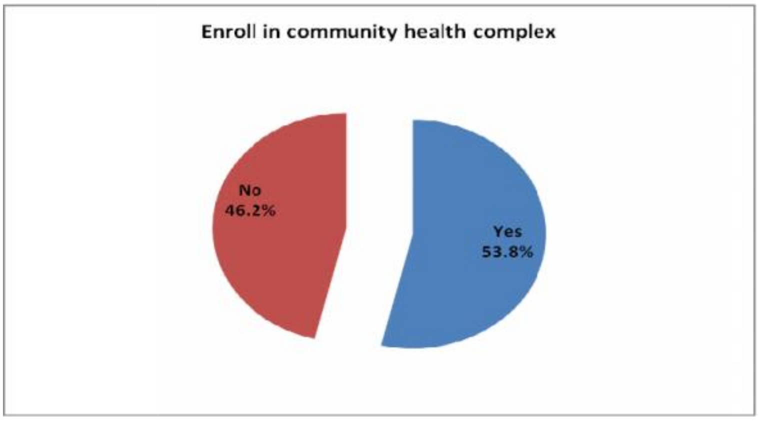


Figure -25: Enrollment of the patient in community health complex

In the present investigation, about 46.2% patients of all over the study area were not enrolled in health complex, so the disease persists and transmission of disease is continued.

Other family members having filariasis: It was observed that the transmission of the disease was not more depending on contaction between patient to other person of the family which is shown in Table: 17 & Figure: 26.

Table-17:Family members having filariasis

District	Other family members having filariasis				Total	
	Yes		No			
	Frequency	%	Frequency	%	Frequency	%
Panchgarh	2	6.7	28	93.3	30	100
Dinajpur	0	0	20	100	20	100
Thakurgaon	3	6	47	94	50	100
Pirojpur	0	0	30	100	30	100
Barisal	2	7.4	25	92.6	27	100
Jhalokathi	1	3.8	25	96.2	26	100
Barguna	2	6.5	29	93.5	31	100
Rangpur	0	0	25	100	25	100
Kurigram	2	7.4	25	92.6	27	100
Gaibandha	2	4.7	41	95.3	43	100
Lalmonirhat	3	5.9	48	94.1	51	100
Nilphamari	0	0	31	100	31	100
Dhaka	0	0	16	100	16	100
Chapainawabganj	4	26.7	11	73.3	15	100
Total	21	5	401	95	422	100

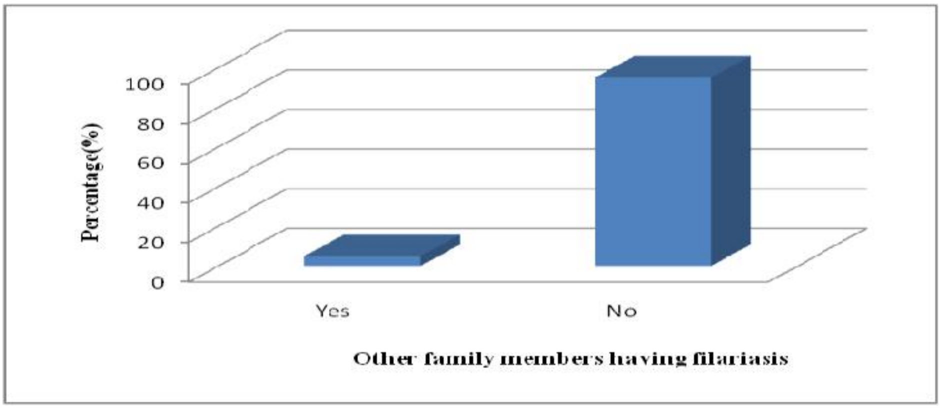


Figure -26: Patients' family members affected in filariasis

About 95% of the family members were not affected by filariasis. So the causes of transmission arenot more dependingon contaction between patients to other person of the family but it is depending on many factors like-availability and condition of warm, its vector: mosquito and the human being.

Knowledge about filariasis: Distribution of respondents according to knowledge about filariasis was determined as shown in following table and figure (Table: 18 & Figure: 27.).

Table-18: Inhabitants knowledge about filariasis

District	Knowledge on filariasis				Total	
	Yes		No			
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Panchgarh	7	23.3	23	76.7	30	100
Dinajpur	6	30	14	70	20	100
Thakurgaon	16	32	34	68	50	100
Pirojpur	8	26.7	22	73.3	30	100
Barisal	8	29.6	19	70.4	27	100
Jhalokathi	8	30.8	18	69.2	26	100
Barguna	9	29	22	71	31	100
Rangpur	9	36	16	94	25	100
Kurigram	7	25.9	20	74.1	27	100
Gaibandha	19	44.2	24	55.8	43	100
Lalmonirhat	15	29.4	36	70.6	51	100
Nilphamari	8	25.8	23	74.2	31	100
Dhaka	0	0	16	100	16	100
Chapainawabganj	2	13.3	13	86.7	15	100
Total	123	29.1	299	70.9	422	100

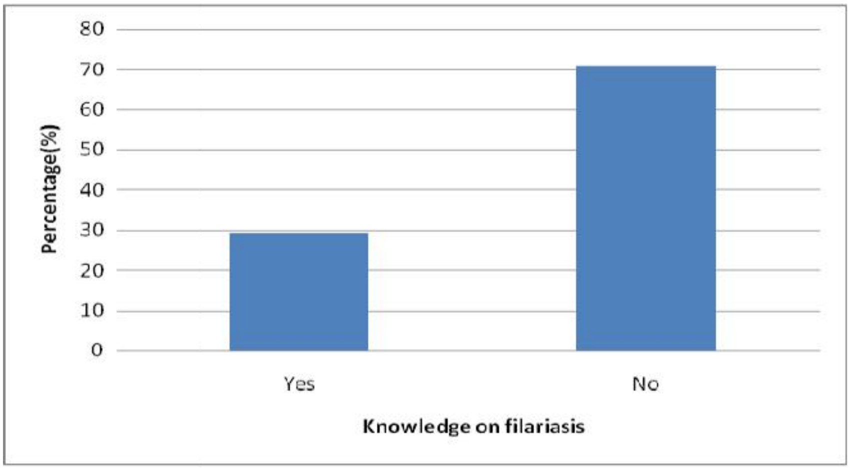


Figure-27: Knowledge about filariasis which may cause transmission of filariasis

70.9% patients of all over the study area have no knowledge about filariasis which may cause of transmission of the disease. So the transmission of this disease is also depended on people's knowledge on filariasis.

Household expenditures of patients: Poverty is one of the most important factors of spread out of the disease. The patients were divided into five categories based on monthly expenditure for determining the importance of solvency to prevent or cure from the disease as the following tables and figures (Table: 19 and Figure: 28&29).

Mostly, patients populated district was Lalmonirhat where only 35.3% household expenditure was above 4000/- taka per month and 11.8% household expenditure was below 1000/- taka per month whereas in Dhaka district's patients monthly household expenditure was ranging from 2000/- taka to above 4000/- taka and 81.2% household expenditure was above 4000/- taka per month where patients distribution was low. So filariasis is depending on solvency of the household that means this disease is a poor people disease.

Table-19: Patients' distribution based on their monthly expenditures

	Monthly expenditure						Total
		<1000	1000-2000	2000-3000	3000-4000	>4000	
Panchgarh	Frequency	0	8	15	4	3	30
	%	0	26.7	50.0	13.3	10	100
Dinajpur	Frequency	0	1	12	6	1	20
	%	0	5	60	30	5	100
Thakurgaon	Frequency	0	11	22	10	7	50
	%	0	22	44	20	14	100
Pirojpur	Frequency	0	0	4	20	6	30
	%	0	0	13.3	66.7	20	100
Barisal	Frequency	0	0	6	20	1	27
	%	0	0	22.2	74.1	3.7	100
Jhalokathi	Frequency	0	0	3	16	7	26
	%	0	0	11.5	61.5	26.9	100
Barguna	Frequency	0	0	5	24	2	31
	%	0	0	16.1	77.4	6.5	100
Rangpur	Frequency	0	2	3	17	3	25
	%	0	8	12	68	12	100
Kurigram	Frequency	0	0	7	15	5	27
	%	0	0	25.9	55.6	18.5	100
Gaibandha	Frequency	0	3	20	15	5	43
	%	0	7	46.5	34.9	11.6	100
Lalmonirhat	Frequency	6	4	7	16	18	51
	%	11.8	7.8	13.7	31.4	35.3	100
Nilphamari	Frequency	5	1	3	8	14	31
	%	16.1	3.2	9.7	25.8	45.2	100
Dhaka	Frequency	0	0	1	2	13	16
	%	0	0	6.2	12.5	81.2	100
Chapainawabganj	Frequency	0	0	1	4	10	15
	%	0	0	6.7	26.7	66.7	100
Total	Frequency	11	30	109	177	95	422
	%	2.6	7.1	25.8	41.9	22.5	100

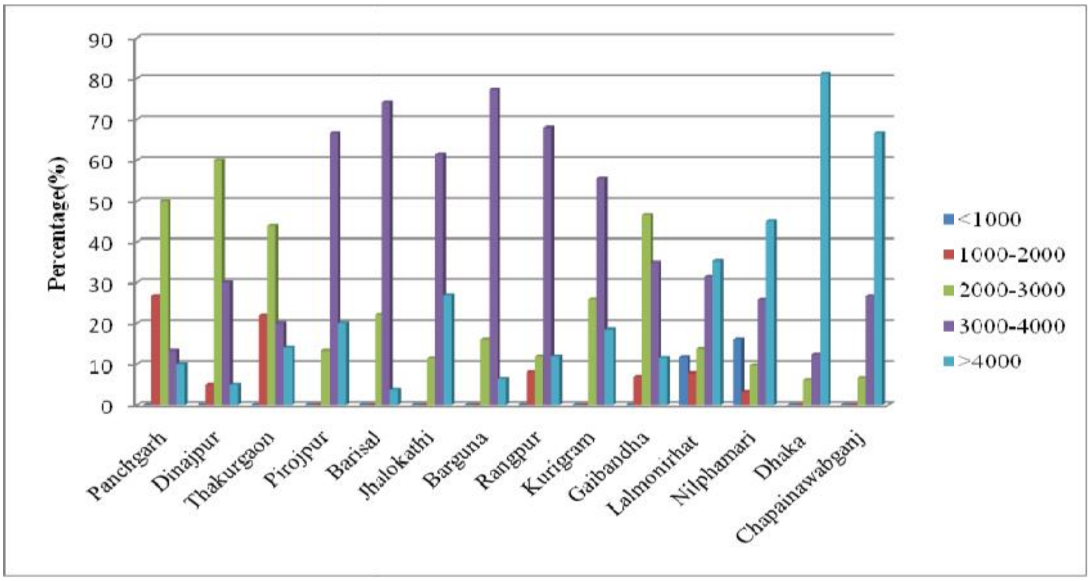


Figure -28: Household expenditure of patients in different district

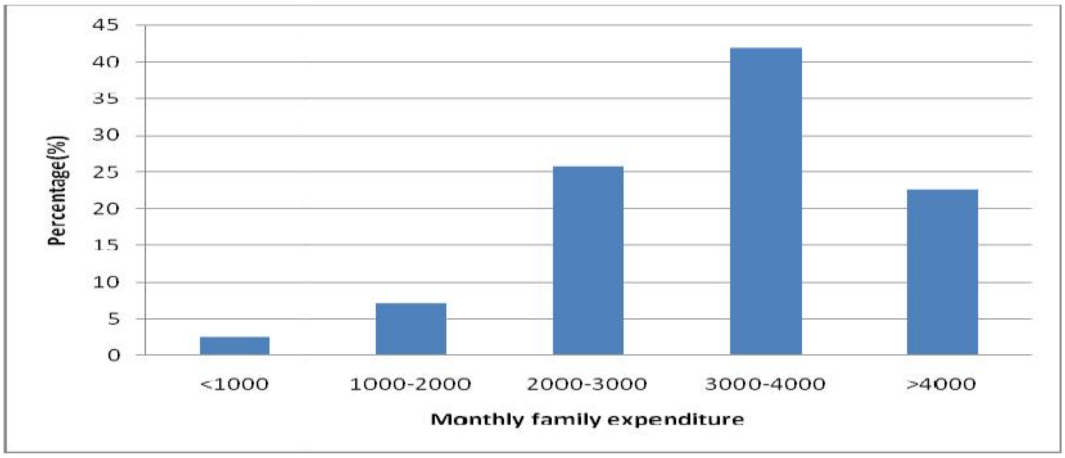


Figure-29: The household expenditure of the filarial patient's family

Maximum patients (41.9%) had capacity to expend only 3 to 4 thousand taka per month only. 2.6% household expenditure was below 1000/-taka per month. Some patients had no capacity to expend even up to 1000/- only. So, it was observed that the filariasis is a poor people disease.

Frequency of mosquito breeding grounds in different studied districts

In this study available breeding grounds were ditch, abandoned pond and Pit surrounding the tube well, which frequency in different districts is shown in table-20 and Figure-30. About 83% to 93.5% patients' household are surrounded by different types of breeding grounds in Nilphamari, Pirojpur, Barisal and Lalmonirhat and these area also have higher frequency of patients among the study districts. One third of the total patients are found in those districts. 62.3% patients' household is surrounded by different types of breeding grounds.

Table-20: Frequency of breeding grounds in different districts

District	Frequency of breeding grounds				Total (%)	
	Yes		No			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Panchgarh	16	53.3	14	46.7	30	100
Dinajpur	6	30	14	70	20	100
Thakurgaon	27	54	23	46	50	100
Pirojpur	25	83.3	5	16.7	30	100
Barisal	23	85.2	4	14.8	27	100
Jhalokathi	18	69.2	8	30.8	26	100
Barguna	17	54.8	14	45.2	31	100
Rangpur	13	52	12	48	25	100
Kurigram	10	37	17	63	27	100
Gaibandha	25	58.1	18	41.9	43	100
Lalmonirhat	46	90.2	5	9.8	51	100
Nilphamari	29	93.5	2	6.5	31	100
Dhaka	0	0	16	100	16	100
Chapainawabganj	8	53.3	7	46.7	15	100
Total	263	62.3	159	37.7	422	100

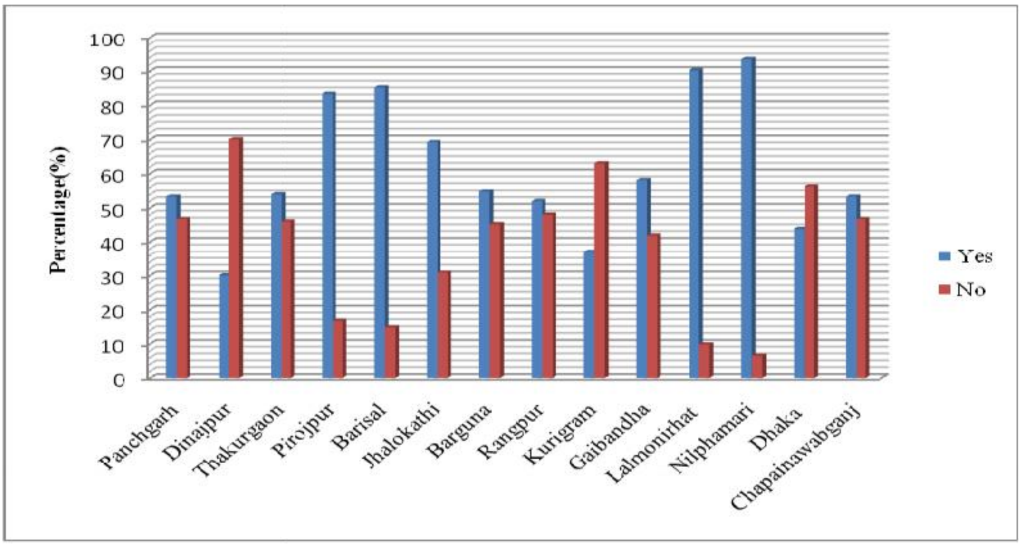


Figure-30: Percentage of mosquito Breeding Grounds in different districs

Comparison between south and north zone in some aspects

The two extreme poor prone areas of Bangladesh are south and north zones and on the other hand,filariasis is a poor people disease, so that it was tried to observe some aspects on filariasis in comparison between two extreme poor prone areas of the country through this study.

Comparison between South and North Zone in case of male-female patients: It was observed that the female of north zone was engaged more time in household works surrounding most effective breeding grounds of mosquito (i.e. tubewell side) than that of south zone, so femaleswere more affected than male in north zone(Table:21-22 and Figure: 31-32).

Table-21:Sex of the respondent patients in south zone

Name of Districts	Sex of the respondent patients in south zone				Total	
	Male		Female			
	Frequency	%	Frequency	%	Frequency	%
Pirojpur	20	66.7	10	33.3	30	100
Barisal	18	66.7	9	33.3	27	100
Jhalokathi	17	65.4	9	34.6	26	100
Barguna	20	64.5	11	35.5	31	100
Dhaka	10	62.5	6	37.5	16	100
Total	85	65.4	45	34.6	130	100

Table-22: Sex of the respondent patients in north zone

Name of Districts	Sex of the respondents patients in north zone				Total	
	Male		Female			
	Frequency	%	Frequency	%	Frequency	%
Panchgarh	13	43.3	17	56.7	30	100
Dinajpur	6	30.0	14	70.0	20	100
Thakurgaon	14	28.0	36	72.0	50	100
Rangpur	17	68.0	8	32.0	25	100
Kurigram	6	22.2	21	77.8	27	100
Gaibandha	19	44.2	24	55.8	43	100
Lalmonirhat	14	27.5	37	72.5	51	100
Nilphamari	17	54.8	14	45.2	31	100
Chapainawabganj	5	33.3	10	66.7	15	100
Total	111	38	181	62	292	100

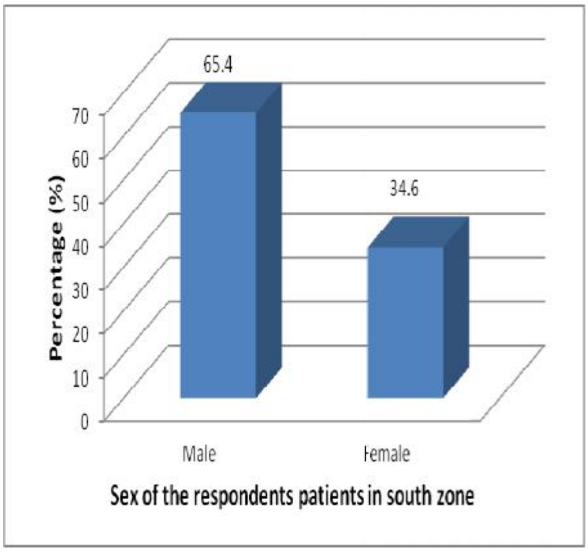


Figure -31: Sex of the respondent patients in south zone

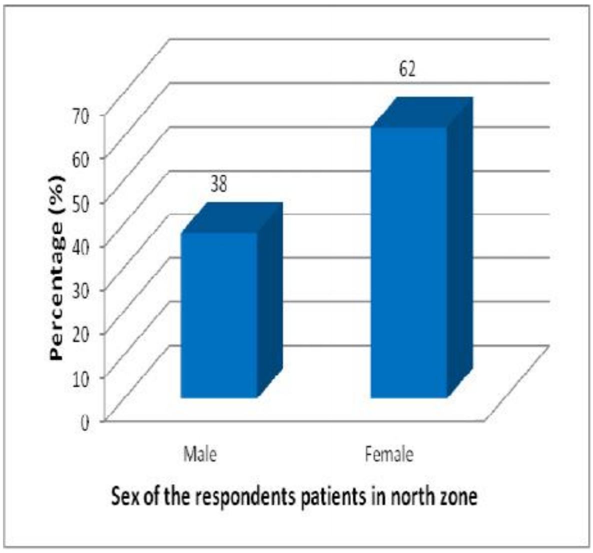


Figure -32: Sex of the respondent patientsin north zone

Comparison between South and North Zone regarding educational status: Higher educated patients are more in south zone than that of north zone. Simultaneously frequency of patients is lower in south zone than that of north zone. So it can be said that, filariasisis almost illiterate-people's disease. In both zones the affected people are mostly illiterate that was 56%-61.6% (Table: 23-24 and Figure: 33-34).

Table-23:Educational status of the patients of South Zone

District		Educational status of South Zone				Total
		Illiterate	Can sign only	Primary	Above	
Pirojpur	Frequency	19	7	3	1	30
	%	63.3	23.3	10.0	3.3	100
Barisal	Frequency	21	3	3	0	27
	%	77.8	11.1	11.1	0	100
Jhalokathi	Frequency	16	2	6	2	26
	%	61.5	7.7	23.1	7.7	100
Barguna	Frequency	19	6	6	0	31
	%	61.3	19.4	19.4	0	100
Dhaka	Frequency	0	0	2	14	16
	%	0	0	12.5	87.5	100
Total	Frequency	74	18	21	17	130
	%	56.9	13.8	16.2	13.1	100

Table-24:Educational status of patients in North Zone

District		Educational status in North Zone				Total
		Illiterate	Can sign only	Primary	Above	
Panchgarh	Frequency	21	6	3	0	30
	%	70.0	20.0	10.0	0	100
Dinajpur	Frequency	12	3	5	0	20
	%	60.0	15.0	25.0	0	100
Thakurgaon	Frequency	23	24	2	1	50
	%	46.0	48.0	4.0	2.0	100
Rangpur	Frequency	17	5	3	0	25
	%	68.0	20.0	12.0	0	100
Kurigram	Frequency	21	2	4	0	27
	%	77.8	7.4	14.8	0	100
Gaibandha	Frequency	25	12	6	0	43
	%	58.1	27.9	14.0	0	100
Lalmonirhat	Frequency	35	7	9	0	51
	%	68.6	13.7	17.6	0	100
Nilphamari	Frequency	24	3	4	0	31
	%	77.4	9.7	12.9	0	100
Chapai Nawabganj	Frequency	2	6	7	0	15
	%	13.3	40	46.7	0	100
Total	Frequency	180	68	39	5	292
	%	61.6	23.3	13.4	1.7	100

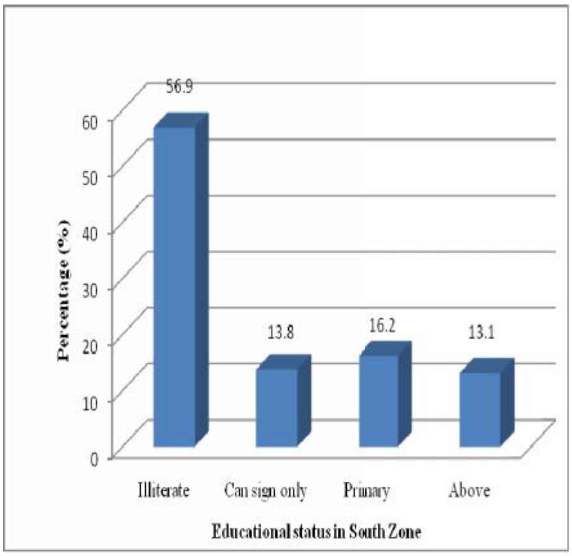


Figure -33: Educational status in south zone

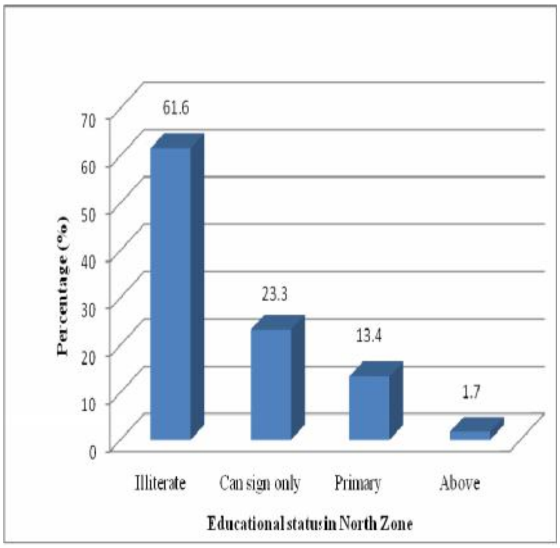


Figure -34: Educational status in north zone

Comparison between south and north zone regarding preventive/control measures taken by the patients' households: Preventive/control measures like use of bed net, aerosol, mosquito-coil and maintaining hygienic living (i.,e., neat and clean households without stagnant water surrounding the households) were also observed during this study. The following tables (Table-25&26) and figures (Figure-35 & 36) shows the results.

