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Original Article

The Impact of Housing Structures on Filarial Infection

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SUMMARY: A study was undertaken to correlate the impact of housing and patterns of house construction on the vector density and transmission of filaria among the inhabitants of these houses. Three different types of houses in ecologically similar hamlets of Hariharpur village in Varanasi were selected for determining the density of *Culex quinquefasciatus*, the vector of *Wuchereria bancrofti* and its infectivity. The maximum per man hour density of the vector was recorded during March (31.66, 40.33 and 41.33) while minimum was recorded during June (1.3, 2.6 and 0.33) in all the three types of houses. Infection rate in the vectors collected from poorly constructed houses was observed during April, May, October and January of the following year, whereas in moderately constructed houses, infection was observed only in September and in the well constructed houses dissection results did not reveal any infection during the months of the study. Infectivity rate was observed to be 10.0% in moderately constructed houses (group B) during the month of September and 14.2% in poorly constructed houses (group C) during the month of October. Parasitological observations of the population showed a 12.2% microfilaria (mf) rate and 6.7% disease rate among the residents of poorly constructed houses, 5.8% mf rate and 2.9% disease rate among residents of moderately constructed houses. Among residents of well built houses (Group A), none were found to be positive with mf, but disease rate was observed to be 2.7%. Throughout the year the relative humidity was observed to be higher in the poorly constructed houses and ambient temperatures were found to be lower during the summer but higher during the winter than to those of the better constructed houses. The study made evident that the construction of houses plays an important role in the vector's resting preference, leading to a higher density in poorly constructed houses, thereby increasing the possibility of infection within them, and thus maintaining a higher potential for filarial transmission among its inhabitants.

INTRODUCTION

The findings of a longitudinal study for estimating the vector density of *Culex quinquefasciatus* showed the vector of bancroftian filariasis in Varanasi projected high-vector density in housing conditions which were unhygienic due to improper lighting and ventilation and suggested conditions which would be ideally conducive for resting this vector species (1,2). Varanasi is a city situated on the bank of the river Ganges and is known for its high filaria endemicity (2). It has been observed that the disease rate is higher among the inhabitants of such houses. These findings authenticate the congenial conditions for the preferred resting of *Cx. quinquefasciatus*; inhabitants of unhygienic houses were more exposed to infection with *Wuchereria bancrofti* as compared to those who lived in the properly designed houses with adequate ventilation and lighting. This observation was supported by the results of the dissection. Higher *Cx. quinquefasciatus* infection and infectivity rate were collected from poorly constructed houses than from well constructed ones.

Reports show that poor housing with dim lighting is a more favorable and congenial resting place for the vector of bancroftian filariasis as compared to houses with tiled roofs and ceilings and stone or brick walls or houses with tiled roofs and cement floors resulting in more intense transmission in the poorly constructed houses (3-5).

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Considering the encouraging findings of the above study, as well as observations made by various authors in other parts of the globe, the present study was undertaken to assess the resting preference of this vector in houses constructed by various means, by studying its density, infection and infectivity rates. The impact of the above factors was assessed by undertaking a night blood survey of the inhabitants of the identified classes of houses. An effort has been made in this paper to correlate the probability of filarial infection by assessing entomological and parasitological parameters.

MATERIALS AND METHODS

The study was carried out between March 1994 and February 1995 in Hariharpur village of Varanasi which has a population of approximately 2,000 and depends on agriculture for its livelihood. The village is composed of small hamlets. For the study, three types of houses from ecologically similar backgrounds were selected and coded as groups A, B and C (Table 1). Group A houses were better constructed, with concrete walls and roofs and cement floors, with well ventilated rooms and proper lighting. Group B houses had unplastered brick walls, tiled roofs and mud floors with inadequate light and ventilation. Group C houses were poorly constructed, with mud-plastered walls, tiled roofs and mud-plastered floors, with inadequate ventilation and light. Twelve houses from each group were selected for the study.

