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COST BENEFIT ANALYSIS OF MALARIA CONTROL AND ERADICATION PROGRAMME IN INDIA

By

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ABSTRACT

This paper analysed the malaria control and eradication activities in India from 1953-54 to 1976-77. The total cost of the disease to the nation with the control and eradication programme and what it would have been if the programme were not to be launched were estimated for each of the years. The difference between the two estimates for a given year is defined to be a measure of benefits derived from control of the disease. The results obtained have been further analysed and their implications to the programme have been discussed.

COST BENEFIT ANALYSIS OF MALARIA CONTROL AND ERADICATION PROGRAMME IN INDIA

T.J.Ramaiah

1. Introduction

Economics of Malaria has been a subject of discussion for the last many decades. Christophers (1924) while discussing the problem of high mortality due to malaria stated "all man must die, but it is hoped that each will have a run for his money, -----" implying that the expenditures incurred on bringing up a child would bear fruits to the society only when he grew up to be a productive member and contributed towards its social and economic wellbeing. Ross (1926) stated that while malaria control costs money, the disease itself was a source of expense to the society. Rao (1928) vigorously advocated estimation of economic losses to India attributable to malaria to provide justification for allocation of resources for its control. First attempt in that direction was made by Sinton (1938). He estimated the magnitude of malaria problem in India in terms of number of cases, number of deaths directly and indirectly attributable to malaria, disability and debility caused by it; identified its consequences - economic, social, physiological and emotional; and attempted to quantify what it was costing India. According to him,

i) malaria had very marked influence in lowering the birth rate by reducing the number of conceptions, causing interruptions in pregnancy (abortions and still births) and thus checking and natural increase of population;

ii) the number of deaths directly attributable to endemic malaria, as a minimum estimates, each year in the then India was one million. Besides, malaria epidemics, when occurred, increased the mortality by one quarter to half a million. In view of its marked indirect effect amongst children, it was responsible for high infant mortality rates. The number of deaths indirectly and directly caused by malaria in India in 1931 was about 2.1722 millions;

iii) at least 100 million persons in India suffered from malaria each year. In addition, indirect morbidity caused by malaria was estimated to be at least 25 million cases each year;

iv) the manifestations of the disease had serious deleterious effects upon the physical development of both children and adults;

v) malaria was an important factor in lowering the expectation of life in India at all ages, but more especially among infants and children;

vi) it resulted in financial and economic losses, due to conditions of inefficient, deficient and expensive labour, not only to the worker but also to the employer in agriculture, industrial and commercial sectors and in the development of natural resources. The cost to the individual and to the family on medical attendance was at least Rs.200 million per annum. The financial loss to the individual and to the family due to actual days of work lost from malaria sickness in India, at its minimum, was about Rs.124 million each year, excluding the economic cost of time and wages lost by persons who were absent from work to attend to the sick and the economic cost of sickness from other diseases contracted as a result of entacedent malaria. The financial loss due to post-malaria inefficiency was about Rs.279

million per annum, again at its very minimum and due to unprofitable funeral expenses was about Rs.4 million;

vii) the economic loss to India from deaths directly due to malaria was nearer to Rs.900 million per year and an equal amount due to deaths caused by indirect effects of the disease;

viii) various other miscellaneous expenses caused to the sick and their families was about Rs.1076 million per annum;

ix) the economic losses to India due to losses in wages of those who were malaria stricken was about 353 million rupees per annum;

x) in addition, the disease caused serious obstacles in the development of large and potentially rich areas of fertile land resulting in enormous financial losses to the nation; obstacles to full development of manufacturing industries, mining industries, railways sea-borne commerce and shipping etc. besides serious set backs to growth and development - physical, physiological and mental of the population.

Thus, he estimated that the economic losses to India due to malaria was Rs.2936 million per year, at its minimum, in addition to a number of intangible or unquantifiable consequences directly and indirectly attributable to malaria. This work had been considered to be a monumental place on the subject, though it suffers from a number of methodological limitations in computation of treatment costs, cost of man-days of work lost, monetary value of future earnings lost due to premature mortality etc. One important component of such an economic analysis is of differential vulnerability of different age-specific population groups to the disease and the need for inclusion of age-distribution of cases and deaths.

Wilson et al (1950) put forward a view that malaria was not of economic importance to adult communities, particularly so in hyperendemic areas who would have developed high levels of immunity to the disease. This view was however, combated by Macdonald (1950) Christophers (1949), Viswanathan (1951) since malaria had been an appreciable public health problem even among adults, though the magnitude of the problem amongst them shined in contrast to that of infants and children due to differentials in mechanisms of development of immunity and its levels.

Another important consequence of malaria had been low level of fertility induced by high levels of malaria-specific mortality (Sinton, loc. cit; Viswanathan, 1949; Ray, 1948; Ramakrishnan et al 1958). While there had been world-wide recognition of reduction in malaria-specific mortality, Frederiksen (1962) based on his work in Ceylon, argued that malaria had not been a major cause of death. The high mortality and low fertility levels got reversed due to substantial reduction in malaria mortality and the resultant increases in fertility levels. Ray (Loc. cit) and Ramakrishnan (Loc. cit) reported sharp increases in crude birth rates and decreases in crude death rates and infant mortality rates after launching of anti-malaria measures. The increases in population induced by the decreases in malaria-specific mortality, quite independent of the levels of consumption and production have been documented by United Nations (1953), Population Reference Bureau, Washington (1955, 1957, 1958), Hagen (1959) and Wilcox (1960) which led to predictions of impoverishment and famine as an ultimate consequence of malaria control. Frederikson (1960, 1961) again refuted the same by the observed effects of malaria control in Ceylon. He argued that malaria control had increased the quality rather than the quantity of human resources through removal of malaria which had been an insurmountable barrier to the development of Ceylon.

While he may be right as far as Ceylon was concerned particularly due to peculiar epidemiology of the disease there, the interactive linkages between mortality, fertility and development, none-the-less have been well documented (Coale and Hoover, 1958; Myrdal, 1968) and also with particular reference to malaria (Newman, 1965; Barlow, 1968; Bruce-Chwatt and Meade, 1968; Cohn, 1973) though such economic effects have not been quantified in monetary terms. Thus, while economic analysis of a disease like malaria necessarily has to include the economic benefits that would accrue to a society as a result of reduction in malaria-specific mortality, it also by implication should reflect the diseconomics brought about due to the resultant increases in fertility and population size, though paradoxical.

Thus, prevalence of malaria has had many consequences/outcomes (W.H.O., 1974) on Indian society. Recognising this, India has supported a large programme, perhaps the largest in the world, since 1953 initially with the objective of its control and later, revised in 1958, with the objective of its eradication. However, since 1965 the magnitude of the disease has showed an increasing trend, having reached a remarkably low level of prevalence in 1962. The reasons for the set back have been many, one important reason however, being shortage of financial resources (Ramachandra Rao, 1973). The disease programme was evaluated many a time by national and international teams and the emphasis of theirs mostly has been on the programme elements, namely, its structure, managerial processes, activities, the epidemiology of the disease and temporal changes therein, programme performance etc. However, one of the recent evaluation (Government of India, 1970) also attempted to examine, though grossly, the comparative costs of control Vs eradication. Based on their recommendations and the advice of national and international experts in malariology, the programme was modified in its objectives and strategy in

1977 when the prevalence of the disease reached alarming proportions.

1.1 Keeping this in background, this paper aims at revisiting the entire span of 24 years (from 1953-54 to 1976-77) of the life of National Malaria Control Programme (NMCP) and National Malaria Eradication (NMEP) in India with a view to recount the expenditures (investments) on its control/eradication and the economic benefits (returns) thereof, bringing to bear upon as much scientific rigour into the methodology of benefit cost estimation as permitted by the available data, its quality and quantity.