Table-25.Preventive/control measures taken by the patients' households of South Zone

District	Preventive/control measures in South Zone				Total	
	Yes		No			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Pirojpur	28	93.3	2	6.7	30	100
Barisal	25	92.6	2	7.4	27	100
Jhalokathi	24	92.3	2	7.7	26	100
Barguna	29	93.5	2	6.5	31	100
Dhaka	16	100	0	0	16	100
Total	122	93.8	8	6.2	130	100

Table-26: Preventive/control measures taken by the patients' households in North Zone

District	Preventive/control measures in North Zone				Total	
	Yes		No			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Panchgarh	27	90.0	3	10.0	30	100
Dinajpur	20	100.0	0	0	20	100
Thakurgaon	46	92.0	4	8.0	50	100
Rangpur	23	92.0	8	8.0	25	100
Kurigram	27	100.0	0	0	27	100
Gaibandha	41	95.3	2	4.7	43	100
Lalmonirhat	2	3.9	49	96.1	51	100
Nilphamari	28	90.3	3	9.7	31	100
Chapainawabganj	7	46.7	8	53.3	15	100
Total	221	75.7	71	24.3	292	100

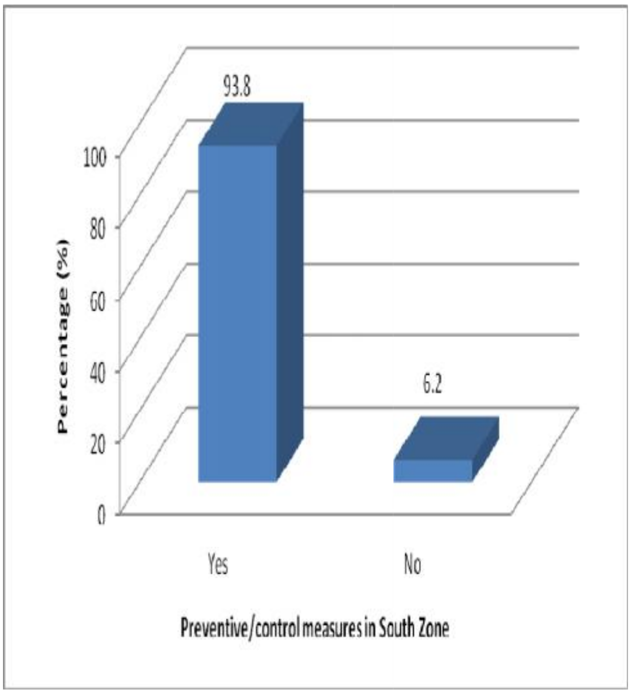


Fig -35: Preventive/control measures taken bythe patients' households of South Zone

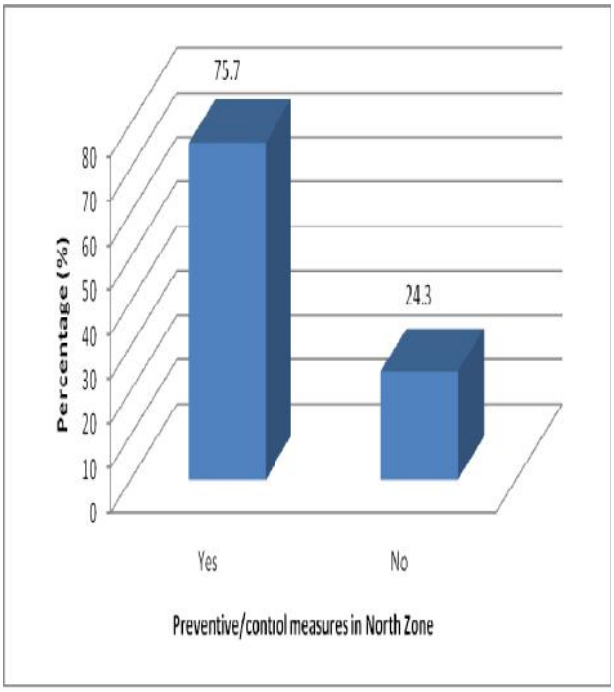


Fig -36: Preventive/control measures taken by the patients' households of North Zone

The rate of preventive measures taken by the patients is higher in south area than that of north area and the frequency of patients is lower in south area than that of north area. So the spread of disease is also depended on the preventive measures taken by the patients.

Comparison between South and North Zone regarding sign and symptoms of filarisis:

Most severly attacked patients are found in north area than that of south area. The rate of starting symptom of the disease was also found higher in north area than that of south area (Table-27 and Figure-37).

Table-27: Distribution of signs and symptoms of filariasis in south and north zone

District		Signs and symptoms				Total
		Swelling with pain and fever	Pain with fever	Swelling with pain	Pain with irritation	
South Zone						
Pirojpur	Frequency	4	2	20	4	30
	%	13.3	6.7	66.7	13.3	100
Barisal	Frequency	9	9	6	3	27
	%	33.3	33.3	22.2	11.1	100
Jhalokathi	Frequency	6	8	12	0	26
	%	23.1	30.8	46.2	0	100
Barguna	Frequency	16	11	3	1	31
	%	51.6	35.5	9.7	3.2	100
Dhaka	Frequency	3	1	11	1	16
	%	18.8	6.2	68.8	6.2	100
Total	Frequency	38	31	52	9	130
	%	29.23	23.84	40	6.92	100
North Zone						
Rangpur	Frequency	7	4	14	0	25
	%	28	16	56	0	100
Kurigram	Frequency	11	7	6	3	27
	%	40.7	25.9	22.2	11.1	100
Gaibandha	Frequency	19	10	13	1	43
	%	44.2	23.3	30.2	2.3	100
Lalmonirhat	Frequency	3	2	2	44	51
	%	7.84	3.9	3.9	84.3	100
Nilphamari	Frequency	4	3	6	18	31
	%	12.9	9.7	19.4	58.1	100
Panchgarh	Frequency	16	5	6	3	30
	%	53.3	16.7	20	10	100
Dinajpur	Frequency	11	0	9	0	20
	%	55	0	45	0	100
Thakurgaon	Frequency	31	16	3	0	50
	%	62	32	6	0	100
Chapainawabganj	Frequency	1	0	11	3	15
	%	6.7	0	73.3	20	100
Total	Frequency	103	47	70	72	292
	%	35.3	16.1	24	24.7	100
Grand Total	Frequency	141	78	122	81	422
	%	33.4	18.5	28.9	19.2	100

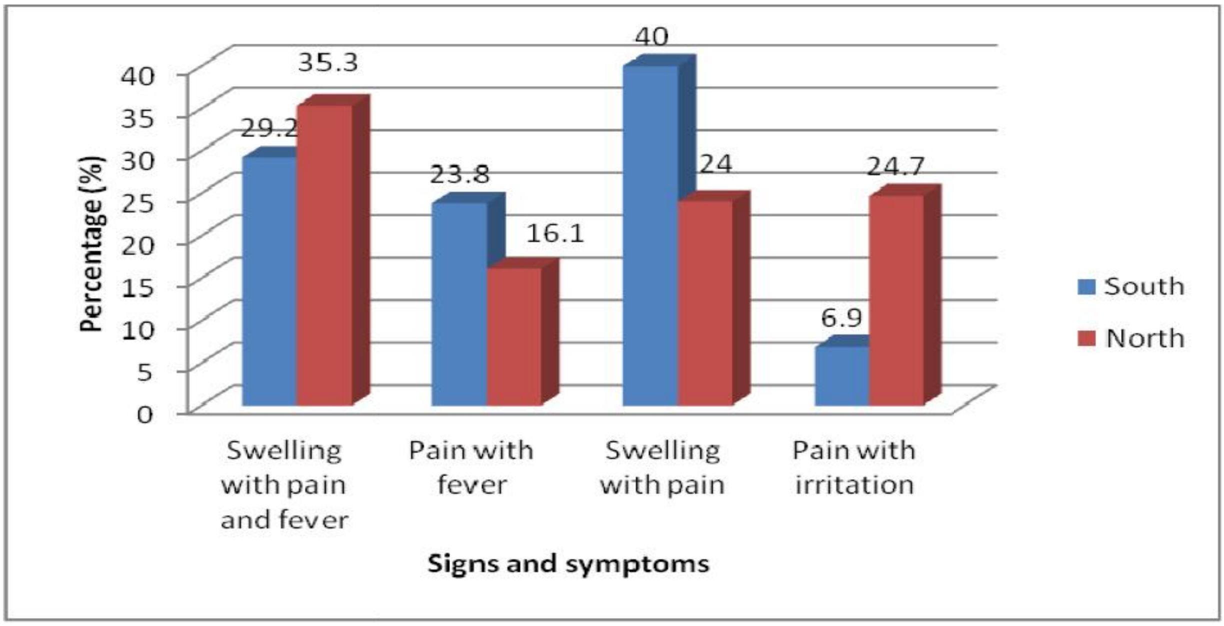


Figure-37: Distribution of signs and symptoms of filariasis in south and north zones

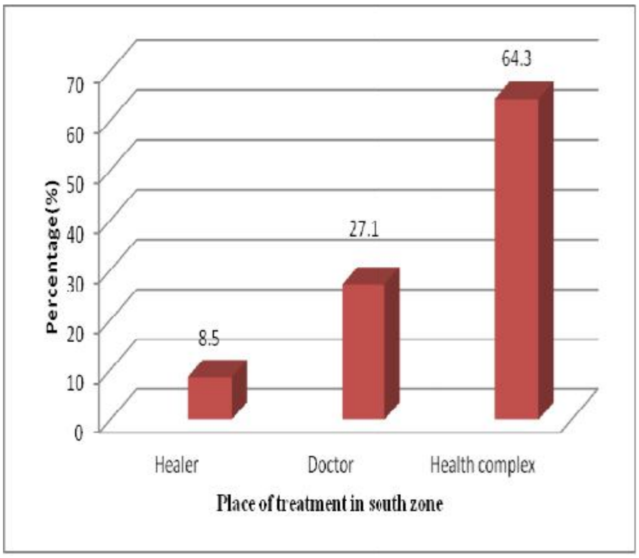
Comparison between south and north zone regarding place of treatment of filariasis: The few patients have gone to healer but most of the patients have gone to health complex for treatment. But it is notable that the rate of going to health complex was higher in south zone than that of north zone. So the frequency of patients was lower in south than that of north zone (Table: 28-29 and Figure: 38-39).

Table-28: Distribution of place of treatment of filariasis in South Zone

District	Place of treatment						Total	
	Healer		Doctor		Health complex			
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Pirojpur	2	6.7	10	33.3	18	60.0	30	100
Barisal	4	14.8	7	25.9	16	59.3	27	100
Jhalokathi	2	7.7	7	26.9	17	65.4	26	100
Barguna	3	9.7	10	32.3	18	58.1	31	100
Dhaka	0	0	2	12.5	14	87.5	16	100
Total	11	8.5	36	27.7	83	63.84	130	100

Table-29: Distribution of place of treatment of filariasis in North Zone

District	Place of treatment						Total	
	Healer		Doctor		Health complex			
	Frequency	%	Frequency	%	Frequency	%	Frequency	Percentage (%)
Panchgarh	3	10.0	9	30.0	18	60.0	30	100
Dinajpur	2	10.0	6	30.0	12	60.0	20	100
Thakurgaon	5	10.0	14	28.0	31	62.0	50	100
Rangpur	2	8.0	7	28.0	16	64.0	25	100
Kurigram	2	7.4	9	33.3	16	59.3	27	100
Gaibandha	3	7.0	14	32.6	26	60.5	43	100
Lalmonirhat	23	70.4	15	18.5	13	11.1	51	100
Nilphamari	1	3.2	16	51.6	14	25.8	31	100
Chapai nawabganj	1	6.7	0	6.7	14	86.7	15	100
Total	42	14.3	90	31.82	160	54.8	292	100



Figgure-38: **Distribution of place of treatment of filariasis in South Zone**

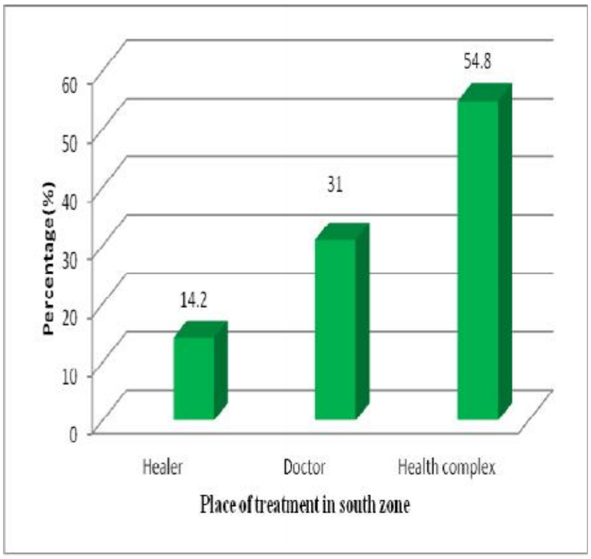


Figure-39: Distribution of place of treatmentof filariasis in North Zone

Comparison between south and north zone regarding enrollment of the patients in the community health complex: The rate of enrollment of patients in the health complex was higher in south area than that of north area and the frequency of patients was lower in south area than that of north area. So the spread of disease is depending on the enrollment in the health complex (Table: 30-31 and Figure:40-41).

Table-30.Enrollment of the patients in the community health complex in South Zone

District	Enroll in community health complex in South Zone				Total	
	Yes		No			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Pirojpur	22	73.3	8	26.7	30	100
Barisal	17	63.0	10	37.0	27	100
Jhalokathi	15	57.7	11	42.3	26	100
Barguna	21	67.7	10	32.3	31	100
Dhaka	0	0	16	100	16	100
Total	75	57.7	55	42.3	130	100

Table-31.Enrollment of the patients in the community health complex in North Zone

District	Enroll in community health complex in North Zone				Total	
	Yes		No			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Panchgarh	21	70.0	9	30.0	30	100
Dinajpur	19	95.0	1	5.0	20	100
Thakurgaon	39	78.0	11	22.0	50	100
Rangpur	10	40.0	15	60.0	25	100
Kurigram	13	48.1	14	51.9	27	100
Gaibandha	35	81.4	8	18.6	43	100
Lalmonirhat	4	7.8	47	92.2	51	100
Nilphamari	5	16.1	26	83.9	31	100
Chapainawabganj	5	33.3	10	66.7	15	100
Total	152	52.1	140	47.9	292	100

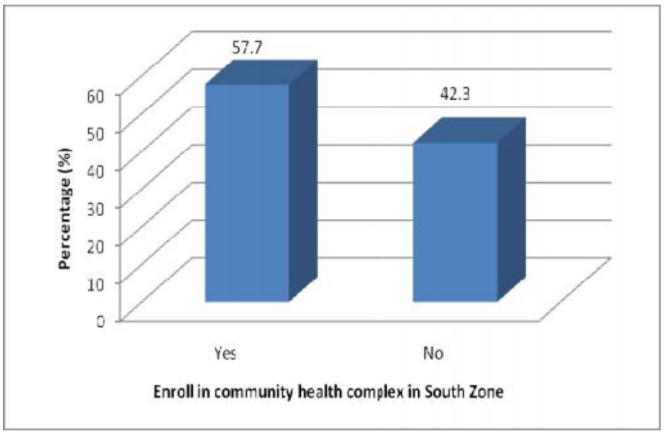


Figure-40: Enrollment of the patients in the community health complex in South Zone

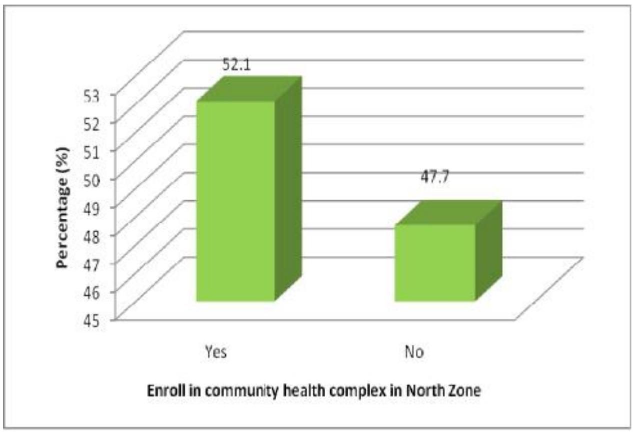


Figure-41: Enrollment of the patients in the community health complex in North Zone

Comparison between south and north zone regarding economic conditions of the patients' households: The household expenditure of south zone is higher (77.7% household's expenditure is 2000/--4000/- per month) than that of north zone (63.3%

household’s expenditure is 2000/--4000/- per month). Simultaneously frequency of patients was lower in south zone than that of north zone. So it can be said that this disease is almost poor people disease. In both zones the affected people are mostly poor (maximum patients’ household expenditure is from taka 2000/- to taka 4000/- per month),(Table: 32-33 and Figure:42-43).

Table-32: Monthly expenditure in south zone

District		Monthly expenditure in South Zone					Total
		<1000	1000-2000	2000-3000	3000-4000	>4000	
Pirojpur	Frequency	0	0	4	20	6	30
	%	0	0	13.3	66.7	20	100
Barisal	Frequency	0	0	6	20	1	27
	%	0	0	22.2	74.1	3.7	100
Jhalokathi	Frequency	0	0	3	16	7	26
	%	0	0	11.5	61.5	26.9	100
Dhaka	Frequency	0	0	1	2	13	16
	%	0	0	6.2	12.5	81.2	100
Total	Frequency	0	0	19	82	29	130
	%	0	0	14.6	63.1	22.3	100

Table-33: Monthly expenditure of patient’s household in north zone

District		Monthly expenditure in North Zone					Total
		<1000	1000-2000	2000-3000	3000-4000	>4000	
Panchgarh	Frequency	0	8	15	4	3	30
	%	0	26.7	50.0	13.3	10	100
Dinajpur	Frequency	0	1	12	6	1	20
	%	0	5	60	30	5	100
Thakurgaon	Frequency	0	11	22	10	7	50
	%	0	22	44	20	14	100
Rangpur	Frequency	0	2	3	17	3	25
	%	0	8	12	68	12	100
Kurigram	Frequency	0	0	7	15	5	27
	%	0	0	25.9	55.6	18.5	100
Gaibandha	Frequency	0	3	20	15	5	43
	%	0	7	46.5	34.9	11.6	100
Lalmonirhat	Frequency	6	4	7	16	18	51
	%	11.8	7.8	13.7	31.4	35.3	100
Nilphamari	Frequency	5	1	3	8	14	31
	%	16.1	3.2	9.7	25.8	45.2	100
Chapai nawabganj	Frequency	0	0	1	4	10	15
	%	0	0	6.7	26.7	66.7	100
Total	Frequency	11	30	90	95	66	292
	%	3.8	10.3	30.8	32.5	22.6	100

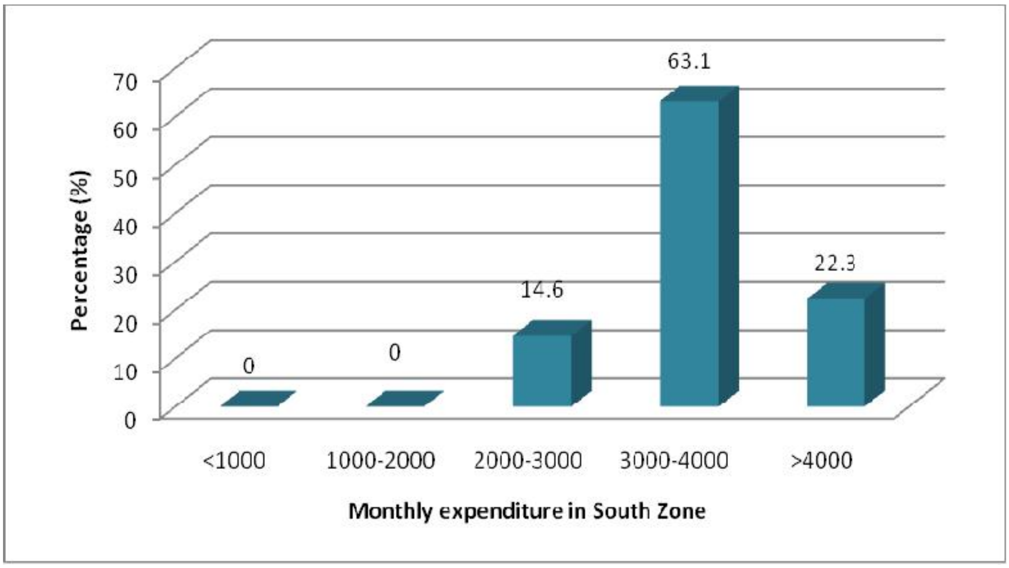


Figure-42: Monthly expenditure of the patient in districts of south zone

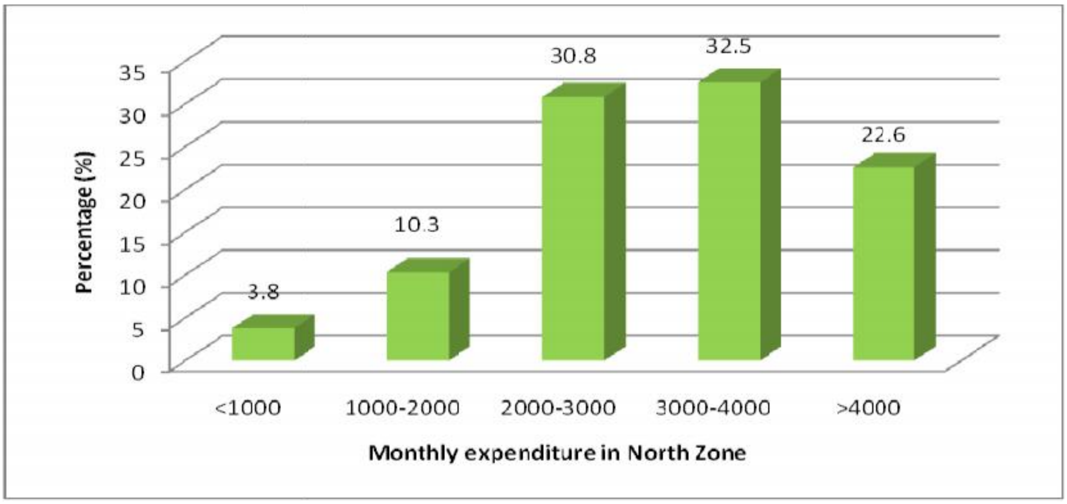


Figure-43: Monthly expenditure of the patients indistricsof north zone

Comparison between south and north zone regarding frequency of mosquito breeding grounds surrounding the patients' households: More numbers of breeding grounds(like-Ditch and abandoned ponds mainly) are located in south zone than that of north zone (only pit surrounding the tubewell in north zone which is more effective breeding grounds). So, moreeffective breeding grounds of *Culex* spp. were located in north zone. So north zone is more affected by filarisis than that of south zone (Table: 34-35 and Figure: 44-45).

