

**Environmental Factors of Malaria Persistence:
A Study at Valiyathura, Thiruvananthapuram City**

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Environmental Factors of Malaria Persistence: A Study at Valiyathura, Thiruvananthapuram City

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1. Background and rationale

Malaria continues to be a major problem of the tropical developing countries. In India, malaria constituted a major public health problem as early as in 1935 with about 100 million cases and 10 lakh deaths every year (WHO/SEARO, 1995). The annual incidence of the disease was reduced to 0.1 million cases in 1964 through Malaria Control and Eradication programmes. However, there was resurgence of malaria with 6.4 million cases in 1976 due to various reasons. Nevertheless, the number of cases dropped to 2.1 million in 1984 following implementation of the Modified Plan of Operation (MPO).

The total number of malaria cases was around 1.4 million in 1992. The entire population of India was deemed to be under the risk of malaria (WHO/SEARO, 1995). The National Malaria Control Strategy (NMCS) came into force in the same year. Under this programme, malariogenic stratification of prioritised endemic areas into high, medium, and low risk areas was undertaken. A resurgence of malaria was observed in some States with several focal epidemics while the total number of malaria cases in the country stood at around 2.4 million. An expert committee (Pattanayak Committee) was appointed in December 1994 to identify high-risk areas and suggest remedial measures. The Malaria Action Programme (MAP) was launched in 1995, and was taken up in high-risk areas.

The history of malaria can be traced back to those periods earlier than the recorded history where it prevailed among tribespeople in the hills and forests (Directorate of Health Services, Kerala, 1964). Coastal areas and the midland plains up to an altitude of 5,000 feet above mean sea level were considered healthy (Krishnan Thampi, 1957). A malaria control programme in the State was started as early as in 1947. Kerala attained the distinction of being the first State in India to be declared 'malaria free.' After this declaration in 1965, only imported cases used to occur for a few years (DHS, Kerala, 1968). However, from 1969 onwards, focal outbreaks of malaria occurred in most of the districts in Kerala. An epidemic of malaria was reported in Kannur district in 1976 and an increasing trend of malaria was observed thereafter (DHS, Kerala, 1969-77).

During 1991, a total of 6,758 malaria cases were reported from the State. Almost all the cases (99.74 per cent) were imported and only 0.25 per cent was indigenous. It is alarming to note that the percentage of indigenous cases is increasing in the State (DHS, 1996).

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Table 1.1 Number of Reported Cases of Malaria in Kerala, 1991 - 1996

Year	Total no. of cases	Indigenous cases	Imported
1991	6758 (100.0)	17 (0.25)	6741 (99.75)
1992	8255 (100.0)	32 (0.39)	8223 (99.61)
1993	9277 (100.0)	101 (1.09)	9176 (98.91)
1994	9075 (100.0)	363 (4.0)	9712 (96.0)
1995	11878 (100.0)	2803 (23.6)	9075 (76.4)
1996 (up to Nov)	11009 (100.0)	3633 (33.0)	7376 (67.0)

Source: Report of Malaria Situation, Directorate of Health Services, Kerala, 1996.

The majority of the infections were due to plasmodium vivax, but an increase in the trend of P. falciparum and mixed infections has also been observed (DHS, Kerala 1994-96).

We noticed that a total of 22 imported cases - and no indigenous ones - was reported from the coastal areas of Thiruvananthapuram Corporation during 1993 (DMOH, Tvm, 1993). The first focal outbreak occurred in the Valiyathura area of Thiruvananthapuram Corporation during April-June 1994. During that period, a total of 89 cases were reported of which 37 per cent was indigenous. The second outbreak occurred in the same area during the same period in 1995. Out of the 2,298 reported cases, 94.3 per cent of them was indigenous. The first six months of 1996 witnessed 2,356 positive cases in the area that accounted for 39.2 per cent of the total number of cases reported in Kerala during the period. It is also striking to note that out of all indigenous cases reported in Kerala in 1996, 98.5 per cent came from this area alone. Despite the efforts by the government, malaria cases continued to be reported from the area at the rate of five to seven cases per day, of which five per cent was due to P. falciparum. Thus the area, which was non-malarious till a few years ago, have become highly malarious and was identified a high-risk malarious area (on the basis of MAP 1995 criteria).

Further, the disease persisting in this area has been mostly of the indigenous type. If this situation continues, this area will become a focal point for the spread of the disease not only to neighbouring places but to other parts of the State as well. Hence urgent steps should be undertaken to control the disease in the area. The control measures introduced by the health authorities have been successful largely, as is evidenced by the drop in the incidence of cases reported. However, there is no room for complacency. New cases of malaria and almost an equal number of relapse cases are still being reported, proving the persistence of the disease and the possibility of an increase in the trend.

It was observed that the control strategies yielded good results when they were introduced consequent to the outbreak of the disease in Valiyathura in 1994. The results were only temporary since there was a much larger outbreak in 1995 (Table 1.2).

The incidence of malaria continued to be high till mid-1996 despite the best efforts by the Health Services Department.

The Valiyathura area, to which the epidemic was confined, consists of four wards: Valiyathura, Sanghumukhom, Vallakkadavu, and Beemapally. The preliminary visits to this area convinced us that the environmental conditions (physical and socio-cultural) in this coastal area, inhabited by a closely-knit community, were different from those of any other area in the vicinity. The majority of the inhabitants of this area belongs to lower economic strata and their level of education is very low. Housing conditions and immediate environment were found deplorably unhygienic and provide an idle breeding ground for mosquitoes. Improper and inadequate treatment of the disease was the prevailing practice among the population despite the availability of facilities for treatment provided by the government. All these factors have contributed to the persistence of disease in the area. Only infection control strategies planned with due recognition of these factors would be effective in providing enduring results.

