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Bancroftian filariasis in four slums of Bankura, West Bengal, India

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ABSTRACT

Objective: To assess the prevalence of disease and microfilaremia in four slums of Bankura, West Bengal, India.
Methods: Data on age and sex-specific of all the respondents were collected and compared with microfilaria rate and density (20 mm^3 blood was collected by finger prick) to examine the relationship between the dynamics of *Wuchereria bancrofti*. Screening of the population for the main signs and symptoms of lymphatic filariasis (LF) in both sexes and hydrocele in men, was performed in a health facility setting (health center/health post) by physicians/trained nurses. Disease rate and endemicity rate were also calculated. Aspects related to vectors were also studied by regular collection and dissection of mosquitoes.
Results: Microfilaria rate, mean microfilarial density, disease rate and endemicity rate were 5.04%, 7.03%, 13.83% and 18.37%, respectively. Causative parasite was identified as *Wuchereria bancrofti* and *Culex quinquefasciatus* was recorded as vector. Per man hour density, infection and infectivity rates of the vector *Culex quinquefasciatus* were found to be 14.12%, 5.98% and 0.87%, respectively.
Conclusions: Using these baseline data would be useful in planning for the elimination of LF in slums of Bankura, West Bengal, India as per World Health Organization goal to eliminate LF by 2020.

1. Introduction

Infection by the filarial parasite, *Wuchereria bancrofti* (*W. bancrofti*), is the most common cause of lymphatic filariasis (LF), accounting globally for approximately 90% of all infections[1]. LF is a parasitic disease of man caused by three species of filarial parasites: *W. bancrofti*, *Brugia malayi* and *Brugia timori*, which are transmitted by anopheline and culicine mosquitoes[2,3]. These worms are endemic in 72 countries in the tropics and sub-tropics where more than 1.4 billion people are at risk of infection. Estimates suggest that 120 million people are presently infected with one or more of the LF. Although many people with filarial infections are asymptomatic, some 40 million people have clinically evident disease (mostly hydroceles and lymphedema), making LF a leading cause of long-term disability[4-7]. A district-level endemicity map created for India in 2000 shows that of the 289 districts surveyed up to 1995 (62% of all districts), as many as 257 were found to be endemic[8]. Seventeen states and six union territories were identified to be endemic with about 553 million people exposed to the risk of infection; and of them, about 146 million live in urban and the remaining in rural areas. About 31 million people are estimated to be the carriers of microfilariae and over 23 million suffer from filarial disease manifestations in India[9]. Information regarding filariasis in West Bengal is scanty. Some urban areas of the state surrounding mainly Kolkata were surveyed by some workers[10]. But very few rural areas have been covered by them[11-14]. A large part of West Bengal is uncovered and practically very little information about filarial epidemiology is available among the rural people who live in the remote villages. No previous systematic information about the different parameters of filarial epidemiology and its vector was available from the area. Due to its significant medical, social, and

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economic impact, the World Health Organization has targeted LF for elimination by the year 2020[15]. The Global Program to Eliminate Lymphatic Filariasis relies on mass administration of anthelmintic drugs to disrupt parasite transmission in endemic communities. By the end of 2005, mass drug administration (MDA) programs had reached nearly half of the global at-risk population. By halftime in 2010, MDA had successfully reduced disease rates (DR) in many areas[16]; however, confounding factors impede the fight for global elimination.

Besides, monitoring of the success of the LF elimination programme depends on entomological studies of the mosquito vectors that transmit the disease in endemic communities[17].

The present study is an attempt to determine the abundance of different species of mosquitoes as well as to identify those responsible for the transmission of LF. The study also aimed to gather epidemiological information such as microfilaria rate (MR), mean microfilarial density (MMD), filarial DR, filarial endemicity rate (ER) among slums of Bankura, West Bengal, India.

2. Materials and methods

2.1. Study area

Bankura is one of the districts of West Bengal, India, located in the western part of the state and known as “Rarh” in Bengal. It is bounded by latitude 22°38' N and longitude 86°36' E to 87°47' E. The Damodar River flows along the northern boundary of Bankura; the adjacent districts are Bardhaman in the north, Purulia in the west, Paschim Medinipur in the south and Hooghly and Bardhaman in the east. The study area comprises town, semi-towns and numerous villages, covers an area of 6 882 km^2 and literacy rate of population of 3 192 695 is 63.84%. Susunia, Biharinath and few small hillocks are located. Soil is red and lateritic type. There is a forest land of 1 481.77 km^2 in the district (21.5% of total geographical area). The variety of trees, shrubs and creepers are noteworthy in the territory of Bankura. The climate in the area is subtropical, with summer (Mar–Jun), monsoon (Jul–Oct) and winter (Nov–Feb). The temperature generally ranges from 19 °C to 35 °C and humidity from 62% to 93%. The area lies in sub-humid zone having average annual rainfalls of 0–25.56 mm. Early morning mist is common in winter season.

Most of the human habitations are hutments, without or with very small windows and ventilations, single storied, some of which (very few) are of reinforced cement concrete structures. Most of the houses are made up of mud, bamboo *etc*, with thatched roofs made up of straw, jute sticks, corrugated tins, tally *etc*. Houses are often situated in very close association or together in clumps and cattle sheds are often found attached with those houses. Modern sanitary facilities like drains, septic tanks *etc*. are very few in this area. Waste water and garbage are generally dumped in dobas (big ditches) near the house.

2.2. Survey and collection of vectors of LF in four slums

A number of houses in each slum were randomly selected for collection of mosquitoes. The purpose of the investigation was explained to the head and members of each of the household selected. Permission to enter each of the household was sought and the right to refuse or withdraw at any time was respected. Mosquitoes were collected in two different ways for an accurate entomological assessment and to assess their role in transmitting bancroftian filariasis in the study area. Mosquitoes were collected with the help of glass test tubes. Collection method was adopted according to recommendation of World Health Organization[18].

In the morning between 0600 and 0800 h India Standard Time, indoor-resting mosquitoes were captured for 12 min from each human habitation by one insect collector with the help of test tube. The test tube was brought perpendicularly up to a mosquito and it was imprisoned in the opening of test tube. After a mosquito had been taken, the tube was closed with a piece of cotton wool and was pushed with the mosquito towards the bottom of the tube. A space was given between the bottom surface of the test tube and the woolen plug, so that the mosquito could move freely. The operation was repeated until there were five or six mosquitoes in a long test tube, each isolated from others by layer/s of cotton wool/s. The tubes were labeled separately for each human habitation and taken to the laboratory.