Adult house-resting mosquitoes were collected fortnightly

Table 1. Classification of various types of houses

Code	Wall	Roof	Floor	Ventilation and Lighting	Percent of population*
Group A Well constructed	Cement	Cement	Cement	Adequate	17.0
Group B Moderate	Brick	Tiled	Cement	Inadequate	35.0
Group C Poor	Mud Plastered	Tiled	Mud	Very poor	48.0

*Percent inhabitants of the village, residing in particular group of houses

during early morning hours (6:00 -9:00 a.m.) from every house in each group. Collections from every house in the study were made for 15 min with aspirator tubes (suction tubes) as per World Health Organization (WHO) guidelines (6) and kept separately. Mosquitoes were identified and per man hour density (pmhd) was calculated. Females of the vector species *Cx. quinquefasciatus* were dissected to determine infection and infectivity rate, if any. The mid-gut blood content of each mosquito was collected on filter paper for serological analyses, and through the use of gel diffusion method, the host predilection of the vector was determined (7). The comparative data generated from each of the three groups was subjected to statistical analyses. Temperature and humidity were recorded inside each house at the time of collection.

A night blood survey was carried out during the month of April 1994. Finger-prick blood smears were collected on glass slides between the hours of 9:00 and 11:00 p.m. Effort was made to collect blood slides from the inhabitants of each group of houses. These slides were stained with J.S.B (Jaswant Singh and Bhattacharjee) stain and examined under a microscope for the presence of microfilariae in accordance with National Filaria Control Program (NFCP) guidelines (9).

The indices and parameters used in the study are as follows:

$$\text{pmhd} = \frac{\text{No. of mosquitoes collected}}{\text{Time in hours spent on mosquito collection}}$$

$$\text{Vector infection rate (\%)} = \frac{\text{No. of females in the vector found to contain developing and developed stages of parasite (stage I, II and III)}}{\text{No. of female dissected in the vector}} \times 100$$

(Microfilaria (mf) stage is not included in the enumerator of vector infection.)

$$\text{Vector infectivity rate (\%)} = \frac{\text{No. of females in the vector found to contain developed stages of parasite (stage III)}}{\text{No. of female dissected in the vector}} \times 100$$

$$\text{Mf rate (\%)} = \frac{\text{Total no. of persons found to harbor mf}}{\text{Total no. of persons examined}} \times 100$$

$$\text{Disease rate (\%)} = \frac{\text{No. of persons showing signs and symptoms of filaria disease manifestation}}{\text{No. of persons examined for filaria disease}} \times 100$$

RESULTS

Month by month pmhd of *Cx. quinquefasciatus*, along with the results of each group's dissection, are presented in Table 2. A maximum pmhd of 31.66, 40.33 and 41.33 were observed during the month of March and a minimum of 1.3, 2.6 and 0.33 during June, in group A, B and C houses respectively. The arithmetic mean for group A, B and C houses was found to be 11.95, 15.28 and 15.98, with a standard deviation of mosquitoes collection 9.33, 13.18 and 13.19. The 95% confidence limit for pmhd in well constructed or group A houses was found to be 6 to 30; in moderately constructed, or group B houses, 11 to 41; and in poorly constructed, or group C houses, 10 to 42. The arithmetic mean of group C was tested for significance against that of A and B: the 't' value for C vs. A was calculated to be 0.86 which was not significant; similarly the 't' value for C vs. B was calculated to be 0.13, which is also not significant.

Comparative analyses of the pmhd of group C with that of groups A and B did not show any significant differences. Chi square values obtained for group C with A were $\chi^2 = 5.577$ ($P < 0.5$) on 11 degrees of freedom; likewise with group B they were $\chi^2 = 5.338$ ($P < 0.5$) on 11 degrees of freedom. This shows that the month-wise distribution of pmhd also not different between the groups.