The methodology adopted for this purpose has been one of 'with' NMCP/NMEP and 'without' NMCP/NMEP (Weisbrod, 1968) in contrast to the social cost benefit methodologies conventionally applied for appraisal of economic projects and programmes. The basic approach adopted has been

i) identification of consequences/outcomes;
ii) quantification of the same; and
iii) conversion of the quantified outcomes into monetary terms

the sum of which would give the gross costs of the disease, in 'with' NMCP/NMEP and 'without' NMCP/NMEP conditions. The difference between the two would provide an estimate of monetary benefits/losses (and streams of benefits/losses over time) acrued to Indian society as a result of efforts to control/eradicate malaria. The principle involved in such an approach is that the total cost of the disease (or part of it) serves as a measure of benefits derived from its eradication or the reduction in costs through partial control.

2. <u>Outcomes of the disease</u>

The large-scale prevalence of malaria has a number of social, economic and demographic consequences arising out of the disease-specific morbidity and mortality. While some of these consequences lead to direct monetary costs to the society, some others cost the society in an indirect way. The important components of such direct costs are

i) treatment costs of malaria in outpatient and inpatient facilities of health institutions (e.g. hospitals and dispensaries);

ii) treatment costs incurred by families as personal medical care expenses;

iii) monetary costs to the sick for transportation to the place of treatment and back;

iv) monetary costs to the families for providing much needed supplementary or special foods to reduce/prevent debilitating effects of malaria.

Certain important indirect consequences of malaria to the society are

i) the productivity losses due to temporary absence from work;

ii) the present monetary value of future earnings lost due to premature mortality, directly ascribable to malaria;

iii) the benefits foregone or the increased monetary expenditures that the society would have to incur to feed the additions to the population (increased fertility) caused by reduced mortality as a consequence of control and eradication measures.

The literature on the subject (Sinton, 1938; W.H.O., 1974; Ray 1977) mentions many other direct and indirect consequences of malaria such as

i) physical debility and disability caused due to the disease thereby indirectly effecting the efficiency and hence productivity of working population;

ii) mental debility and retardation of physical and mental growth and development with the resultant effects on education, innovation and future orientation;

iii) the stree, strain and suffering caused to the sick and to their family members;

iv) fertile agricultural land that could not be cultivated or the land that could not have been brought under cultivation due to shortage of labour, absenteism from work due to sickness etc;

v) lack of exploitation of natural resources, mining, small and heavy industries etc. etc.

Many of these outcomes are intangible and their monetary costs cannot be quantified. The quantification of some others such as monetary losses in agriculture productivity, though difficult, retrospectively since time lag has been long, is not an impossible task. It demands extensive micro analysis, district by district or even by smaller geographical areas, requiring considerable resources and time that too of a group of workers to obtain a meaningful estimate of the same. Hence the same is not attempted particularly because it might turn out to be a theoretical exercise. In view of these, the monetary costs of the seven former outcomes are estimated. The analysis has been fraught with many a problem mainly due to lack of availability of requisite data of right quality. In view of this, the available secondary data were adjusted and corrected for wherever necessary.

The estimates of certain parameters, for whom the data were not available, were obtained by indirect approaches. However, the attempt all along has been to make meaning full assumptions about different processes of relevance to derive lower bounds so that neither the costs nor the benefits are magnified.

3. The Malaria Programme

National Malaria Control Programme, though launched in 1952 in a small way, the programme activities got underway only during 1953-54. The same was gradually enlarged to cover the total malaria population at risk. During 1958-59, however, the programme was converted into one of eradication. The present analysis requires understanding of the programme in terms of its strategy, activities and their implications to the number of cases reported. The same are recorded below to the extent relevant to the present analysis.

1. The structure of NMCP was gradually enlarged to cover an estimated population in 1952 at risk of about 202.78 million. The programme structure* covered about 84 million population by the end of 1953-54, about 110.75 million by the end of 1954-55 and about 132.25 million by the end of 1955-56. It was only by 1961-62, the malaria control activities were extended to the total population at risk at about 364 million. Table presents the development of NMCP in terms of population coverage.

Table 1: Programme coverage and population protected by DDT spraying - 1953-54 to 1961-62

Year	No. of Units	Estimated Total population (million)	Population protected (million)	Percent population protected
1953-54*	84	375	75	20.00
1954-55*	110.75	382	99	25.92
1955-56*	132.25	389	125.75	32.33
1956-57	NA	396	147.25	37.18
1957-58@	200	404	165.16	40.74
1958-59@	230	412	180.16	43.73
1959-60@	290	419	245	58.47
1960-61**	334.25	427	374	87.59
1961-62**	364.25	435	406	93.33

Source: *Jaswant Singh et al (1953). The population protected includes non-malarious population of about 15 million.
@ Gandhi H S (1979)
** NMEP (1976)

*The structure is in terms of no. of malaria units, each unit covering a population of about one million.

2. The strategy was to spray the internal surfaces of every house in the programme area with 100 mg. of DDT per sq. ft. twice during the transmission period of about six months in a year in endemic areas and once in hypoendemic areas.
3. There was no specific case detection mechanism in NMCP, The cases recorded were those of clinical malaria treated in hospitals, dispensaries and primary health centres which is known as passive surveillance.
4. The content of NMEP which was started during 1958-59 was essentially the same as the ones described above upto 1961-62 (Attach phase) where the total population of the country was to be covered by protective intensified indoor residual spraying operations except those (about 15 million) living in areas with altitude higher than 5000 ft. above sea level.
5. From 1962-63 onwards, areas (population groups) with low levels of malaria* moved into another phase of activity (consolidation phase) wherein the spraying operations were suspended, but active surveillance in addition to passive surveillance, was instituted through regular fortnightly home visits by surveillance workers for case detection and treatment. In other words, from 1962-63 onwards the occurrence of clinical malaria was recorded by only hospitals, dispensaries etc. in some areas (attach phase areas) and the same was detected by home visiting (active surveillance) and by hospitals, dispensaries, primary health centres etc. (passive surveillance) in some other areas (consolidation phase). Appendix 1 presents the movement of population groups from one phase of the programme to the other.

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* level predefined based on malariometric indices such as Annual parasite Rate (API) and child and Infant Spleen Rates. These levels determined the kind of programme activity in a given area.

During the period 1952-53 to 1976-77, the programme involved monetary expenditures to help/achieve its objectives. The same are presented in Table 2.

Table 2 : Expenditures incurred on NMCP/NMEP. yearwise from 1952-53 to 1976-77

Year	Total Expenditures at current prices (in million Rs.)	Whole sale price Index (1978-79 = 100)	Total expenditure at 1978-79 prices inflated by whole sale price index (Rs. in million)
1952-53	2.7	22.88	11.80
1953-54	33.1	23.28	142.18
1954-55	41.0	22.27	184.10
1955-56	38.9	20.46	190.13
1956-57	53.8	22.94	234.52
1957-58	67.6	24.31	278.07
1958-59	99.6	24.82	401.29
1959-60	144.7	25.82	560.42
1960-61	176.9	27.48	643.74
1961-62	200.4	28.13	712.41
1962-63	186.2	28.44	654.71
1963-64	166.6	29.63	562.27
1964-65	164.2	33.16	495.17
1965-66	157.4	36.07	436.37
1966-67	143.2	40.97	349.52
1967-68	140.9	47.23	298.33
1968-69	188.0	46.85	401.28
1969-70	187.5	47.47	394.99
1970-71	200.7	50.40	398.21
1971-72	231.7	52.35	442.60
1972-73	240.5	56.46	425.97
1973-74	234.71	67.31	348.70
1974-75	239.639	85.49	280.31
1975-76	371.422	86.99	426.97
1976-77	455.592	88.42	515.26
Total	4166.953		9789.32

1. Expenditures data for the years 1970-71 to 1973-74 are estimated (by the author) since the data available on 'operational costs' reflected the central subsidy only and not the total operational costs.
2. The expenditures data for the year 1974-75 to 1976-77 are the 'estimated' expenditures.

Source: NMEP Office, New Delhi.

