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Bancroftian filariasis in Pondicherry, South India: 1. Pre-control epidemiological observations

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SUMMARY

A 5-year Integrated Vector Management (IVM) project was implemented in Pondicherry, South India, for the control of Bancroftian filariasis. The efficacy of the IVM strategy was compared with routine control strategy under the national programme. The present paper describes the pre-control epidemiological features of filariasis as determined by a mass blood survey in 1981. Of 24946 persons examined 8·41% were microfilaraemic. Microfilaraemia prevalence was homogeneous throughout the study area. The prevalence and intensity of microfilaraemia were age dependent, and increased monotonically until about 20 years, following which there was a decline until about 40 years to become relatively stable in older age classes. The gender profiles of both prevalence and intensity of microfilaraemia showed no difference between the sexes until about 15 years of age, following which both were higher in males compared to females. The distribution of microfilarial counts was overdispersed, indicating aggregation of adult worms.

INTRODUCTION

Filariasis is a major health problem in India (1–3). Recognizing the limitations of existing strategies of using diethylcarbamazine (DEC) against parasite and chemical insecticides against vector (4), the Vector Control Research Centre (VCRC) of the Indian Council of Medical Research launched a 5-year programme to examine the efficacy of Integrated Vector Management (IVM) as a rational alternative.

The programme for the evaluation of the IVM strategy was carried out in the town of Pondicherry. The programme required that two separate areas of the town received two different control interventions: the IVM activities of the VCRC would be concentrated in one area, while in the comparison area the routine activities under the National Filariasis Control Programme (NFCP) would continue. The VCRC programme was based on reducing vector (*Culex quinquefasciatus*) breeding through environmental management and judicious use of insecticides for larval control, while larviciding formed the main tool for vector

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control operations in the comparison area under the NFCP. The progress of these activities has been documented in a series of publications (4–8). The paper describes the epidemiological features of endemic filariasis in Pondicherry, as determined by surveys carried out during 1981 prior to the initiation of the IVM programme.

MATERIAL AND METHODS

The methods used in the control and evaluation aspects of the programme have been described in detail elsewhere (4). The study area of the Pondicherry town is located at 11·45° to 12·15° north latitude and 79·35° to 80·0° each longitude in Southern India. The area comprises 60 km^2 and is situated on the coast of the Bay of Bengal.

A mass night blood survey was conducted from January to June 1981 to detect microfilaria in peripheral blood by finger prick method. Membrane filtration is known to enhance the estimation of prevalence (9) by a proportion of 0·2, but it was considered that the risk and discomfort associated with the venipuncture procedure required for this method made it inappropriate for the present mass survey application.

Sampling design

Since the population was not uniformly distributed, a stratified random sampling protocol was adopted. The study area was already stratified into seven zones for operation and evaluation of control programmes (4). The sample survey was aimed to cover 10% of the estimated population in each of the zone. The total number of households to be covered in each zone was decided according to the average number of persons per household in the zone. The households within each zone were identified by using random number tables. Prior to the survey a social worker informed and explained the purpose of the survey to the members of the selected households. Blood smears were collected from all the individuals in the selected house. Each locality was visited more than once to ensure as far as possible that all members of the household are sampled. The programme was designed to collect blood specimens from approximately 27000 persons (10% of the total population) in Pondicherry town, and a minimum coverage of 5% of the population was expected in each age class. The blood collection teams visited the households between 8 p.m. and 12 p.m. A 20 mm^3 peripheral blood smear was collected for subsequent laboratory assessment. Permission for blood sampling was received from all individuals, or in the case of children, from their guardians. All infected individuals were referred to the filaria clinic under NFCP for treatment.

Statistical methods

The χ^2 statistics was used to see if there are any significant difference in prevalence of microfilaraemia between sexes and among different age classes. The observed frequency distribution of microfilaria counts for each age class was fitted to the negative binomial probability distribution and zero truncated negative binomial distribution by using the method of maximum likelihood (10, 11).