Human habitations of each of slums were searched serially (1st slum in the 1st week, 2nd slum in the 2nd week and so on) once in each month from March 2007 to February 2009. Mosquitoes were collected from 40 fixed human habitations of the selected 4 slums, namely, Rampur, Kenduadihi, Lokepur and Pratapbagan once in each month for 2 years. One year was divided into 3 seasons, namely, summer (March–June), rainy (July–October) and winter (November–February). Collections were made employing 32 man-hours in each season, *i.e.* 192 man-hours during the 2 year study period. Collections were made serially from different slums in one season (one season includes four months *i.e.* 16 weeks). Collections were made in all seasons of the year *i.e.* rainy (July–October), winter (November–February) and summer (March–June) following the method of De and Chandra[11]. Mosquito samples collected were placed gently into plain containers containing modified Carnoy’s fixative (ethanol + glacial acetic acid 3:1 respectively + glycerin) at 20 °C. Samples were carefully transported to laboratory for examination.

The percentage of a sample of a population found to be carrying microfilariae is considered as MR. Average microfilaria count of positive samples of a population is considered as MMD. The percentage of a sample of a population showing visible manifestation of filarial diseases is considered as filarial DR. Combination of MR and filarial DR (any subject with both microfilaria and disease manifestation was counted once) is considered as ER.

Infection rate = Number of infected mosquitoes/Total number of mosquitoes dissected × 100

Infectivity rate = Number of mosquitoes with L3 larva/Total number of mosquitoes dissected × 100

2.3. Identification and dissection of mosquitoes

A mosquito was placed on the middle of a grease free slide and identified up to generic or species level based on morphological features of mosquitoes done following the keys of different authors[19-22] under a 40× microscope (Olympus CH20i). After identification of mosquitoes, the legs and wings were removed, laid in a drop of saline on a slide which was then placed on the stage of a dissecting microscope. The head, thorax, and abdomen were separated and transferred to separate drops of saline. The severed head was steadied with one needle, and with the aid of another very fine needle, the labium was split from the base to the tip.

The thorax, abdomen and the remainder of the head were then teased up and examined as individual fresh preparations under the low powers of a compound microscope (10×, 40×) to observe filarial species. The staining of slides containing the parasite was done and after 24 h, stains were washed by alcohol, cleared in berlyes fluid and covered. The preparations were re-examined carefully using a compound microscope at about 10–40 or 100 magnification. Infective mosquitoes were defined as those containing L3 larvae in any of the body segments.

Mosquitoes carrying microfilaria, L1, L2, or L3 larvae were defined as infected. The numbers of stages of all *W. bancrofti* larvae were recorded for each body part. Third stage (L3) larvae were examined carefully under high power of binocular microscope for the three caudal papillae characteristic of *W. bancrofti*.

2.4. Identification of different stages of W. bancrofti

The *W. bancrofti* larvae dissected out of the different parts of the body (head, thorax, and abdomen) of *Culex quinquefasciatus* (*Cx. quinquefasciatus*) mosquitoes were identified according to Schmidt and Roberts and Nelson[23,24]. First stage (L1) was sausage-like stage. Second stage (L2) was J-shaped stage. Third stage (L3) larva was infective, which was characterized by the three large cow teat-like knobs on the caudal extremity. Microfilaria embryos were long and the tails were tapered to a point.

2.4.1. Larval length of W. bancrofti L3 larvae found in the heads, thorax and abdomen of mosquitoes

According to measurement of Nelson[24], the length of L3 larvae of *W. bancrofti* ranged between 1 170 and 1 575 µm and breadth 18–32 µm. In this study, the length of L3 in the head was 1 288 µm and breadth was 29 µm; in the thorax the length was 995 µm, and the breadth was 17.2 µm and in the abdomen the length was 1 265 µm and the breadth was 23 µm.

2.4.2. Length of W. bancrofti microfilaria found in the mosquito and human blood

In this study, the average length of microfilaria in the human blood smear was approximately 287 µm; this measurement was similar to length of microfilaria in the mosquito's abdomen before the development to L1 which was 250 µm[25].

2.5. Blood sampling and clinical assessment

A door to door random night blood survey was carried out from each of 4 slums between 1900 and 2300 h Indian Standard Time. 20 mm^3 blood was collected from all the individuals available at the time of survey by finger prick[26]. Then the slides were examined for detection of microfilariae.

Screening of the study population for the main signs and symptoms of LF, *i.e.* elephantiasis or lymphoedema in both sexes and hydrocele in men, was performed in a health facility setting (health center/health post) by physicians or trained nurses. All men who reported having genital signs of LF agreed to genital examination. Less than 5% of those who did not report genital pathology were examined, and were indeed negative; in the others LF genital signs were considered to be absent based on self report. Physical examination of women's genitalia was not performed. Lymphoedema and hydrocele were identified only at advanced stages, using pitting edema and loss of contour as minimum criteria for lymphoedema diagnosis, and large fluid-filled scrotum for hydrocele. Signs of onchocercal skin disease (such as dermatitis, onchocercomata, lymphadenopathy, and pigmentary changes of skin) were documented.

The total surveyed population was divided into different age groups (≤ 10 years, 11–20 years, 21–30 years, 31–40 years and so on) followed by many earlier epidemiologists[27,28].

2.6. Statistical analysis

Statistical analysis one way ANOVA together with Tukey's *t*- test was done to test whether any significant difference noticed in two year collection of mosquitoes. Data obtained on slum wise collection of indoor-resting *Cx. quinquefasciatus* and season wise man hour density of indoor-resting *Cx. quinquefasciatus* were subjected to *t*-test analysis[29]. *Z*-test and χ^2 test were considered into account to analyze MR, DR and ER of four slums. Five different assumptions were tested. 1. Whether proportion of male persons affected by the disease in different age groups is significantly different from overall rate. 2. Whether proportion of female persons affected by the disease in different age groups is significantly different from overall rate. 3. Whether proportion of persons affected by the disease among males and females in different age groups is significantly different. 4. Whether proportion of persons affected by the disease is significantly different between overall male and overall female. 5. Considering all age group for testing whether proportion of persons affected by the disease is significantly different between male and female. *Z*-test followed by Tukey's *t*-test were done for MMD. Same assumptions were also considered for adenolymphangitis, elephantiasis and lymphoedema among males and females in the study area.