4. Magnitude of malaria with NMCP/NMEP

4.1 Morbidity: The information on the number of cases of malaria occurred in India is the most basic data required to estimate the streams of 'benefits' accrured to the society as a consequence of organised activities to control and eradicate the disease. Table 3 (cols. 2 to 4) present the number of cases of malaria detected by NMCP/NMEP during each of the years of its activity. However, they are known to be under estimates of the actual number of cases.

Sinton (1938) after a comprehensive survey of the status of malaria in the then British India, careful analysis of the data available and dovetailing his vast experience connected with malaria, estimated that there were about 100 million cases of malaria in India annually. This estimate was said to be modest but an underestimate of the prevalence of malaria. The decade following this was characterised by limited technology and little or no commitment to combat the disease, the effects of second world war where the emphasis was most on defence services and consequently least attention was paid to the needs of the people, that too to a public health problem like malaria. Hence, it is quite reasonable to expect that the magnitude of the malaria remained the same (Bhora Committee, 1946). In 1947, with India attaining Independence, size of the population of India got reduced and consequently the number of cases of malaria in Independant India also got dimished. It was estimated by Jaswant Singh et al (1957) that the number of cases of malaria in Independent India was about 75 million per year, prior to NMCP.

The second world war led to the discovery of the great potential of DDT as a killer of mosquito. This in conjuction with a number of facilitating factors such as increased availability of DDT for civilian purposes, formation of a welfare state with concern for public health and the health of the public, led to the iniation of a number of anti-mosquito activities through out the country, though out in an organised manner. The impact of these control activities on malaria was said to be substantial (Gorden Covell, 1955; Jaswant Singh, 1957; NMEP, 1974). The Spleen Rate in two of the hyperendemic districts of Andhra Pradesh, recorded a decline of 44.2 percent and 74 percent. Morsand, Madhubani, Kishanganj and Purnia districts of Bihar where pilot anti-malaria activities were started in 1949, recorded decline in Spleen Rates ranging between 2 to 60.6 percent. The number of malaria cases in Gujarat was reported to have recorded a substantial decline. The anti-mosquito activities started in 1947 in an hyperendemic district (koraput) of Orissa recorded 'some' decline. Punjab also seemed to have recorded such a decline in the Spleen Rates. Similar reports existed from different hyperendemic areas of Uttar Pradesh, West Bengal, Madhya Pradesh and Assam. Analysis of the available data from different parts of the country on such reported decline, in Spleen Rates indicates that there was a reasonable decline in the prevalance of malaria due to wide spread malaria control activities and the decline was to a tune of about 18 per cent by 1953-54 when the organised activity of National Malaria Control Programme (NMCP) was initiated. In other words, the estimate of number of cases of malaria in 1953-54 was about 61.65 million, which is close to the estimate of 60.7 million made by Jaswant Singh et al (1957).

As it was described earlier, the population at risk was under passive surveillance (attack phase) for case detection till 1961-62. Parts of it moved gradually into active and passive surveillance (consolidation phase) and later into maintainance phase. It is to be recognised that the rates of reporting would very from phase to phase in that it would be higher amongst population groups with active surveillance (consolidation phase) than in those with only passive surveillance (attach phase); and within each of the phases the rates would increase over time because of increased availability of health facilities and increased levels of health consciousness brought about through multitude of other health activities. For the purpose of this analysis, therefore, two distinct time periods have been considered separately, viz., 1953-54 to 1961-62 when the country was under attack phase; and 1962-63 to 1976-77 when population groups were under different phases depending upon the magnitude of the disease.

Since the passive surveillance data was based on institutional statistics, the extent of reporting is expected to be low. Rao et al (1963) based on their study of a number of primary health centres and dispensaries in Maharashtra, reported that the passive case detection ranged from 4.9 percent to 59.3 percent in different institutions. Ansari (1980) reported that, out of the voluntary fever cases sought treatment in a dispensary during 1978 and 1979, he found 16 and 10 malaria positives while NMEP recorded only 2 (12.5%) and 0 (0%) respectively for the two years. Further, the passive surveillance records mostly clinical malaria cases. Somasundara Rao (1973) stated that chronic malaria cases do not present typical symptoms of malaria and hence many of such 'other cases' treated in hospitals and dispensaries could as well as be suffering from malaria. He diagnosed 525 malaria positives, out of those otherwise diagnosed based on his study in chittoor district. These findings clearly go to show that the passive surveillance maintained during 1953-54 to 1961-62 considerably underestimated the actual number of malaria cases in the country.

Sinton (1938), Bhore Committee (1946) and later Jaswant Singh et al (1957) reported that the rate of reporting of cases of malaria to different health institutions was only about 10 per cent. However, after 1953-54 there had been considerable growth of health care institutions particularly of primary health centres and dispensaries in rural areas, which in itself had increased the accessibility and hence utilisation by the people. In other words, the rate of reporting of malaria cases in attach phase areas would have increased over time (beyond the initial 10 percent) and it is quite reasonable the assume, as one approach for estimation for the first time segment, that this increase would be proportional to the increase in the number of health care institutions. However, one more important factor that determines the magnitude of disease is the extent to which the population is protected through DDT spraying of internal surfaces of households. It is said that if all the houses in an hyperendemic area are covered with the spray twice during a transmission season, the malaria transmission can be broken. In other words, the percentage of population offered such protection would be a relatively better proxy variable to estimate the number of cases of malaria in India during 1953-54 to 1961-62. Table 1 presents the distribution of the same for the period 1953-54 to 1961-62. Using these values the number of cases have been estimated for this period and presented in column 7 of Table 3. These estimates closely agree with those of Jaswant Singh et al (Loc. cit) thereby indicating that the method of estimation has been fairly reliable. According to this, an estimated number of cases of 61.65 million during 1953-54 decreased to a level of 3.7873 million during 1961-62 recording thereby a decrease of about 94 percent (see column 7 of Table 3).

Table 3 : No. of malaria cases in India, 1953-54 to 1976-77 year-wise - Reported and Estimated

Year	No. of malaria cases reported (millions)			Extent of reporting (%)		Estimated no. of cases (millions)
	Passive surveillance	Active surveillance	Total	Attach phase	Consolidation phase	
1	2	3	4	5	6	7
1953-54	1.2371	-	1.2371	-	-	61.6500
1954-55	2.4433	-	2.4433	-	-	47.5694
1955-56	2.2912	-	2.2912	-	-	38.1380
1956-57	2.3327	-	2.3327	-	-	33.1630
1957-58	2.1959	-	2.1959	-	-	30.2651
1958-59	1.9160	-	1.9160	-	-	28.1958
1959-60	2.0051	-	2.0051	-	-	21.0877
1960-61	1.3870	-	1.3870	-	-	13.2617
1961-62	0.0492	-	0.0492	-	-	3.7873
1962-63	0.0545	0.0051	0.0596	18.0	45.33	0.3138
1963-64	0.0730	0.0143	0.0873	19.3	46.20	0.4092
1964-65	0.0837	0.0293	0.1129	20.5	47.00	0.4704
1965-66	0.0681	0.0316	0.0997	21.5	47.67	0.3841
1966-67	0.0593	0.0888	0.1480	22.8	48.53	0.4432
1967-68	0.1211	0.1576	0.2782	23.0	48.66	0.8501
1968-69	0.2358	0.0391	0.2746	23.5	49.00	1.0831
1969-70	0.2998	0.0488	0.3480	23.6	49.07	1.3699
1970-71	0.5998	0.0949	0.6940	23.7	49.13	2.7238
1971-72	1.0933	0.2299	1.3224	23.8	49.20	5.0607
1972-73	1.0845	0.3455	1.4286	23.9	49.27	5.2390
1973-74	1.1967	0.7378	1.9303	23.9	49.27	6.5047
1974-75	1.7789	1.3940	3.1677	24.0	49.33	10.2377
1975-76	2.7759	2.3903	5.1661	24.0	49.33	16.4112
1976-77	3.4749	2.9923	6.4672	24.0	49.33	20.5443

Let us now examine the second time period, namely, 1962-63 to 1976-77. Certain geographical areas with a population of about 157 million entered consolidation phase during 1962-63. This proportion continued to increase (with the resultant decrease in size of population in attach phase) upto 1967-68. Thereafter, because of increased incidence of the disease and the alarm it caused, there was backward shift in that the population groups in attack phase started increasing. Appendix 1 presents the distribution of the population in attack, consolidation and maintainance phase, year-wise from 1962-63 to 1976-77. One important aspect of these phases of activity is that the extent of case detection (that is, case reporting) even in consolidation and maintainance phase areas* was not hundred percent, though much better than that in attack phase areas. It is, therefore, necessary to estimate the same, separately so that year-wise estimates of actual number of cases are obtained for the period 1962-63 to 1976-77. The approaches for their estimation have also to be different, by necessity.