Table-34: Frequency of Mosquito Breeding Grounds around the patient's house in South Zone

District	Mosquito Breeding Grounds in South Zone				Total	
	Yes		No			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Pirojpur	25	83.3	5	16.7	30	100
Barisal	23	85.2	4	14.8	27	100
Jhalokathi	18	69.2	18	30.8	26	100
Barguna	17	54.8	14	45.2	31	100
Dhaka	7	43.8	9	56.2	16	100
Total	90	69.2	40	30.8	130	100

Table-35: Frequency of Mosquito Breeding Grounds around the patient'shouse in North Zone

District	Mosquito Breeding Grounds (Drain/ditch/water logging/bush)in North Zone				Total	
	Yes		No			
	Frequency	%	Frequency	%	Frequency	%
Panchgarh	16	53.3	14	46.7	30	100
Dinajpur	6	30	14	70	20	100
Thakurgaon	27	54	23	46	50	100
Rangpur	13	52	12	48	**25**	**100**
Kurigram	10	37	17	63	27	100
Gaibandha	25	58.1	18	41.9	43	100
Lalmonirhat	46	90.2	5	9.8	51	100
Nilphamari	29	93.5	2	6.5	31	100
Chapainawabganj	8	53.3	7	46.7	15	100
Total	180	61.6	112	68.4	292	100

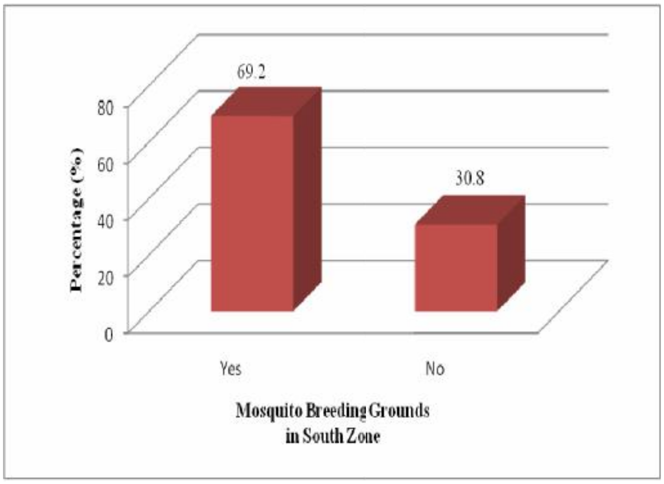


Figure-44: Mosquito Breeding Grounds in Sorth Zone

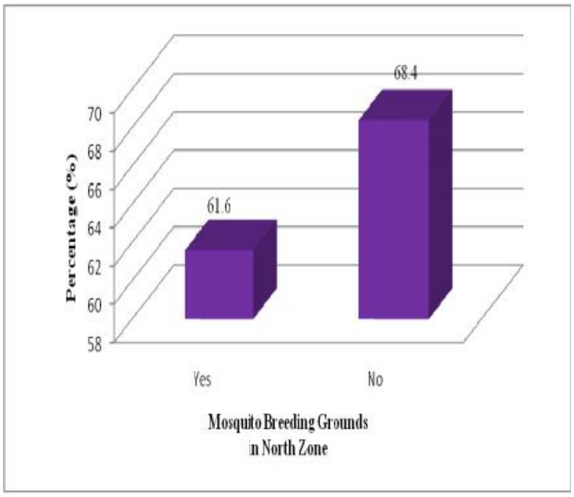


Figure-45: Mosquito Breeding Grounds inNorth Zone

Comparison between endemic and non-endemic areas in some aspects

We know that on the basis of endemism of filariasis, Bangladesh is divided into two like- endemic districts and non-endemic districts. According to JICA 2004, there are 32 endemic districts for filariasis in Bangladesh. According to Programme coverage in WHO- LF-database, 34 districts are endemic infilariasis in Bangladesh. Some aspects offilariasis in comparison between endemic and non-endemic districts of the country were observed through this study. In the present study, have selected one representative district from endemic area and another representative district from non-endemic area for comparison and which were Barisal and Gaibandha respectively.

Comparison of mosquito breeding grounds between two representive districts of endemic and non-endemic area: Comparison of mosquito breeding grounds between two representive districts of endemic and non-endemic area is shown in the following table (table-36) and graph (figure-46). The rate of breeding grounds is higher in endemic area than that of non-endemic area. So the endemic situation of the disease is also depended on the vector population.

Table-36: Comparison of mosquito breeding grounds between endemic and non-endemic area

District		Frequency of breeding grounds		Total
		Yes	No	
Representative one district from endemic zone according to JICA and WHO LF database				
Barisal (endemic)	Frequency	23	4	27
	%	85.2	14.8	100
Representative one district from non-endemic zone according to JICA and WHO LF database				
Gaibandha (non-endemic)	Frequency	25	18	43
	%	58.1	41.9	100

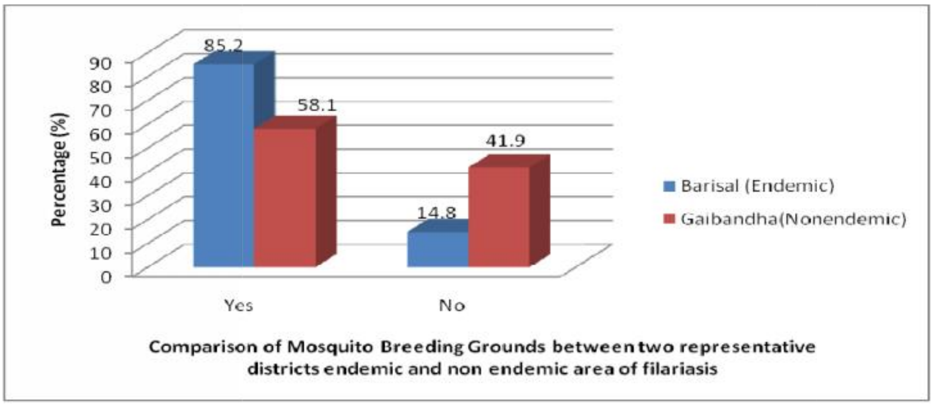


Figure-46:Comparison of mosquito breeding grounds between endemicand non-endemic area

Comparison of educational status between two representive districts of endemic and non-endemic area: Comparison of educational status between two representive districts of endemic and non-endemic area is shown in the following table (table-37) and figure (figure-47). The most patients of endemic districts are illiterate than that of non-endemic district. So this disease is also depended on educational status of the household.

Table-37: Comparison of educational status between endemic and non-endemic area

District		Educational status				Total
		Illiterate	Can sign only	Primary	Above	
Representative one district from endemic zone according to JICA and WHO LF database						
Barisal(endemic)	Frequency	21	3	3	0	27
	%	77.8	11.1	11.1	0	100
Representative one district from non-endemic zone according to JICA and WHO LF database						
Gaibandha(non-endemic)	Frequency	25	12	6	0	43
	%	58.1	27.9	14.0	0	100

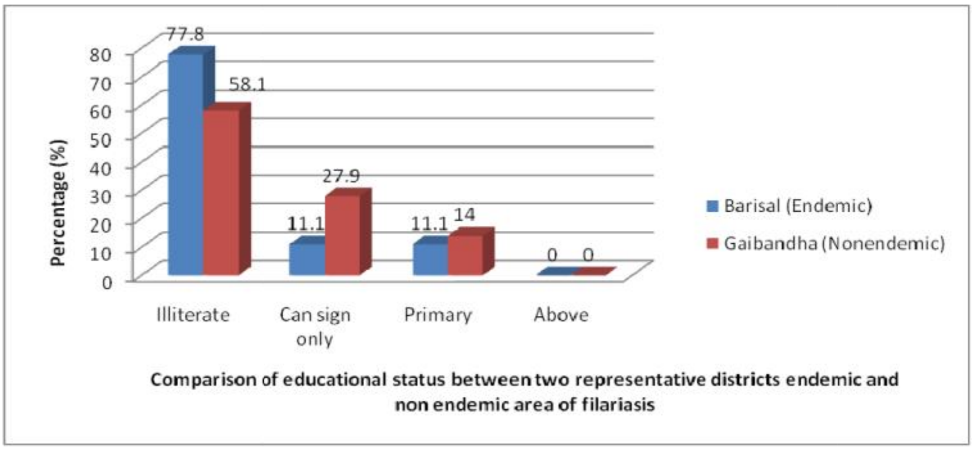


Figure-47: Comparison of educational status between endemic and non-endemic area

Comparison of knowledge about filariasis between two representive districts of endemic and non-endemic area: Comparison of knowledge about filariasis between two representive districts of endemic and non-endemic area is shown in the following table (table-38) and figure (figure-48). The most patients of endemic districts have knowledge gap than that of non-endemic district. So the spread out of the disease is also depended on knowledge-gap of the members of the household towards the disease.

Table-38:Comparison of knowledge about filariasisbetween endemic and non-endemic area

District	Knowledge on filariasis				Total	
	Yes		No			
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Representative one district from endemic zone according to JICA and WHO LF database						
Barisal (endemic)	8	29.6	19	70.4	27	100
Representative one district fromnon non-endemic according to JICA and WHO LF database						
Gaibandha (non-endemic)	19	44.2	24	55.8	43	100

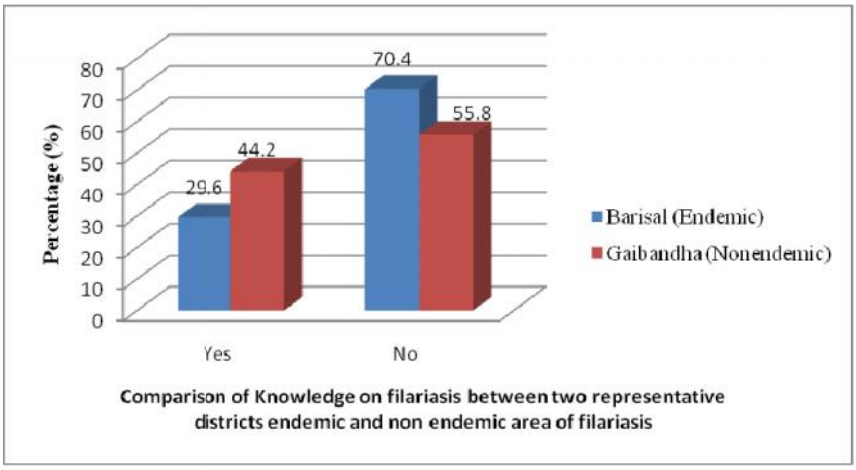


Figure-48: Comparison of knowledge about filariasisbetween endemicand non-endemic area

Comparison of enrollment of the patients of filarisis in community health complex between two representive districts of endemic and non-endemic area: Comparison of enrollment of the patients of filarisis in community health complex between two representive districts of endemic and non-endemic area is shown in the following table (table-39) and figure (figure-49). The rate of enrollment of patients in the health complex is higher in non-endemic area than that of endemic area. So the endemic situation of the disease is depended on the enrollment in the health complex also.

Table-39: Comparison of enrollment of the patients of filarisis in community health complex between endemic and non-endemic area

District	Enrollment in community health complex				Total	
	Yes		No			
	Frequency	%	Frequency	%	Frequency	%
Representative one district from endemic zone according to JICA and WHO LF database						
Barisal (endemic)	17	63.0	10	37.0	27	100
Representative one district from non-endemic according to JICA and WHO LF database						
Gaibandha (non-endemic)	35	81.4	8	18.6	43	100

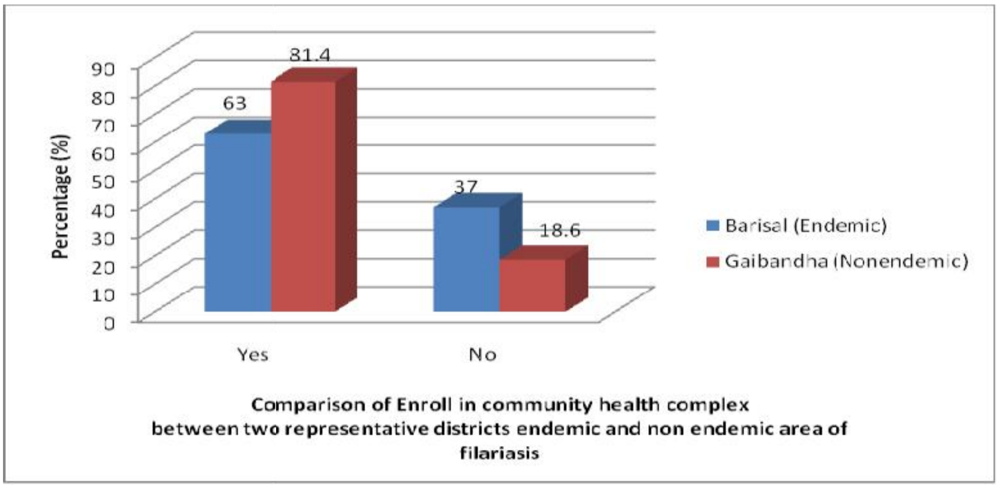


Figure-49: Comparison of enrollment of the patients of filarisis in communityhealth complex between endemic and non-endemic area

Comparison of pattern of latrine use between two representive districts of endemic and non-endemic area: Comparison of pattern of latrine use between two representive districts of endemic and non-endemic area is shown in the following table (table-40) and figure (figure-50). From the following observations, it may be mentioned that the hygenic pattern of the household of the patients in endemic area is unsatisfactory than that of non-endemic area so the endemic situation is also depended on the behavior of the member of the household.

Table-40: Comparison of pattern of latrine usebetween endemic and non-endemic area

District		Type of latrine				Total
		Sanitary	Pit	Hanging	No latrine (Open field)	
Representative one district from endemic zone according to JICA and WHO LF database						
Barisal(endemic)	Frequency	17	4	4	2	27
	%	63	14.8	14.8	7.4	100
Representative one district from non-endemic zone according to JICA and WHO LF database						
Gaibandha(non-endemic)	Frequency	31	4	7	1	43
	%	72.1	9.3	16.3	2.3	100

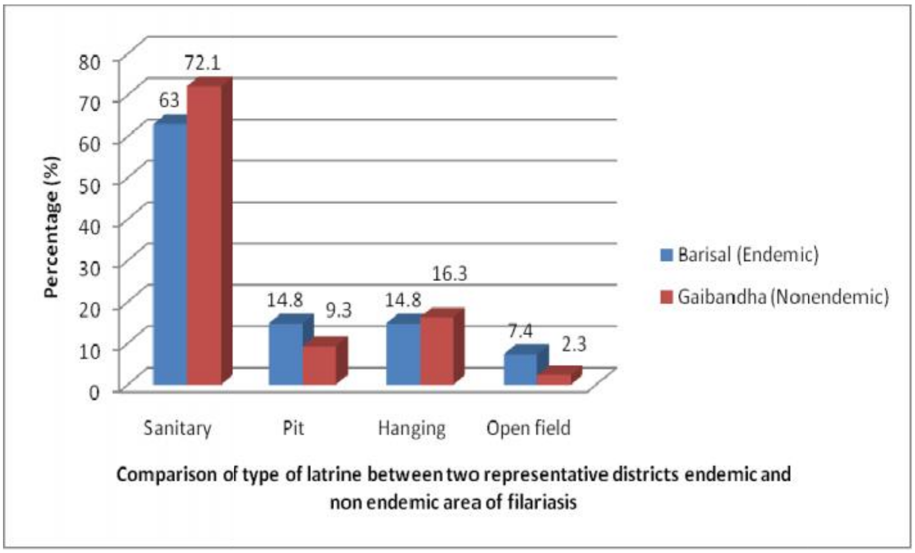


Figure-50: Comparison of pattern of latrine usebetween endemic and non-endemic area

Comparison of place for treatment between two representive districts of endemic and non-endemic area: Comparison of place for treatment between two representive districts of endemic and non-endemic area is shown in the following table (table-41) and figure (figure-51).From the present observations, it can be mentioned that, fewer patients of endemic district has gone for treatment to the health complex than that of non-endemic district and again the more patients of endemic districts has gone to healer than that of non-endemic district. This is one of the reasons of the concentration of the disease in the endemic area in the point of treatment view.

Table-41: Comparison of place for treatment between endemic and non-endemic area

District	Place of treatment						Total	
	Healer		Doctor		Health complex			
	frequency	%	frequenc y	%	frequency	%	frequency	%
Representative one district from endemic zone according to JICA and WHO LF database								
Barisal (endemic)	4	14.8	7	25.9	16	59.3	27	100
Representative one district from non-endemic zone according to JICA and WHO LF database								
Gaibandha (non-endemic)	3	7.0	14	32.6	26	60.5	43	100

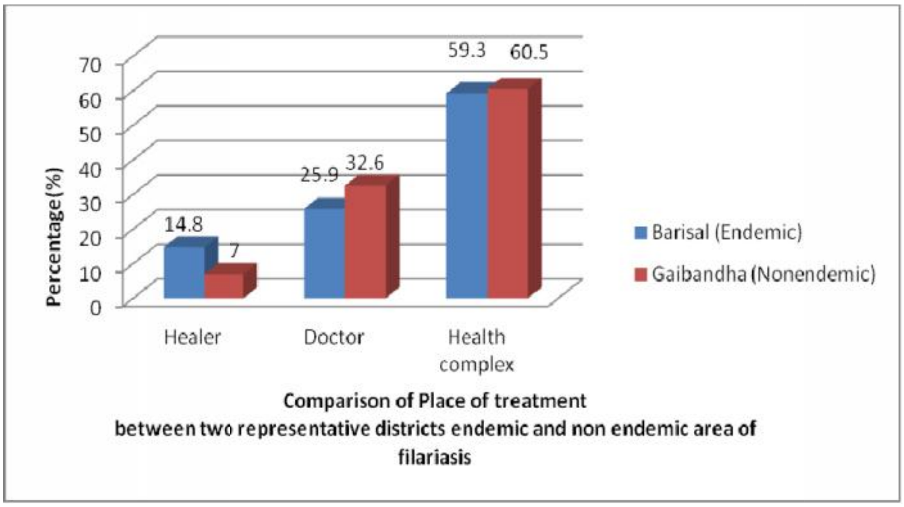
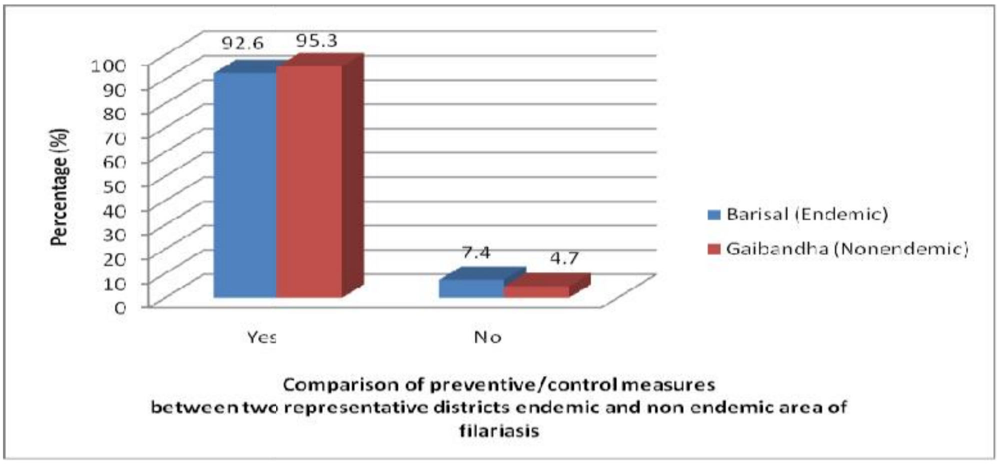


Figure-51: Comparison of place for treatment between endemic and non-endemic area

Comparison of preventive/control measures taken by the patients' householdsbetween endemic and non-endemic area: Comparison of preventive/control measures taken by the patients' households between two representive districts of endemic and non-endemic area is shown in the following table (table-42) and figure (figure-52). Observations on the following table and figure revealed that, the lower rate of preventive measures has been taken by the patients of endemic districts than that of non-endemic districts. So the endemic situation also depends on control measures taken by the patients.

Table-42: Comparison of preventive/control measures taken by the patients' householdsbetween endemic and non-endemic area

District	Preventive/control measures				Total	
	Yes		No			
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Representative one district from endemic zone according to JICA and WHO LF database						
Barisal (endemic)	25	92.6	2	7.4	27	100
Representative one district from non-endemic zone according to JICA and WHO LF database						
Gaibandha (non-endemic)	41	95.3	2	4.7	43	100



Figure–52:Comparison of preventive/control measures taken by the patients'Householdsbetween endemic and non-endemic area

Prevention of filariasis by using some fish predators found in the breeding grounds surrounding the patients' house

The easier cost effective control of the vector of filariasis will be the biological control like predation of vector's larvae by the aquatic predators. As filariasis is transmitted from one patient to another by the mosquito, so this disease would be prevented through controlling the mosquito breeding. The use of predators could be a useful alternative against chemicals in controlling mosquito larvae. Fish can be used as predators of mosquito larvae because their population can be maneuvered by man, they are quite tolerant of a variety water conditions and they can be moved to water areas where they needed. In this context, samples of mosquito larvae and their predators were colleted from the same water bodies surrounding the patients' house as breeding grounds of mosquito larvae. Some fishes, collected from mosquito breeding grounds surrounding the patients' house of study area, were allowed to feed upon the mosquito larvae to determine their predation capacity.

A single predator was put in a jar half-filled with tap water. Counted number of different instars of mosquito larvae was then introduced into the jar. The number was determined after some trials. The predator was thus allowed to feed upon mosquito larvae for 24 hours. Then after 24 hours, number of uneaten larvae was counted and then found out the number of larvae eaten by a single fish predator and the capacity of predation of the selected fish predator was determined. The fishes which were collected namely *Clarias batrachus* (Linnaeus, 1758), *Oreochromis mossambicus* (Peters, 1852), *Anabas testudineus* (Bloch, 1792), *Colisa fasciata* (Bloch and Schneider, 1801), *Channa striata* (Bloch, 1793), *Channa orientalis* (Bloch and Schneider, 1801), *Channa punctata* (Bloch, 1793) and *Poecilia reticulata* (Peters, 1859) were selected as predators for laboratory experiment. The predation capasity of different fishes are shown in the following tables and figures (tables: 43-54 and figures: 53-64).