Table 1. *Age structure of population compared with sample*

Age (years)	Population size	% of total population	Sample size	% of total sampled	% covered in each age class
0–5	40838	15·0	1397	5·60	3·42
6–8	24503	9·0	1983	7·95	8·09
9–11	24503	9·0	2185	8·76	8·92
12–14	24503	9·0	2403	9·63	9·81
15–19	23686	8·7	3527	14·14	14·89
20–24	21508	7·9	2963	11·88	13·78
25–29	20147	7·4	2506	10·05	12·44
30–34	17969	6·6	1790	7·18	9·96
35–44	30492	11·2	2713	10·88	8·90
45–54	21508	7·9	1861	7·46	8·65
> = 55	22597	8·3	1618	6·49	7·16

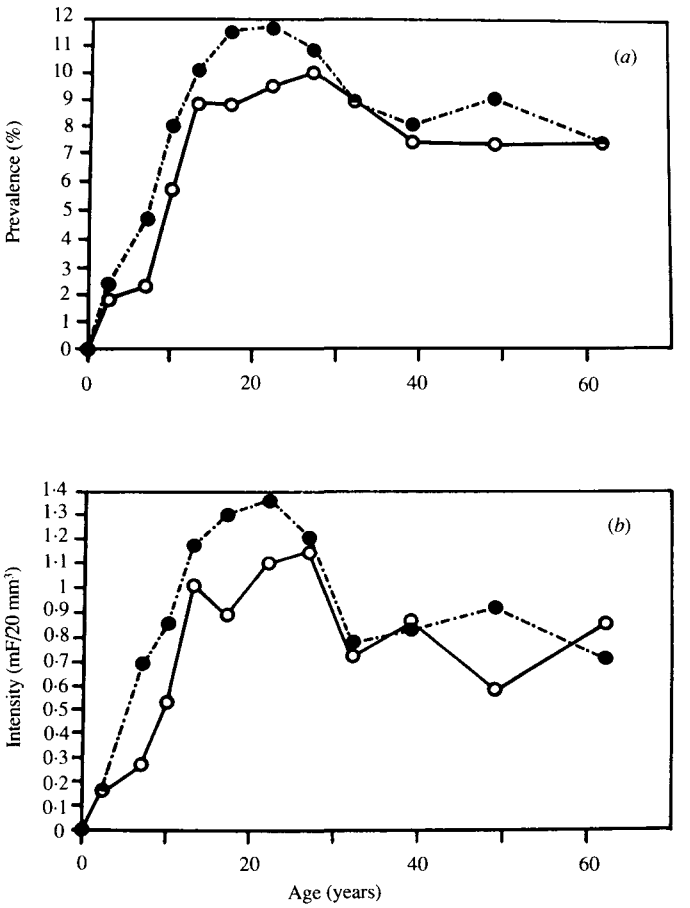

Fig. 1. Relationship between host age and microfilaraemia prevalence (*a*) and intensity (*b*) in IVM (●–·–●) and comparison (○—○) areas.

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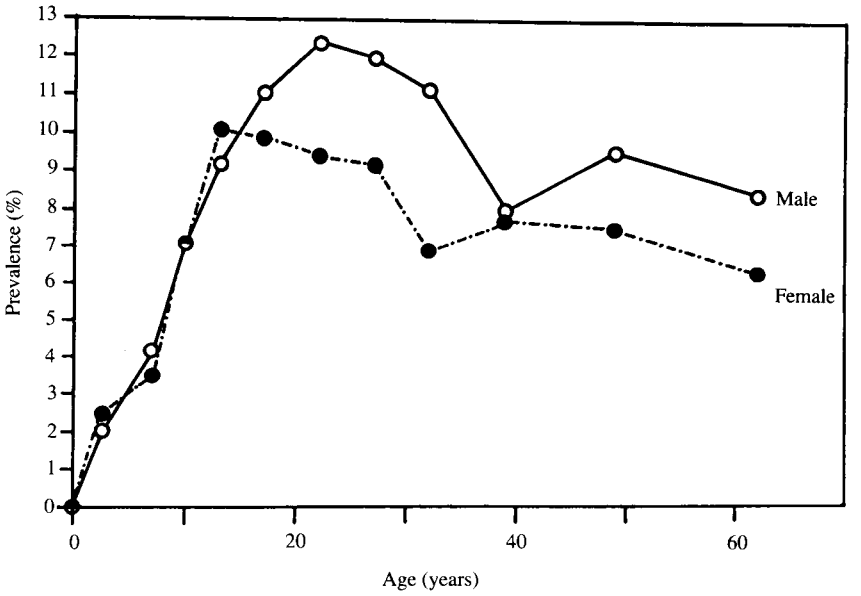

Fig. 2. Prevalence of microfilaraemia in females and males in Pondicherry.