As it was indicated earlier, the case detection was based on institutional data in attach phase areas. It is however known that accessibility of an institution is an important precondition for seeking care. In other words, recognising that the health institutions larger would be the population covered and hence higher would be the case detection rate. After independence, there has been a phenomenal growth of health institutions in the country. The rate of growth of these institutions (Appendix 2) over t'e period has been worked out. Given the case detection rate of about 10 percent during pre-control period, it can, therefore, be surmised that this rate would have increased in proportion to the increase in health institutions. Based on this, the case detection rates (R_p) in the areas of attach phase have been worked out for each of the years during 1962-63 to 1976-77 and presented in column 5 of Table 3. In areas where the programme entered into maintainance phase, the case detection

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* Since the content of the programme in consolidation phase and maintainance phase are essentially the same, these two phases are treated together.

was done through active surveillance wherein surveillance workers were expected to pay fortnightly visits to each house-hold in the area, identify fever cases present, take blood slides for testing for presence of malaria parasite and give presumptive treatment. Since the visit is once a fortnight, the fever cases occuring during the early period of the fortnight seek treatment from elsewhere and a small proportion of them do so from health care institutions located in the area, thus becoming part of passive surveillance data or go completely unreported. Thus, if the actual number of cases occurred during a year is N, then cases detected by both active and passive surveillance (n) is

$$n = C_1 \cdot N + C_2 \cdot N$$

where, C_1 and C_2 are the proportions of total cases detected by a active and passive surveillance, respectively. Assuming that the density of cases during a fortnight is uniformity distributed through out the period in a consolidation phase area, C_1 and C_2 bear certain relationship to each other in that

$$C_2 = \frac{(1-C_1) \cdot R_p}{100} \quad \text{and}$$

$$C_1 = \frac{t}{100}$$

where t is number of days prior to a home visit by surveillance worker corresponding to hundred percent detection of fever cases for collection of blood slides and presumotive treatment; and R_p is the case detection rate (percent) by passive surveillance. It is suggested by a number of workers in NMEP that the most reasonable value for t is 5 days. R_p values for different years have already been worked earlier (column 5 of Table 3).

With these relationship and values,

$$C_1 = \frac{t}{15} = \frac{t}{3} ,$$

$$C_2 = \frac{2}{3} \cdot \frac{R_p}{100} \text{ and hence}$$

$$n = N(1/3 + 2/3 . \frac{R_p}{100}) \text{ or}$$

$$n = \frac{(100 + 2R_p)}{300} \cdot N \quad \ldots\ldots\ldots\ldots (1)$$

Thus, $\frac{(100 + 2R_p)}{300}$ is the case detection rate (%) in the areas of where the NMEP was in consolidation and maintainance phases. The same have been worked out for different values of R_p and presented in column 6 of Table 3. The estimated number of cases actually occurred (Ni) during a year i is

$$N_i = \frac{n_{ip} \times 100}{R_{pi}} + \frac{n_{ia} \times 100}{R_{ai}} \quad \ldots.(2)$$

where, n_{ip} = number cases detected through passive surveillance (attack phase) in year i;

n_{ia} = number of cases detected through active surveillance and passive surveillance (consolidation-maintainance phases) in year i;

R_{pi} = case detection rate (%) under passive surveillance in year i ; and

R_{ai} = case detection rate (%) under active and passive surveillance in year i.

The same have been worked out and presented in column 7 of Table 3, which provide a set of estimate of actual number of cases of malaria occurred in India in different years during 1962-63 to 1976-77.

4.2 Morality : One view, largely prevalent amongst all malariologies has been that malaria was directly and indirectly responsible for a considerable number of deaths in India. Sinton (1938) estimated that about one million deaths (case fatality rate of one percent) of those occurred every year in India were directly ascribable to malaria and an equal number were indirectly due to malaria. These estimates formed the basis for all subsequent calculations by other workers. One approach, therefore, is to accept it (that malaria was directly responsible for mortality and the case fatality rate then was one percent) to be true and generate a set of estimates of it, with NMCP/NMEP. Further, the evidence available corraborates the same. Ramakrishna et al (1948) based on the results of a pilot scheme of spray operations with DDT in about 16,583 hyperendemic population of Puthur Taluk of South Kanara District, found that there were about 346 deaths (20.86 per 1000 population) in 1945 and about 217 (13.09 per 1000) in 1946 directly due to Malaria. Ray (1948) based on the results of a prophylactic trial with Paludrine in tea estates of Dima (Assam) showed that the death rate came down to 16.60 per 1000 population in 1947 from 32.77 in 1946. Viswanathan (1951) stated that the death rate decreased by 10 per 1000 due to intensive control measures during 1946 to 1950 in Kanara district which was known to be highly hyperendemic to malaria. The reports indicated that malaria control activities of pre-NMCP period brought down the mortality considerably. In view of the pancity of reliable data on malaria-specific mortality, the need for built in provision for validation of estimates is imminent. Therefore, three different approaches have been adopted to estimate the same.

Method 1 : The estimates of case load for different years of NMCP and NMEP were worked out earlier (Table 3). Assuming the case fatality rate of one percent of pre NMCP period valid for 1953-54 the year when NMCP* was systematically launched in selected areas, the estimates of the same for subsequent years of NMCP have been worked out based on exponential decrease where the case fatality rate reaches zero level during 1961-62 when the total population was under attack phase for second successive year. With these case-fatality rates and the set of estimates of case load already worked out (column 7 of Table 3) the number of deaths directly attributable to malaria in different years have been worked out (column 2 of Table 4).

Method 2 : On the other hand, some workers believe that intensive residual spraying of all internal surfaces of houses of malarious population at least for one year with DDT would dramatically bring down the deaths due to malaria. If this is accepted, such an activity covered only about 20 percent of malarious population during 1953-54 which gradually increased to about 100 percent during 1961-62 (Table 1). Using these rates of percentage of population protected during different years of NMCP and NMEP and assuming them to be inversely proportional to the rates of reduction in mortality in successive years, a second set of estimates of the number of deaths has been generated (column 3 of Table 4).

Method 3 : The third method uses the available data on malaria-specific mortality, collected through Registration System, which are known to be considerably underenumerated. However, estimates of underenumeration of deaths in registration data can be obtained by their comparison with mortality estimates obtained through census crude death rates. The annual estimates of crude death

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*The NMCP came into being during December, 1952 with actual work started from April, 1953.

rates have been computed using 1951 and 1961 census rates. Given the total mortality rates in India by Civil Registration (Chandrasekhar, 1972), the estimates of extent of their enumeration in Civil Registration System have been computed (see column 4 of Appendix 3). Central Bureau of Health Intelligence (1953 to 1966) presented the number of deaths due to malaria for each of the years (column 5 of Appendix 3). The correction of these data by the extent of enumeration gave a set of estimates of malaria-specific deaths in India during the years, 1953-54 to 1965-66 (column 4 of Table 4). The implied assumption here is that the extent under registration in total mortality and malaria-specific mortality are equal which according to Preston (1976) is quite reasonable.