Table-43: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus*Say by a *Clariasbatrachus*

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	38,000	35831.8
2nd	2nd day	36,000	29798.5
3rd	3rd day	30,000	16984.6
4th	4th day	18,000	14875.74
			Average→ 24372.76

Length of the predator= 15cm
Width of the predator= 3cm

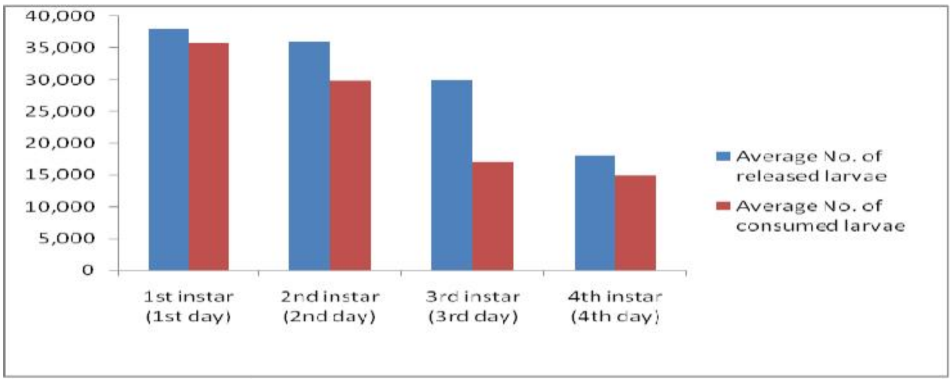


Figure-53: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus* by a *Clariasbatrachus*

Table-44: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus*Say by a genus of Tilapia (*Oreochromis mossambicus*)

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	6000.00	5650.00
2nd	2nd day	5800.00	5475.00
3rd	3rd day	5500.00	3663.00
4th	4th day	5000.00	4873.92
			Average → 4915.48

Length of the predator= 14.5cm
Width of the predator= 6.0cm

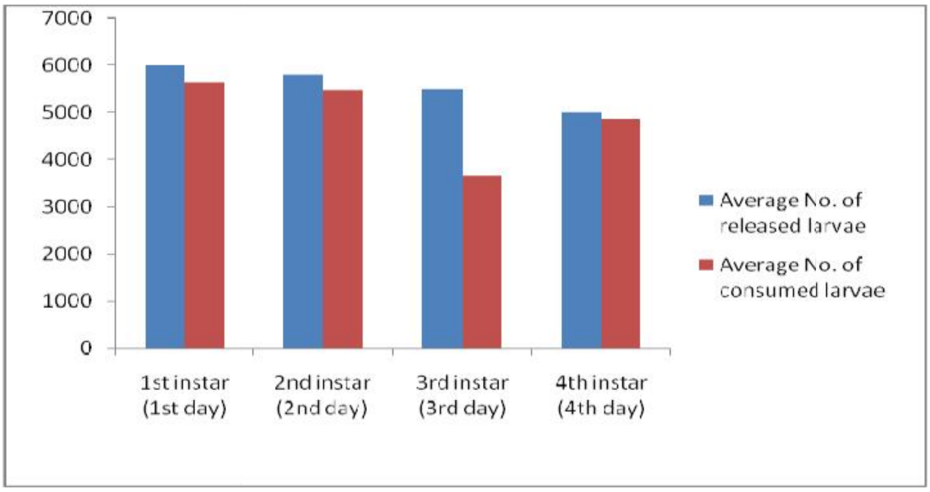


Figure-54: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus*by a singleTilapia (*Oreochromis mossambicus*)

Table-45:Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus* by a single *Anabas testudineus*

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	1000.00	883.70
2nd	2nd day	970.00	715.50
3rd	3rd day	856.20	624.80
4th	4th day	780.00	556.70
Average→ 695.18			

Length of the predator= 8.8cm
Width of the predator= 2.5cm

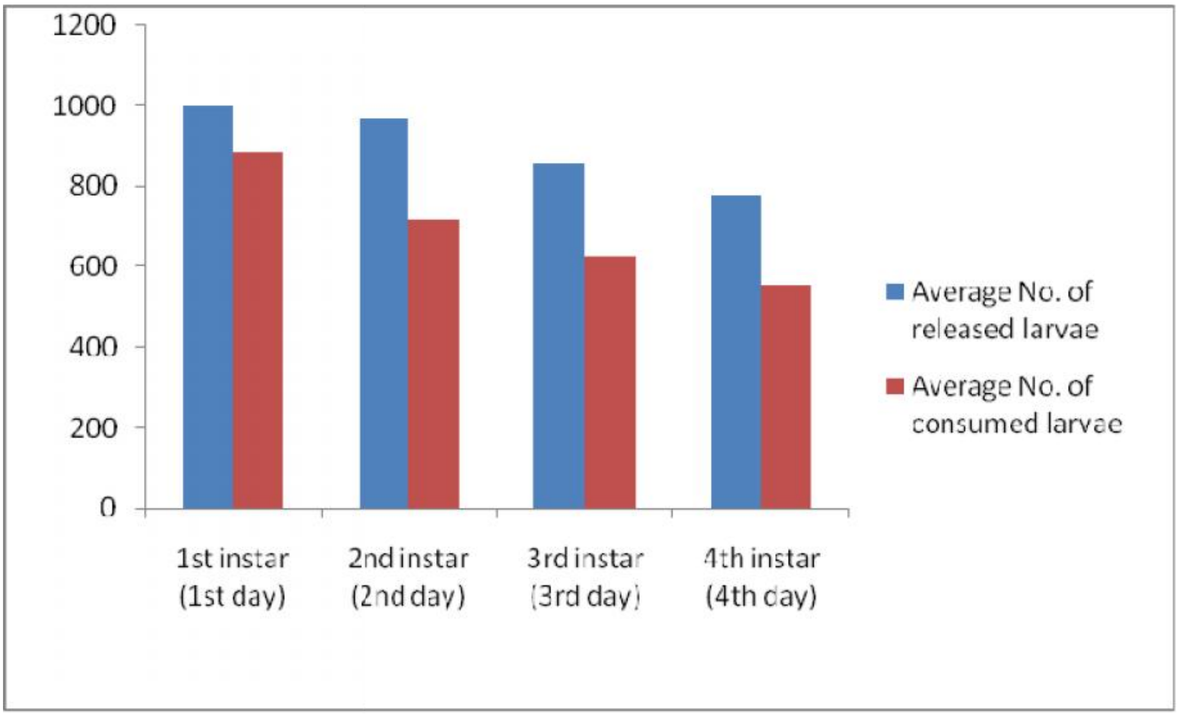


Figure-55: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus*Say by a single *Anabas testudineus*

Table-46. Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatus* by a single *Colisha fasciata*

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	46.00	15.90
2nd	2nd day	200.60	155.40
3rd	3rd day	160.00	87.20
4th	4th day	150.00	117.80
Average→ 94.08			

Length of the predator= 3.7cm
Width of the predator= 1.4cm

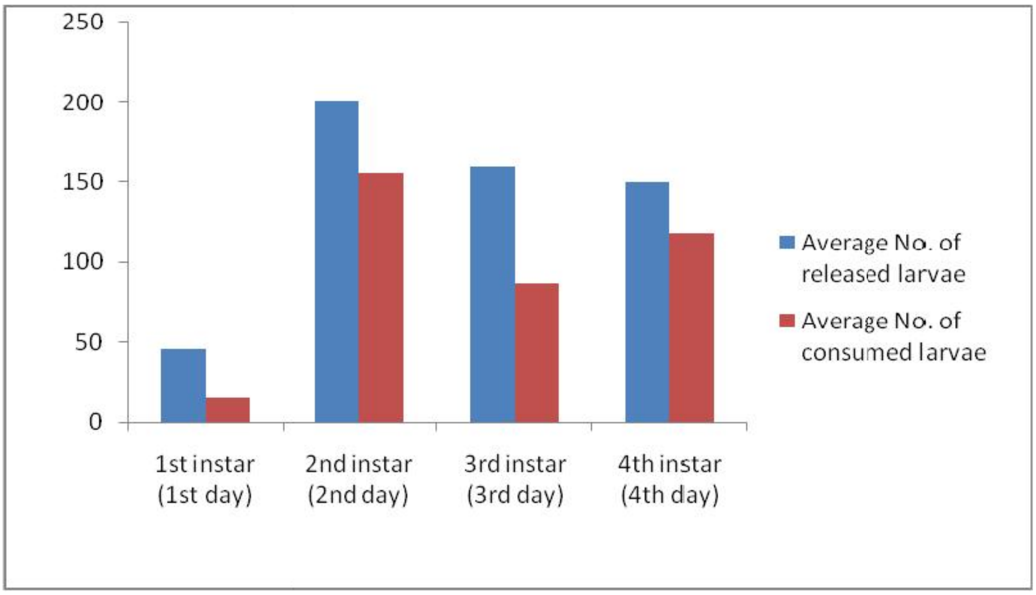


Figure-56: Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatus* by asingle*Colisha fasciata*

Table-47: Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatus* by a single *Channa striata*

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	300.00	159.50
2nd	2nd day	400.00	395.00
3rd	3rd day	180.00	158.20
4th	4th day	270.00	215.80
Average → 232.13			

Length of the predator= 3.5cm
Width of the predator= 0.8cm

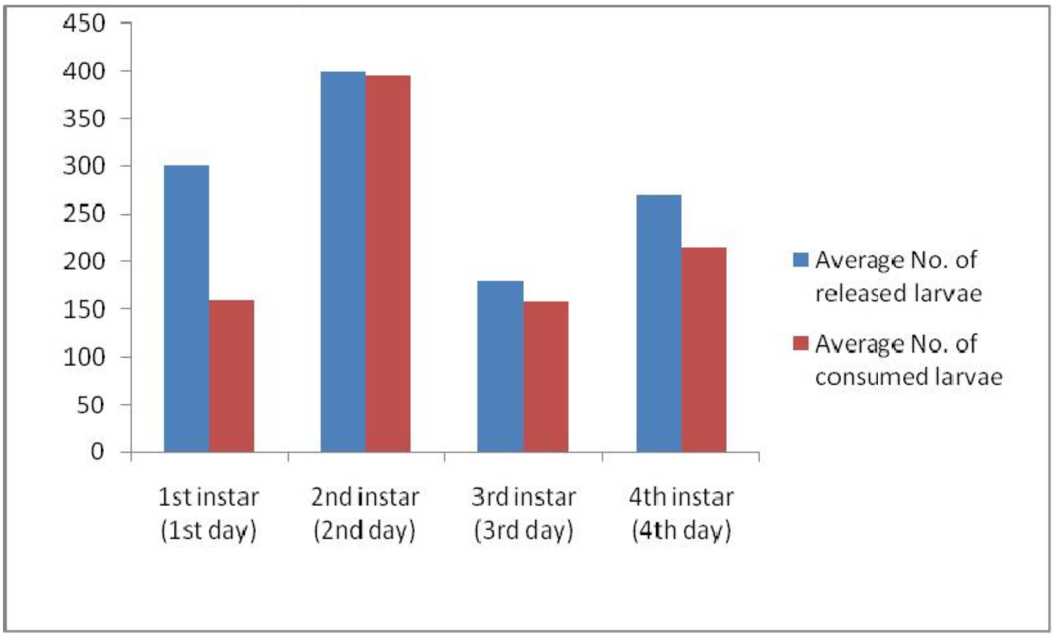


Figure-57: Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatu s*Say by a *Channa striata*

Table-48: Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatus* by a single *Channa orientalis*

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	97.00	27.40
2nd	2nd day	88.00	45.00
3rd	3rd day	74.00	48.70
4th	4th day	100.00	67.30
Average→ 47.1			

Length of the predator= 14.0cm
Width of the predator= 6.0cm

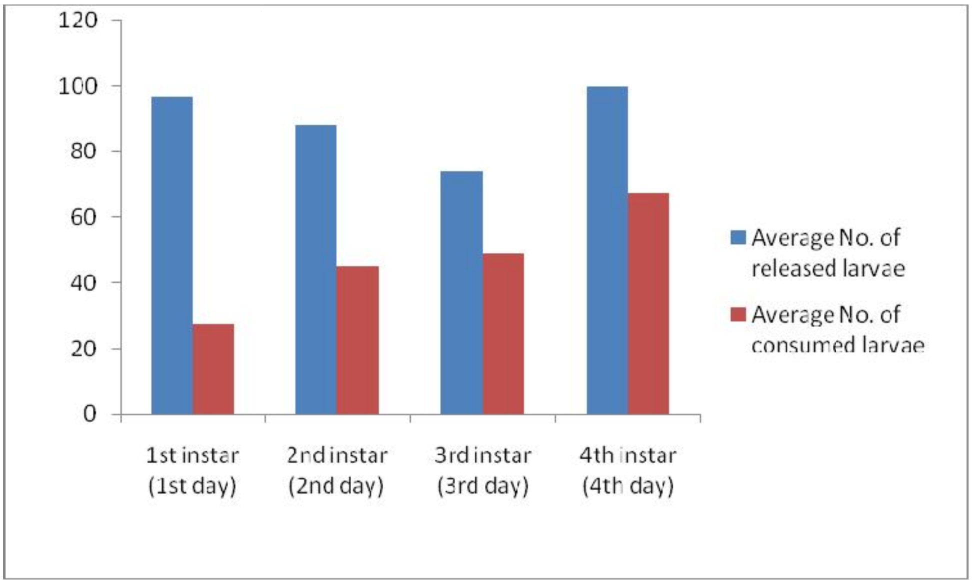


Figure-58: Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatus* Say by a *Channa orientalis*

Table-49: Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatus* Say by a*Channa punctata*.

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	100.00	15.50
2nd	2nd day	110.00	86.30
3rd	3rd day	80.00	19.90
4th	4th day	130.00	28.50
Average → 37.55			

Length of the predator= 15.50cm
Width of the predator= 7.5cm

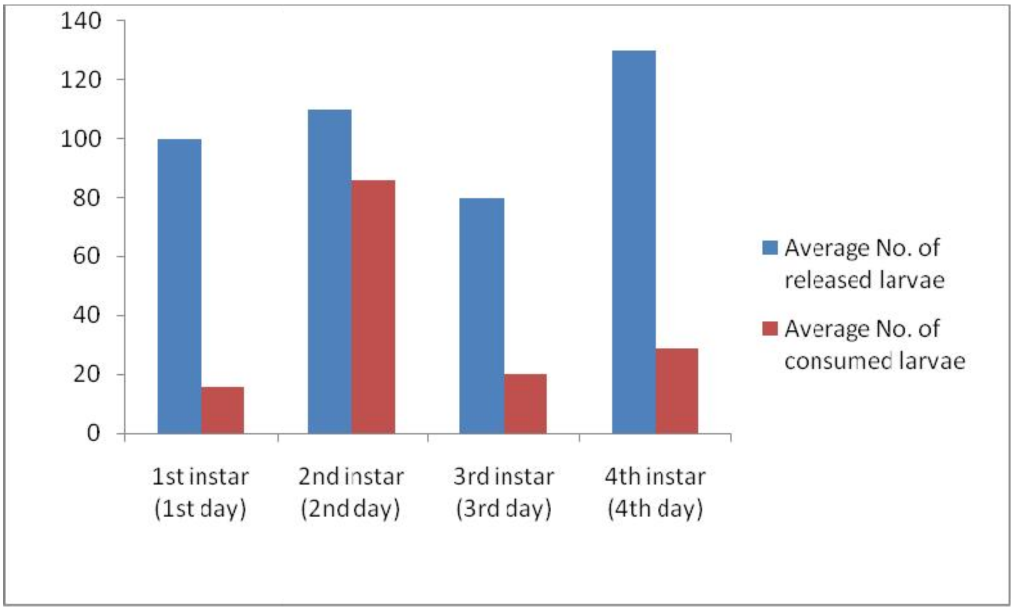


Figure-59: Rate of predation of different instars of mosquito larvae; *Culex quinquefasciatus* by *Channa punctata*

Table-50: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus*by a finger ling of guppy,*Lebistes reticulata*(Just hatched)

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	130.00	26.30
2nd	2nd day	100.80	10.20
3rd	3rd day	50.00	5.30
4th	4th day	30.00	0.00
Average→ 10.45			

Length of the predator= 0.6cm
Width of the predator= 0.1cm

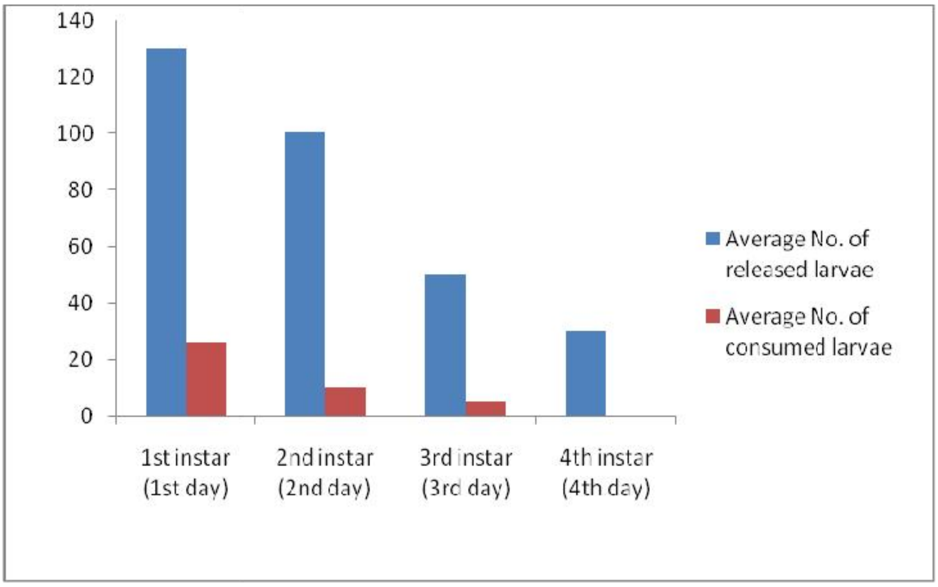


Figure-60: Rate of predation of different instars of mosquito larvae; Culexquinquefasciatus Say by a finger ling of guppy, *Lebistes reticulata*(Just hatched)

Table-51: Rate of predation of different instars of mosquito larvae; Culexquinquefasciatus by amoderate sized guppy, *Lebistes reticulata*

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1st	1st day	142.00	33.60
2nd	2nd day	130.00	24.20
3rd	3rd day	110.40	9.70
4th	4th day	120.50	28.50
Average → 24.00			

Length of the predator= 1.7cm
Width of the predator= 0.33cm

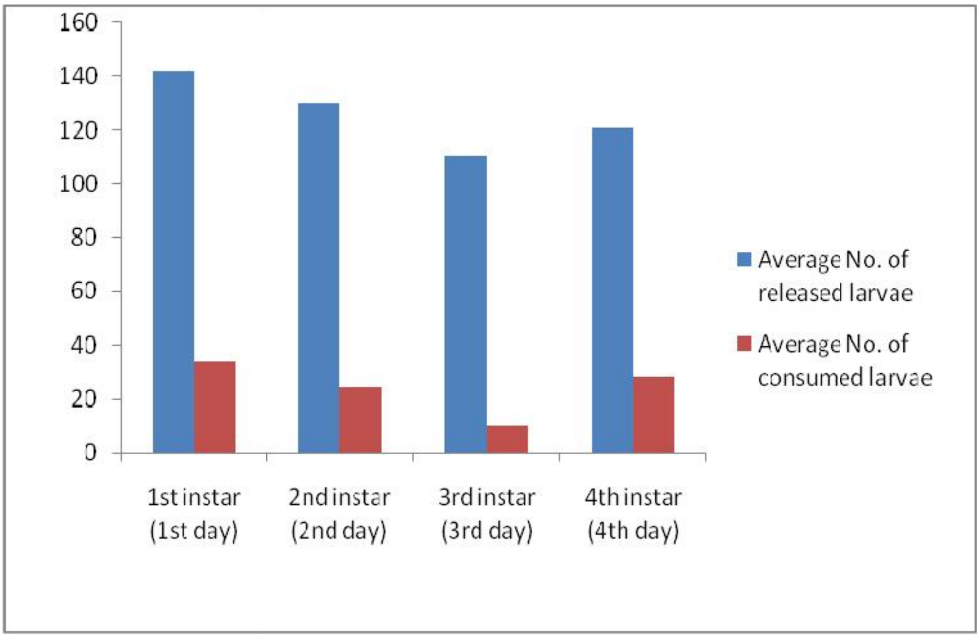


Figure-61: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus*by amoderate sized guppy, *Lebistes reticulata*

Table-52: Rate of predation of different instars of mosquito larvae; *Culexquinquefasciatus*by an adult guppy,*Lebistes reticulata*

During 24 hours

Instar	Time/Day	Average number of larvae released in the jar	Average number of larvae consumed by the predator
1^{st}	1^{st} day	472.00	267.70
2^{nd}	2^{nd} day	325.00	168.50
3^{rd}	3^{rd} day	210.00	58.60
4^{th}	4^{th} day	141.40	87.30
Average → 145.53			

Length of the predator= 2.6cm
Width of the predator= 0.6cm

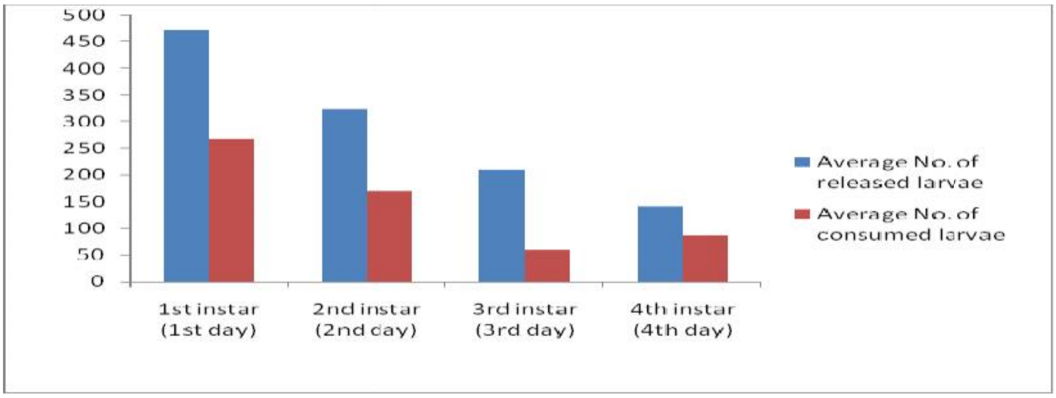


Figure-62: Rate of predation of different instars of mosquito larvae; *Culex Quinquefasciatus* by an adult guppy,*Lebistes reticulata*

Table-53: Average number of larvae consumed by the predators

No	Name of the predator	Average number of larvae consumed by the predator
1.	*Clarias batrachus* (Linnaeus, 1758)	24372.76
2.	*Oreochromis mossambicus* (Peters, 1852)	4915.48
3.	*Anabas testudineus* (Bloch, 1792)	695.18
4.	*Colisa fasciata* (Bloch and Schneider, 1801)	94.08
5.	*Channa striata* (Bloch, 1793)	232.13
6.	*Channa orientalis* (Bloch and Schneider, 1801)	47.1
7.	*Channa punctata* (Bloch, 1793)	37.55
8.	*Fingerling of guppy,Poecilia reticulata* (Peters, 1859) (Just hatched)	10.45(average of all instars larvae consumed) 26.30 (only 1^{st} Instar larvae consumed)
9.	*Moderate sized guppy Poecilia reticulata* (Peters, 1859)	24.00
10.	*Adult guppy Poecilia reticulate* (Peters, 1859)	145.53

Among the fishes *Clarias batrachus* consumed the highest number of larvae (24,372.76per day) followed by *Oreochromis mossambicus* (4,915.48 per day). Different sizes of guppy fish consumed mosquito larvae, the newly hatched fingerlings of guppy fish consuming 26.30 first instar larvae per day and an adult guppy fish consumed on an average 145.53 larvae per day.