2.7. Ethical clearance

Ethical clearance for the study was obtained from the Institutional Ethics Committee (IEC) of Vidyasagar University, Midnapore, West Bengal, India, IEC No. IEC/5-11/C-5/15.

3. Results

3.1. Mosquito study

A total of 7 996 mosquitoes of eight species under five genera were collected from the four slums (Table 1). *Cx. quinquefasciatus* was incriminated as vector of *W. bancrofti* in these slums. Slum wise number and percent of collected indoor-resting *Cx. quinquefasciatus* is presented in Table 2. Average per man hour density of *Cx. quinquefasciatus* was 14.12 (Table 3) (per man hour density in different season varied as 15.78 in summer, 18.15 in rainy and 8.41 in winter). Availability of vector species in human habitations showed seasonal ($P < 0.05$) variations in summer (80.94%) and rainy (89.06%) but in winter (58.75%) ($P > 0.05$) it showed no seasonal prevalence. Out of total infected 144 *Cx. quinquefasciatus*, 70 (48.61%), 32 (22.22%), 21 (14.58%) and 21 (14.58%) were found to carry microfilariae, 1st stage, 2nd stage, and third infective stages, respectively. Overall vector infection rate was 5.98% (ranging from 1.39% to 13.00% in four slums). Seasonal vector infection rates were 8.84% in summer, 4.61% in rainy and 3.64% in winter. Vector infectivity rates were 0.87.

Table 1

Combination of different species of indoor-resting mosquitoes during March 2007 to February 2009 at Bankura, West Bengal, India [*n* (%)].

Species	Mar 2007 to Feb 2008	Mar 2008 to Feb 2009	Total
Cx. quinquefasciatus	1375 (34.95)	1335 (32.87)	2710 (33.90)
Culex vishnui group	255 (6.48)	218 (5.37)	473 (5.92)
Anopheles annularis	184 (4.68)	296 (7.29)	480 (6.00)
Anopheles barbirostris	199 (5.06)	212 (5.21)	411 (5.14)
Anopheles subpictus	327 (8.31)	425 (10.46)	752 (9.40)
Armigeres subalbatus	1423 (36.17)	1411 (34.74)	2834 (35.44)
Mansonia annulifera	67 (1.70)	57 (1.40)	124 (1.56)
Aedes albopictus	104 (2.64)	108 (2.66)	212 (2.65)
Total	3934	4062	7996

Table 2

Slum wise number and percent of collected indoor-resting *Cx. quinquefasciatus*.

Slum	Mar 2007 to Feb 2008		Mar 2008 to Feb 2009		Total Number	Overall percent
	Number	Percent	Number	Percent		
Rampur	328	23.85	282	21.12	610	22.51
Kenduadihi	348	25.31	360	26.97	708	26.13
Lokepur	431	31.35	411	30.79	842	31.07
Pratapbagan	268	19.49	282	21.12	550	20.30
Total	1375	100.00	1335	100.00	2710	100.00

Table 3

Slum wise man hour density of indoor-resting *Cx. quinquefasciatus*.

Slum	Mar 2007 to Feb 2008	Mar 2008 to Feb 2009	Average
Rampur	13.67	11.75	12.71
Kenduadihi	14.50	15.00	14.75
Lokepur	17.96	17.13	17.55
Pratapbagan	11.17	11.75	11.46
Mean	14.32	13.91	14.12

3.2. Parasitological and clinical studies

2025 people (1250 male and 775 female) were brought into the study and overall MR, MMD, DR and ER were assessed as 5.04%, 7.03%, 13.83% and 18.37%, respectively. Overall MR (Figure 1) and MMD were higher in the age group of 41–50 years (9.38% and 10.06%, respectively) than the other age groups and DR (Figure 2) and ER (Figure 3) were higher in the age group of 31–40 years (27.91% and 36.20%) than the other age groups (Table 4).

In all the slums, generally, all the parameters were higher in males than the females but not in all age groups (Table 4). In all the study areas, different filarial etiologies were encountered during the study. In the study area, out of 2025 persons, 280 (242 male and 38 female) were found with filarial diseases, of which most prevalent symptom was hydrocele (12.56%). Adenolymphangitis was higher in the age group of 31–40 years in both males (8.50%) and females (10.32%). Lymphoedema was higher in the age group of 31–40 years in both males (4.50%) and females (7.14%). Elephantiasis was higher in the age group of 51–60 years in males (6.58%) and in the age group of 31–40 years in females (1.59%). Epididymo-orchitis and hydrocele were higher in the age group of 31–40 years and 21–30 years, respectively (5.50% and 27.17%, respectively) (Table 5).

3.3. Statistical analysis

The results of one way ANOVA (Table 6) revealed significant difference in mosquito collection between two years and Tukey's *t*-test revealed that percentage of collected *Culex vishnui* group, *Anopheles annularis, Anopheles barbirostris, Anopheles subpictus, Mansonia annulifera* and *Aedes albopictus* was not significantly different from other species but significant difference in collection was noted among *Cx. quinquefasciatus* and *Armigeres subalbatus*. The result of *t*-test for slum wise number of collected indoor-resting *Cx. quinquefasciatus* revealed significant result for all the slums having *t*-values 13.26, 59.00, 42.10 and 39.28 for Rampur, Kenduadihi, Lokepur and Pratapbagan, respectively (for all $df = 1$, $P < 0.05$). The result of *t*-test of season wise man hour density of