Thus, we have three sets of such estimates. The first assumes exponential decrease in case fatality rates, the second assumes direct inverse relationship with the percent of population protected through DDT spraying and the third is obtained through the registration data. A close scrutiny of the data used, methods employed and the estimates obtained by the three approaches indicate that the second set of estimates is the best amongst the three because the available experimental evidence based on pilot projects (Ramakrishnan et al, 1949; Ray, 1948) clearly showed that intensive spraying of houses had dramatically brought down malaria-specific mortality. However the data used in Estimate III and Estimate I did ignore this fact. Further, the degree of variation exhibited by the data used for arriving at Estimate III indicated its poor quality. Besides, the NMEP was at its greatest tempo during 1960-62 when almost the total malarious population of India was under attach phase and hence deaths due to malaria could not have occurred after that. On the other hand Estimate I is based on a simplistic assumption without use of any data of the programme.

In view of these, the second set of estimates had been considered to be realistic and used for all future computation of costs due to premature mortality.

Table 4 : Estimated no. of deaths due to Malaria in India year-wise, 1953-54 to 1976-77

Year	No. of deaths (millions) with programme			No.of deaths without programme (millions)
	Estimate I	Estimate II	Estimate III	
1953-54	0.6165	0.4932	0.8293	0.6165
1954-55	0.2137	0.4567	0.6982	0.5850
1955-56	0.0768	0.4171	0.3976	0.5600
1956-57	0.0259	0.3873	0.7042	0.5300
1957-58	0.0091	0.3653	0.1131	0.5000
1958-59	0.0049	0.3468	0.2277	0.4700
1959-60	0.0014	0.2560	0.6928	0.4400
1960-61	0.0004	0.0765	0.4650	0.3900
1961-62	-	0.0411	0.2435	0.3300
1962-63	-	-	0.2431	0.2600
1963-64	-	-	0.2785	0.1800
1964-65	-	-	0.1322	0.0900
1965-66	-	-	0.0756	-
1966-67	-	-	-	-
1967-68	-	-	-	-
1968-69	-	-	-	-
1969-70	-	-	-	-
1970-71	-	-	-	-
1971-72	-	-	-	-
1972-73	-	-	-	-
1973-74	-	-	-	-
1974-75	-	-	-	-
1975-76	-	-	-	-
Total	0.9487	2.8400	5.0918	4.9515

5. Disease Magnitude 'without' NMCP and NMEP

5.1 Morbidity : We have estimated the number of cases of malaria occurred in India during successive years of the programme in the earlier section. The question, that arises now is "what would have been the malaria situation in India, in terms of number of cases and number of deaths, if this programme were not to be launched at all?". The answer(s) to this question may very well be dependent upon the imagination (or fantasy?), the degree of concern (or attachment?) for the disease, the understanding of its epidemiology and the capacity to project under conditions of changing social, political and economic mileau (interactions between a disease dynamics and development). In other words, the issue is one of 'futurelogy' the judgments on which can always be challenged. It is however to be realised that such judgments are inevitable in pre-project/ programme appraisals* for their financial, economic and/or social feasibility; and the need to bring as such objectivity as possible to bear upon the problem is imperative.

The starting point for such an assessment is the incidence of malaria in India of about 61.65 million cases per year just before launching of NMCP. Given this, the plausible assumptions that would help arrive at a judgment, based on the transmission process takes place (facilitating and inhibiting factors), are 1. the transmission chain can be broken only through the attack on mosquito, human host or both; 2. with the availability of technology, the Governments, local bodies and voluntary agencies would have launched some measures (anti-larval and anti-mosquito), though in an unorganised manner, to control mosquito population, 3. with the availability of technology for treatment, there would have been increased demand on health institutions, private

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* The present study is one such appraisal though in retrospect

practioners etc. for radical treatment (in other words, a substantial proportion of the beneficiaries of the present NMCP/NMEP would have turned to them for treatment.

The assumption (2) above would have resulted in some reduction of mosquito population and hence the number of cases of malaria in later years of fifties. However, the same would have been off set by i) increased agricultural operations (green revolution, multiple cropping, irrigation canals etc etc.), ii) increasing urbanisation resulting in increased slums, open drains and iii) development of resistance of mosquitoes to DDT faster. These would have led to increased mosquito population and hence increased number of cases of malaria.

The assumption (3) would have led to 'uncontrolled' use of demotherapy* by many 'suspected' malaria cases, resulting in increased toxicity amongst patients and resistance of the parasite to the drugs. In other words, while there would have been some marginal decrease in the size of the human carriers (due to eradication of the vector in human blood after radical treatment) in the initial years, the same would have increased in the sixties and later.

The outcomes of assumptions (2) and (3) when analysed together, would clearly indicate that there would have been some marginal reduction in the number of cases during the period 1953-60 which would have sharply risen again during early sixties to the levels of pre-control era**. In other words, the number of malaria cases would have marginally decreased from its 1953-54 level of 61.65 million, and recorded a sharp increase to the level of 51.65 million by about the middle of sixties and continued to fluctuate at that level.

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* This practice has been in evidence even now after commercialisation of chloroquins and the related compounds.

** Similar trend (not of such sharp increase) was witnessed even under conditions of an organised programme after 1965.

5.2 Mortality : On the other hand, the assumptions (2) and (3) above will have important implications for malaria-specific mortality. The mortality experiences all over the world have clearly shown fast declining trends and the major factor ascribed for the same has been of the availability of technology to combat the mass killer diseases like plague, small pox, malaria, tuberculosis etc (Preston, 1976). Given this and the increased tempo of all round development that had been systematically planned in India, coupled with massive increases in infrastructural facilities for delivery of comprehensive health services in rural areas, the malaria-specific mortality would have come down in any case, gradually though, by about middle of sixties.

Based on this analysis, it therefore follows that the incidence of malaria would have been about 61.65 million cases per year and that of malaria-specific mortality would have declined to near zero by about middle of sixties if the NMCP/NMEP were not launched in India. The numbers of deaths that would have occurred in India due to malaria in different years have been worked out and presented in column 5 of Table 4.

6. Monetary Costs due to Morbidity

This section attempts to examine different components of direct and indirect outcomes of morbidity due to malaria, derive analytical approaches for estimation of costs of the outcomes under 'with' and 'without' NMCP/NMEP conditions and estimates the costs of each one of them for different years. As was discussed in the earlier section, four different outcomes of morbidity are taken into consideration, namely,

i) treatment costs;

ii) monetary costs to the sick for transportation to place of treatment and back;

iii) monetary costs to the families on special foods; and

iv) productivity losses due to sickness absenteism.

The same are presented in the following pages.

6.1 Treatment costs : We have estimated the number of cases of malaria that occurred in India during the period 1953-54 to 1976-77, year-wise. Some of them were treated in hospitals, dispensaries and primary health centres as out patients and some others, who required intensive care, as inpatients. In view of lack of adequate health facilities and inaccessibility of the available facilitates, a large proportion of the patients have been seeking home care or treatment from private practitioners of different systems of medicine in rural areas. In 1962, when active surveillance of fever cases was instituted as a part of malaria eradication in areas of consolidation phase, a part of such expenditure on treatment of malaria cases detected through active surveillance became a part of the programme expenditure. Thus, the costs incurred by Indian society on treatment of malaria cases can be estimated from

$$c_1 = \sum_{i=1}^{24} k_i n_{1i} \cdot c_{1i} \qquad (3)$$

for out patient treatment, where k_i is the multiplier for constant prices (at 1978-79 = 100) in year i, n_{1i} is the number of such patients in year i and c_{1i} is the cost per outpatient in year i;

$$C_2 = \sum_{i=1}^{24} k_i\, n_{2i} \cdot c_{2i} \quad \ldots\ldots (4)$$

for self care and private treatment, where n_{2i} is the number of such patients in year i, and c_{2i} is the average cost per patient for self care and by private practitioners in year i;

$$C_3 = \sum_{i=1}^{24} k_i\, n_{3i} \cdot c_{3i} \quad \ldots\ldots (5)$$

for inpatients, where n_{3i} is the number of malaria cases treated as inpatients in hospitals in year i and c_{3i} is the average cost per inpatient in year i. The estimate of total treatment costs, therefore, is obtained by

$$C = \sum_{j=1}^{3} c_j \quad \ldots\ldots\ldots\ldots (6)$$

The number of cases treated as outpatients in hospitals and dispensaries (n_{1i}) for different years is obtained from the records of NMEP based on the hospital and dispensary statistics through passive surveillance.