It is against this background that we have planned to carry out an enquiry with a view to exploring in depth the environmental factors influencing the persistence of malaria in Valiyathura area of Thiruvananthapuram city.

Table 1.2 Epidemiological Situation in Valiyathura, 1994-96

Month	1994		1995		1996	
	Total	Ind	Total	Ind	Total	Ind
January			11	11	276	276
February			72	72	475	473
March			139	139	404	404
April	4		434	434	336	332
May	18	18	291	291	425	423
June	12	12	264	260	193	193
July	4	3	239	239	245	242
August	4		222	156	272	271
Septemeber	6		192	192	129	129
October	5		123	123	104	103
November	4		154	144	47	45
December	32		158	147	43	41
Total	89	33	2299	2208	2949	2932

Source: DHS, Kerala

2. Objectives and Methodology

Objectives

The following are the major objectives of the enquiry:

- (i) a study of the environmental conditions (physical and socio-cultural) of Valiyathura which make the population of the area susceptible to infection of malaria; and
- (ii) an appraisal of the existing control strategies being pursued in this area by public authorities.

Methodology

Setting

The study was carried out at the community level in Valiyathura area.

Malaria cases were reported from all the wards of the area; but the areas with the highest incidence were the four coastal wards - Valiyathura, Vallakkadavu, Sanghumukhom, and Beemapally. Recently, the Department of Health Services has earmarked an area stretching the endemic pockets of all the four wards and divided it into 24 sectors. The total number of houses in this area is 6,515. The present study was concentrated along the coastal belt covering 11 of the 24 sectors having a population of about 15,000 in nearly 2,800 households. The Poonthura ward, adjacent to the study area and identified as non-endemic, was included in the study as a control. The total number of houses in this ward was 2,200 (1991 Census).

The study and the control areas are lowland coastal areas, bounded in the west by the Arabian Sea and in the east by the Parvathi Puthanar and the Sewage farm. The transportation facilities in the area are adequate. The area experiences three seasons - a hot season and two monsoons. Government agencies, private practitioners, and voluntary organisations like TSS (Trivandrum Social Services) provide health care services to the population. A primary health centre is located at Poonthura. The Poonthura ward does not, however, come under the Thiruvananthapuram Corporation. The study area has a government dispensary with in-patient facilities, MCH centres (of the Thiruvananthapuram Corporation), and Anganwadis (under the ICDS scheme). Besides, a Government Malaria Treatment and Control unit was established during 1995-96 to bring the epidemic under control. The majority of the inhabitants are Christians and nearly 26 per cent of them are illiterate (1991 Census). Being a coastal area, most of the working population is engaged in fishing and related activities.

Population and Sample

Three hundred households were selected from Valiyathura area (study area) and an equal number from Poonthura area (control area) for intensive study. The control area lies within the flight range of the mosquito, *Anopheles stephensi*, and is about one km away from the urban belt of Thiruvananthapuram. The sample size was determined based on the prevalence

of malaria, as understood from the pilot study. The prevalence estimate from the pilot study being four per cent, the number of households to be covered in the survey was calculated using the formula.

$$\begin{aligned}
 n &= \frac{P(1-P) \times 1.96^2}{\Delta^2} \\
 &= \frac{4 \times 96 \times 1.96^2}{1^2} = 1,475
 \end{aligned}$$

Assuming the size of a family in the area to be 5.5, the total number of houses covered came to $1475/5.5=268$. Considering a non-response rate of 10 per cent, the sample size was fixed as 300. Three hundred households were drawn from control area for comparison.

Sampling and Study and Outcome Variables

A systematic sampling strategy was followed for the study as well as the control population. The sampling interval was fixed by dividing the total number of houses by the sample size. Families and permanent residents, who have been in the area for more than six months, were included in the study. The study variables included physical environment (including climatological details), housing conditions, breeding and resting places of mosquito, socio-economic characteristics of the households (such as education, occupation, and income), population mobility, sleeping and clothing habits of the members of the households, community perceptions on malaria and availability, and awareness and utilisation of health care services.

Outcome variables were individuals with symptoms suggestive of malaria (fever and rigour) and those who had undergone treatment. We relied on self-reporting as no records were available with most of the patients.

Data Collection

Quantitative and qualitative methods were used for collecting data. Semi-structured, pre-tested, and interviewer-administered questionnaire was the main tool for collecting data. Besides, focus group discussions (FGDs) and key informant interviews were carried out at the community level to supplement the information collected through a survey. Open-ended interviews with health service personnel and secondary sources like reports and records were also used for collecting data.

Trained investigators through house-to-house visits collected the data. The timings of data collection were varied to suit the respondents. The respondents were the heads or any other adult members of the households. Revisits were easy as the houses existed close together. The period of data collection by questionnaire was February–August 1997. Consequently, FGDs and open-ended interviews were conducted in the area. Three FGDs were conducted - two in the study area and one in the control area - with the help of an FGD guide prepared in advance. Data for the second objective namely, appraisal of the existing malaria-control strategies, mostly came from the FGDs and open-ended interviews.

Analysis

The data were computerised and descriptive statistics were used to discuss the population characteristics and inferential statistics to find out the association of a risk factor with relation to the outcome. The content analysis of qualitative data was done by categorising, coding, and summarising manually. The findings of the qualitative study were incorporated while interpreting the results of the quantitative survey wherever needed. The additional information collected is discussed separately.