Dissection of vectors from each group (Table 2) revealed that in group C houses infections were observed during April, May, October and January of the following year, while in group B houses 10.0% infection was observed only during the month of September. However, no infection was found in group A houses at any time throughout the year. The infectivity rate was found to be 10.0% in the month of September in group B houses and 14.2% in group C houses in the month of October. The mid-gut blood of 2375 (half fed, full fed and Semi gravid) females was subjected to serological analyses by gel diffusion method, which revealed that 92.0% (2185 out of 2375) of the vector *Cx. quinquefasciatus* collected fed on human blood.

Results of the night blood survey presented in Table 3 show that, out of a total of 194 blood smears collected, 15 were found to be positive for mf (mf rate 7.7%) and 9 of these positive blood smears had disease manifestations. The mf rate was 5.8 and 12.2% in group B and C houses respectively; no positive blood smears were found in group A houses. The disease rate was found to be 2.7, 2.9 and 6.7 in group A, B and C houses respectively. Temperature and relative humidity data inside the houses of each group at the time of collection are presented in Table 4. The room temperature in group C houses was observed to be 0.5 to 1.0°C lower during warm months (March to September) than that of group A and B houses while during cooler months (October to February), it was 0.5 to 1.0°C higher. Similarly, the relative humidity was observed to be 5.0 to 10.0% higher in group C houses. Analyses of the meteorological data for the study period revealed that the 95% confidence limit of average room temperature was 11 to 39 in group A, 11 to 39 in group B and 12 to 37 in group C houses. Similarly, the 95% confidence limit of relative humidity was 19 to 78 in group A, 20 to 81 in group B and 26 to 90 in group C houses. However, the 5 to 10% difference in the relative humidity in group C houses could not be proven to be statistically significant for the present sample.

Table 2. Man hour density, infection and infectivity rate of *Culex quinquefasciatus* among three groups of houses

	Group A				Group B				Group C			
Months /Year	Total no. of mosquitoes collected	Man hour density	Infection rate	Infectivity rate	Total no. of mosquitoes collected	Man hour density	Infection rate	Infectivity rate	Total no. of mosquitoes collected	Man hour density	Infection rate	Infectivity rate
Mar 94	190	31.66	0	0	242	40.33	0	0	248	41.33	0	0
Apr	158	26.33	0	0	236	39.33	0	0	247	41.13	1.26	0
May	78	13.00	0	0	146	24.33	0	0	116	19.33	3.33	0
Jun	8	1.3	0	0	16	2.60	0	0	2	0.33	0	0
Jul	44	7.33	0	0	44	7.33	0	0	46	7.66	0	0
Aug	32	5.33	0	0	30	5.00	0	0	50	8.33	0	0
Sept	24	4.00	0	0	20	3.33	10.00	10.00	36	6.00	0	0
Oct	16	2.6	0	0	32	5.30	0	0	32	5.30	14.2	14.2
Nov	74	12.3	0	0	50	8.33	0	0	76	12.66	0	0
Dec	104	17.3	0	0	92	15.30	0	0	80	13.30	0	0
Jan 95	72	12.0	0	0	90	15.00	0	0	104	17.30	4.5	0
Feb	62	10.3	0	0	103	17.20	0	0	115	19.10	0	0
Arith-metic mean		11.95				15.28				15.98		
SD		9.33				13.18				13.19		
95% C.L.	6-30				11-41				10-42			

χ^2 (C vs. A)=5.577 on 11 degrees of freedom ($P < 0.5$); (C vs. B)=5.338 on 11 degrees of freedom ($P < 0.5$), C.L.: confidence limit.

Table 3. Results of the night blood survey

	Group A	Group B	Group C	Total
Total no. of blood smears collected	36	68	90	194
Positive for microfilaria	–	4	11	15
Microfilaria rate (%)	–	5.8	12.2	7.7
Disease manifestation	1	2	6	9
Disease rate (%)	2.7	2.9	6.7	4.6

DISCUSSION

House construction and ambient eco-climatic conditions influence vector density and man/ mosquito contact, which in turn determine the intensity of disease transmission. A long term study in Tanzania satisfactorily demonstrated that modification of houses may supplement other control strategies for filariasis (8).