RESULTS

A total of 24946 persons (9·16% of the total population) was examined for microfilaraemia. Though age stratified sampling was not intended, it was aimed to obtain a minimum coverage of 5% in each age class and this was achieved in all age classes except in 0 to 5-year age class (Table 1). In comparison with older age classes, only 3·42% of the age class 0–5 years was sampled due to practical difficulties encountered in getting blood smears from infants and young children. This age class therefore was undersampled, and any possible bias on this score could not be avoided. It was also found that 46·1% of those sampled were less than 20 years compared to 50·7% in the population (Table 1).

A total of 2009 persons was found to be infected in the town of Pondicherry, giving an overall prevalence of 8·41%. The prevalence of microfilaraemia and its intensity were age dependent (Fig. 1). Prevalence and intensity increased monotonically throughout the child and young adult age classes to attain a peak at approximately 20 years of age. Prevalence declined sharply from approximately 20 to 40 years of age, but in older adult age-classes the prevalence was relatively stable. There was a more obvious trend of decline in intensity in the 20–30 years age range. Comparison between microfilaraemia prevalence in females and males showed significant differences only in the age range of 20–34 years (Fig. 2, Table 2).

Comparison of age specific prevalence and intensity of microfilaraemia between IVM controlled and the comparison (NFCP) areas of Pondicherry indicated that the distributions had similar overall profiles (Fig. 1*a*,*b*). Comparison of age specific prevalence of microfilaraemia among the seven zones of Pondicherry showed that the distribution was spatially homogenous.

The frequency distribution of microfilarial density in infected individuals was

Table 2. *Comparison of microfilaraemia prevalence in females and males in Pondicherry*

Age (years)	Sample size		Microfilaria prevalence (%)		χ^2 P
	Males	Females	Males	Females	
0–5	742	655	2·02	2·44	0·725
6–8	1037	946	4·15	3·49	0·519
9–11	1099	1086	7·10	7·18	0·995
12–14	1274	1129	9·18	10·10	0·491
15–19	1865	1662	11·05	9·87	0·278
20–24	1498	1465	12·35	9·42	0·028*
25–29	1221	1285	11·96	9·18	0·012*
30–34	862	928	11·14	6·90	0·002*
35–44	1189	1524	7·99	7·68	0·819
45–54	832	1029	9·50	7·48	0·141
> = 55	870	748	8·39	6·28	0·129

* Significant.

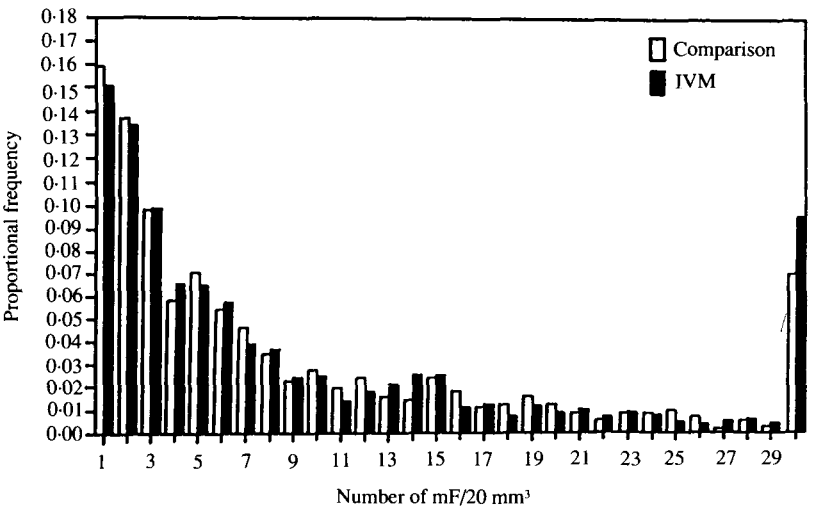

Fig. 3. Proportional frequency distribution of microfilaria numbers in the IVM and comparison areas.

similar for both areas and was markedly overdispersed (Fig. 3); while the mean infection intensity was 0·98 mF/20 mm^3, a maximum density of 300 mF/20 mm^3 was observed. This distribution for Pondicherry as a whole was not adequately described either by the negative binomial ($\chi^2 = 200{\cdot}17$, D.F. = 54, $P = 0{\cdot}000$) or the zero truncated negative binomial ($\chi^2 = 105{\cdot}87$, D.F. = 50, $P = 0{\cdot}000$) probability distributions. Further analysis was carried out for fitting the microfilarial distributions in different age classes for the IVM and comparison area separately and the results are presented in Table 3. While the observed distribution of microfilaria counts without considering age classes did not fit the negative binomial probability law in either area, the zero truncated negative binomial