3. Observation and Discussion

Description of the Study Population

General Characteristics

Valiyathura (study area) has a population of 1,606 residing in 300 houses with an average family size of 5.4. The average family size in Poonthura (control area) comes to 5.8; the population is 1,764 and the number of households, 300. It was found that the average family size in the study and control areas are above the State average. Nearly, 95 per cent of the families in Valiyathura belong to the Christian community; Hindus and Muslims constitute the rest. In Poonthura also Christians constitute 94 per cent of the total households. Nuclear families constitute 67 per cent of the total households in Valiyathura and the rest are the joint families or the extended type. The percentage of nuclear families in Poonthura is around 52.

Type of Vector

Vector studies conducted by Department of Health Services and Medical Entomologists of the Department of Community Medicine have isolated *Anopheles stephensi*, as the only vector responsible for transmission of malarial infection in these areas. This vector breeds in domestic and peri-domestic water collections, overhead tanks, wells, artificial containers, and water collections on roofs and sunshades. It has been found that *A. stephensi* usually feeds on humans and cattle. In the areas under study cattle population is practically nil that make man-vector contact more and cause increased exposure to infection.

Parasitic Species

As regards the species of parasitic infections in the area, the majority of infections were due to *Plasmodium vivax*. *Plasmodium falciparum* constituted 5.6 per cent and 6.9 per cent of cases in 1995 and 1996. The percentage came down to 2.6 in 1997 (DHS, Kerala). A few cases of mixed infections were also reported by the Department of Health Services.

Malaria Cases in the Study Population

The number of households that reported a positive history of malaria, since the epidemic broke out in 1994 was 187 (62.3 per cent) in Valiyathura. In Poonthura area, only 36 (12 per cent) households reported a positive history. The number of episodes per household shows remarkable difference between the two areas. The total number of episodes in a family since 1994 in the study area showed a maximum of 20 and a minimum of 1, whereas in the control area, the maximum was 4 and the minimum 1. While eliciting the history of malaria

episodes during the three months' period preceding the date of the survey, it was observed that 72 households had a positive history of malaria in the study area. The total number of episodes in these houses came up to 102. Thus the households level prevalence came to 24 per cent and the population prevalence 6.3 per cent (with a 95 per cent CI of 5.11 – 7.49). In the control area, only three households reported a positive history. That too only a single episode each during a recall period of three months, thus giving a household level prevalence of one per cent and a population prevalence of 0.17 per cent (with a 95 per cent CI of 0 – 0.36).

It was interesting to note that a drastic reduction in the incidence of malaria was taking place in the study area despite 72 households reported a positive history of malaria. We noticed a change in the treatment strategy; from a five-day regime to a 14-day regime that came into force in early 1997. Reports of systematic control and surveillance activities were also received. The total number of malaria cases in Valiyathura came down to 570 in 1997 from 2,948 in 1996. The number of *P.falciparum* cases also came down, from 206 in 1996 to 15 in 1997. No indigenous cases have been reported from Valiyathura during the last three months of 1997 ie from October to December 1997 (Epidemiological Situation Report of Valiyathura, 1994–97, DHS, Kerala). Though the cases are coming down in the area, it is important to understand the reasons why this area is more at risk to a malaria outbreak than when compared to the adjacent areas having similar socio-economic, climatic, and environmental characteristics. Moreover, an appraisal of the current control strategies and their impact on the local people are also worthy of investigation.

Physical Environment

Climatic Factors

Variations in the climate have a profound influence on malaria. The important climatic factors are rainfall, temperature, and humidity. The data collected from the Airport station of the Meteorological Department, Government of India, showed the following characteristics.

The area experiences three seasons namely, the hot season (from March to May), the southwest monsoon season (*edavapathy*: From June to September), and the north-east monsoon season (*thulavarsham*: From October to February). Normally peak rainfall for the whole of Kerala is received during June, the next highest is received in October. From 1993 onwards, a change in the normal pattern is noticed in the study area with rainfall distributed throughout the year with peaks in between, the highest rainfall being in October.

The average temperature in the area is around 27°C; it ranges from 25°C to 29°C. The temperature falls in the optimal range (20–30°C) for development of the malarial parasite in the vector mosquitoes. The average relative humidity in the area is around 76.5 per cent and ranges from 60 to 90 per cent. It is reported that an average relative humidity of 73 per cent is associated with the malaria epidemic. Since these climatic factors are common to the whole of the coastal area in the State, they cannot be considered to be a major factor for incidence of malaria in the study area.

Housing Condition

The distribution of households according to housing condition in the study area and the control area are indicated in Table 3.1. Housing condition was poor in 54.7 per cent of the households in the study area and 35.3 per cent of the households in the control area. A significant OR of 2.21 reveals that the chances of malaria were more than twice in the study area than that in the control area. This is due to the fact that characteristics of poor housing like thatched roof, thatched wall, insufficient light, and ventilation provide ideal resting place and ideal micro-climate for vector mosquitoes, which exposes the population to great risk. In the study area, it has been observed that mosquitoes rest in between layers of thatched wall during daytime. Panicker et al (1984), Sethi et al (1990), and Subramoniam et al (1991) have made similar observations.

Table 3.1 Distribution of Households in Study and Control Area According to Housing Conditions

Housing conditions	Study area No. (%)	Control area No. (%)	Total No. (%)
Poor	164 (54.7)	106 (35.3)	270 (45.0)
Satisfactory	136 (45.3)	194 (64.7)	330 (55.0)
Total	300 (100.0)	300 (100.0)	600 (100.0)

OR 2.21 95% CI 1.57 - 3.11 (OR = Odds Ratio, CI = Confidence Interval)

Actual/Potential Breeding Places

Potential breeding places for *A.stephensi* in the area include wells, overhead tanks, and stagnant water collections on roofs and sunshades during intermittent rainy seasons. The breeding places of *A.stephensi* in this area are wells, some of them unused. We did not find any mosquito larvae in the wells during the survey due to stringent anti-larval measures executed by the authorities by maintaining larvivorous fishes and treatment of extra breeding places by temephos. Panicker et al (1980), Bheema Rao (1982), Kumar et al (1991), and Manga (1995) reported wells as one of the most frequent breeding places for *A.stephensi* mosquito. The difference in the number of wells as between the study and the control areas is shown in Table 3.2.