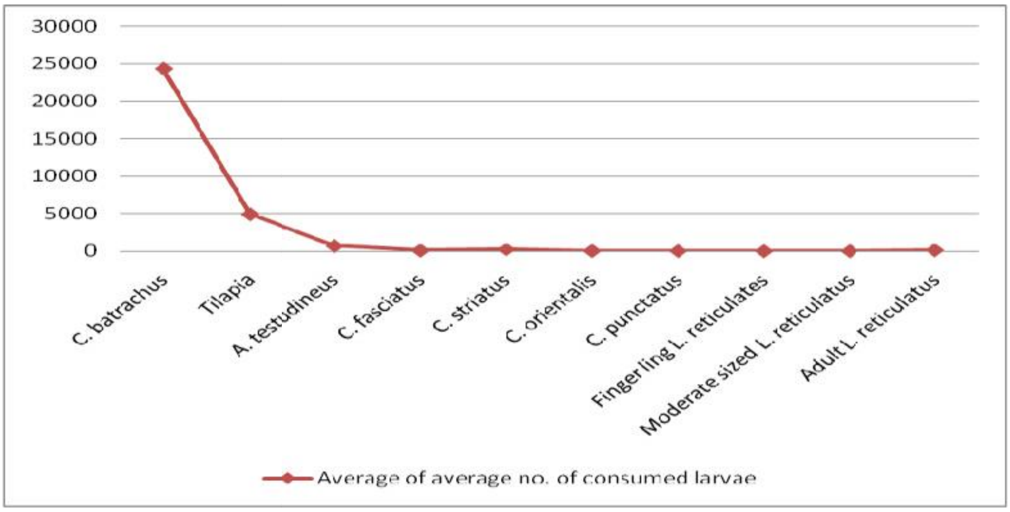


Figure-63: Average of average number of larvae consumed by the predators.

In the present observation, the highest capable consuming fishes are *C. batrachus* & Tilapia *(Oreochromis mossambicus*), moderate capable consuming fishes are *Anabas* spp. &*Channa* spp. and the lower capable consuming fish is Guppy. The newly hatched (Fingerling) *Lebistes reticulata* consumed 26.30 1st instar larvae in the 1st day. A Guppy just after hatching could not consume 4th instar larvae but could consume 1st, 2nd and 3rd instar larvae. So the guppy may be used as a good preadator of mosquito in south area beacuse the water body of nortrh area is not very suitable for them. The choice of fishes to consume of *Culex sp.* is varied from instar to instar. The cause of choice may be depending on shape, size, external organ, activeness and other physical and environmental factors.

Average number of larvae consumedper day by the predators in the point of comparision between south and north zone: The Comparison of average per day consumption of mosquito larvae between South and North zone is shown in the following table.

Table- 54: The Comparison of consumption of mosquito larvaeby fishes per day on an average between South and North zone

Name of zone	Per day average consume
South	30539.84
North	29983.41

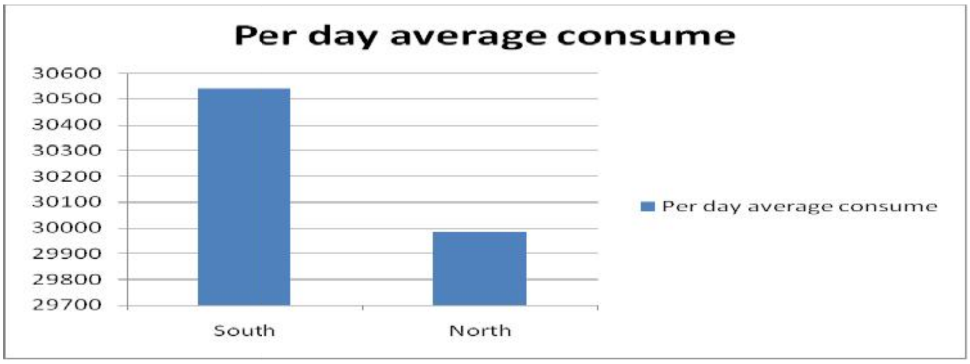


Figure-64: The Comparison of consumption of mosquito larvae by fishes between South and North zone

It was observed that thesuitability of the habitat of more fishes was found in south zone but the habitat of more larvae consuming capable fishes was found in north zone also. So the per day average consumption in both zones was more or less similar. In this connection, the study findings can suggest for cultering suitable fish as mentioned above in the same breeding grounds of mosquito larvae.

Mosquito breeding grounds found in two extreme poor zones in Bangladesh

The Prevalence of *Culex quinquefasciatus* larvae collected from different habitats, viz., ditch, abandond pond and Pit surrounding the tubewell from two extreme poor prone zones of Bangladesh like-north zone and south zone. Main breeding grounds of *Culex quinquefasciatus* found in the surrounding studied household in south and north zone of Bangladesh is as follows.

Table-55: Main breeding grounds of Culex spp. found in the surrounding surved household inSouth and North Zone of Bangladesh

Main breeding grounds surrounding the surved household in South Zone of Bangladesh	Main breeding grounds surrounding the surved household in North Zone of Bangladesh	Comments
Ditch	Pit surrounding the tubewell	There are some other breeding grounds in both zone, but mentioned breeding grounds are about 80% of the total breeding grounds.
Abandoned pond	-	

The prevalence of predators in south area is greater than that of north area, so that the prevalence of filaria is greater in north area than that of southarea.Though the number and type of breeding grounds of north area are lesser than that of south area but the breeding grounds found in north zone is suitable for *Culex* mosquito round the year. Besides, some of the breeeding grounds in south area are dried in dry season but pit surrrounding the tubewell found in north area is watery in all season.

Monthwise frequency of *culexquinquefasciatus*larvae from different breeding grounds in the study area

On observations of the following table(table-56) and figure (figure-65), it was revealed that the maximum percentage (75.07%) of *Culex quinquefasciatus* were collected from Pits surrounding the tubewell followed by abandoned ponds (20.68%) and then ditches (4.25%). It is again mentionable thatthe Pit surrounding the tubewell was found in north zone and abandoned pond &ditch were found in south zone (table-55). The maximum percentage of *Culex quinquefasciatus* larvae (12.07%) collected in January followed by February (11.77%) and the least in June (4.67%). These are presented in the following table and figure (table-56 & figure-65).

Table-56: Monthly collection data (No./dip) of *Culex quinquefasciatus* larvae from different breeding grounds in the study areas in 2010

Moths	Pit surrounding the tubewell	Ditch	Abandoned pond	total	%
January	503	46	133	682	12.07%
February	493	34	138	665	11.77%
March	292	17	128	437	7.74%
April	299	19	124	442	7.83%
May	218	21	134	373	6.60%
June	179	11	74	264	4.67%
July	306	08	78	392	6.94%
August	362	07	66	435	7.70%
September	294	09	60	363	6.43%
October	338	16	51	405	7.17%
November	474	27	94	595	10.53%
December	483	25	88	596	10.55%
Total	4241	240	1168	5649	-
%	75.07%	4.25%	20.68%	-	-

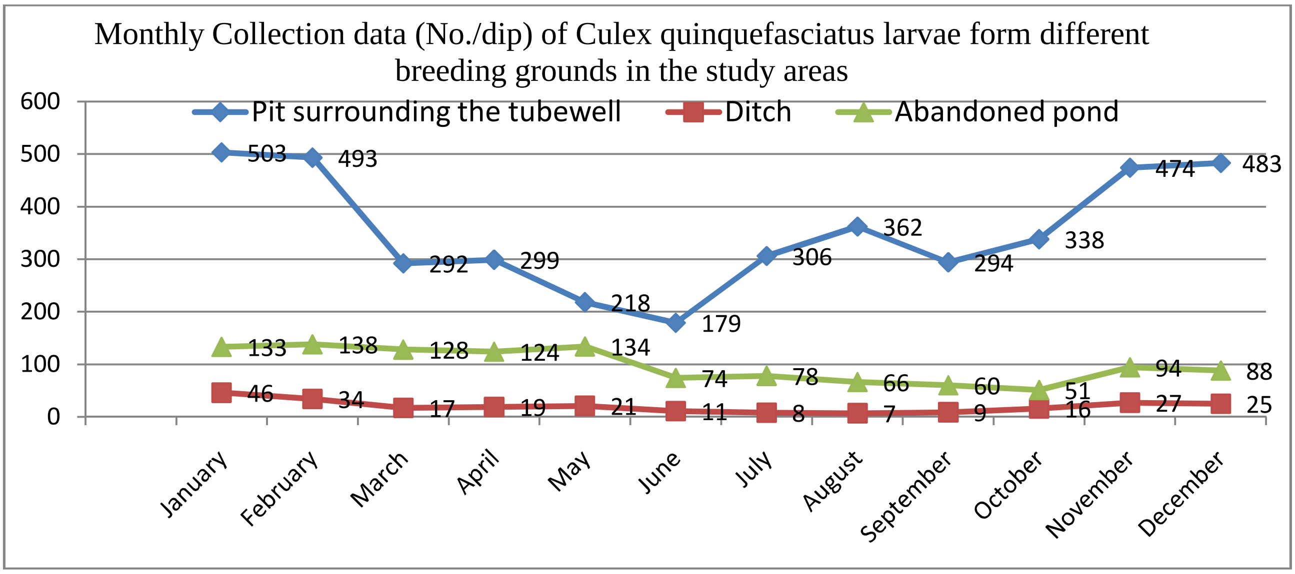


Figure-65: Monthly collection data (No./dip) of *Culex quinquefasciatus* larvae from different breeding grounds in the study areas in 2010

Fishes as the predators of mosquito larvae found in the same breeding grounds of mosquito in two extreme poor zones in Bangladesh

The three fishes like; *Clarias batrachus*, *Oreochromis mossambicus* and *Anabas testudineus*are common in the breeding grounds of both two zones in the country (table-57). Among all fishes found in the study, the above mentioned three fishes have higher consuming rate (table-53). So those fishes can be used for mosquito control. Though the number of predators is higher in south zone than that of north zone but the suitability to use predators in a sustainable manner is higher in north zone than that of south zone.

Table-57: Fishes naturally found/ cultured in the breeding grounds surrounding the surveyed household in South and North Zone of Bangladesh

Fish found in the breeding grounds surrounding the surveyed household in South Zone of Bangladesh	Fish cultured in the pit of tubewell surrounding the surveyed household in North Zone of Bangladesh
Clarias batrachus (Linnaeus, 1758)	*Clarias batrachus (Linnaeus, 1758)*
Oreochromis mossambicus (Peters, 1852)	*Oreochromis mossambicus (Peters, 1852)*
Anabas testudineus (Bloch, 1792)	*Anabas testudineus (Bloch, 1792)*
Colisa fasciata (Bloch and Schneider, 1801)	
Channa striata (Bloch, 1793) (small size)	
Channa orientalis (Bloch and Schneider, 1801)	
Channa punctata (Bloch, 1793)	
Poecilia reticulata (Peters, 1859)	

Predators of *culexquinquefasciatus*larvae found in different types of breeding grounds in the study areas during the year

All together eight different predators werecollected ofwhich *Clarias batrachus* were found in all of the breeding grounds.According to the observations, theditch is the more effective natural grounds for almost all of the predators of *Culex quinquefasciatus* but Pit surrounding the tubewellis the artificial grounds for the predators (cultured fish in that pit) of *Culex quinquefasciatus* (table-58). In north zone, the more effective breeding grounds of *Culex quinquefasciatus* in that pit. So for controlling the vector of filarisis, we can use this pit as a ground of culture of fish in north zone. We can use the suitable fish (as mentioned in the table-58) in ditch & abandoned pond for controlling the vector of filarisis in south zone as the available breeding grounds in south zone are ditch and abandoned pond.

Table–58: Predators of *Culexquinquefasciatus*larvae from different types of breeding grounds in the study areas from January to December

Predators	Pit surrounding the tubewell (cultured fish were found)	Ditch (predators were naturally found)	Abandoned pond (predators were naturally found)	Total (%)
Clariasbatrachus (Linnaeus, 1758)	3	1	1	5(8.48%)
Oreochromis mossambicus (Peters, 1852)	5	2		7(11.86%)
Anabas testudineus (Bloch, 1792)	4		1	5(8.48%)
Colisa fasciata (Bloch and Schneider, 1801)		9	2	11(18.64%
Channa striata (Bloch, 1793) (small size)		3	1	4(6.78%)
Channa orientalis (Bloch and Schneider, 1801)		1		1(1.7%)
Channa punctata (Bloch, 1793)		2	1	3(5.08%)
Poecilia reticulata (Peters, 1859)		23		23(38.98%)
Total	12	41	6	59 (100)

Observations and results at a glance

i) Out of 20 studied districts, Bagerhat, Gopalganj, Sylhet, Narail, Mymensingh and Norshindhi have no patients of Filariasis.

ii) The highest frequency of patients found in Lalmonirhat and Thakurgaon followed by Gaibandha. The highest percentage of patients was severely attacked by filariasis in Lalmonirhat (86.3%) followed by Thakurgaon (62%) and these two districts have highest number of patients according to this study.

iii) The 69.2% patients are found in north zone and 30.8% patients in south zone. 89.81% patients are found in endemic area (17 districts) and 10.18% patients are found in non-endemic area(3 districts).

iv) There is no patient in age group (0-10), the highest number of patients is found in age group (41-50) and gradually it is decreasing with the age.

v) 2.6% household expenditure was below 1000/-taka per month. Some patients had no capacity to expend even up to 1000/- only. The household expenditure of south zone is higher than that of north zone. Simultaneously frequency of patients was lower in south zone than that of north zone. In both zones the affected people are mostly poor because maximum patients' household expenditure is ranging from taka 2000/- to taka 4000/- per month.So it can be said that this disease is almost poor people disease.

v) Higher percentage of female patients was found in Kurigram (77.8%), Lalmonirhat (72.5%), Thakurgaon (72%), Dinajpur (70%), Chapainawbganj (66.7%), and Panchgarh (56.7%). Border areas as well as insolvent areas' females were more affected than that of central areas. The female of north zone was engaged more time in household works surrounding most effective breeding grounds of mosquito (i.e. pit surrounding the tubewell side) than that of south zone, so females were more affected than male in north zone.

vii) The patients were mostly illiterate (60.2%) followed by the patients who can sign only (20.4%). 5.2% patients were above the primary level. Higher educated patients are more in south zone than that of north zone. Simultaneously frequency of patients is lower in south zone than that of north zone. It is observed that the filarisis is occurred in the illeterate people and the prevalence is decreasing with the higher educational status.

viii) 70.9% patients of all over the study area have no knowledge about filariasis. 12.28%patients go to healer for treatment too.So this disease is also depended on educational status/ knowledge/awareness of the households' people.

ix) Somepatients of three districts: Lalmonirhat, Nilphamary and Chapainawabganj never go for treatment and the frequency of the patients of those districts was also high.

x) 91% patients are suffering from leg swelling followed by hand swelling (7.35%). 0.5% and 1.18% patients were suffering from breast and scrotum swelling respectively. Perhaps the patients may not be splled out about their sensitive organ because of shame.

xi) Though 87.91 % patients' use bed net but they are actually protected only more or less 6 hours during night time, so they are not safe from the mosquito biting during the rest of the 18 hours. They are mostly attacked during the use of latrine because in and around the latrines are more suitable area for breeding and resting place of mosquitoes.

xii) The fewer patients of endemic district has gone for treatment to the health complex than that of non-endemic district and again the more patients of endemic districts has gone to healer than that of non-endemic district. This is one of the reasons of the prevalence of filariasis in the endemic area.

xiii) More numbers of breeding grounds (like-Ditch and abandoned ponds mainly) are located in south zone than that of north zone (only pit surrounding the tubewell in north zone which is more effective breeding grounds). In north zone, the more effective breeding grounds of *Culex quinquefasciatus* are pit surrounding the tubewell. So for controlling the vector of filarisis, we can use this pit as a ground of culture of fish in north zone. We can use the suitable fish (as mentioned in the table-58) in ditch & abandoned pond for controlling the vector of filarisis in south zone as the available breeding grounds in south zone are ditch and abandoned pond.

xvi) 62.3% patients' household is surrounded by different types of breeding grounds. About 83% to 93.5% patients' household are surrounded by different types of breeding grounds in Nilphamari, Pirojpur, Barisal and Lalmonirhat and these area also have higher frequency of patients among the studied districts. One third of the total patients are found in those districts.

xv) The suitability of the habitat of more fishes was found in south zone but the habitat of more larvae consuming capable fishes was found in north zone also. So the per day average consumption in both zones was more or less similar.

xvi) All together eight different fish predators were collected of which *Clarias batrachus* were found in all of the breeding grounds. The three fishes like; *Clarias batrachus, Oreochromis mossambicus* and *Anabas testudineus a*re common in the breeding grounds of both two zones in the country. Among all fishes found in the study, the above mentioned three fishes have higher consuming rate. So those fishes can be used for mosquito control.

xvii) Among the fishes *Clarias batrachus c*onsumed the highest number of larvae (24,372.76 per day) followed by *Oreochromis mossambicus (*4,915.48 per day*).* Different sizes of guppy fish consumed mosquito larvae, the newly hatched fingerlings of guppy fish consuming 26.30 first instar larvae per day and an adult guppy fish consumed on an average 145.53 larvae per day. Moderate capable consuming fishes are *Anabas s*pp. and *Channa s*pp. A Guppy just after hatching could not consume 4th instar larvae but could consume 1^{st,} 2nd and 3rd instar larvae. So the guppy may be used as a good preadator of mosquito in south area beacuse the water body of nortrh area is not very suitable for them. The choice of fishes to consume of *Culex sp.* is varied from instar to instar of *Culex sp.* The cause of choice may be depending on shape, size, external organ, activeness and other physical and environmental factors.

xviii) Themaximum percentage (75.07%) of *Culexquinquefasciatus* were collected from Pits surrounding the tubewell followed by abandoned ponds (20.68%) and then ditches (4.25%). It is mentionable that the Pit surrounding the tubewell was found in north zone and abandoned pond & ditch were found in south zone. Though the number and type of breeding grounds of north area are lesser than that of south area but the breeding grounds found in north zone is suitable for *Culex* mosquito round the year. Besides, some of the breeeding grounds in south area are dried in dry season but pit surrrounding the tubewell found in north area is watery in all season.

Chapter-5

DISCUSSION

Lymphatic filariasis (LF) has been recognized for more than 4000 years. It is a mosquito born parasitic disease endemic in 83 countries located mostly in tropical region of the world and many of which are among the poorest in the world. Filariasis is one of the leading causes of physical deformities and disabilities in the world. This is the highest disease burden of any tropical disease except malaria. It takes a large toll on individuals both through physical disability and social stigmatization caused by the parasite *Wuchereria bancrofty*, classic causative agent of this disease in humans. The word "filariasis" is derived from filar which means threadlike, its ancient name was "Malabar leg". Filariasis was the first disease proved to be transmitted by insects. In spite of the long history, no effective drug was found against filariasis till 1946. In 1947 after the Second World War, 1st effective drug "diethyicarbamazine" Hotrazan was discovered by an American term.

Lewis established the fact that the organism lives principally in the blood of man and consequently named it filarial *Sanguinis hominis* while Cobbold (1877) wrote a description of the adult worm and named filarial *bancrofti.* Lewis (1877) did the same in India. Manson in 1878 made the important observation that the mosquito served the parasite as intermediary host and described the remarkable phenomenon of filaria periodicity, the other filaria of the blood are name microfilaria *Loa loa*, microfilaria *malayi*, Microfilaria *volvulus*, Microfilaria *prestans*, the embryo of *Acanthoceilonema prestans.*

Filaria *bancrofti* has been renamed *Wuchereria bancrofti* and an allied speies *W. malayi* has been discovered. *W. bancrofti* occurs indigenously in almost every tropical and sub-tropical country, in the United States and Southern Spain in Europe and Brisbane in Australia. It is extremely common in India and South China, Samoa and many of the pacific Islands, where fully 60 % of the inhabitants are affected. It is also found in the West Indies, South Africa, Southern Sudan, West and central Africa.

40 million people have clinical manifestations of the disease, 120 million are infected in 83 countries and one billion live at risk of infection (Dreyer *et al*. 1997; Ottesen, 2000). Recognizing this, the Fifty World Health Assembly of 1997 adopted a resolution to work towards elimination of lymphatic filariasis as a public health problem by 2020.

Since then, with the formation of Global Alliance for the Elimination of Lymphatic Filariasis (GAELF) and the partnership of many Ministries of Health, NGOs and philanthropic foundations, effort to eliminate this disease have scaled up in over 38 countries. The GAELF currently recommends a dual strategy of prevention and treatment in order to achieve complete elimination. The prevention part of an elimination program involves in interruption of disease transmission through annual mass drug administration (MDAs). Treatment activities consist of morbidity control programs designed to alleviate the suffering of individuals who show clinical manifestations of the disease (Molyneux and Gazaria, 2002).

In 1997, the World Health Assembly (WHA) urged its member states to make commitment to the global elimination of Lymphatic Filariasis (LF) as a public health problem (WHA, 1997). LF is the fourth leading cause of permanent disability (WHO, 1998). For countries with national program, an important requirement was to have information on spatial spread and status of the risk of final infection, which would facilitate an appropriate planning for control/elimination. Lymphatic filariasis distribution map has been created for India, based on the historical data available in 2000.

This disease is prevailing in the tropical or subtropical countries of the world. Because of the parasite *Wuchereria bancrofti*, it needs about 90% humidity. In Bangldesh, especially in the North Bengal it is found that averagely 95.31% humidity prevails all the year round. So climate is also an important factor for this disease to be caused. *W.*

bancrofti transmission is largely determined by the geo-environmental variables, and hence it is possible to identify the areas where risk of transmission can be determined on a macro-scale. Environmental conditions are widely conducive, to transmission efficiency; human factors are also key determinants contributing to the local occurrence of filariasis. The influence of human factors such as population density, movement, economic status, occupation, literacy level and health seeking behaviour on the occurrence of lymphatic filariasis at micro level has been described elsewhere (Coreil *et al.* 1998; Ramaiah *et al.* 1999, 2000 and Galvez 2003). Similarly, the vector abundance may vary widely at micro level depending on the geo-physical and human associated factors, but the 'vectorial capacity' (vector survival and capacity for parasite development) and the transmission of infection are greatly determined by the geo-environmental factors at macro level (Khanum *et al.* 2013).

According to the objectives of the present study, the prevalence and epidemiological aspects of lymphatic filariasis in different zones/districts of Bangladesh, the socio-economic characteristics and the infrastructural condition of the community for participation in prevention and elimination of this disease, to assess the attitude and level of knowledge of the community towards the causes, preventions and control measures of filarial disease, the magnitude of negligence to lymphatic filariasis, the factors which make the growth prevalence of lymphatic filariasis were observed. Along these, the cost effective and safe way control of the vectors of lymphatic filariasis, the effectiveness of predation by fish as a control measure of the vector of lymphatic filariasis and the occurrence of the mosquito larvae and their predators in the same water bodies around the lymphatic filariasis affected patient’s house were also investigated.

The present study was carried out among the people of the 12 districts of North zone and 8 districts of South zone of Bangladesh. Out of those 20 districts, 17 districts were endemic and 3 districts were non-endemic (according to JICA, 2004 and WHO, 2007) areas. According to JICA and WHO, Gaibandha was non-endemic district but in the present study, the patients were identified in Gaibandha. Besides, out of those 20 districts, patients were found in 14 districts and were not found in other 6 districts. District maps were used to select the sampling sites. Within selected sites, patients and their selected family members and selected community people, health institute, NGO-staff have been interviewed / communicated. Mosquito larvae and their predators had been collected from different types of breeding grounds around the patients' house in the study areas. Out of 20 studied districts, Bagerhat, Gopalganj, Sylhet, Narail, Mymensingh and Norshindhi have no patients of Filariasis. The highest frequency of patients found in Lalmonirhat and Thakurgaon followed by Gaibandha. The highest percentage of patients was severely attacked by filariasis in Lalmonirhat (86.3%) followed by Thakurgaon (62%) and these two districts have highest percentage of patients according to this study which are 12.1% and 11.8% respectively (table-12 and table-2). The 69.2% patients are found in north zone and 30.8% patients in south zone(table-4) 89.81% patients are found in endemic area (17 districts) and 10.18% patients are found in non-endemic area (3 districts),(table-3).