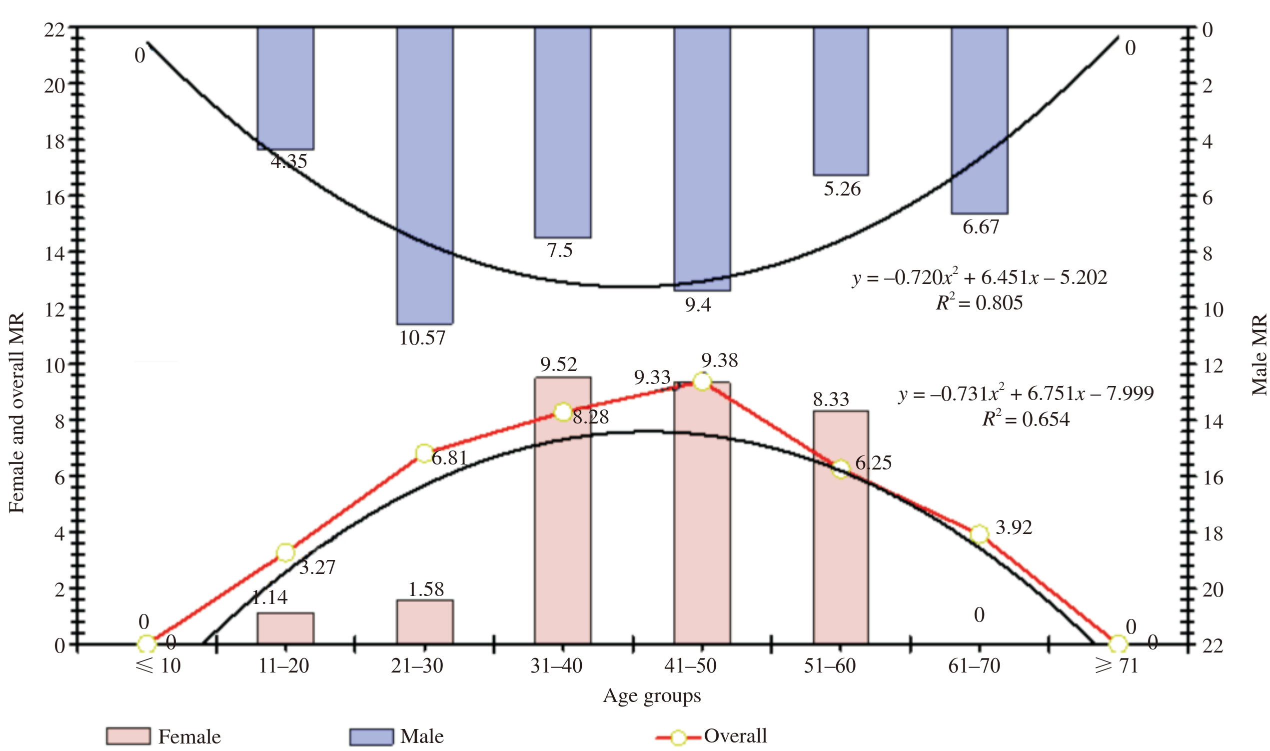

Figure 1. MR of all slums.

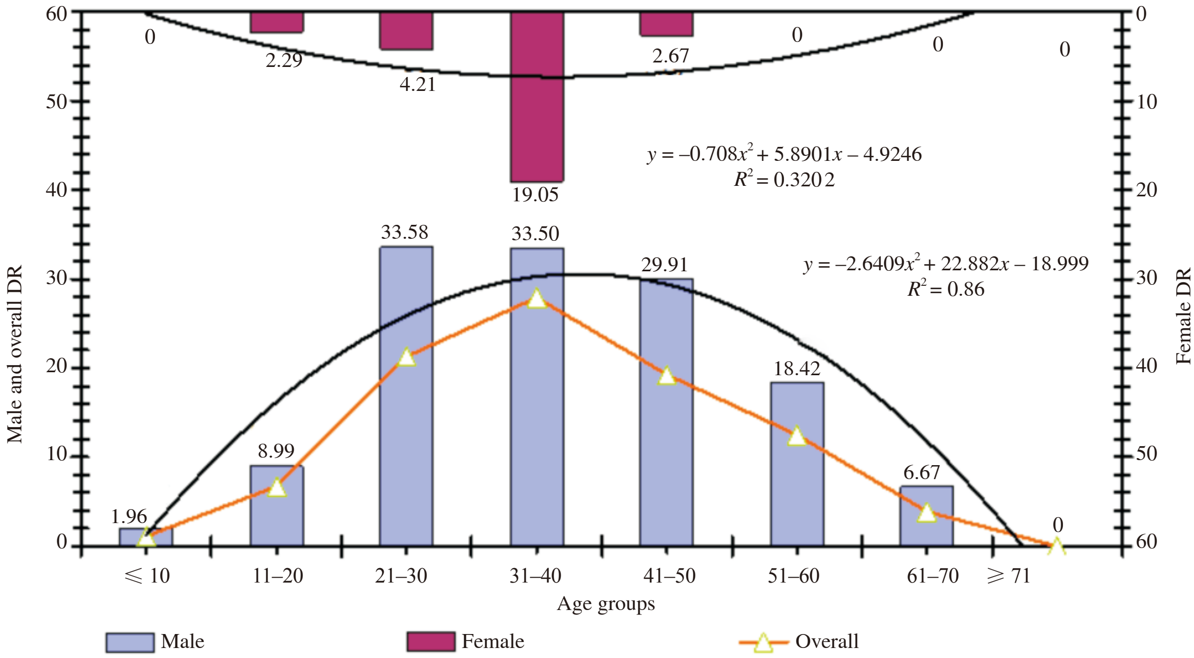

Figure 2. DR of all slums.