Table 3.2 Distribution of Households in Study and Control Areas According to Availability of Wells (*per cent*)

Whether well exists or not	Study area	Control area	Total
Exists	56.0	1.3	28.7
Does not exist	44.0	98.7	71.3
Total	100.0	100.0	100.0

OR 94.18 59% CI 32.86 - 304.65

The presence of 168 wells in the study area in contrast to only 4 wells in the control area is significant in the light of the breeding practices of this urban vector *A. stephensi*. This might have been one important cause of intense transmission of the disease until systematic anti-larval measures were adopted.

It is alarming to note that about 3,700 wells exist in the 24 sectors covering parts of all the four endemic coastal wards. About 60 of them are unused wells (Records at Treatment Centre, Valiyathura).

During the peak period of transmission, the adjoining areas of this endemic pocket seldom reported any case of malaria, probably because of the existence of a large number of wells in the Valiyathura area which provided most congenial breeding sites for *A. stephensi*. Moreover, it was noticed that the inner walls of the wells provided outdoor resting-place for the mosquitoes. Outdoor wells are in fact just like a peri-domestic container as far as this mosquito is concerned. Other than in this coastal area, we did not find such a large number of wells in any of the rural or urban settings, the main reason being the overcrowded living conditions in this area with houses situated so close together. Most of the houses exist on plots of less than one cent or one-and-a half cents.

Social Environment

Socio-economic Background

In this section, we present a comparison of the educational, occupational, and income conditions of the households in the study and the control areas.

Education

The distribution of the households by educational level is given in Table 3.3. Prasad et al (1992), Ettling et al (1994), and Koran et al (1995) reported that malaria was associated with low education levels. But in the present study the percentage of heads of households who are illiterate and literate with no formal schooling constitute 52 per cent in the study area and 56 per cent in the control area. Odds ratio shows no significant of risk in either area in relation to this variable.

Table 3.3
Distribution of Households According to Education of Head (*per cent*)

Education	Study area	Control area	Total
Illiterate + Literate with no schooling	52.0	56.7	54.3
Primary and above	48.0	43.3	45.7
Total	100.0	100.0	100.0

OR 0.38 95% CI 0.59 - 1.16

Occupation

Table 3.4 shows the occupation-wise distribution of households. It was found that 90 per cent households was engaged in fishing in the control area whereas the corresponding percentage was only 84 per cent in the study area. Odds ratio shows no significant chance of risk to malaria due to fishing occupation (rather, a protective effect is seen). However, a few studies, such as the ones by the DHO, Rameswaram (1980), Panicker et al (1984), and Panicker and Rajagopal (1986) have reported a higher incidence of malaria among fisherfolk than among other occupational groups.

**Table 3.4 Distribution of Households According to Occupation of the Head
(per cent)**

Occupation	Study Area	Control Area	Total
Fishing	84.3	90.6	87.5
Non-fishing	15.7	9.4	12.5
Total	100.0	100.0	100.0

OR 0.55 95% CI 0.33 - 0.94

Monthly Family Income

The median income of the family was Rs. 1,500 with an IQR 1000-2000 (25-75 per cent) in the study area. The same was observed in control area also (median Rs. 1,500; IQR 900-1800) thus showing no significant difference between the two areas as far as the income was concerned. This is again in contrast to the findings in several studies. Prasad et al (1992), Kondrashin (1992), and Ettling et al (1994) reported higher prevalence of malaria among individuals with low socio-economic status.

An unpublished study conducted by Iyer R.H. (1996) in Valiyathura ward of Thiruvananthapuram Corporation shows significant malaria risk for population with low levels of education, engaged in fishing, and having low levels of income. The results of the present study indicate that these variables are not significant when applied to another area having the same socio-economic background, thereby confirming the influence of other variables unidentified in these studies in disease causation and transmission.

Habits and Practices

Sleeping Habit

The distribution of the sample population according to sleeping habits is given in Table 3.5. A larger percentage of households in the study area do have a history of sleeping outdoors than in the control area. A significant positive association between the habit of sleeping

outdoors and the prevalence of malaria was observed in the present study. Rajagopal (1976), Bheema Rao (1982), Panicker et al (1984), and Leake and Hii (1994) also have reported similar findings. Persons sleeping outdoors are exposed to mosquito bites and they are more prone to the risk of developing malaria. This practice could, therefore, be one of the reasons for the high incidence and persistence of malaria in the area.

Table 3.5 Distribution of Households According to Sleeping Habits (*per cent*)

Sleeping habit	Study area	Control area	Total
Sleep outdoors	53.3	2.3	27.8
Sleep indoors	46.7	97.7	72.2
Total	100.0	100.0	100.0

OR 47.84 95% CI 21.04 - 114.4

During our interviews, we were convinced that it was the poor housing and the hot and humid climatic conditions that force them to sleep outdoors. The clean stretch of broad seashore in the study area offers an environment favourable to sleeping outdoors. In the control area, seashore is narrow and houses are separated from the sea by stone walls. The housing conditions here are comparatively better, but environmental sanitation is poor. All these conditions contribute to the practice of sleeping indoors in the control area.