Filariasis caused by *Wuchereria bancrofti* has generally been considered an urban infection on the Indian subcontinent, as the breeding conditions preferred by the usual vector, *Culex pipiens* fatigans / *Culex quinquefasciatus* are found more frequently in towns. Bancroftian filariasis has, however, been found in non-urban areas, especially in north-eastern India, and it has been stated that some breeding of *Culex pipiens fatigans* can occur even in villages, depending upon the amount of wastes and the method of its disposal. This disease spreads through *Culex* mosquitoes. But there are no activities of authority for destroying mosquito breeding places. Mosquito spread easily due to unlearning the drain and ditches. The breeding place of mosquito should be cleaned to control the filaria disease. In the present study, it was observed that the maximum percentages (75.07%) of *Culex quinquefasciatus* were collected from Pits surrounding the tubewell followed by abandoned ponds (20.68%) and then ditches (4.25%), (table-56). The Pit surrounding the tubewell was found in north zone and abandoned pond & ditch were found in south zone (table-55).

Risk factors for lymphatic filariasis that do not seem to be the direct causes of the disease, but seem to be associated in some way. Having the risk factor for lymphatic filariasis make the chances of getting a condition for higher prevalence. In our country the infra-structure is very poor, especially in the northern part (Thakurgaon, Rangpur, Dinajpur, Lalmonirhat, kurigram etc). The communication system between the urban and rural areas is not good. Electricity is not available in the village. So most of the villagers do not have television, radio, etc. as a result they cannot get the information regarding filariasis. The healthy sanitation is not well established in the rural areas and mosquito gets the healthy environment for their breeding (Barry et al. 1971). There is no single factor responsible for this disease. Many factors responsible for this disease to be caused. Illiteracy, poverty as well as negligence of the government and nongovernment/society are the most notable ones to be caused lymphatic filariasis.

Lymphatic filariasis is not a serious communicable disease such as TB, HIV / AIDS, in Bangladesh. The WHO estimated the number of people at risk from Lymphatic Filariasis is 49 million (annual report 2002) in mainly North West area of Bangladesh. It is categorized a local disease, but the conditions of patients do not know how to treat, prevent and control the disease. Especially there is a good simple treatment for Elephantiasis which is recommended by WHO and CDC Atlanta. If they had known how to treat, it might have been possible to prevent inflammation. And there is a tradition widely spread among villagers that Elephantiasis and Hydrocele are signs of God's anger. Because of their belief, the patients neglect the affected parts. Another side, they belief that the Filariasis is inherited. Braga *et al.* 1948 stated that maternal microfilaraemia is not found to be a risk factor for the occurrence of microfilaraemia in offspring. There is a present situation of a woman who cannot get married, because of her symptoms of Elephantiasis. Almost all the patient of Lymphatic Filariasis loses their quality of life. It is a necessary that all people learn about Filariasis infection and Filariasis symptoms. If people have a proper understanding of Lymphatic Filariasis, they will not keep patients at a distance. Moreover it will stimulate the co-operation of social community.

Filariasis is the one of the national problem of Bangladesh. The disease is fatal one. If once attacked the patient may be disabled for life. It is burden of the family and also to the society. They wholly depend on others. This study will form a basis for dissemination of knowledge on prevention and control of filariasis and that area of ignorance will stimulated more research for further study. The consequences of filariasis are many. A large number of affected persons exhibit physical and mental disabilities, an impaired ability to work and a compromised quality of life. These problems arise not only from the disease process, but also from social stigma directed towards the affected persons. All of problems moreover have a cumulative, adverse impact at the individual, household, community and national levels. The social and individual adverse impacts are as follows:

- Permanent long-term disability (lymphatic filariasis is the world's second leading cause)
- Social loss (lost or broken marriages, lost parenthood opportunities) specially in developing countries where the disease is often at its worst.
- Side-reactions for taking large number of tablets.
- No or poor knowledge regarding the disease causation.
- Superstition and wrong believe about the disease etc.

Population density in the endemic areas

According to WHO 1992, Filariasis spreads normally in those areas where the population densities is very much high along with deficiencies in urban infrastructure. It was found in the study area that the population was over crowded. It was also observed from the study that for control, prevention and elimination of filariasis from Bangladesh, the activities such as MDA, Social mobilization, Community based Information, Education and Communication (IEC), Morbidity control, Training to health, Para-medical health personnel including volunteers and NGOs for MDA and morbidity control must need to strengthen by the government.

Nearly 60% of the lymphatic filariasis problem is in the South East Asia Region, 30% in the African Region, 5% in the Eastern Mediterranean Region, 4% in the Western Pacific Region and 1% in the American region. Except the Panjab, Haryana, Rajasthan, Jammu and Kashmir, Himachel Pradesh, Sikkim, Nagaland, Meghalaya, Mizoram, Munipuri, Tripura, Chandigarh and Delhi, the entire country of India is endemic for *W. bancrofti.* In 1955 the Govt. of India launched a national programme against filariasis known as National Filaria control Programme (Park and Park . 1985).

The look of a suitable experimental animal contamination to be the main hurdle in research microfilaria in filariasis. Filariasis is one of the major tropical diseases taken up by WHO/ UNDP in its “special program for research and training on tropical disease’’ in recent year. (Park and Park 1985).

The Indian Sub-Continent comprises of 5 countries namely, Bangladesh, India, Maldives, Nepal and Sri Lanka. It harbors nearly half the world’s lymphatic filariasis burden. Sri Lanka with a formidable 50000 strong volunteer force has been able to target its entire endemic population of 9.8 million during the past 4 years with a reported coverage of over 80% in the MDAs of 2002 and 2003. An independent assessment of coverage carried out on 4000 individuals in all implementation units revealed that 79% of the targeted population received the drugs but only 71% had taken them. Compliance was thus about 10% less than the reported figures. The MDA for 2004 was carried out on the 10th of August 2004 and the mopping up operation is now in progress.

India has a major problem with 450 million people at risk. They scaled up to 71 million in 2002. Of this 21 million were given DEC/Albendazole and 50 million DEC only. India carried out a large scale study on the comparative efficacy of DEC/Albendazole versus DEC alone and the results indicate that DEC/Albendazole is the better option. In 2004 India launched an ambitious program to carry out MDA in 201 districts (population 407 million). 89 districts (population 174 million) have been treated already with DEC immunotherapy. The remaining 112 districts (population 233 million) will be treated.

It is estimated that about 236 million people live in the endemic area of which 18 million are microfilaria carrier and 14 million with different types of filaria diseases manifestation in India. *B. malayi* filariasis is spreaded by Mansonia mosquitoes, is limited in its distribution to some areas in Kerala and small pockets in Andhra Pradesh, Tamil Naru, Madhya Pradesh, Orissa, West-Bengal, Assam and is found exclusively in rural area.

West Bengal is noted endemic area of hydrocoele. The possibility of eradicating hydrocoele has recently received considerable attention because of several significant improvements in the tools available to control this disease. Efforts at hydrocoele control in populations through reducing the numbers of mosquito vectors have been proven largely ineffective. Even when good mosquito control can be put into place, the long life span of parasite (4-8 parasites) means that the infection remain in the community for a long period of time, generally longer than intensive vector control efforts can be sustained. More recently with the advent extremely effective dose is occurred (Vanamali, *et al*. 1989).

Nepal after a few teething problems started their MDA program in 2003 in one district with a 500,000 population and achieved coverage of 83%. It has planned to conduct MDA in 3 districts (population 1.5 million) in September 2004. In the Maldives, only 8 of the 200 islands are endemic for filariasis and the microfilaria rate has been below 1%. As these surveys were carried out in 1995 the Ministry of Health has planned to re-survey all the endemic islands in 2004 and carry out MDA where applicable. Bangladesh, Nepal and Sri Lanka have attributed their ‘over 80% coverage’ to two key factors, firstly to a good health infrastructure and secondly to vigorous social mobilization. All three countries carried out a comprehensive COMBI exercise including appropriate training program for health staff and volunteers. The COMBI program has been funded by WHO, LF Support Centre Liverpool, USAID etc. Sustainability of this program as the MDA is scaled up is bound to be difficult. One of the major constraints to scaling up MDA is inadequate financial resources and countries such as Bangladesh and Nepal are finding it difficult to expand their program.

Bangladesh is known to be surrounded by endemic areas of filariasis, particularly the north-west border area which is adjacent to the Assam and Bihar state of India. Filariasis is most endemic in North-Bengal of Bangladesh. So this disease is being spreaded silently from one district to another district of our country without any notice and day by day is being more dangerous being for our nation. The WHO estimated the number of people at risk from lymphatic filariasis is 49 million in mainly North-West area of Bangladesh. So there should be a continuous surveillance for detection the mode of spread and transmission of this disease. Ignorance is another social risk factor of this disease. In this study it was found that only 20.33% patient knows about filariasis and the rest 79.67% patient does not know at all about this disease, Superstition is the most notable social problem for the disease "filariasis". The program design and monitoring status are very week. Government should make the field health workers to regular follow up visit to their patients' house. There is a filaria endemic focus place in Mirpur-12 under Kurmitola camp of Dhaka city. This has attracted interest for researcher of the Department of Medical Entomology, NIPSOM, Dhaka. The present study reveals that 70.9% patients of all over the study area have no knowledge about filariasis (table-18) and 12.28% patients go to healer for treatment too (table-15). So this disease is also depended on educational status/ knowledge/awareness of the households' people. Some patients of three districts: Lalmonirhat, Nilphamary and Chapainawabganj never go for treatment and the frequency of the patients of those districts was also high (table-14).

According to the source of Lymphatic Filariasis News Letter (May, 2003), there are 23 total endemic districts in Bangladesh. But according to JICA, 2004 (Japan International Cooperation Agency), 34 districts out of a total 64 districts in Bangladesh with about 70 million people are identified are endemic to filariasis. Increased attention has been focused on disability management in Bangladesh.

Globally filariasis is mosquito borne emerging and reemerging disease. It is the worst, most neglected disability, disfiguring disease and have got lowest priority. This have been recognized as a seriously underestimated as a disability, social and economic burden caused by lymphatic filariasis poorly understood and unqualified. Prevalence of filariasis is found in most of the districts in Bangladesh, but highest in the Northern districts especially in greater Rangpur and Dinajpur areas. Thakurgaon is situated in the northern belt of Bangladesh and is bounded by West Bengal, a province of India.

A study in epidemic prone areas like Thakurgaon of Bangladesh has been done and 4.20% of the people were found infected by filariasis. Among the respondents 55.67% were illiterate. The sanitation was very poor and low income groups were more affected and females were more susceptible than males (Rahman *et al*. 2008) They also reported that, it is creating a major health problem in these areas and perhaps spreading silently to the other adjacent districts of our country. In the present study, it was found that Thakurgaon is severely attacked area (62% patients are severly attacked) and this district has higher percentage of patients which is 11.8% (table-12 and table-2).

Epidemiology is the health science that deals with the distribution and determinants of health and illness in populations. Filariasis is one of the most common diseases of developing countries. Microfilaria infection and clinical manifestation rates increased with ascending age group. An endemicity rate of 24.2 % and a medium microfilaria density of 14.0 microfilariae per 20 m3 of peripheral blood indicated a moderately endemic focus of filariasis that serves as a reservoir of infection and constitutes a significant public health problem in Thakurgaon.

In view of the magnitude of the problem and of the differences among the various filariasis which make it impossible to control them all at the same time, and in view of their varying public health importance in different endemic areas, WHO has found it necessary to proceed gradually with a long term program of activities for the control of theses group of diseases. In this program priority has been given to that filariasis which constitutes major public health problems for many countries and in the control of which increasing interest has been shown as a result of recent advances in treatment and prevention (Rahman *et al*. 2008).

Bangladesh is known to be an endemic zone of several infectious diseases. It is one of the poorest countries in the world. It beat a burden of over population. Like other developing countries, people still struggling against poverty, malnutrition and illiteracy. Apart from these, we are facing the burden of many communicable diseases.

All those published and unpublished information shows that filariasis is present in Bangladesh with different endemicity with highest in northern districts of Bangladesh. Thakurgaon district happened to be the area with highest filarial endemicity rate. But no control measure was taken there. Anti-filarial drugs are usually not available. If available in the markets, people are not in a position to buy it because of their poor economic condition. Other factors, such as poor facilities for early detection by blood examinations. Also definitely helped for the continuous presence of the disease in those localities. (WHO Expert committee on filariasis. WHO tech. Rep. 1974; No. 542:5-6.)

Lymphatic filariasis and poverty

It is the disease of poverty so called neglected disease. Because it affects the world's poorest people, 2.7 billion people who subsist on less than $2 per day. The poor people are unhygienic as well as unable to buy mosquito net. They do not know how to control the disease. Moreover they are illiterate and do not know why and how the disease occurs and spreads. Moreover, neither the well-off society nor the government gives the attention to them. So this disease is being remained neglected year after year. This neglected disease is a devastating obstacle to socio-economic development because they debilitate, deform, can make blind and kill. It is relatively easy to understand the significance of death rates and mortality figures. It is more difficult translate chronic disability and illness into a value that is readily understood by public health officials and health advocates in relation to their contribution to poverty. In1998, the World Health report ranked LF as the 4th leading cause of permanent disability (WHO, 1998). Rural to Urban Migration and increasing urbanization, both of which are occurring increasingly in low income countries, facilitate the read of LF. This is mostly due to inadequate waste disposal and sanitation facilities, which increases the number of breeding sites for the mosquito vectors (Even et al. 1993). Present study shows that the higher percentage of female patients was found in Kurigram (77.8%), Lalmonirhat (72.5%), Thakurgaon (72%), Dinajpur (70%), Chapainawbganj (66.7%), and Panchgarh (56.7%). That means, the vulnerable poor people like Border areas as well as insolvent areas' females were more affected than that of central areas (Table-5).

Mostly, patients populated district was Lalmonirhat where only 35.3% household expenditure was above 4000/- taka per month and 11.8% household expenditure was below 1000/- taka per month whereas in Dhaka district's patients monthly household expenditure was ranging from 2000/- taka to above 4000/- taka and 81.2% household expenditure was above 4000/- taka per month where patients distribution was low. So filariasis is depending on solvency of the household that means this disease is a poor people disease (Table-19). Maximum patients (41.9%) had capacity to expend only 3 to 4 thousand taka per month only. 2.6% household expenditure was below 1000/-taka per month. Some patients had no capacity to expend even up to 1000/- only. So, it was observed that the filariasis is a poor people disease (Table-19).

The household expenditure of south zone is higher (77.7% household's expenditure is 2000/--4000/- per month) than that of north zone (63.3% household's expenditure is 2000/--4000/- per month). Simultaneously frequency of patients was lower in south zone than that of north zone. So it can be said that this disease is almost poor people disease. In both zones the affected people are mostly poor (maximum patients' household expenditure is from taka 2000/- to taka 4000/- per month), (table -32).

Pathogenesis

Pathogenesis in filariasis is heavily influenced by the immune responses and the degree of inflammation. They are predominantly responses to the adult worms, primarily females. The clinical phases can be divided into the incubation, acute (or, inflammation), and obstructive stages.

It the individual who exhibit the microfilaria in their blood be reckoned in addition to those who exhibit the pathological effects of filaria diseases, but in whose blood the microfilaria is no longer to be found the incidence of filarial disease in some of the pacific islands is very high as high as 80 %. *B. malayi* is predominantly an infection of rural populations, in contrast to the urban *W. bancrofti.* The periodic form has a focal distribution in Asia in rural area of Ceylon, Thailand, Malaysia, Vietnam, China, South Korea and Indonesia and transmitted by open swamp species of Mansonia and some Anopheline. It is parasite of man and no natural infections have been found in animals. The nocturnally sub periodic from which is transmitted by shade swamp Mansonia and is a natural infection of a variety of animals, is a true zoonosis and is found in Malayi only along the Pahang and Perak rivers. It has however recently been described from palawan island in the Philippines.

According to the physician versions, the symptoms cannot be seen after filaria germs center the body. For diagnosis of the disease, the physician and researchers described that first itching starts in some parts of the body. Blood collection during sleep is only the proper time of examination for diagnosis of the disease. Because during that time, the germs run throughout the body. The germs exist in the body, but no sign and symptoms can be seen on the body. According to the experts 'Benocides' 300 mg should be prescribed for a month to recovery such patient.

Once yearly regimen (selecting among Albendazole and either Invermectin or DEC-diethylcarbamazine), an initiative being launched through the WHO to utilize a strategy of yearly mass treatment to "all risk" population to eliminate lymphatic filariasis as a public health problem by decreasing Mf (microfilariae) in the disease depend in large measure, on community wide awareness, understanding and support for the control Programme.

Habitats and predators of the larvae of the vector of filariasis

Filariasis caused by *W. bancrofti* causes major public health problem in Bangladesh. The permanent solution of this problem will be to alleviate the vectors. *Culex quinquefasciatus* is the vector of bancroftian filariasis in Dhaka city (Begum et al. 1987). The mosquito is known to impoverish in urban areas and breed in stagnant and dirty water. As filariasis is transmitted from one patient to another by the mosquito, so this disease may be controlled through controlling the mosquito breeding places. By using different types of predators in the mosquito breeding grounds, this disease control may be ensured. The easier cost effective control of this vector will be the zoological control like predation of the vector's larvae by the aquatic vectors. So, the present study in Bangladesh was the most logical one.

During the present study larvae of *Culex quinquefasciatus* were found more or less in three types of mosquito breeding grounds, e.g., pit surrounding the tube well, ditch and abandoned pond (Table-55). These are ground level breeding sites. More or less similar types of breeding sites of *Culex quinquefasciatus* have been reported by the following authors:

DeMeillon *et al.*, (1968) observed like the present findings that gravid females, *Culex quinquefasciatus* performed to lay eggs at ground level due to their positive geotaxis. Gravid females of the species also search any kind of water container having a high organic pollution, which is closely associated with human dwellings (Bram, 1967).

Hossain *et. al.*, (1997) recorded that the highest density of mosquito larvae in derelict pond in Dhaka city. Present study also found almost same condition that is the main breeding grounds of the vector of filariasis surrounding the surveyed household in South Zone of Bangladesh are Ditch & Abandoned pond. Main breeding grounds surrounding the surveyed household in North Zone of Bangladesh is Pit surrounding tube well.

The present findings demonstrated that the highest population density of *C. quinquefasciatus* was found during the dry season and the lowest population density during the rainy season. It was observed that there was a peak population of *Culex quinquefasciatus* from November to April. The maximum number of *Culex quinquefasciatus* larvae (12%) were collected in January followed by February (11.77%) and the least in June (4.67%), (Table-56). Similar observations were also made by DeMeillon *et al*. (1967) in Yangon, Rozeboom *et al.*, (1968) in urban

Kolkata, Khan and Ameen (1970), in Dhaka city and Rozeboom *et al.*,(1968) also found the peak population of the species in March, 1966 and February 1967. Therefore it may be concluded that *C. quinquefasciatus* has the maximum population between post-monsoon and pre- monsoon month, i.e., during dry weather.

The chemical insecticides also kill non-target organisms including the natural predators of mosquito larvae (Mulla *et al.* 1975). Pederson, 1985 stated that chemical insecticides are expensive and have a harmful effect on the environment.

Resistance to DDT, Malathion and other organophosphate insecticides by the mosquito of Dhaka city has already been reported (Ottesen, 1997). Use of chemical insecticides for mosquito control is expensive and liable for developing resistance against those insecticides. Mosquitoes of Dhaka city have already developed resistance against some insecticides. On the other hand mosquito control by using biological agents is non-hazardous and could be less expensive if applied judiciously.

The use of predators could be a useful alternative against chemicals in controlling mosquito larvae. A number of fishes and insects has been tested in the laboratory to evaluate their predatory role against mosquito larvae (Chakraverthy *et al*. 1976).

The utility of predator fish as destroyers of mosquito larvae with special reference to their habits and habitat under same ecological conditions is significant. Southwall (1920) found the *Channa* as a useful mosquito larvivore in East India. Russel and Rao (1940) stated the mosquito control by fish can give clear cut result only in certain restricted types of breeding places such as wells, tanks, pools or in any place where vegetation gives little protection to mosquito larvae.

Prashad (1919) discussed the utility of fish as destroyers of mosquito larvae with special reference to their habits, their food under different conditions. They also argued that the mosquito control by use of fish is a cheap and efficient method. Chemical insecticide is expensive and has a harmful effect on the environment. The chemical insecticide also kill non-target organisms including the natural predators of mosquito larvae (Mulla *et al.* 1975; Wolf and Khan, 1972a, 1972b).

Huda and Rahman (1982) performed laboratory experiment in the University of Chittagong. Their study was undertaken to determine the larvicidal potential of eight indigenous fishes of Bangladesh. The fishes were *Amblypharyngodon mola* Ham, *Anabas testudineus* Bloch, *Apocheilus panchax* Ham, *Clarias batrachus*,L., *Colisha fasciata* Bloch, *Channa* spp. Bloch, *Puntius ticto* Ham and *Rasbora daniconius* Ham.

Hossain *et al.* (1997) performed laboratory experiment in the University of Dhaka. Their study was undertaken to determine the larvicidal potential of 20 aquatic species. Among those 20 species, six species were indigenous fishes of Bangladesh like *Anabas testudineus, Clarias batrachus, Colisha fasciata*, *Channa* spp, *Lebistus reticulaus*, *Oreochromis* spp. Eight species were found in different breeding grounds of mosquito larvae in the present study like- *Clarias batrachus (Linnaeus, 1758) Oreochromis mossambicus (Peters, 1852) Anabas testudineus (Bloch, 1792) Colisa fasciata (Bloch and Schneider, 1801) Channa striata (Bloch, 1793) Channa orientalis (Bloch and Schneider, 1801) Channa punctata (Bloch, 1793)* and *Poecilia reticulata (Peters, 1859).*

Hossain *et. al.,* (1997) reported that domestic stagnant water harboured the highest concentration (29.2%) of *C. quinquefasciatus,* followed by kutcha drains (23.6%) and pucca drains (21.3%). Altogether 21 different predators were collected of which *Ranatra elongate* and *Naucons* sp were found in most of the breeding grounds. Guppy fish, *Poecilia reticulata*, was common in the drains. The present study revealed that the maximum percentage (75.07%) of *Culex quinquefasciatus* were found from Pits surrounding the tubewell followed by abandoned ponds (20.68%) and then ditches (4.25%),(table-56).