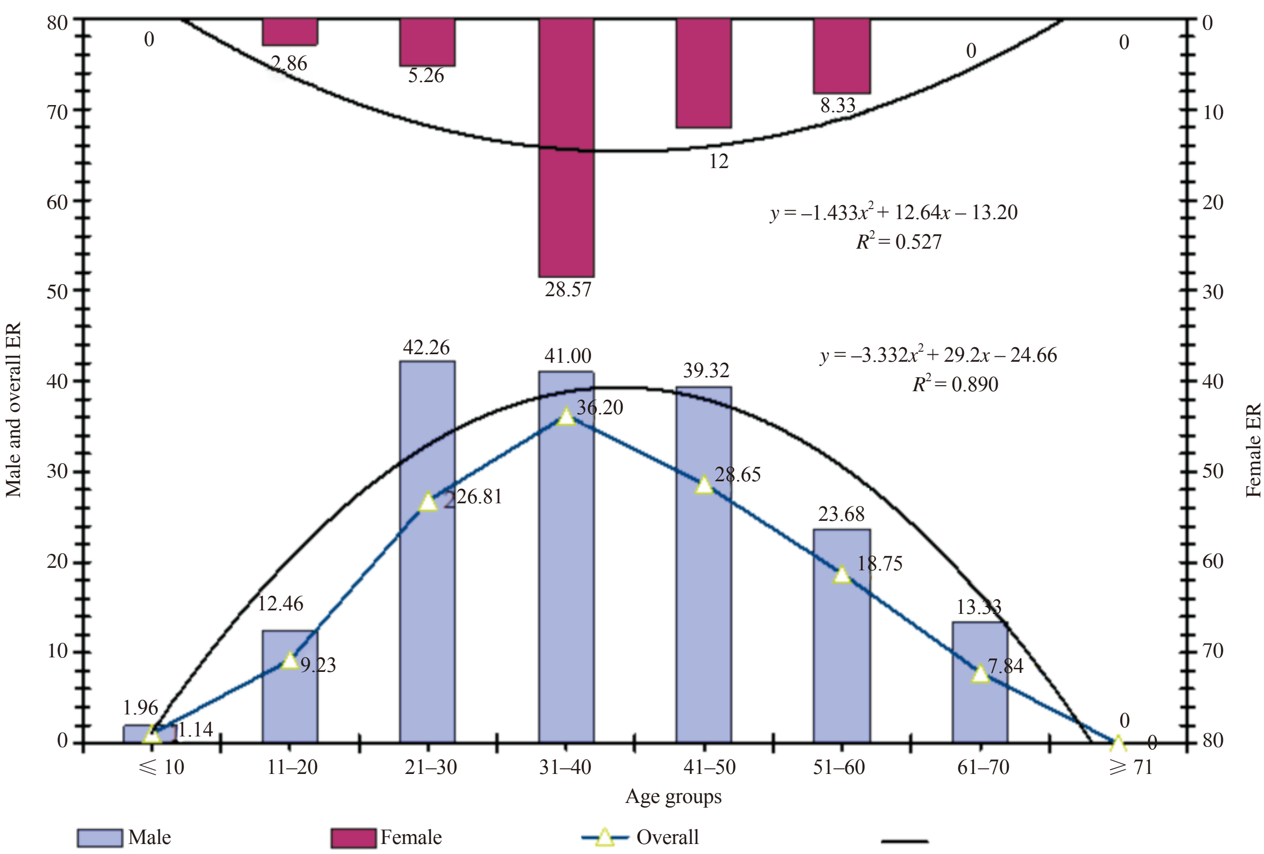

Figure 3. ER of all slums.

indoor-resting *Cx. quinquefasciatus* revealed significant difference (Table 7). Considering all age groups' males and females of all slums, the Z value for MMD of only Lokepur slum seemed to be significant (Z = 2.06). The MMD of age groups 21–30 seemed to be significant (Z = 1.64). Tukey's *t*-test between different age groups of males and females revealed that none of the values became significant. The result of Z and χ^2 test of MR, DR and ER was as follows.

3.3.1. MR

When all slums males were considered together according to their age groups, significant difference of MR from overall rate was noted among proportion of persons affected by the disease in different age groups of ≤ 10, 21–30 and ≥ 71 (Z = 8.93, Z = 2.27 and Z = 8.93).

Table 4

MR, MMD, DR and ER according to sex and age group among the populations of slums in Bankura, West Bengal, India.

Age group (years)	No. of person examined			MR (%)			MMD (%)			DR (%)			ER (%)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
⩽ 10	204	147	351	0.00	0.00	0.00	0.00	0.00	0.00	1.96	0.00	1.14	1.96	0.00	1.14
11–20	345	175	520	4.35	1.14	3.27	6.33	4.00	6.06	8.99	2.29	6.73	12.46	2.86	9.23
21–30	265	190	455	10.57	1.58	6.81	4.64	3.67	4.55	33.58	4.21	21.32	42.26	5.26	26.81
31–40	200	126	326	7.50	9.52	8.28	13.60	5.33	9.93	33.50	19.05	27.91	41.00	28.57	36.20
41–50	117	75	192	9.40	9.33	9.38	14.91	2.43	10.06	29.91	2.67	19.27	39.32	12.00	28.65
51–60	76	36	112	5.26	8.33	6.25	3.50	2.67	3.14	18.42	0.00	12.50	23.68	8.33	18.75
61–70	30	21	51	6.67	0.00	3.92	1.00	0.00	1.00	6.67	0.00	3.92	13.33	0.00	7.84
⩾ 71	13	5	18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1 250	775	2 025	6.00	3.48	5.04	8.12	4.00	7.03	19.36	4.90	13.83	24.72	8.13	18.37

Table 5

The manifestation of filarial disease (percent) according to sex and age group among the population.

Age group (years)	Adenolymphangitis		Lymphoedema		Elephantiasis		Epididymo-orchitis	Hydrocele	Total no of diseased persons		Total affected
	M	F	M	F	M	F	M	M	MT	FT	MT + FT
⩽ 10	3 (1.47)	0 (0.00)	1 (0.49)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	4	0	4
11–20	2 (0.58)	4 (2.29)	2 (0.58)	0 (0.00)	0 (0.00)	0 (0.00)	7 (2.03)	20 (5.80)	31	4	35
21–30	7 (2.64)	2 (1.05)	7 (2.64)	5 (2.63)	0 (0.00)	1 (0.53)	3 (1.13)	72 (27.17)	89	8	97
31–40	17 (8.50)	13 (10.32)	9 (4.50)	9 (7.14)	2 (1.00)	2 (1.59)	11 (5.50)	28 (14.00)	67	24	91
41–50	2 (1.71)	0 (0.00)	0 (0.00)	2 (2.67)	2 (1.71)	0 (0.00)	5 (4.27)	26 (22.22)	35	2	37
51–60	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	5 (6.58)	0 (0.00)	0 (0.00)	9 (11.84)	14	0	14
61–70	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (6.67)	2	0	2
⩾ 71	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0	0	0
Total	31 (2.48)	19 (2.45)	19 (1.52)	16 (2.06)	9 (0.72)	3 (0.39)	26 (2.08)	157 (12.56)	242	38	280
Total (M + F)	50 (2.47)		35 (1.73)		12 (0.59)						

M: Male; F: Female; MT: Male total; FT: Female total.

Age group 21–30 males were more susceptible to the disease than other age groups (at 5% level). For slums, significant difference of MR from overall rate was noted among age groups of 10, 11–20, 41–50 and ⩾ 71 (Z = 4.85, Z = 3.08, Z = 1.71 and Z = 4.85) for Rampur; 10, 21–30, 41–50, 51–60, 61–70 and ⩾ 71 (Z = 6.30, Z = 2.74, Z = 2.24, Z = 6.30, Z = 6.30 and Z = 6.30) for Kenduadihi and 10, 61–70 and ⩾ 71 (Z = 4.23, Z = 4.23 and Z = 4.23) for Lokepur. Comparing among individuals of slums, significant difference of MR from overall rate was noted among persons of Kenduadihi and Pratapbagan (Z = 2.15, Z = 8.93).

Table 6

One way ANOVA of mosquito collection between two years.