Clothing Habit

Among poor sections of the society, the clothing habits are scanty and most part of the body are left exposed. This practice also helps to ward off the severity of the hot and humid climatic conditions. Exposure of the body, however, invites mosquito bites. Clothing habits thus constitute a factor in determining the extent of malaria incidence and transmission. The clothing habit of the people in the study and the control areas are indicated in Table 3.6.

Table 3.6 Distribution of Households According to Clothing Habit (*per cent*)

Clothing habit	Study area	Control area	Total
Inadequate cover	51.0	55.7	53.3
Adequate cover	49.0	44.3	46.7
Total	100.0	100.0	100.0

OR 0.83 95% CI 0.59 - 1.116

No significant relationship was observed between clothing and malaria transmission since the two areas showed similar clothing habits. We, therefore, conclude that clothing habits do not constitute a significant factor for prevalence of malaria.

Use of Personal Protective Measures

Information on the use of personal protective measures like bed nets, repellents etc was elicited. During our field enquiries, use of these measures formed an important component of vector control measures. Use of these protective devices was minimal among the study population. Table 3.7 gives the distribution of households according to use of bed nets.

**Table 3.7 Distribution of Households According to the Prevalence of Use of Bed nets
(per cent)**

Use of Bed nets	Study area	Control area	Total
Not used	97.3	95.7	96.5
Used	2.7	4.3	3.5
Total	100.0	100.0	100.0

OR 1.65 95% CI 0.63 - 4.43

To the question regarding the use of bed nets, only 2.7 per cent of households gave a positive answer. In the control area, the corresponding figure was 4.3 per cent. However, this variable was found to have no significant relationship with the prevalence of malaria as evidenced by the OR of 1.65 with 95 per cent of CI 0.63 – 4.43.

Regarding the use of repellents, the study and control areas did not differ much. Only 3.3 per cent of the households in both the areas reported use of repellents.

The practice of using bed nets and repellents was very minimal among the population under study. On further enquiry, it was found that even among users, the practice was not regular or adequate. The bed nets were used for small children only and the poor housing condition is not conducive to the use of bed nets. The cost of these personal protective devices was not affordable to the population either, as was evidenced during focus discussions.

Time of Fishing

The time of fishing among the study population is given in Table 3.8. Several studies have reported high prevalence rates of malaria among fisherfolk (see 3.4.1.2). One explanation for such a situation is that they get exposed to the risk of infection during early morning hours, the peak biting time of *Anopheles stephensi*, when they are out for fishing. Nevertheless, the risk of getting infected by malaria does not seem to vary between the study and the control areas.

Table 3.8 Distribution of Households According to Practice of Night Fishing (per cent)

Night fishing	Study area	Control area	Total
Yes	79.7	80.3	80.0
No	20.3	19.7	20.0
Total	100.0	100.0	100.0

OR 0.96 95% CI 0.63 - 1.46

Population Mobility

In the present study, questions were asked to elicit information on mobility of people into and from (in-migration and out-migration) the study area during the past one year. It was found that only six households had moved into study area whereas none had moved into the control area. However, more people had moved out to other places from the study area than from the control area (Table 3.9).

Table 3.9 Distribution of Households According to Migratory Practices (per cent)

Migration	Study area	Control area	Total
Yes	12.0	4.0	8.0
No	88.0	96.0	92.0
Total	100.0	100.0	100.0

OR 3.27 95% CI 1.60 - 6.80

It was revealed during focus group discussion that population movements are a common feature in these coastal areas, more in the study area than in the control area. People go to places like Thuthukkudy, Mangalapuram, Kanjangad, Kannur, and Kollam for fishing during the off-season in Valiyathura. Thuthukkudy and Mangalapuram are the places that are frequently visited. It is important to note that these places are endemic to malaria. Transmigration leads to regular parasite import and hence this practice could be a reason for the persistence of malaria in the area. Studies conducted by Bheema Rao et al (1982), Chandrahas et al (1984), Tewari et al (1984), Panicker et al (1984), and Mathur et al (1992) reported that large floating population contributed to the persistence of malaria.

However, no remarkable difference is observed between the two areas with regard to in-migration. Only three families in the study area and two in the control area reported visits by people from outside the village, and that too, during religious congregations.

Community Perceptions Regarding Malaria

The community perceptions regarding the disease were elicited by asking questions on several aspects of the disease, its cause, spread, treatment, control, and prevention. A composite scoring system was used to analyse the data so collected. The system had two categories *satisfactory* and *poor* (See section 2).

The community perception about the disease is an important factor influencing their cooperation with the treatment and control strategies and thereby their outcome. Table 3.10 shows the distribution of households according to the level of their awareness regarding various aspects of the disease.

**Table 3.10 Distribution of Households According to Levels of Community Awareness
(per cent)**

Awareness	Study area	Control area	Total
Poor	14.3	32.0	23.2
Satisfactory	85.7	68.0	76.8
Total	100.0	100.0	100.0

OR 0.36 95 % CI 0.27 - 0.59

It is observed that the level of community awareness is poor only in 14.3 per cent households in the study area whereas the corresponding figure was 32 per cent in the control area. This finding is reliable since the data were collected in 1997 after the study population was intensively sensitised by the personnel of the Health Department. Awareness campaign using different methods and the media formed an important aspect of the control strategy. Community involvement through voluntary organisations in the community was strong. In fact, this factor was largely responsible for the cooperation extended by the community to the treatment and control strategies during the later phases of the epidemic and for the ultimate success achieved in controlling the disease.