The estimates of n_{2i} have been worked out differently for the two phases of the programme, namely, control phase and eradication phase. During the control phase (1953-54 to 1961-62) since no active surveillance was in existence, the estimated number of cases of malaria in a given year minus the number of cases treated in institutions gave such estimates. However, during and after 1962-63 when active surveillance came into being, the estimates of n_{2i} were calculated by substracting the number of cases detected through passive surveillance and active surveillance from the estimated total for a given year. The data for n_{3i} (that is, the number of cases of malaria treated as inpatients) were available for only eight years, namely, from 1956 to 1963 (CBHI, 1956 to 1963). The trend of the data clearly showed a substantial decline over the years. However, there was no meaningful way to estimate the same for the years 1953 to 1955 when the prevalence of malaria was very high. In view of this, this component of the costs is calculated only for the years 1956 to 1963 which, therefore, is an underestimate of the inpatient treatment costs. Further, it is reported that a number of patients admitted to hospitals for other disease conditions was also found to be suffering from malaria (Somasundara Rao, 1973) whose estimate is not available, which adds to the magnitude of underestimation of inpatients and hence the inpatient treatment costs.

The next step in the computation of treatment costs is of obtaining unit costs, namely, treatment cost per outpatient (C_{1i}), treatment cost per patient on self care and from private practitioner (C_{2i}) and treatment cost per inpatient (C_{3i}) for successive years. Such estimates overtime are not at all available. However, some cost studies conducted during the very recent years in some hospitals provide estimates of the same. A study in two district hospitals (Sharma and Trinmappaya, 1973) in the state of Haryana during 1969-70 brought out that the cost per outpatient was Rs.1.82 and that for inpatient-day was 6.54. Another study in 18 hospitals (general and specialised) of Tamil Nadu during 1973-74 (Narayanan and Tilak Shankar, 1975) indicated that the average cost per outpatient was Rs.2.20 and that for inpatient-day was Rs.13.18. Yet another study of a nursing home of a large government hospital in Delhi during 1972 (Kataria et al, 1973) estimated the average cost per outpatient visit to be Rs.9.87 and the average cost per inpatient day to be Rs.58-41. Which one these estimates is to be considered as a reasonable one for the present analysis? Certain criteria that would enable such a selection are i) the hospital(s) under consideration should not be a typical; and ii) the estimates should be based on the study of a fairly large number of hospitals so that they have an intrinsic potential for generalisation. These criteria led towards the choice of Rs.2.20 and Rs.13.18 as the estimates of the two parameters (c_{1i} and c_{3i}) under consideration. The estimate of Rs.13.18 is of average cost of hospitalisation per inpatient-day. Ramaiah et al (1974) reported based on their study of 23 large non-teaching general hospitals located at district headquarters towns in the country, that the average length of stay of patients suffering from infective and parasitic diseases fevers and PUC to be 6.1 days. This provides a measure to estimate the cost of hospitalisation per patient of malaria. The estimate thus derived is Rs.80.40.

A number of health surveys (Seal et al 1956; 1957; 1958) carried out in rural areas during 1953-58 estimated average expenditure on medical care per episode* of sickness. The pooled estimate of them gives the private expenditure per episode of sickness to be Rs.12.39. Bhombre et al (1952) reported the same, with reference to malaria alone, based on their survey in a few villages located in malarious irrigated tract in the then Mysore State to be varying between Rs.17.04 to 26.18. These villages, however, were known to be 'rich' inagriculture. In view of the same, the earlier one of rupees 12.39 appears to be a quite reasonable estimate of average private expenditure on medical care per episode of sickness ($\hat{C}_{2i}$).

In ciew of these considerations, the formulae given above for calculation of treatment costs are modified as given below:

$$C_1 = \hat{C}_1 \sum_{i=1}^{24} k_i . n_{1i} \quad \ldots\ldots\ (8)$$

$$C_2 = \hat{C}_2 \sum_{i=1}^{24} k_i . n_{2i} \quad \ldots\ldots\ (9)$$

* These estimates are quite stable, reflecting the variations due to variations in population groups only.

$$C_3 = \hat{C}_3 \sum_{i=1}^{24} k_i . n_{3i} \quad \ldots\ldots\ldots \quad (10)$$

$$\text{and} \quad C = \sum_{j=1}^{3} C_j \quad \ldots\ldots\ldots \quad (11)$$

where $\hat{C}_1$, $\hat{C}_2$ and $\hat{C}_3$ are the average cost of treatment per outpatient (Rs.2.20); average private expenditure on medical care per episode of sickness (Rs.12.39); and average cost of hospitalisation per inpatient (Rs.88.40). The estimates of treatment costs of malaria thus obtained year-wise under conditions of 'with' NMCP/NMEP are presented in Table 5.

Table 5 : Treatment costs of malaria year-wise from 1953-54 to 1976-77 at constant prices (1978-79 = 100)

Year	Treatment costs (million rupees)			
	Outpatient care	Private care	Inpatient care	Total
1953-54	2.7216	3215.27	NA	3217.99
1954-55	5.3753	2510.61	NA	2515.99
1955-56	5.0406	2170.78	NA	2175.82
1956-57	5.1319	1665.16	108.6146	1778.91
1957-58	4.8310	1431.59	89.9859	1526.41
1958-59	4.2152	1311.87	60.7175	1376.80
1959-60	4.4112	915.70	52.1683	972.28
1960-61	3.0514	535.40	10.2579	548.71
1961-62	0.1082	164.65	4.7593	169.41
1962-63	0.1199	11.07	1.8517	13.04
1963-64	0.1606	13.46	1.2309	14.85
1964-65	0.1841	13.36	-	13.54
1965-66	0.1498	9.75	-	9.90
1966-67	0.1305	8.92	-	9.05
1967-68	0.2664	14.99	-	15.26
1968-69	0.5188	21.37	-	21.89
1969-70	0.6595	26.65	-	27.31
1970-71	1.3196	49.88	-	51.20
1971-72	2.4053	88.46	-	90.87
1972-73	2.3859	83.59	-	85.98
1973-74	2.6327	84.13	-	86.76
1974-75	5.8143	102.39	-	108.20
1975-76	7.0203	160.16	-	167.18
1976-77	8.6460	197.26	-	205.91
Total	67.3002	14806.47	329.5861	15203.35

On the otherhand, if NMCP/NMEP were not to be launched, Indian society would have incurred an annual cost of Rs.3217.99 millions at constant prices (1978-79 = 100) on treatment of cases during each of the 24 years under study. In other words, while the total *treatment costs* for all the 24 years 'with' the programme is about Rs.15203.35 millions, the same 'without' programme would have been Rs.77,231.76 million. Thus, the net monetary benefit on this account turns out to be Rs.62,028.41 millions.

6.2. <u>Cost of transportation for treatment</u>: As it was presented earlier, a sizeable number of patients of malaria have been seeking medical care from the outpatient and inpatient units of hospitals, dispensaries and primary health centres. While it is true that a large majority of these patients generally originate from villages within a radius of 3 to 5 kilometers from the health care institutions, even they by necessity have had to incur certain expenditures on transportation to the place of treatment and back not only for themselves but also to the kith and kin who accompany them. In the earlier study (Ramaiah, 1976), it was estimated by Delhi Technique that the average cost per inpatient on transportation to and from the hospital in 1976 was Rs.12.89 and that per outpatient was Rs.8.62. The annual direct costs on account of this, therefore, have been worked out under conditions of 'with' NMCP/NMEP and presented in Table 6. The same has varied from Rs.12.06 million in 1953-54 to Rs.63.05 million in 1976-77 at constant prices (1978-79 = 100), the total such direct expenditures due to malaria being Rs.405.23 millions.