Group		Sum of squares	*df*	Mean square	*F*	*P*
Mar 2007 to Feb 2008	Between different mosquito species	560 431.375	7	80 061.62	45.43	0.01
	Residual	42 288.500	24	1 762.02		
	Total	602 719.875	31			
Mar 2008 to Feb 2009	Between different mosquito species	521 571.875	7	74 510.26	22.73	0.01
	Residual	78 662.000	24	3 277.58		
	Total	600 233.875	31			

Table 7

t-test of season wise man hour density of indoor-resting *Cx. quinquefasciatus*.

Season	*t*-value	*df*	*P* (2-tailed)
Summer	31.560	1	0.020
Rainy	44.827	1	0.014
Winter	15.868	1	0.040
Summer–Rainy	2.624	1	0.232
Summer–Winter	245.667	1	0.003
Rainy–Winter	10.422	1	0.061
First year	5.256	2	0.034
Second year	4.403	2	0.048

When all slums females were considered together according to their age groups, significant difference of MR from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 21–30, 31–40, 41–50, 61–70 and ⩾ 71 (Z = 5.28, Z = 2.25, Z = 1.69, Z = 2.24, Z = 1.70, Z = 5.28 and Z = 5.28). Age group 31–40 and 41–50 females were more susceptible to the disease than other age groups (at 5% and 10% levels, respectively). For slums, significant difference of MR from overall rate was noted among age groups of ⩽ 10, 41–50, 61–70 and ⩾ 71 (Z = 3.41, Z = 1.61, Z = 3.41, Z = 3.41) for Rampur; ⩽ 10, 61–70 and ⩾ 71 (Z = 3.05, Z = 3.05, Z = 3.05) for Kenduadihi and ⩽ 10, 11–20, 21–30, 61–70 and ⩾ 71 (Z = 2.68, Z = 2.68, Z = 2.68, Z = 2.68, Z = 2.68) for Lokepur. Comparing among individuals of slums, significant difference of MR from overall rate was noted among persons of Pratapbagan (Z = 5.28).

When all slum males and females were considered together according to their age groups, significant difference of MR between males and females was noted among proportion of persons affected by the disease in age groups 11–20 and 21–30 (Z = 2.36 and Z = 4.29). For slums, significant difference of MR between males and females was noted among age groups of 21–30 (Z = 1.60) and 61–70 (Z = 1.67) for Rampur; 11–20 and 21–30 (Z = 2.43 and Z = 3.91) for Kenduadihi and 11–20 (Z = 2.04) and 21–30 (Z = 1.77) for Lokepur. Comparing among individuals of slums, significant difference of MR between males and females was noted among persons of Kenduadihi (Z = 3.23).

When overall males and females were considered according to their age groups for all slums, proportion of persons affected by the disease differed significantly (Z = 2.67) at 1% level. For Rampur slum, no significant difference of MR between overall males and females was noted (Z = 0.46) at 10% level; for Kenduadihi slum, there was significant difference of MR between overall males and females (Z = 3.235) at 1% level and for Lokepur slum no significant difference of MR between overall males and females was noted (Z = 1.048) at 10% level. Comparing among individuals of slums, significant difference of MR between overall males and females differed significantly (Z = 2.67) at 1%, 2%, 5%, 10% levels.

Considering all age groups together for all slums, proportion of persons affected by the disease varied significantly (χ^2 = 26.87) at 1% level between male and female. For Rampur slum, the disease did not vary significantly (χ^2 = 5.8945) at 10% level. For Kenduadihi slum, the disease varied significantly (χ^2 = 22.484) at 1% level and for Lokepur, the disease did not vary significantly (χ^2 = 8.0874) at 10% level.

3.3.2. DR

When all slums males were considered together according to their age groups, significant difference of DR from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 21–30, 31–40, 41–50, 61–70 and ⩾ 71 (Z = 11.75, Z = 5.44, Z = 4.57, Z = 4.01, Z = 2.40, Z = 2.70 and Z = 17.32). Age group 21–30, 31–40 and 41–50 males were more susceptible to the disease than other age groups (at 10%, 5% and 2% levels, respectively). For slums, significant difference of DR from overall rate was noted among age groups of ⩽ 10, 11–20, 21–30, 31–40, 61–70 and ⩾ 71 (Z = 6.06, Z = 1.92, Z = 1.77, Z = 1.84, Z = 8.91 and Z = 8.91) for Rampur; ⩽ 10, 21–30, 41–50, 51–60, 61–70 and ⩾ 71 (Z = 6.30, Z = 2.74, Z = 2.24, Z = 6.30, Z = 6.30 and Z = 6.30) for Kenduadihi; ⩽ 10, 11–20, 21–30, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 4.47, Z = 2.03, Z = 1.95, Z = 2.65, Z = 6.93, Z = 6.93 and Z = 6.93) for Lokepur and ⩽ 10, 11–20, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 3.23, Z = 3.23, Z = 2.19, Z = 3.23, Z = 3.23, Z = 3.23) for Pratapbagan. Comparing among individuals of slums, significant difference of DR from overall rate was noted among persons of Kenduadihi, Lokepur and Pratapbagan (Z = 5.28, Z = 3.08, Z = 8.11).

When all slums females were considered together according to their age groups, significant difference of DR from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 6.31, Z = 1.90, Z = 3.94, Z = 6.31, Z = 6.31 and Z = 6.31). Age group 31–40 females were more susceptible to the disease than other age groups (at 10%, 5%, 2% and 1% levels respectively). For slums, significant difference of DR from overall rate was noted among age groups of ⩽ 10, 31–40, 41–50, 51–60, 61–70 and ⩾ 71 (Z = 3.24, Z = 2.16, Z = 3.24, Z = 3.24, Z = 3.24 and Z = 3.24) for Rampur; ⩽ 10, 61–70 and ⩾ 71 (Z = 3.05, Z = 3.05, Z = 3.05) for Kenduadihi and ⩽ 10, 11–20, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 2.88, Z = 2.88, Z = 1.75, Z = 2.88, Z = 2.88 and Z = 2.88) for Lokepur. Comparing among individuals of slums, significant difference of DR from overall rate was noted among persons of Pratapbagan (Z = 2.09).