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Table 3. *Results of fitting negative binomial probability distribution in IVM and comparison areas*

Age (years)	Negative binomial				Truncated negative binomial			
	Comparison area		IVM area		Comparison area		IVM area	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P
0–5	3·01	0·390*	0·62	0·735*	3·35	0·067*	0·61	0·435*
6–8	1·06	0·304*	12·16	0·058*	3·62	0·460*	5·55	0·475*
9–11	8·21	0·084*	4·03	0·095*	2·45	0·783*	4·07	0·907*
12–14	9·05	0·433*	27·67	0·010	5·52	0·701*	17·50	0·230*
15–19	33·15	0·001	44·13	0·001	28·26	0·003	39·65	0·006
20–24	15·68	0·109*	44·10	0·001	14·33	0·215*	28·91	0·068*
25–29	18·51	0·030	21·83	0·112*	9·69	0·376*	10·29	0·851*
30–34	18·53	0·024	24·48	0·004	16·42	0·057*	18·03	0·035
35–44	13·18	0·070*	23·80	0·014	5·87	0·554*	14·22	0·287*
45–54	10·63	0·059*	18·16	0·033	6·39	0·270*	14·22	0·115*
> = 55	14·40	0·013	15·69	0·028	9·79	0·082*	6·91	0·439*
Total	76·1	0·000	154·5	0·000	42.26	0·130*	73·49	0·003

* Good fit.

probability distribution fitted the data from comparison area alone. Age class-wise analyses showed that while the negative binomial distribution fitted the data for age classes less than 11 years in both areas, the zero truncated negative binomial fitted for most age classes in both areas.

DISCUSSION

The age dependency of microfilaraemia prevalence and intensity has a form that was described elsewhere (12–13). The monotonic rise in age prevalance and age intensity implies a constant rate of acquisition of infection in all age classes below the age of 20 years. At this age both prevalence and intensity attained peak values before declining in the adult age classes. This peak may correspond to the age at which acquisition of infection is balanced by loss of infection (14). For a long-lived helminth such as *Wuchereria bancrofti*, where the mean expected lifespan is in the range of 8–15 years (15–21), it would be expected that this balance would be achieved many years after first infection and not in the child age classes as observed in the present study. The decline in intensity of microfilaraemia in the adult age classes implies an age dependent reduction in the rate of acquisition of infection or an age dependent increase in the rate of loss of infection or some combination of both processes. This could also mean, that there is a rise in acquired immunity with age, in an endemic area, which affects the rate of establishment of infection, longevity of worms, or worm fecundity. The relatively rapid decline in microfilaraemia intensity with age compared to prevalence is consistent with theoretical predictions of the relationship between the two variables for overdispersed parasite population (22).

The gender-dependent analysis of prevalence as well as intensity shows that the difference is well marked above the age of 15 years. Similar gender dependent

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patterns have been described elsewhere (13, 23, 24). This could imply that both sexes are equally exposed up to adolescence but not thereafter, perhaps indicating that adult cultural practices are important. For example, clothing practices in this community result in adult women being more completely covered than adult men, while children of both sexes are similarly clothed.

The distribution of microfilaria density in the population is overdispersed. This may indicate aggregation of adult worms, as has been consistently observed for other helminth infections of humans (22, 25, 26) and for filarial infection in non-human hosts (27, 28). In a recent paper, Park (29) suggested that the distribution of microfilaria counts can be described as a compound of a Poisson distribution of sampling and a Gamma distribution of microfilariae, and should therefore follow the negative binomial probability distribution. In consequence, the form of this distribution should be independent of sampling sensitivity, although this would affect the mean of the distribution. The results of present study, however, indicate that the overdispersed distribution is not adequately described by the negative binomial distribution particularly in adult age classes, a discrepancy which could arise due to an excess proportion of amicrofilaraemic individuals. The observation that truncated negative binomial describes the distribution of microfilaria counts for most age classes and nontruncated negative binomial only in children below 11 years, indicate that there are more amicrofilaraemics among the adults. This again could be due to several reasons. Microfilaria sampling does not detect non-fecund single worm or single sex infections (which could be predicted to be a numerically significant group) or because a significant proportion of the adult population successfully limit their infection, perhaps by an effective immune response. The epidemiological implication of this phenomenon needs further examination.

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