Parasitological observations in the present study clearly indicate a higher prevalence of mf rate (12.2%) among the inhabitants of poorly constructed houses than that among the inhabitants of moderately constructed houses (5.8%) and nil in well constructed houses. In a study carried out at the sea port

Table 4. Average temperature and relative humidity recorded at the time of collection between 6:00 and 9:00 a.m.

Month/Year	Group A		Group B		Group C	
	Temp °C	RH %	Temp °C	RH %	Temp °C	RH %
March/94	22.9	42.0	22.0	43.9	21.5	50.0
April	26.7	34.6	26.5	35.3	25.7	41.9
May	35.7	35.0	35.7	35.9	34.5	43.2
June	32.9	20.3	32.0	20.8	31.7	30.0
July	30.7	70.2	30.5	72.0	30.0	85.0
August	29.0	67.8	29.0	69.9	28.5	80.2
September	30.9	58.5	29.9	60.7	29.0	64.5
October	29.1	45.3	28.1	46.5	28.8	53.8
November	21.5	48.0	21.1	50.2	22.0	56.2
December	15.7	57.4	15.0	59.6	16.9	65.7
January/95	15.1	60.0	15.0	61.5	16.0	69.4
February	16.7	49.7	16.5	52.0	17.0	58.9
Arithmetic mean	25.57	49.07	25.11	50.69	25.13	58.23
SD	7.04	14.69	7.02	15.18	6.29	15.96
95% C.L. (Mean±2 SD)=	11-39	19-78	11-39	20-81	12-37	26-90

RH: relative humidity, C.L.: confidence limit

of Alleppy in Kerala, India, showed that 41.1% of the total mf carriers were inhabitants of thatched houses and only 22.6% were inhabitants of tiled houses (5). Reports from Indonesia showed higher mf and disease rates in poorly constructed houses with partial brick/wooden or bamboo-woven walls, mud or partly cement floors, and unscreened windows which were inadequately lit or poorly ventilated (3). In Mambrui, Kenya, transmission was observed to be more intense, with higher mf rates and heavy mf densities, along with enlarged lymphnodes in the groins of people inhabiting poorly constructed houses (4).

Man-hour density of this vector in the present study showed similar seasonal variations to those found in earlier studies (1). Dissection of vectors in group B houses revealed a 10.0% infection and infectivity rate during the month of September. This high rate may be due to the low sample size: out of 10 females collected during a 3 h time span, only 1 was positive, and this positive female contained third or infective stage larvae. However, in group C houses, infections were observed during April, May, October and January of the following year. Earlier filaria vector *Cx. quinquefasciatus* was also observed in Varanasi to be positive with mf during the months of March, April and May, and again in September and October (1,2). In the present study, the anthropophilic index was found to be 92.0%. It may be due to the fact that the entire collection was comprised of adults and collected only from human dwellings. Earlier reports show that the density of an anthropophilic species is not the only major factor in determining prevalence of the disease; the relationship between the human host and the vector density is equally important (10).

During the study it was observed that the average humidity in group C houses was 5.0 to 10.0% higher throughout the year than that of group A and B houses. Earlier reports show that high humidity is required by the filaria larvae because as soon as the larvae escapes from the proboscis of the infected vector a drop of fluid exudes from the labium and the larvae must enter into the bite wound of the human host before this fluid evaporates (10). Though the entomological data has not yet revealed any significant difference between the various groups of houses, infective mosquitoes prefer to rest indoor, and the high humidity in group C or poorly constructed houses probably results in more exposure of their inhabitants to infective bites, a conclusion which is well supported by the parasitological findings. However, measurement of the intensity of transmission of human filarial infection is complex and none of the methods available for measuring it is ideal.

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