When all slum males and females were considered together according to their age groups, significant difference of DR between males and females was noted among proportion of persons affected by the disease in age groups ⩽ 10, 11–20, 21–30, 31–40, 41–50, 51–60 (Z = 2.01, Z = 3.50, Z = 9.04, Z = 2.98, Z = 5.89 and Z = 4.14). For slums, significant difference of DR between males and females was noted among age groups of 11–20, 21–30, 41–50 and 51–60 (Z = 2.18, Z = 4.10, Z = 3.81 and Z = 2.23) for Rampur; 11–20, 21–30, 31–40, 41–50, 51–60 and 61–70 (Z = 3.38, Z = 8.60, Z = 1.91, Z = 6.59, Z = 4.03 and Z = 1.56) for Kenduadihi; 11–20, 21–30 (Z = 2.53, Z = 3.78) and 31–40 (Z = 1.76) for Lokepur and 31–40 (Z = 2.94) for Pratapbagan. Comparing among individuals of slums, significant difference of DR between males and females was noted among persons of Rampur, Kenduadihi and Lokepur (Z = 5.29, Z = 9.18, Z = 3.94).

When overall males and females are considered according to their age groups for all slums, proportion of persons affected by the disease differed significantly (Z = 10.63) at 5%, 2% and 1% levels. For Rampur slum, significant difference of DR between overall males and females was noted (Z = 5.29) at 1%, 2%, 5% and 10% levels; for Kenduadihi slum, significant difference of DR between overall males and females was noted (Z = 9.18) at 1%, 2%, 5% and 10% levels; for Lokepur slum significant difference of DR between overall males and females was noted (Z = 3.94) at 1%, 2%, 5% and 10% levels and for Pratapbagan slum no significant difference of DR between overall males and females was noted (Z = 1.48) at 10% level. Comparing among individuals of slums significant difference of DR between overall males and females differed significantly (Z = 10.63) at 1%, 2%, 5%, 10% levels.

Considering all age groups together for all slums, proportion of persons affected by the disease varied significantly (χ^2 = 161.16) at 1%, 5% and 10% levels between male and female. For Rampur slum, the disease varied significantly (χ^2 = 43.57) at 1%, 5% and 10% levels. For Kenduadihi slum, the disease varied significantly (χ^2 = 153.54) at 1%, 5% and 10% levels and for Lokepur, the disease varied significantly (χ^2 = 25.06) at 1%, 5% and 10% levels and for Pratapbagan, the disease varied significantly (χ^2 = 13.97) at 10% level.

3.3.3. ER

When all slums males were considered together according to their age groups, significant difference of ER from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 21–30, 31–40, 41–50, 61–70 and ⩾ 71 (Z = 14.59, Z = 5.68, Z = 5.36, Z = 4.41, Z = 3.12, Z = 1.80 and Z = 20.26). Age group 21–30, 31–40 and 41–50 males were more susceptible to the disease than other age groups (at 10%, 5% and 2% levels respectively). For slums, significant difference of ER from overall rate was noted among age groups of ⩽ 10, 11–20, 21–30, 31–40, 61–70 and ⩾ 71 (Z = 7.71, Z = 3.70, Z = 2.05, Z = 2.12, Z = 2.66 and Z = 10.62) for Rampur; ⩽

10, 11–20, 21–30, 31–40, 41–50, 61–70 and ⩾ 71 (Z = 10.82, Z = 3.83, Z = 7.70, Z = 2.40, Z = 1.72, Z = 2.00 and Z= 16.50) for Kenduadihi; ⩽ 10, 11–20, 31–40, 61–70 and ⩾ 71 (Z = 5.86, Z = 1.74, Z = 2.93, Z = 8.29 and Z = 8.29) for Lokepur and ⩽ 10, 11–20, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 3.23, Z = 3.23, Z = 2.19, Z = 3.23, Z = 3.23, Z = 3.23) for Pratapbagan. Comparing among individuals of slums, significant difference of ER from overall rate was noted among persons of Kenduadihi, Lokepur and Pratapbagan (Z = 6.12, Z = 3.08, Z = 10.68).

When all slums females were considered together according to their age groups, significant difference of ER from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 31–40, 61–70 and ⩾ 71 (Z = 8.28, Z = 3.29, Z = 4.93, Z = 8.28, Z = 8.28). Age group 31–40 females were more susceptible to the disease than other age groups (at 10%, 5%, 2% and 1% levels, respectively). For slums, significant difference of ER from overall rate was noted among age groups of ⩽ 10, 11–20, 31–40, 61–70 and ⩾ 71 (Z = 4.72, Z = 2.43, Z = 2.64, Z = 4.72 and Z = 4.72) for Rampur; ⩽ 10, 11–20, 31–40, 61–70 and ⩾ 71 (Z = 5.37, Z = 2.31, Z = 3.70, Z = 5.37 and Z = 5.37) for Kenduadihi and ⩽ 10, 11–20, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 4.01, Z = 4.01, Z = 1.86, Z = 2.48, Z = 4.01 and Z = 4.01) for Lokepur. Comparing among individuals of slums, significant difference of ER from overall rate was noted among persons of Pratapbagan (Z = 3.95).

When all slum males and females were considered together according to their age groups, significant difference of ER between males and females was noted among proportion of persons affected by the disease in age groups ⩽ 10, 11–20, 21–30, 31–40, 41–50, 51–60, 61–70 (Z = 2.01, Z = 4.40, Z = 10.75, Z = 2.33, Z = 4.65 Z = 2.28 and Z = 2.14). For slums, significant difference of ER between males and females was noted among age groups of 11–20, 21–30 and 41–50 (Z = 1.96, Z = 4.67 and Z = 2.24) for Rampur; 11–20, 21–30, 31–40, 41–50, 51–60 and 61–70 (Z = 4.24, Z = 12.80, Z = 1.99, Z = 5.89, Z = 2.11 and Z = 1.56) for Kenduadihi; 11–20, 21–30 (Z = 3.34, Z = 3.98) for Lokepur and 31–40 (Z = 2.94) for Pratapbagan. Comparing among individuals of slums, significant difference of ER between males and females was noted among persons of Rampur, Kenduadihi and Lokepur (Z = 4.67, Z = 10.18, Z = 3.70).

When overall males and females were considered according to their age groups for all slums, proportion of persons affected by the disease differed significantly (Z = 10.59) at 5%, 2% and 1% levels. For Rampur slum, significant difference of ER between overall males and females was noted (Z = 4.67) at 1%, 2%, 5% and 10% levels; for Kenduadihi slum, significant difference of ER between overall males and females (Z = 10.18) at 1%, 2%, 5% and 10% levels; for Lokepur slum significant difference of ER between overall males and females was noted (Z = 3.70) at 1%, 2%, 5% and 10% levels and for Pratapbagan slum no significant difference of ER between overall males and females was noted (Z = 1.48) at 10% level. Comparing among individuals of slums, significant difference of ER between overall males and females differed significantly (Z = 10.59) at 1%, 2%, 5% and 10% levels.