The present investigation observed that pit surrounded the tube well (i.e. domestic stagnant water) harboured the highest concentration (75.07%) of *Culex quinquefasciatus*, followed by abandoned pond (20.08%) and ditch (4.25%),(Table-

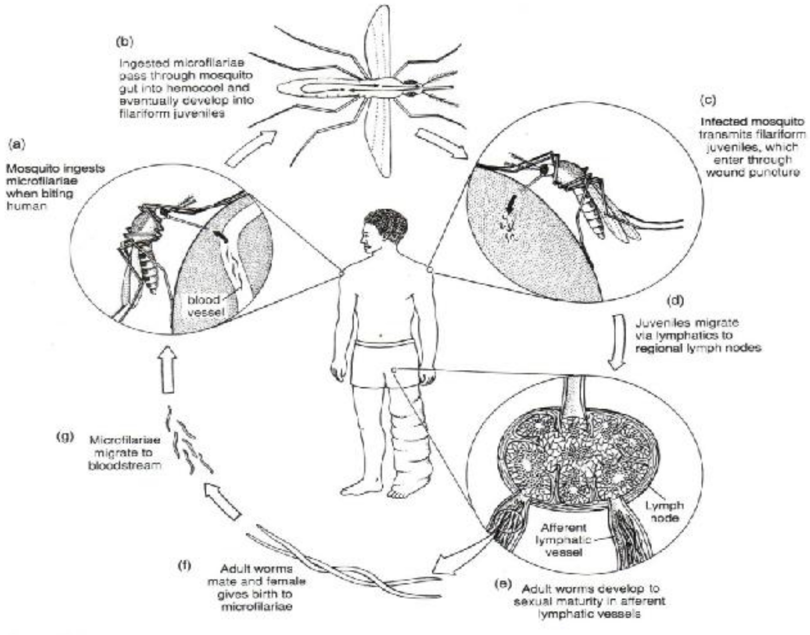
56). All together eight species of fish predators were collected of which *Clarias batrachus (Linnaeus, 1758) was* found in all of the breeding grounds but *Poecilia reticulata (Peters, 1859)* is the highest population among all predators found only in the ditch (table-58) which was supported by Barraud,(1934) reported that *Culex quinquefasciatus* generally breeds in domestic collections of water. It was also mentionable that larval habitats of *Culex quinquefasciatus* were septic tank and any type of stagnant water with organic contamination (Raghavan, 1961; Aslam Khan and Salman, 1969.) *Culex quinquefasciatus* breeds in wells, pools and other stagnant water collections with different degrees of organic contamination and it was also similar to the present study.

Hossain *et. al.,* (1997) studied the orders Odonata and Hemiptera and some fishes collected from mosquito breeding grounds of Dhaka city, were allowed to feed upon different larval instars of *Culex quenquefasciatus* say to determine their predation capacity. Among the fishes *Clarias batrachus* consumed the highest number of larvae (26,189.5 per day) followed by *Oreochromis nilotica* (4,770.5 per day). All the three different sizes of guppy fish consumed mosquito larvae, the newly hatched fingerlings consuming as many as 2504 first instars mosquito larvae per day and an adult guppy consumed on an average 145.7 larvae per day. These findings are more or less similar to the findings of the present study, that is *Clarias batrachus* consumed the highest number of larvae (24372.76; per day) followed by *Oreochromis mossambicus* (4915.48 per day) and an adult guppy consumed on an average 145.53 larvae per day (table-53).

Hypothesis of nocturnal periodicity

There are several hypotheses have been contributed to explain nocturnal periodicity. There is chemotactic attraction between the microfilariae and the saliva of mosquito hosts, which are more plentiful at night. The relaxation of host during sleep induces the microfilariae to migrate into the peripheral circulation (Vanamali and Ramaiah, 1991).

The migration resume from a response to oxygen and carbon dioxide supply. The microfilariae survive for only a short period and it is during the nocturnal period that they are most abundant and are readily found in the peripheral circulation.



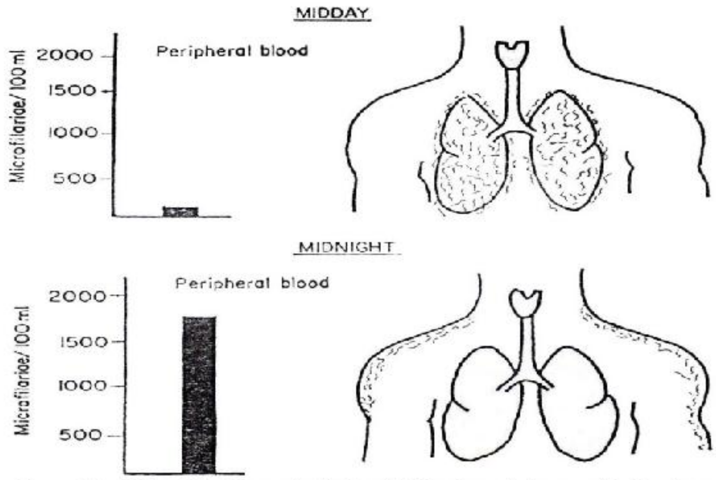


FIG. 16. Microfilarial periodicity of *Wuchereria bancrofti*. During the daytime the microfilariae are held in the lungs by a 'retention factor' which is not operative, or below its threshold at night. It has been suggested that the periodicity is related to a circadian rhythm in the host, and oxygen tension has been implicated. The biological advantage is that the microfilariae are present in the peripheral blood at the same time that the mosquito vector is feeding.

Plate-25: Nocturnal Periodicity

Other Related works already performed in the country

Several works and investigations have been done on vector borne diseases eg. Leishmaniasis, PKDL, malaria, filariasis, hydrocoel and human intestinal worms and protozoan parasites with nutritional deficiencies and clinical aspects, skin diseases, Urinary tract infection in collaboration with other Institutions such as, ICDDRB, NIPSOM, IEDCR.

A significant amount of research work on filariasis had been done for a long time and is still going on. An epidemiological survey on multistage stratified sampling scheme was carried out by the Malaria Institute of Pakistan through 1969-73 in the districts of Dinajpur and Rangpur to determine the prevalence and distribution of filariasis. In the districts of Dinajpur a total of 12426 examinations in different area results a microfilaria rate of total 14.18%. Similarly in the district of Rangpur a total examination of 6536 persons resulting a microfilaria rate of 7.92 % (Institute of Epidemiology, Disease Control and Research, 1977 unpublished document).

Barry *et al*, (1971) surveyed Thakurgaon to determine the prevalence and distribution of human filariasis. Emaciation of microfilariae and clinical manifestation was obtained from peripheral blood smears and physical examination of 9624 inhabitants. The microfilaria rate of 16.86 represented infection by *Wuchereria bancrofti* of natural periodicity. The clinical manifestation rate of 10 % consisted primarily of genital hydrocoel and elephantiasis in the scrotum in the male population and Lymphoderm and elephantiasis of the limbs were observed in both sexes. The neighboring districts like Rangpur and Pabna, as well as Barisal in the south also had relatively high prevalence and positive cases were found throughout the Chittagaong Hill tracts. A highly endemic focus was found among tribal people in the Matamuhuri river valley. This emphasized the focal nature of filariasis infection, which seems to be true through Bangladesh. Only a few instances of microfilariae were found in Dhaka city. Positive cases were found in the two extreme corners of Bangladesh, Tetulia in the North-West and Teknuf in the south-east. Although much attention has been paid to MDA and steps taken to prevent disability and control morbidity associated with lymphatic filariasis. Existing clinics were used so far on temporary basis to treat clinical filariasis and to impart health education on prevention of secondary infection. Training program on hydrocoelectromy has been held in some districts of Bangladesh with Japanese assistance and hospital has been set up as an active center for the treatment of lymphoedema and hydrocoele.

Wolf and Khan (1972) studied in two villages in Thakurgaon Upazila and found high microfilaria rate and they tried to prove that filariasis existed in the locality for a quite long time and not introduced from imported cases of Bihari population who migrated to Pakistan after the partition of India in 1947. They also worked on night microfilaria and revealed that Dinajpur have the highest prevalence of filariasis and hydrocoel was also common. Hydrocoele has been recognized as a common occurrence in the district for over 100 years and the doctors at the local hospital perform surgical repair of hydrocoele. Bary *et al.* (1971) investigated filariasis in entire Thakurgaon. His survey were made in 39 institutions, consists of 27 hospitals and 12 students hostels, and results of blood of 41,900 persons and 3% people was positive. Practically all the infected persons were born in and lifelong residence of Bangladesh. Rahman *et al.* (2008) worked on prevalence of filariasis in Thakurgaon and its occurrence among the sexes and different age groups of the population.

A survey on filariasis was carried out by researchers in two villages of Dinajpur in June, 1977 (Sujalpur and Noapara) and it was found that, out of 716, there were 80 clinical positive cases and 75 microfilaria cases were identified. The microfilarian infection rate of Sujalpur village 0.44% and corresponding endemicity rate was 24.77%. The inhabitants of Sujalpur are almost Muslims with a good scope of education and living a moderate status of life, while the inhabitants of Noapara village are almost schedule cast and economically with very poor status and little knowledge of health education. In 1983, a survey was carried out by NIPSOM in Thakurgaon district; it was found that, the microfilaria rate in blood examination was 27.13%. Very recently, another observation on filariasis in endemic prone area Thakurgaon of Bangladesh was done by Khanum and Rahman (2005-2007). They reported that

4.20% of the people were found infected by filariasis. And among the respondents, 55.67% population was illiterate, the sanitation of the study areas were very poor, most of the people were very poor and of low income groups and the females were more susceptible than male.

Khanum and Islam (2013) worked in the Northern part of Bangladesh, especially in Kurigram, Lalmonirhat and Chapai Nawabgonj district, three villages were selected randomly from each sadar upazilla to find out the current status and risk factors for the disease filariasis. They observed that the filariasis in Kurigram was 14.33%, in Chapai Nawabgonj was 4.11% and in Lalmonirhat it was 3.12%. The highest prevalence was found in the age of 31-40 years. Illiteracy is one of the important social risk factors of this disease. It was found that 56.27% patients were illiterate. The second and third highest infected people were maktab (18.38%) and primary educated (17.27). It was found that the highest number of infected people was unemployed (15.32%) and the second highest group was rickshaw puller (29.53%) and third highest group was others (beggars, children etc) (13.84%) and the fourth was day labour (12.48%). Most of the low incoming people are unhygienic and they are unable to buy mosquito curtain, aerosol, coil or others repellent.

Khanum and Sarker (2006) worked on hydrocele in epidemic area Thakurgaon in Bangladesh and reported that, Thakurgaon is known to be endemic area of hydrocele. The prevalence of hydrocele was 17.25%. Most of the respondents were poor and ignorant about the cause and transmission of the disease. They also reported that, it is creating a major health problem in these areas and perhaps spreading silently to the other adjacent districts of our country.

Rahman *et al.* (2008) worked on current status, endemicity and prevalence of filariasis in Thakurgaon and its occurrence among the sexes and different age groups of the population. The concise findings are as follows.

- Geographical information based data could be used for visualizing current trends of filaria infection and apparent risk up to specific level

- GIS based risk map developed in this study could be followed to develop similar risk map for certain important vector born diseases in Bangladesh
- Further studies should be targeted to eliminate the risk of filariasis not only for endemic district but for all over Bangladesh
- An immediate control programme should be targeted to control vector species in the endemic areas
- Computer network should be facilitated between Thana Health Complexes with the Civil Surgeon's Office and M&PDC unit for immediate notification of the epidemics and its control

Achievements :

1. MDA done among 33.0 million populations of 19 districts with >80% coverage
2. 8,908 Lymphoedema patient were trained on morbidity control management
3. 50,000 Kit Box were distributed among Lymphoedema patients of 10 districts.
5. About 19 million of 6-12 years school age children of 64 districts were de-wormed
6. 25,119 school teachers were trained on STH control, sanitation and hygiene.
7. Training of Doctors, District & Upazila manager, Paramedic, Health Worker, Formal/ informal leaders, Teachers, NGOs workers, Medical Technologists were conducted

8. Social awareness through IEC activities-

   i. Advocacy meeting

   ii. Audiovisual- Documentary spot, docudrama, TV spot, Radio jingle

   iii. Advertisement through Mass media-Newspaper, Radio, Television

   iv. Poster, leaflet, festoon, billboard, newsletter, training module etc.

9.0 Microfilaria survey was conducted in 12 districts and no Microfilaria-positive cases were found.

On-going activities :

a) Mass Drug Administration (MDA) : By Tab (Diethylecarbamazine) DEC and Tab Albendazole once in a year (Nov.) in 21 districts/ IU (Implementation unit-District).

b) Morbidity control & Hydrocele operation.

Social Mobilization / IEC activities :

a) Advocacy meeting

b) Audiovisual- Documentary spot, docudrama, TV spot, Radio

c) Advertisement through Mass media- Newspaper, Radio, Television, Poster, leaflet, festoon, Billboard, Newsletter, Training module etc.

d) Morbidity Control Kit Box distribution

e) Microfilaria Survey & survey to detect the stage of elimination after 5 round of MDA according to WHO protocol

f) Post MDA Coverage Survey: 79% coverage in 2008, 85% in 2011.

g) MDA was scaled-up to 21 Districts till 2014. Program started in 2001.

h) Mass Drug Administration (MDA) : By Tab (Diethylecarbamazine) DEC and Tab Albendazole once in a year (Nov.) in 21 districts/ IU (Implementation unit-District).

i) Yearly Mass Drug Administration (MDA) with DEC (Diethylcarbamazine) and Albendazole to all “at risk” population for at least five years.

j) Morbidity control by community-level care of:

- Lymphoedema
- Acute inflammatory attacks
- Hydrocoele

k) LF elimination as a public Health Problem is defined as:

- Microfilaraemia rate < 1%
- Evidence that there is no new parasitic infection in the community i.e. 5-Year cumulative incidence in children born in a given implementation unit (IU) after the start of MDA, is less than 1 per 1000 children.

Criteria for stopping MDA (flow chart)

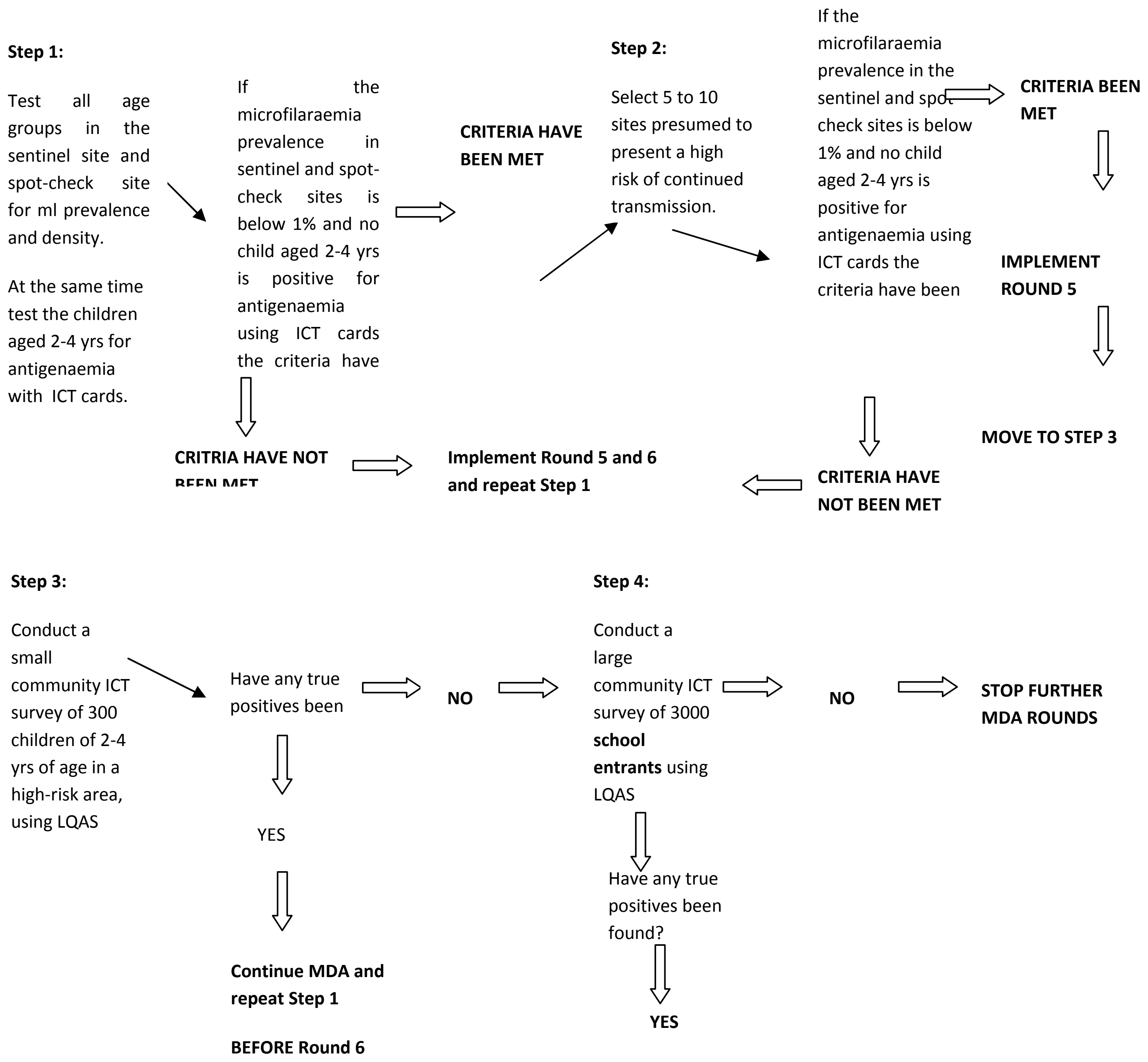


Plate-26: Criteria for stopping MDA (flow chart)

Chapter-6

SUMMARY

The present study was recruited and compiled out mainly in the two extreme poor zones like north and south zones of the country. The name of those 20 districts are Panchagarh, Thakurgaon, Nilphamary, Lalmonirhat, Kurigram, Dinajpur, Rangpur, Gaibandha, Chapainawabganj, Sylhet, Mymensingh, Norshindhi, Dhaka, Narail, Gopalgonj, Barisal, Pirojpur, Bagerhat, Jhalakathi, Barguna. Among those 20 districts, patients are not found in 6 districts namely Norshindhi, Mymensingh, Narail, Sylhet, Gopalganj and Bagerhat (table-1) and three districts like Gaibandha, Sylhet, Mymensingh are non-endemic area of filariasis (table-3).

The objectives of this study were to find out the prevalence of lymphatic filariasis in different zones/districts of Bangladesh; to determine the socio-economic characteristics and the infrastructural condition of the community for participation in prevention and elimination of this disease; to study the attitude, practice and level of knowledge of the community towards the causes, preventions and control measures of filarial disease; to find out the magnitude of negligence to lymphatic filariasis; to determine the factors which make the growth prevalence of lymphatic filariasis; to find out the cost effective and safe way control of the vector of lymphatic filariasis; to study the effectiveness of predation by fish as a control measure of the vector of lymphatic filariasis; to find the availability and suitability for surviving the mosquito larvae and their predators in the same water bodies surrounding the lymphatic filariasis affected patient’s house.

The study design is a multistage sampling design with stages of selection at the levels like districts, Upazillas, villages, and patient’s house and water bodies. District maps were used to select the sampling sites. Within selected sites, patients and their selected family member and selected member of community people, health institute, NGO-staff have been interviewed. Mosquito larvae and their predators were collected from same different types of breeding grounds of different locations in the selected areas.

The study was carried out from door to door through recordings in the questionnaire and beside this, the environment of their household was observed carefully to find out whether their environment was suitable for mosquito breeding or not.

The Lymphatic filariasis (LF) has been recognized for more than 4000 years. The disease is endemic in 83 countries with more than a billion people at risk of infection and 120 million people clinically affected worldwide (Ottesen 2000). Nearly 60% of the lymphatic filariasis problem is in the South East Asia Region. Since the prevalence and intensity of infection are linked to poverty, LF elimination can contribute to achieving the United Nations Millennium Development Goals. LF is primarily a disease of the poor in tropical countries (Molyneux *et al.* 2003). Young, unmarried women with LF are unable to abide by the standards set by society, due to limited marriage prospects (Wynd *et al*., 2009). Men with LF share similar sentiments, especially in regards to marriage and employment problems (Wynd *et al.*, 2009). Filariasis caused by the parasite called *Wuchereria bancrofti* creates major public health problem in Bangladesh. This disease is being neglected year after year. According to JICA (2004), thirty-two out of total 64 districts in Bangladesh with about 70 million people are identified as endemic to filariasis in mainly North West area which is the relatively poor area of Bangladesh. In this connection, increased attention has to be focused on disability management in Bangladesh. Ameen and Moizuddin (1973); Ameen *et al.* (1982, 1984) and Ahmed *et al.* (1986, 1989, 1991), *Culex quinquefasciatus,* the vector of Bancroftian filariasis in Bangladesh, is a domestic mosquito. Bancroftian filariasis is found in different parts of Bangladesh with high prevalence rate in northern districts. The permanent solutions of this problem will be to alleviate its vector. *Culex quinquefasciatus* is the vector of bancroftian Filariasis (Begum et al. 1987).

In recent years, many national vector control operations have been facing difficulties technically on account of the increases insecticide resistance in many vector species like mosquitoes and operationally on higher cost of the alternate insecticides. The easier cost effective control of this vector will be the biological control like predation of vector's larvae by the aquatic predators. As filariasis is transmitted from one patient to another by the mosquito, so this disease would be prevented through controlling the mosquito breeding. The use of predators could be a useful alternative against chemicals in controlling mosquito larvae. So this study in Bangladesh was the more logical one.

Huda and Rahman (1982) performed laboratory experiment in the University of Chittagong. Their study was undertaken to determine the larvicidal potential of eight indigenous fishes of Bangladesh. The fishes were *Amblypharyngodon mola* Ham, *Anabas testudineus* Bloch, *Apocheilus panchax* Ham, *Clarias batrachus*,L., *Colisha fasciata* Bloch, *Channa* spp. Bloch, *Puntius ticto* Ham and *Rasbora daniconius* Ham.

Hossain *et al. (*1997) performed laboratory experiment in the University of Dhaka. Their study was undertaken to determine the larvicidal potential of 20 aquatic species. Among those 20 species, six species were indigenous fishes of Bangladesh like *Anabas testudineus, Clarias batrachus, Colisha fasciata*, *Channa* spp, *Lebistus reticulaus, Oreochromis* spp. Among the fishes *Clarias batrachus* (Linnaeus, 1758), consumed the highest number of larvae (26,189.5 per day) followed by *Oreochromis niloticus* (4,770.5 per day). All the three different sizes of guppy fish consumed mosquito larvae. The newly hatched fingerlings of guppy consumed as many as 25.4 first instars of mosquito larvae per day and an adult guppy consumed on an average 145.7 larvae per day (Hossain *et al.* 1997).

There has also been a spontaneous decline in prevalence of filariasis, which was associated with improvement in economic status of the community and in sanitation and with effective mosquito control (WHO, 1998). Travis (1957) reported that fish can be used as predators of mosquito larvae because their population can be maneuvered by man, they are quite tolerant of a variety water conditions and they can be moved to water areas where they needed.

On the basis of the above mentioned circumstances, different aspects of Lymphatic filariasis in Bangladesh including its epidemiological aspects, knowledge attitude and practices of the people and the scope of its prevention by using some fish predators were studied in the present study.

Through this study it was found that the highest frequency of patients found in Lalmonirhat (12.1%) and Thakurgaon (11.8%) followed by Gaibandha (10.2),(table-2). The 69.2% patients are found in north zone and 30.8% patients in south zone (table-4). 89.81% patients are found in endemic area (17 districts) and 10.18% patients are found in non-endemic area (3 districts), (table-3). There was no patient in age group (0-10), the highest number of patients is found in age group (41-50) and gradually decreasing with the age (table-6). Most patients' populated district is Lalmonirhat where only 35.3% household expenditure is above Tk. 4000/- per month and 11.8% house hold expenditure is below Tk. 1000/- per month (table-19). In both zones (south and north), the affected people are mostly poor because maximum patients' household expenditure is ranging from taka 2000/- to taka 4000/- per month (table: 32-33). So the proverb like 'filariasis is a poor people disease' is endorsed. 70.9% patients of all over the study area have no knowledge about filariasis (table-18). Still some patients (12.28%) go to healer for treatment rather than doctor and health complex (table-15). So this disease is also depended on educational status/ knowledge/awareness of the households' people. About 91% patients are suffering in leg swelling followed by hand swelling (7.35%) and about 0.5% and 1.18% patients are suffering in breast and scrotum swelling respectively (table-13). Through this study it was also found that the eight species of fishes were available in different breeding grounds of mosquito larvae in the study area like- *Clarias batrachus (Linnaeus, 1758), Oreochromis mossambicus (Peters, 1852,) Anabas testudineus (Bloch, 1792), Colisa fasciata (Bloch and Schneider, 1801) Channa striata (Bloch, 1793) Channa orientalis (Bloch and Schneider, 1801) Channa punctata (Bloch, 1793) and Poecilia reticulata (Peters, 1859)* (table-58). Among these fishes *Clarias batrachus* consumed the highest number of mosquito larvae (24372.76; per day) followed by *Oreochromis nilotica* (4915.48 per day) and an adult guppy consumed on an average 145.53 larvae per day (Table-53) which is more or less similar to the findings of other previous study (Huda and Rahman,1982) and (Hossain *et al.*,1997).