Since the efforts at controlling the epidemic were confined largely to the study area, we observe a difference between the two areas in the matter of the sources of information. While it was the hospital or health workers which provided information in 99 per cent of the households in the study area, the primary sources of information in the control area were mass media (20 per cent), neighbours, friends or spouses (25.7 per cent), and health staff/hospitals (54.3 per cent).

Health Services and Utilisation

Information on availability and utilisation of health services was collected mainly by qualitative methods. Secondary sources like records and reports from the Valiyathura dispensary and Directorate of Health Services formed another major source of information. Open-ended interviews with health services personnel and focus group discussions with people in the community were the qualitative methods used for the study. An appraisal of the control

strategies adopted by health services and the utilisation of the facilities by the community is presented in the following sections.

Genesis of the Malaria Epidemic in Valiyathura

Valiyathura was unaffected by malaria till 1993, when 22 imported cases were reported for the first time (DMOH, Tvm 1994). Focus group discussions revealed perceptions of the local population regarding the first occurrence of disease in the area. According to them, during that time there was an unusual influx of people from neighbouring countries, especially Srilanka, for business purposes. Srilanka is an area endemic to malaria. Possibly this visit could have been one of the sources of the introduction of the parasite into this area. Another possibility is the import of infected and infective mosquitoes through aircrafts near Thiruvananthapuram airport area. The first case of malaria was reported from a place opposite to the airport area. At that time no in-built infrastructure facilities were available to tackle malaria cases in the Corporation area. Absence of an effective surveillance system to monitor and control malaria led to the first-ever focal outbreak of malaria with 33 indigenous cases in 1994 in places adjacent to Thiruvananthapuram airport. Larval collections made in and around the airport area identified *Anopheles stephensi*, an urban vector, responsible for malaria infection in the area. No other species was identified from anywhere in this area. Thus malaria entered the urban areas of Kerala which had remained unaffected by it till then.

Control Strategies Executed by Health Services Department and Its Impact

Following the focal outbreak, the Department of Health Services of the State Government became alert. All possible containment and preventive measures were promptly taken by deploying staff from other primary health centers. Surveillance, prompt treatment of positive cases, and DDT spraying operations were immediately undertaken. The measures yielded good results and the incidence of malaria came down drastically and the foci could be controlled quickly. As a result, no indigenous cases were reported from the area during August-December 1994.

However, in 1995, fresh cases began to appear in the area from January onwards and the number continued to swell rapidly (see Appendix I). (Epidemiological Situation Report of Valiyathura from 1994–97, DHS, Kerala). The re-emergence of the disease was immediately taken into consideration by the Department of Health Services and containment measures were instituted again. The following were the activities carried out during 1995.

- (i) Intensified surveillance, (ii) Prompt treatment of all positive cases,
- (iii) DDT spray operation, (iv) Baygon space spray, (v) Larviciding of breeding places, and (vi) Introduction of fishes into wells.

Providing mosquito nets for the wells was also tried, but it was successful only partially.

The incidence of malaria continued unabated throughout most of the year despite these activities. Majority of them was indigenous cases. Infection cases of *plasmodium falciparum*, a severe

form of malaria, also were reported during the year. The situation remained unchanged or even worsened during the early months of 1996. Two deaths were reported in April 1995 and another four deaths in May and July 1996. By this time the epidemic began to spread to the adjoining areas. Panic spread in the local community. Local leaders became involved in the fight against the menace and extended all support to the efforts by the Government. Realising the magnitude of the problem and its consequences, the State Government decided to tackle it by all the means at its disposal.

A new strategy was developed and implemented. As part of this strategy, the Government dispensary and the Filariasis Survey Unit that were newly installed at Valiyathura were fully equipped and adequately staffed. Parasite and vector control operations were systematically planned. The Medical Officer in charge of the Government dispensary was entrusted with the responsibility of possible control activities. Vector control operations were the responsibility of the Senior Biologist of the Filariasis Survey Unit. The following were the activities under the new strategy:

1. Parasite Control.

- (i) Fortnightly domiciliary surveillance, (ii) Rapid fever survey, (iii) Mass and contact survey, (iv) 14-days' domiciliary treatment under supervision, and (v) Follow-up of positive cases.

2. Vector Control operations.

- (i) Pyrethrum space spray, (ii) Thermal fogging, (iii) DDT spray, (iv) Larviciding of breeding places, and (v) Introduction of fishes into the wells.

(The Malaria Problem at Valiyathura: A detailed report on the activities and achievements, DHS, Kerala).

All these activities were properly planned, and perfectly integrated, and systematically implemented. The Government of Kerala constituted a State-level high-power technical committee including experts from the Medical Education Department, to monitor, assess, evaluate, and suggest appropriate measures for implementing the strategy successfully. Local voluntary organisations like TSS and PCO (Programme for Community Action) participated actively in the programme. Information education and communication activities were also undertaken to motivate the public to render generous cooperation in activities. A mass blood survey was conducted in collaboration with the Department of Community Medicine of the Medical College, Thiruvananthapuram.

The measures taken by the health department personnel during 1994-95 were unsystematic and inadequate to eliminate the infection from the community. Lack of experience in handling such an entirely new situation could have been one of the reasons. The integrated vector control activities, as part of the new strategy, were developed and implemented in full, only by the end of 1996. The 14-days' treatment strategy came into force in March 1997. The new strategy was proved highly effective. Its success is reflected in the success achieved in reducing the number of reported cases of malaria infection drastically since the last few months of 1996.

The year 1997 witnessed a rapid reduction in the incidence of malaria in the area. The transmission of the disease was successfully interrupted and deaths due to the disease completely prevented. There were only 570 reported cases in 1997 in contrast to 2,948 in 1996 and 2,208 in 1995. During 1997, there were only 459 cases of indigenous origin and no such cases have been reported since October 1997. The number of falciparum cases was as low as 15 in 1997 (as compared to 206 in 1996).