Considering all age groups together for all slums, proportion of persons affected by the disease varied significantly (χ^2 = 176.16) at 1%, 5% and 10% levels between male and female. For Rampur slum, the disease varied significantly (χ^2 = 33.61) at 1%, 5% and 10% levels. For Kenduadihi slum, the disease varied significantly (χ^2 = 229.78) at 1%, 5% and 10% levels and for Lokepur, the disease varied significantly (χ^2 = 29.81) at 1%, 5% and 10% levels and for Pratapbagan, the disease varied significantly (χ^2 = 13.97) at 10% level.

The statistical result of Z and χ^2 test of adenolymphangitis, elephantiasis and lymphoedema among males and females were as follows.

3.3.4. Adenolymphangitis

When all slums males were considered together according to their age groups, significant difference of adenolymphangitis from overall rate was noted among proportion of persons affected by the disease in different age groups of 11–20, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 3.16, Z = 2.97, Z = 5.63, Z = 5.63 and Z = 5.63). Age group 31–40 males were more susceptible to the disease than other age groups at 10%, 5% and 2% levels.

When all slums females were considered together according to their age groups, significant difference of adenolymphangitis from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 31–40, 41–50, 51–60, 61–70 and ⩾ 71 (Z = 4.41, Z = 2.84, Z = 4.41, Z = 4.41, Z = 4.41 and Z = 4.41). Age group 31–40 and 41–50 females were more susceptible to the disease than other age groups at 1%, 2%, 5% and 10% levels, respectively.

When all slum males and females were considered together according to their age groups, no significant difference of adenolymphangitis between males and females was noted among proportion of persons affected by the disease.

When overall males and females were considered according to their age groups for all slums, proportion of persons affected by adenolymphangitis did not differ significantly (Z = 0.042).

Considering all age groups together for all slums, proportion of persons affected by adenolymphangitis did not vary significantly (χ^2 = 6.01) at 10% level between male and female.

3.3.5. Elephantiasis

When all slums males were considered together according to their age groups, significant difference of elephantiasis from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 21–30, 51–60, 61–70 and ⩾ 71 (Z = 3.01, Z = 3.01, Z = 3.01, Z = 2.05, Z = 3.01 and Z = 3.01). Age group 21–30 males were more susceptible to the disease than other age groups at 1%, 2%, 5% and 10% levels.

When all slums females were considered together according to their age groups, significant difference of elephantiasis from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 41–50, 51–60, 61–70 and ⩾ 71 (Z = 1.74, Z = 1.74, Z = 1.74, Z = 1.74, Z = 1.74 and Z = 1.74). Age group 41–50 females were more susceptible to the disease than other age groups at 10% level.

When all slum males and females were considered together according to their age groups, no significant difference of elephantiasis between males and females was noted among proportion of persons affected by the disease.

When overall males and females were considered according to their age groups for all slums, proportion of persons affected by elephantiasis did not differ significantly (Z = 1.007).

Considering all age groups together for all slums, proportion of persons affected by elephantiasis did not vary significantly (χ^2 = 3.24) at 10% level between male and female.

3.3.6. Lymphoedema

When all slums males were considered together according to their age groups, significant difference of lymphoedema from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 31–40, 41–50, 51–60, 61–70 and ⩾ 71 (Z = 1.71, Z = 1.75, Z = 1.97, Z = 4.39, Z = 4.39, Z = 4.39 and Z = 4.39). Age group 31–40 males were more susceptible to the disease than other age groups at 10% level.

When all slums females were considered together according to their age groups, significant difference of lymphoedema from overall rate was noted among proportion of persons affected by the disease in different age groups of ⩽ 10, 11–20, 31–40, 51–60, 61–70 and ⩾ 71 (Z = 4.03, Z = 4.03, Z = 2.16, Z = 4.03, Z = 4.03 and Z = 4.03). Age group 31–40 females were more susceptible to the disease than other age groups at 5% and 10% levels respectively.

When all slum males and females were considered together according to their age groups, no significant difference of lymphoedema between males and females was noted among proportion of persons affected by the disease.

When overall males and females were considered according to their age groups for all slums, proportion of persons affected by lymphoedema did not differ significantly (Z = 0.875).

Considering all age groups together for all slums, proportion of persons affected by lymphoedema did not vary significantly (χ^2 = 5.01) at 10% level between male and female.

4. Discussion

First-hand information regarding filarial endemicity and its vector was gathered in the present study from the slum areas of Bankura district, West Bengal, India. Gender wise distribution showed that overall MR, MMD, DR and ER were higher among males than females in all the slum areas as also reported in some other studies[28,30,31]. This can be explained by the fact that, males were more exposed to mosquito bites than females, and this is true for all the selected areas (slums) under study.

Age group wise distribution showed that, in both the study area, MR, DR and ER were generally higher among the people of younger to middle age, which is somewhat similar to some other areas[13,32]. MMD was higher in middle age group, which is similar to the findings of many other areas[13,32]. In both the study area, people of active working age groups were more affected by the filarial parasites, which may seriously affect their efficiency and economy. Moreover, higher MMD among the middle age group is indicative of intensified filarial problem in near future. In the areas under study, there was a tendency of acquiring *W. bancrofti* infection as well as developing filarial diseases in childhood, as also found in some recent works[33].

Among the aetiologies, frequency of hydrocele and adenolymphangitis was higher than all other symptoms. A steady state of transmission was indicated by the fact that, different disease symptoms were distributed unevenly in different age groups and in both genders, in both the areas.

Different aetiologies in both the sexes and almost in all the age groups were more or less higher in human population of slums under study. Presence of dense human population, closely situated human habitations, favourable mosquito breeding place, gathering of too many outsiders every day *etc*. probably aided to this situation.

It is apparent that though the urban area is more endemic, the rural area is also becoming potentially dangerous regarding filarial transmission day by day due to indiscriminate development. From the present study, it appears that management of filarial problems is not working properly in some slum areas of Bankura, West Bengal, India. MDA programme should be strengthened in these areas with proper implementation to achieve the goal of National Filariasis Control Programme. During the formulation of control strategies, the slum areas should be given due importance keeping in mind the recommendations made by different authors[34-36].

Conflict of interest statement

We declare that we have no conflict of interest.

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