On the other hand, if NMCP/NMEP were not to be launched, what would have been the magnitude of such expenditure? During pre NMCP/NMEP the number of health institutions was small which however gradually increased and hence the number of cases transporting to places of treatment would have increased. The real experience during 1961-62 to 1976-77 throws some light on the same. During this period, both the case load and the number seeking care from health institutions were found to be increasing from year-to-year. However, the proportion of malaria patients seeking such care out of the total cases remained generally constant, varying only between 16.91 per cent and 22.02 per cent with an average of 18.43 per cent. The observed variations over time can be said to be rather random. In other words, even under conditions of 'without' NMCP/NMEP about 18.43 percent of malaria cases would have got transported to different health institutions for treatment every year.

What proportion out of them would have sought inpatient care and what proportion, outpatient care are certainly imponderables. To err only on the lower side, it would be reasonable to assume that all of them would have sought outpatient care only whose transportation cost per case was Rs.8.62 (lower than that of inpatient transportation cost of Rs.12.89 per case).

With about 61.65 million malaria cases every year, about 18.43 per cent of whom would have incurred transportation costs to place of treatment and back for treatment purposes and such costs per case being Rs.8.62 as of 1976, the total such costs per year, under conditions of 'without' NMCP/NMEP, worked out to be Rs.110.77 million. The same for the 24 year time span (at constant prices) is Rs.2658.44 million.

This analysis shows, therefore, that the estimate of net benefits accrued on account of this component of expenditure to the Indian society due to NMCP/NMEP over the period if about Rs.2253.11 millions.

Table 6: Transportation costs and costs on special foods due to morbidity - 1953-54 to 1976-77 at constant prices (1978-79 = 100) with NMCP/NMEP

Year	Transportation costs (Rs. in millions)	Costs of special foods (Rs. in millions)
1953-54	12.06	293.45
1954-55	23.82	276.43
1955-56	22.34	181.54
1956-57	35.99	157.85
1957-58	32.39	144.06
1958-59	26.09	134.21
1959-60	25.91	100.37
1960-61	14.77	63.12
1961-62	1.06	18.03
1962-63	0.80	1.49
1963-64	1.01	1.95
1964-65	1.10	2.24
1965-66	0.97	1.83
1966-67	1.45	2.11
1967-68	2.71	4.04
1968-69	2.68	5.15
1969-70	3.39	6.52
1970-71	6.76	12.96
1971-72	12.99	24.09
1972-73	13.92	24.94
1973-74	18.82	30.96
1974-75	30.89	48.73
1975-76	50.36	78.11
1976-77	63.05	97.79
Total	405.33	1662.01

6.3 Cost of Special Focds: The epidemiology of malaria clearly points out the deleterious effects on human system during as well as after the episode of sickness. The malaria phasmodium by destroying the white blood cells in human blood produces severe forms of anaemia. Further, it is stated (Pattanayak, 1980) that every rigour produced, when merozoits forms of the parasite are released into blood circulation from dividing schizonts, consumes about 5000 calories. This excessive energy consumed, it not replanished, would further add to anaemia in the victim. In view of these, it is a common practice that the households incur certain expenditures on special diets (in the form of glucoss, fruits, milk etc.) to help the malaria pstient recuperate from such effects of the disease. How much does it cost per family, on an average, on this account? Ramaiah (1976) estimated the same to be about Rs.19.06 per patient of smallpox whose duration of sickness is about three weeks. In other words, this provides an estimate of cost per sickness-day of about Rs.0.91 Seal et al (1956, 1957, 1958) estimated the average duration of sickness due to malaria to be about 5 days, which gives an estimate of cost of special diets per patient of malaria of Rs.4.55. The total cost to the society on this account, with NMCP/NMEP is therefore estimated to be Rs.1662.01 millions at constant prices (1978-79 = 100). The annual estimates of the same for the period 1953-54 to 1976-77 are presented in Table 6. Under conditions of 'without' NMCP/NMEP, this component of costs to Indian society would have been to a tune of about Rs.293.45 million every year. Total such costs for the 24 years period would have been Rs.7042.80 million. In other words, the net benefits accrued due to the programme on this account alone works out to be Rs.5380.79 millions, at 1978-79 prices.

6.4 Productivity losses due to sickness:

Absenteism: Absenteism from work is an inevitable consequence when one is sick, which is as well true of Malaria, resulting in economic losses to the society in terms of monetary costs of goods and services which otherwise would have been produced. An indirect measure of monetary cost of productivity per day of absence from work, employed in this analysis, is per capita earnings per day.

The data requirements for estimation of the same are

i) age-sex distribution of malaria cases amongst adults (16 years and above)*;

ii) age-sex distribution of employment rates; and

iii) age-sex distribution of per capita earnings per day.

Given these distributions, the economic value of productivity losses (E_{pi}) during year i due to temporary absence from work because of malaria can be worked out using the formula,

$$E_{pi} = \sum_{j=15-19}^{60+} \sum_{k=1}^{2} n_{jk} \cdot e_{jk} \cdot w_{jk} \cdot \hat{d} \quad \ldots\ldots (12)$$

j = all age groups from 15-19 and above

k = the two sex groups, 1 and 2

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* In this analysis, only those with age 16 years and above are included though child labour is quite prevalent in India.

where n_{jk} is no. of malaria cases amongst persons of age group j and sex group k;

e_{jk} is the employment rate amongst general population in age group j and sex group k;

w_{jk} is the percapita wages per day amongst general population in age group j and sex group k; and

$\hat{d}$ is the average duration (days) of absence from work due to sickness.

Detailed age-sex distributions of malaria cases for each of the 24 years of NMCP/NMEP were hard to get. However, Pattanayak et al (1978) prepared the same for three time periods, namely, 1965, 1971, and 1975 for the State of Karnataka which gave the proportion of cases amongst individuals of age 15 years and above as 46.4 percent, 51.4 percent and 56.2 per cent respectively. Further, NMEP (1972) based on the analysis of cases that occurred in 14 states and Union Territories during 1972 in India reported it to be 52.3 percent. Nair (1973) based on his study of malaria in Jammu & Kashmir during 1963 reported the proportional case rate amongst individuals of age 15 and above to be 45.1 percent and Sharma et al (1973) based on their study in Madhya Pradesh in 1973 reported the same to be 54.5 percent. These data available for six different years, when plotted on a graph found to give a perfect straight line fit, the proportion of cases amongst the age group 15 and above increasing linearly with time. This cannot be said to be accidental when the role of immunity on the incidence of malaria is examined. Boyd (1949) reported that in a society which is highly endemic to malaria, the level of immunity is highest amongst adults (all ages irrespective of sex) which decreased with age amongst children and infants and hence the proportional case rate amongst adults is lower than that amongst children and infants. However, with decreasing endemicity of the disease, as happened in India with the launching of NMCP/NMEP, the levels of immunity amongst adults decrease and hence the proportional case rate increases over time, till a point in time when all ages and sexes are equally susceptible to malaria. Thus, using the linear fit available, the proportional case rates amongst adults have been estimated for each of the 24 years during 1953-54 to 1976-77 (Appendix 10). Given the total number of cases in a year, this gives an estimate of number of cases (n_a) amongst adults of age 15+. Further, given that the probability of an individual of age group j and sex group k suffering from malaria is constant over all adult age and sex groups, the number of malaria cases (n_{jk}) in age group j and sex group k in a given year can be calculated using the formula,

$$n_{jk} = n_a \cdot p_k \cdot p_{jk} \quad \ldots\ldots\ldots (13)$$

where n_a = Total malaria cases amongst adults;

p_k = Proportion of adult sex group k in total adult population; and

p_{jk} = Proportion of age group j amongst adult sex group k.