Even after the transmission of the disease was brought well under control and no indigenous case was reported since then, systematic and regular parasitic as well as vector control measures continue to be implemented. Currently 18 (senior and junior) health inspectors are working under the Medical Officer in charge of the Government dispensary for parasitic control activities. The current activities include

- (i) fortnightly visit for surveillance, (ii) fever smear and contact smear, (iii) mass and contact survey, and (iv) domiciliary treatment for 14-days under supervision.

Complicated cases are treated as in-patients in hospitals. 18 field workers and 2 insect collectors are carrying out vector control activities. Weekly larvicidal operations in breeding places are done using abate (temephos). Pyrethram space spraying is being carried out in 50 houses in the neighbourhood if any positive case is detected. Fogging activities are done around a positive case next day after Pyrethran spraying. The 24 coastal sectors identified as risk areas in 1996 are divided among the 18 field workers.

Weekly larvicidal operations are being carried out in Poonthura (control) area also. The main targets for larvicidal activities are the wells. Out of nearly 7,000 wells in the Valiyathura area, fishes were introduced in 2,500 wells. Half the wells are in the extreme coastal areas included under the 24 sectors. Fishes are still there in some of these wells. Larvicidal operations are done if mosquito larvae are isolated from these wells. Routine weekly operations are carried out in all wells without fishes. Random larval check is done to ensure larvae-free water. There are about 60 unused wells. Baytex is used as a larvicide in these wells. Baytex is not used in potable water, as it is harmful. Abate is safe in drinking water and the dose is 2 ml 50 per cent abate in 1 cubic metre (1000 litre) volume of water.

Utilisation of Health Care Services by the Community

The health care seeking practices in the community and its compliance to the treatment and control strategies executed by the authorities were revealed during the FGDs.

The health care seeking behaviour of the people in the early phase of the epidemic was found to have been different from what it is at present. In those days even though blood test and treatment facilities were offered by the treatment centre (opened exclusively for this purpose) and the government dispensary at Valiyathura, people opted for other sources such as medical stores, private practitioners and homoeo, sidha, and ayurveda systems. More and more relapse cases were reported and some families gave a history of 20 episodes of malaria. The occurrence of a few deaths in 1995-96 created fear among the local population. The efforts by the authorities did not receive due recognition. People's faith in the type of treatment offered by government also eroded because of such errant behaviour on the part of the community.

The level of community awareness regarding various aspects of the disease remained poor. Some subjects reported to have taken antibiotics purchased from medical stores when symptoms developed. An unpublished study on Valiyathura done by Abdul Azeez (1996) on compliance to an anti-malarial drug reports that 11 per cent of those who had started treatment at the government facility discontinued the treatment before completion of the full course. The most important reason for non-compliance was relief from symptoms and feeling of well being experienced by the patient after consumption of the initial dose of medicine. Majority of the people perceived the disease as mild during the early phase of infection and used to go to work without taking radical treatment. Difficulty in taking too many tablets at a time was another reason reported for non-compliance to drug therapy. In the early years of the infection, an adult patient had to take a total of 10 tablets for presumptive treatment and 40 tablets for radical treatment (Primaquine was 2.5 mg base along with Chloroquine) in the case of P.vivax. People felt that heavy dose of medicine intake was unnecessary and injurious to health. The importance of taking the tablets as prescribed was not recognised by the local people. This is evident when one of our subjects said during focus group discussion: *“They (health workers) used to give us bread and medicines. We would eat the bread and throw away the medicines”*.

Non-compliance was reported not just with treatment, but with control strategies as well. People seldom cooperated with the authorities in spraying activities. They were of the view that even though mosquitoes died, bed bugs appeared in hordes when DDT was sprayed. Their attitude towards health personnel was in general non-cooperative and negative.

The following points summarise the beliefs and practices of the people at Valiyathura during the peak years of the epidemic (1994-'96):

- (i) The people were not convinced about the efficacy of treatment offered by health department officials and medical professionals;
- (ii) Relapse of malaria cases and emergence of new cases eroded confidence in the prescribed treatment; the modern medical system failed to attract those who resorted to self-treatment or treatment by quacks.
- (iii) Community awareness was poor regarding the nature of the disease and its treatment and control; the dangerous consequences of non-treatment or inadequate treatment were also little known.
- (iv) People had apathy not merely towards treatment but also control activities; therefore their attitude towards health service personnel was one of non-cooperation.

It would appear that the flows in the control strategies of the health service personnel coupled with the attitude and behaviour of the community might have contributed to the persistence of the disease during 1995 and 1996.

The revised integrated strategy implemented from the end of 1996 onwards incorporated the components decided upon after taking into account the local peculiarities. The strategy was implemented more systematically and regularly. The drastic reduction in the incidence of

malaria achieved in a short period brought in new enthusiasm among the population that had been disenchanted with frequent recurrence of malaria episodes. People became more confident in treatment. There was a rise in the number of people who utilised the government health care facility. Compliance rates improved and relapse and recrudescence came down remarkably.

The present survey revealed that only 6 families out of 72, who gave a history of malaria during the three months preceding the date of the survey, resorted to health facility other than that of the Government. The level of community awareness was high and stood at 86 per cent. Non-compliance was very low; only 2 subjects out of 102 who had a positive history of malaria during the three months' recall period reported as non-compliant (these two subjects utilised the private facility for treatment). Passive detection of fever cases is quite common among the population together with active surveillance. This impression which was gathered from focus group discussion was confirmed in our interviews with the Medical Officer in charge of the Valiyathura Hospital.