Main breeding grounds surrounding the surveyed household in South Zone of Bangladesh are Ditches and Abandoned ponds. Main breeding grounds surrounding the surveyed household in North Zone of Bangladesh is Pit surrounding the tube well (table-55). So more effective breeding grounds for the vector of filariasis; like-*Culex spp*. is more in north zone than that of south zone. So north zone is more affected than south zone. The fewer patients of endemic district has gone for treatment to the health complex than that of non-endemic district and again the more patients of endemic districts has gone to healer than that of non-endemic district (table-41). This is one of the reasons of the prevalence of filariasis in the endemic area.

So it may be also summarized that this disease is poor people disease because of their standard of living. So the extreme poor area like north zone is the most affected area in Bangladesh. Endemicity of this disease is also depend on the lack of awareness, unhygienic behaviour of the people and unhealthy household condition and living place surrounded by the mosquito breeding grounds.

Mainly ditches and ponds are located in south zone but pit surrounding the tube well is the main breeding grounds in north zone. Pit surrounding the tube well is more effective breeding ground of *Culex spp.* So north zone is more affected than south zone. So the study findings suggest for culturing suitable fish in the breeding grounds of mosquito larvae as a preventive measure against filariasis which will be safe for health and cost effective.

The study findings also suggest taking poverty alleviation program including holistic approach of development for the poor people for upgrading their economic condition and also for upgrading their socio-cultural condition; increasing awareness; changing attitude; increasing knowledge towards preventions, causes, treatment of this disease and taking safe way control measures of the vector of filarisis.

Chapter-7

RECOMMENDATION AND CONCLUSION

In view of the magnitude of the problem and the differences of the various filariasisand in view of their varying public health importance in different endemic areaswhich make it impossible to control them all at the same time.Increasing interest has been shown as a result of recent advances in treatment and prevention (Raghavan, 1957; Well *et al*. 1997; Well *et al*. 1987).

Local foci of high prevalence are often surrounded by non-endemic areas. High prevalence of infection depends on large reservoir of infection and abundant vector breeding places. It has been stated that some breeding of *C. fatigans* can occur even in villages, depending upon amount of sullage and the method of disposal.

Chemotherapy will induce sustained reduction of filariasis in the endemic areas.The beneficial effects of physical and mental growth, physical fitness and other functions have been demonstrated with chemotherapy. We should develop an effective and comprehensive strategy for the control of elephantiasis and hydrocoele.

Filariasis Elimination Programme in Bangladesh depends on MDA and sustainable morbidity control, but at the same time, importance is to be given on mosquito control. As the elimination programme has already been started, direct vector control measures may be challenging, Efforts may be taken to educate people about this and integrated vector management is to be undertaken.

Reduction of man vector contact is also necessary using insecticide treated net (ITN). As the sufferers are poor and neglected people in the society, ITN may be distributed free of cost from Government and NGO level and also ITN should be made available in local markets at a subsidized rate.

Although, the general pattern in the population biology and microfilaria rate indicate that, infections and epidemic have acquired and spread gradually and compelling circumstantial evidence from various references indicate that, filariasis migrate from one district to another district of Bangladesh through the vectors of the disease and other modifying climate factors are associated with the disease in the country. Research on filariasis and climate change and health is to be done.

The list of risk factors of lymphatic filariasis includes:

Biological risk (Mosquito bite)
Social risk (Ignorance, Poverty, Illiteracy, Negligence)
Border countries and international travel
Developing country with poor infra-structure
Tropical climate and climatechanges

LF is the second leading cause of disability worldwide and is primarily a disease of the poorest of the poor. Despite this, there is a limited socio-cultural research into the burden of disability associated with LF (Wynd *et al* 2007). In depth qualitative research exploring disability from the client, family, community and service provider perspectives is limited. There is a need to find out the level of disability at various stages of the disease (i.e., acute vs chronic). This information is vital for public health planners for cost rehabilitation needs within LF endemic communities (Dreyer *et al* 2002). There is a need for identification of measurable and operationally feasible indicators for assessing the impact of interventions, availability of affordable quality diagnostics to measure progress of interventions, development of easily-applicable tools for assessing when to end interventions and cost-effective and sustainable simple strategies for management of lymphoedema.

There is a need for huge social mobilization and advocacy for high coverage of MDA, morbidity control, its sustainability, strong surveillance system, partnership with GO-NGOs, GIS mapping and researches on climate change and research covering use of DEM and ALOS satellite photo to understand more detail about environmental (land-cover) situation including elevation, vegetation, vector abundance etc at areas where there more 10 LF cases per 1000 population.

Ministry of Health and Family Welfare (MoH&FW), Bangladesh obviously cannot achieve the goal of elimination of filariasis by 2015 by themselves. Strong political commitment of the MoH&FW to follow the National Guidelines and Strategies for control, elimination and eradication of parasitic diseases is necessary. To achieve the goal of timely elimination of LF strong political commitment, good governance, strong international cooperation, support from NGOs and partnership development through GO-NGO collaboration are very important. NGOs must be involved for health education, social mobilization, morbidity control and other services required for elimination of Filariasis including vector control, environmental management, improvement of water and sanitation, hygiene etc.

Government must support and cooperate to conduct various researches on climate change, environmental factors, identification of measurable and operationally feasible indicators for assessing the impact of program interventions, quality diagnostics to measure progress of interventions, safe way control measuresofthe vector of the disease. Implementation research for the management of lymphoedema, with the help of national and international researchers, research organizations and support from donors and NGOs.

The strategy proposed by WHO (2010) to achieve thegoal of elimination comprises two components:

1. Interruption of transmission of filarial infection through drasticreduction of microfilariae(MF) prevalence levels;
2. Prevention and alleviation of disability and suffering in individuals already affected by LF.

Interruption of transmission of infection can only be achieved if the entire population at risk is covered by yearly mass drug administration (MDA) for a period of long enough to ensure a reduction in the MF level in the blood to a point where transmission can no longer be sustained. The following recommended drug regimens must be administered once a year for at least successive 4-6 years, with coverage of at least 65% of the total at-risk population.

A third option is to follow a treatment regimen using DEC-fortified cooking salt daily for a period of 12 months 6 mg/kg diethylcarbamazine citrate (DEC)+400mg albendazole (WHO Report 1998- 2007, Ottesen *et al.* 1997).

However, successful timely elimination of lymphatic filariasis depends on political commitment, community wide awareness, understanding and support for the program for high compliance of MDA and morbidity control by regular washing, physiotherapy, elevation of affected part and applying tourniquet and surgery for hydrocele.

There is an urgent need for researchers to investigate further the potential impact of climate changes on the transmission of neglected tropical diseases (NTD). So poverty is another important social risk factor for this disease filariasis. Government initiative for prevention and control of filariasis in the study areas is not sufficient. It can be reveal that the endemicity of filariasis also due to the environmental conditions and climatic factors which are very much suitable for breeding of the vector. Investigation on climate change is required so that people might be able to adopt or if necessary migrate to overcome the increased risk for transmission of NTD caused by the climate change. At the same time, vectors can adopt with the changing environment for their survival. As a result of this many known vectors might disappear but at the same time many new vectors might emerge.

On the basis of present study the following recommendations are considered appropriate and worthy to be pointed out:

- Government should take necessary steps for upgrading the techniques of Kala-azar, Filaria and Malaria in its Diagnosis, Prevention and Control measures.

- All of health workers those are related with the elimination program of Vector borne disease should be well trained about recent technique to his/her related works.

- All important diagnostic techniques and drugs those are used as worldwide for treating of Filaria and Malaria should be imported and distributed to the specially endemic areas of the country.

- The people should be educated with modern ideas on health problem and its solution through health education program by the competent authority.

- Mass Media (Newspaper, Radio, Television etc) should be utilized to create good knowledge about Filaria and its prophylaxis.

- Efforts to interrupt transmission and eliminate LF as a public health problem will certainly depend on effective mass chemotherapy campaigns and other public health strategies, including vector control where appropriate. However, to increase the success of elimination strategies, the socio-cultural understandings of affected community groups are pivotal in achieving sustainability, local participation and ownership.

- Early evidence suggests that long-term efforts to eliminate the disease may fall short of elimination in areas where community acquiescence has been replaced by distrust, engendered by misguided communication and vertical program delivery, or a shift in local power structures.

- Strategies responsive to community socio-cultural understandings will have key roles in reversing this trend and in addressing the disability burden that is currently only superficially understood in affected communities. If disability is detected early and correctly managed, the negative economic and psychosocial consequences may be averted.

- To sustain interruption of the LF transmission cycle and prevent this disease's negative impacts on future generations, socio-cultural analysis must be brought into the mainstream of LF elimination efforts. By ensuring that socio-cultural perceptions are critical in developing program strategies and policies, we stand a much greater chance of eliminating LF.

- To study the knowledge, attitude and practices of the people of the selected areas, towards vector borne diseases, especially filariasis and to plan, implement and evaluate an educational program for development of their knowledge, attitude towards the desired health habitats; the development is obviously the major requirement for the ultimate achievement of a fully satisfactory nutritional and health status. But development is a slow process, and there is growing evidence that the use of direct health environmental interventions can bring about a substantial improvement in health status, especially in infants and young children before development has occurred. The technical feasibility of alternative intervention has been demonstrated in numerous projects involving, for instance, nutritional program, improvement of water quantity and quality, the provision of preventive services and provision of curative clinical care.

- The study findings suggest for culturing suitable fish in the breeding grounds of mosquito larvae as a preventive measure against filariasis. The study findings also suggest taking poverty alleviation program for the poorest of the poor not only for upgrading their economic condition but also for upgrading their socio-cultural condition; increasing community participation in infrastructural condition, increasing awareness; changing attitude; providing health knowledge towards the causes, preventions and safe way control measures of filarial disease.

Conclusion: Filariasisis mainly poor people disease because of their illiteracy and unhygienic-unhealthy living of standard. The lack of awareness, poor water-sanitation condition and living place surrounded by the mosquito breeding grounds are also responsible for endemism of this disease in poor area. So the north and south zone are affected by this disease which is poverty stricken area of Bangladesh. The extreme poor area like north zone is the most affectedarea by filariasis in Bangladesh. Therefore, taking poverty alleviation program along with social safety net program in holistic-development approach for the poorest of the poor is necessary not only for upgrading their economic condition but also for upgrading their socio-cultural condition; increasing community participation in infrastructural condition, increasing awareness; changing attitude; providing knowledge towards the causes, treatment preventions of the disease and safe way control measures against the vector of filariasis. The prevention mechanism of this disease should be the predation of larvae by fish predators which will be safe for health and cost effective. Mainly ditches and ponds were located in south zone but pit surrounding the tube well, themore effective breeding grounds for the vector of filariasis; like-*Culexspp* were found in north zone. So north zone is more affected than south zone. The suitable fish may be cultured in the concerned breeding grounds of predation of mosquito larvae.

Chapter-8

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Chapter-9

APPENDIX

Photograph:

Collection of mosquito larvae and their predators

Plate-27: Collection technique of mosquito larvae and their predators

Plate-28: Collection technique of mosquito larvae and their predators

Plate-29: Collection technique of mosquito larvae and their predators

Plate-30: Collection of predators of mosquito larvae.

Observation of consuming capacity of the predators of mosquito larvae

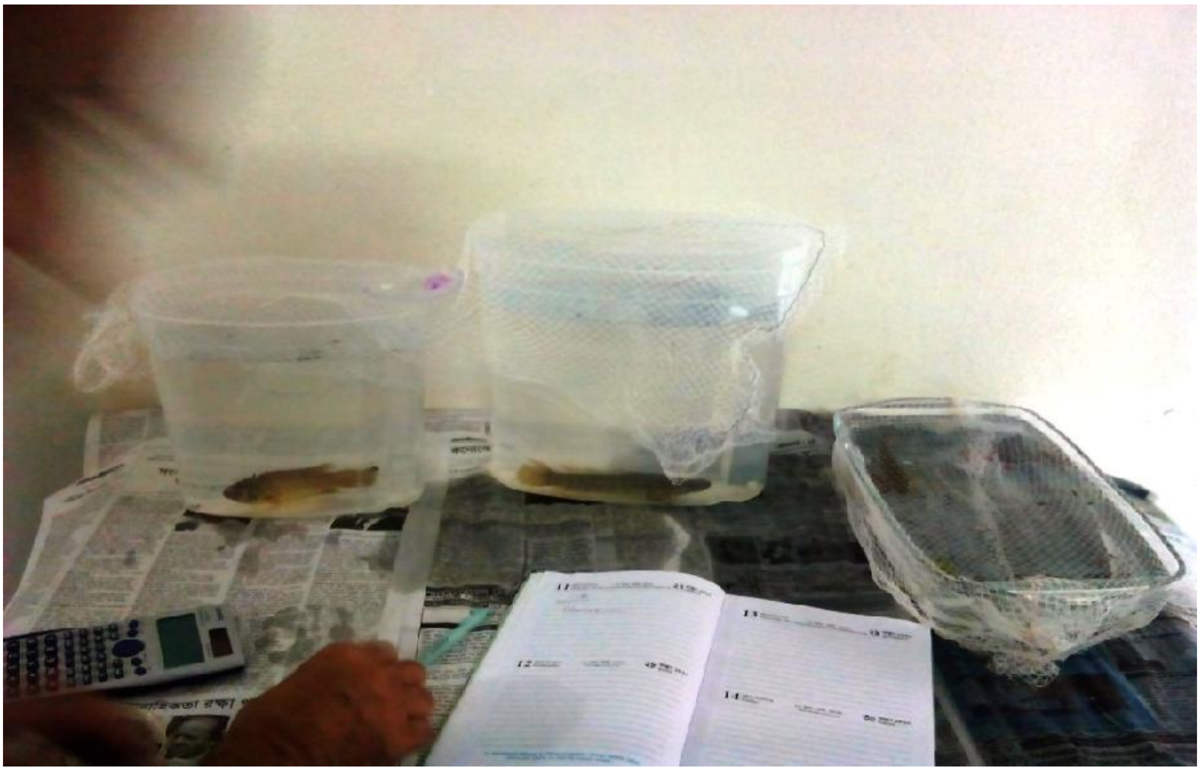

Plate-31: Observation of consuming capacity of the fish predators

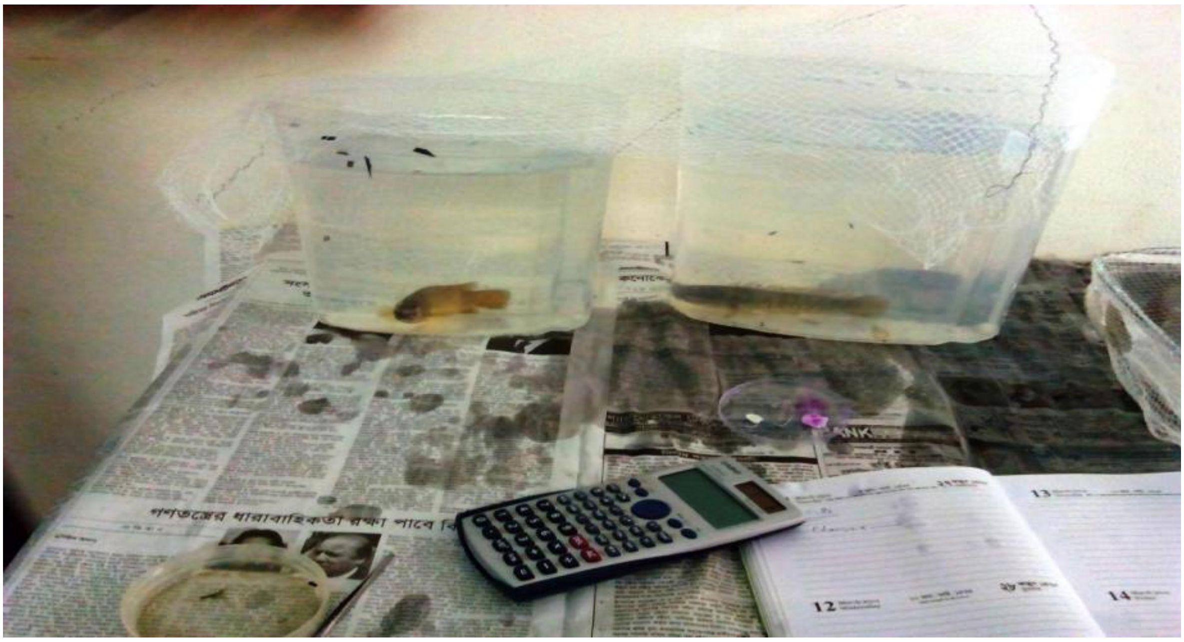

Plate-32.Observation of consuming capacity of the fish predators

Plate-33.Observation of consuming capacity of the fish predators

Visit to the Filaria Hospital atSavar, Dhaka

Plate-34. Visit to Filaria Hospital at Savar, Dhaka along with the honorable supervisor of the study and other experts

Filaria patients from different area of Bangladesh

Plate- 35.Patients found in different area of Bangladesh

Treatment by the Local Healer

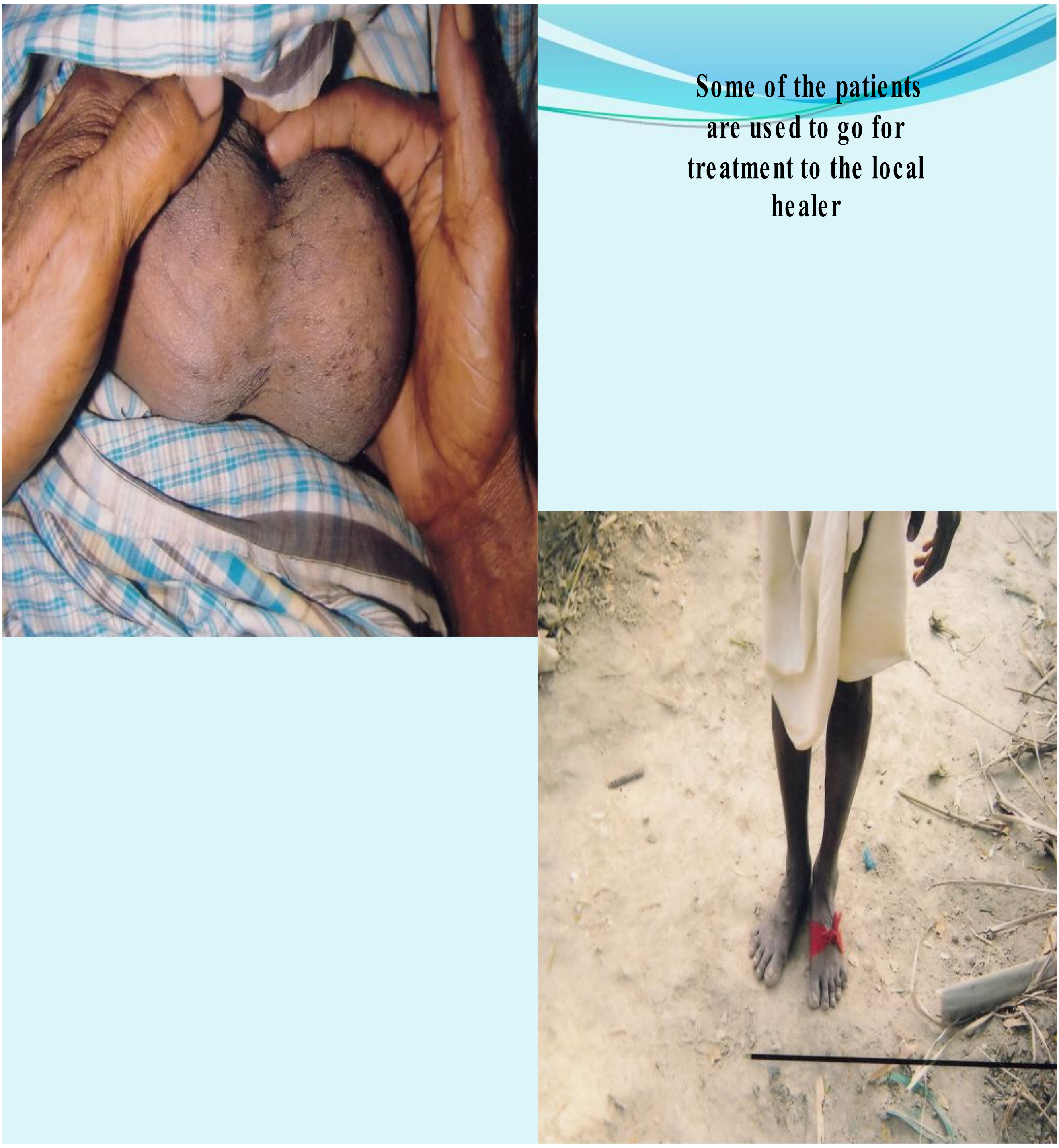

Plate- 36.A significant Patientis used to go for treatment to the local healer rather than doctors/clinic/hospital.

Breeding grounds of mosquito larvae in south zone

Breeding grounds in south zone

Plate- 37. Pictures of different breeding grounds in south zone

Plate- 38.Pictures of different breeding grounds in south zone

Plate- 39.Pictures of different breeding grounds in south zone

Breeding grounds of mosquito larvaein north zone

Plate- 40.Pictures of breeding grounds in north zone

Several FilariaConcerned Pictures are found in Internet

Plate-41.Concerned Pictures are found in Internet

Plate-42. Patients of filariasis found in Internet

Plate-43. Patients of filariasis found in Internet

Questionnaire used for the study

Questionnaire

Risk Factors and Clinical Features For Filariasis In Different Areas of Bangladesh

1.Study Area --------------------------

2.Personal ID -----------------------

3.Sex: a) Male b) Female

4.Age:

5.Weight

6.Educational status:

a) Illiterate b)Can sign only c) Primary d) Above

7.Is there any breeding ground around the house? ☐ Yes ☐ No

8.Monthly family expenditure:

a)Less than 1000/- b) 1000- 2000/- c) 2000-3000/- d) 3000-4000/- e) More than 4000/-

9. Type of latrine used:

a) Sanitary b) Pit c) Hanging d) Open field

10. Washing hand after defecation:

a)Soap & water b) Ash & water c) Soil & water d) Water only

11. Does any other family member have filariasis? ☐ Yes ☐ No

12. Use bed net: ☐ Yes ☐ No

13. Knowledge on Filariasis: ☐ Yes ☐ No

14. Treatment of filariasis: ☐ Yes ☐ No

15. Place of treatment for filariasis: a) Healer b) Doctor c) Health complex

16. Sign & symptoms of filariasis:a) Swelling with pain and fever b) pain with fever c) Swelling with pain d) Pain with irritation

17. Swelling of organ: a) Leg b) Hand c) Breast d) Scrotum

18. Action taken by NGO or Private? ☐ Yes ☐ No