To sum up, the integrated parasitic and vector control activities systematically implemented in the area have succeeded in controlling the transmission. The Department of Health Services was able to win over the trust and confidence of the people through its new strategy. The local population cooperated with the department in all its endeavours to keep the malaria epidemic at bay.

4. Summary and Conclusions

In Kerala, malaria had been eradicated as early as in 1965. But imported malaria used to occur even thereafter; and indigenous malaria showed signs of resurgence from 1969 onwards. Recently an increasing trend of both imported and indigenous malaria cases were observed. Malaria began to occur in epidemic proportions in the coastal areas of Thiruvananthapuram city since 1994, an area which had till then been a non-endemic area for this disease. Moreover, the disease persisted in the area during 1995 and 1996 despite control measures implemented by the health care personnel of the State Government. The present study was carried out in Valiyathura to explore the environmental factors influencing the persistence of malaria in this coastal area.

A cross-sectional survey was conducted covering 300 households in 11 sectors (out of a total of 24 sectors) in Valiyathura area during 1997 identified as high-risk area by the Health Services Department. An equal number of houses were drawn as control from the adjoining Poonthura ward of Thiruvananthapuram Corporation, which was non-endemic to malaria. A systematic random sampling technique was followed in the selection of households. The tools for data collection were a pre-tested interview schedule and qualitative methods like focus group discussion and open-ended interviews. The period of study was from January to December in 1997.

The background characteristics of Valiyathura and Poonthura areas are similar. Both are coastal areas lying adjacent with similar distributions of religion, family size, and family type. The majority of the adult population in both the areas is engaged in fishing. But sharp

contrast exists between them in the prevalence of malaria. The prevalence of malaria cases observed in the study area during a recall period of three months, was 6.3 per cent and the corresponding figure for the control area was only 0.17 per cent.

Climatological factors are common to both the areas and hence they do not explain the difference in the prevalence of malaria between the two areas. Prevalence of malaria was found higher in the study in which housing conditions were poor in the majority of households (54.7 per cent Vs 35.3 per cent). Presence of a significantly large number of wells in the study area indicates higher risk of malaria. Socio-economic background reported frequently as a risk factor for malaria is found to have little significance in this area. Habit of sleeping outdoors during night and transmigration of working population to endemic areas outside the State might have increased the risk of malaria, but the relationship observed between the two is weak and insignificant.

Regarding the use of personal protective measures, no significant difference was noticed between the study area and control area. The study revealed fairly high levels of community awareness regarding malaria among the study population, more in the study area than in the control area. This could have been due to the increased exposure of the residents of the study area to IEC activities.

It was found that certain flaws in the formulation and implementation of the strategy for controlling malaria and the indifferent attitudes of the local population had contributed to the ineffectiveness of the interventions of the Health Department till about the end of 1996. The new strategy, which is being implemented as an integrated parasitic and vector control measure in a systematic manner since 1997 has proved effective. The attitude of the entire local population towards treatment and control of malaria has changed from one of apathy to that of extreme compliance and cooperation.

The present study points out certain important environmental factors, which influenced the persistence of the disease in the study area. The current rigorous control activities have successfully interrupted the transmission of disease and brought down the number of malaria cases drastically. But these rigorous measures are more like treating symptoms than curing disease. While it is essential to continue the activities as a short term measure, preventive strategy should be developed and executed on a long term basis to eradicate the factors.

5. Limitation and Strength of the Study

Limitation

The study was planned in the first half of 1996, when the epidemic of malaria was at its peak in Valiyathura. When the study was started in 1997, drastic reduction in the number of cases was already achieved. The disease is not persisting in the area any longer. This change in the ground situation might have influenced emphasis of the study to a limited extent especially with regard to its second objective of making a critical appraisal of the current control strategies.

Strength

The environmental factors that the study has pointed out, still in existence in the area, pose a threat to health of the local population despite the fact that the number of cases came down in the study area. The rigorous control strategies responsible for the current comfortable situation are not the result of the existing health infrastructure of the area. Hence, the results of the study would be of immense help to planners and health care providers in developing strategies on a long-term basis.

6. Recommendations

In the light of the present study, we put forward the following recommendations.

- (i) The large number of wells in the study area has been identified as a potential breeding ground and resting-place for *Anophels stephensi*, the vector mosquito responsible for malaria in this urban area. The wells, together with the poor housing conditions in the area, are responsible for the high density of vectors for effective transmission. Since it is not feasible to modify the housing conditions in the area given their living conditions and occupational patterns, the alternative is to provide protected pipe water supply and fill up the wells in the area. This could be achieved in a phased manner. This is justifiable as an eco-friendly vector control method since DDT and BHC are reported to be environmental pollutants.
- (ii) There is regular import of vectors from cities like Mumbai, Delhi, and Chennai through aircraft landing at Thiruvananthapuram Airport, as evidenced by the larval collections in and around the airport. Moreover, transmigration of fisherfolk leads to continuous import of parasite from endemic areas. Hence the existing surveillance system should be continued as any lapse in the present system may lead to focal outbreaks of malaria as it did in previous years.
- (iii) Alternative strategies like having a basic health infrastructure on the lines of the primary health centres in rural areas should be thought of in the underprivileged urban areas since the present set-up for surveillance and control could not be continued indefinitely. It should be possible to integrate the existing system of surveillance, detection, and treatment of malaria with the proposed system.
- (iv) The community should be made aware of the possibility of contracting infection during episodes of transmigration and of the need to report to the health facility in case of any history of fever surfacing again.
- (v) The airport health authorities should take stringent measures to disinsectise both incoming and outgoing aircrafts and cargo.

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