The value of p_k and p_{jk} are obtainable from age-sex distribution of Indian population of 1951, 1961 and 1971 censuses (Mukherjee, 1976). The same are applied to n_a values of each of the years to derive age-sex distributions of cases amongst adults, year-wise from 1953-54 to 1976-77. The distributions thus derived are of seven broad age groups, namely, 15-19, 25-29, 30-39, 40-49, 50-59 and 60+, separately for males and females since the employment rates and earnings differ significantly between sexes.

The age-sex distributions of employment rates (e_{jk}) as obtained by Indian censuses of 1951, 1961 and 1971 (Planning Commission, 1970; Registrar General and Census Commissioner of India, 1971) have been used for the time periods 1953-54 to 1955-56, 1956-57 to 1965-66 and 1966-67 to 1976-77 respectively.

The age-sex distribution of per capita earnings have been developed for each of the years for the purpose of deriving present value of future earnings lost due to premature mortality ascribable to malaria presented elsewhere in this monograph under mortality. The same when divided by number of days in a year (365) provide meaningful estimates of per capita earnings per day (w_{jk}) (See Appendices 4 and 5).

A variety of estimates are available for the average duration of absence from work ($\bar{d}$). Sinton (Loc. cit) extensively quoted the same for different population groups, employed differently in different occupations. These estimates varied between 5 and 14 days per individual per year. Based on the evidence available, he infered that 14 adult days per head per year of absence from work would be a conservative estimate. These estimates pertain to a period (pre-NMCP/NMEP) when the chemotherapy for malaria was not much available for widespread use and the limited quantities available were generally used by the elite and the prefered population groups (such as armed forces) and not available for general population who were the major victims of the disease. However, after Independance there was much more wide spread availability of drugs, particularly through NMEP. It is, therefore, logical to infer that the average duration of absence from work after 1953-54 when NMCP/NMEP had been active would be much shorter than Sinton's (Loc. cit) estimate of 14 days. NMCP (1975) estimated the same based on their surveillance reports, to be 5 days per episode of sickness. In the absence of any community based survey data on the same, it appears quite logical to assume it to be 5 days per head per year of those who suffered from malaria in a given year.

Thus, with the use of those data sets and the formula (12) specified above, the monetary costs of productivity losses attributable to absence from work due to malaria, under conditions of 'with' NMCP/NMEP, have been computed for each of the years from 1953-54 to 1976-77 at current prices and at constant (1978-79 = 100) prices. The same are presented in Table 7.

Under the conditions of 'without' NMCP/NMEP, it was, however, argued that there would have been about 61.65 million cases of malaria in India every year. Using the methodology detailed in the earlier pages, the monetary costs of productivity losses due to sickness absenteism, under conditions of 'without' programme have been calculated (Table 7). The only variance in the data set used here from that of 'with' programme, besides the number of cases, is the proportion of cases amongst adults of age 15 years and above. Under 'with' programme conditions, this proportion increased over time as discussed earlier. However, under conditions of 'without' programme, this proportion would be stationary around 36 percent (as of 1953-54 in Appendix 10) because of high incidence of the disease over successive years, the levels of immunity amongst adults would be relatively much higher and hence case rate would be lower, when compared to children.

It can be seen from Table 7, the total estimated monetary costs ascribable to sickness absenteism under conditions in 'with' programme and 'without' programme are Rs.3051.82 million and Rs.11297.16 million. The monetary benefits to the society, in terms of avoiding such costs which otherwise would have occurred if NMCP/NMEP were not launched, works out to Rs.8245.34 million, over the 24 years span of the programme. These costs (benefits) gradually increased from 1953-54 until 1964-65. Therefore, however, it recorded gradual decreases reaching in 1976-77 a level equivalent to that of 1955-56. In other words, though the programme continued to yield positive monetary gains year-after-year, the magnitude of the same has been on a declining path since 1964-65.

Table 7: Productivity losses due to sickness absenteism with programme and without programme - yearwise.

Year	with programme (Rs. in millions)		without programme (Rs. in millions)		Monetary benefits at constant prices
	at current prices	at constant prices (1978-79=100)	at current prices	at constant prices (1978-79=100)	
1953-54	115.94	498.00	115.94	498.00	0
1954-55.	83.09	373.11	104.38	469.00	95.89
1955-56	69.73	341.08	106.36	520.00	178.92
1956-57	66.96	292.00	117.94	514.00	222.00
1957-58	63.62	261.00	116.48	479.00	217.30
1958-59	51.87	208.99	125.76	507.00	298.01
1959-60	49.25	190.50	127.64	494.00	303.50
1960-61	31.78	116.30	126.62	461.00	344.70
1961-62	9.65	34.32	131.26	467.00	432.68
1962-63	0.84	2.96	135.81	478.00	475.04
1963-64	1.26	4,25	151.63	512.00	507.75
1964-65	1.70	5.11	174.00	525.00	519.89
1965-66	1.43	3.96	175.55	487.00	483.04
1966-67	1.68	5.09	176.21	430.20	426.11
1967-68	3.69	7.81	201.63	426.96	419.15
1968-69	4.78	10.20	201.63	430.20	420.00
1969-70	6.71	14.15	230.55	485.64	471.49
1970-71	14.51	28.79	232.29	460.80	432.01
1971-72	26.64	50.89	241.62	461.52	410.63
1972-73	30.57	54.14	260.33	461.16	407.02
1973-74	39.54	58.74	319.04	474.12	415.38
1974-75	76.87	89.92	367.61	429.84	339.92
1975-76	152.19	174.95	367.61	422.64	247.69
1976-77	198.44	224.43	382.88	403.08	178.65
		3051.82		11297.16	8245.34

7. Monetary Costs due to Mortality

One important consequence of mortality due to malaria is the monetary losses to society because of future earnings lost. If these people were not to die so prematurely due to malaria they would have survived longer and contributed towards the productivity. The estimation of these costs (monetary losses) therefore require examination of

i) age-sex distribution of per capita earnings;

ii) age-sex distribution of employment rates; and

iii) age-sex distribution of per capita consumption expenditure

because the loss of a life due to premature death involves the loss of an actual or potential producer. This loss is equal to the amount he/she would have produced* if he/she did not die prematurely, corrected for unemployment, minus the amount he/she would have consumed. In other words, the streams of net earnings for future years have to be determined and the same have to be discounted at a specified rate to derive estimates of the present value of the net future earnings for different age-sex groups. These provide the basis to work out the economic losses associated with premature mortality due to malaria under 'with' and 'without' NMCP/NMEP conditions.

Such distributions are needed for each of the years 1953-54 to 1964-65 since the deaths due to malaria had occurred during

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* Assumes that the 'earnings' is a reasonably adequate measure of the value of the marginal product of work.

these years. A comprehensive data set was worked out earlier by Ramaiah (1976) based on survey data on household incomes, consumption and savings (NCAER, 1969) during 1967-68. While there have been many such surveys, none of them, however, presented the data by age and sex. In view of this, the data set prepared earlier formed the basis for deriving similar data sets for each of the years, 1953-54 to 1964-65.

First set of elements of the data is of per capita earnings per year by age for males and females separately. Each of the elements in this was corrected by a factor

$$\frac{I_i}{I_{67-68}}$$

where I_i is the per capita income in India at current prices of year i, i = 1953-54, 1954-55, ———— 1964-65, and I_{67-68} is the per capita income for the year 1967-68 at current prices (Appendix 6), to obtain earnings by age and sex for each of the years.

The employment rates (percent employed) by age and sex obtained from 1951 census was adopted for the years 1953-54 to 1955-56 and of 1961 census was adopted for 1956-57 to 1964-65. The third set of elements of data is of per capita consumption expenditure per year by age for males and females, separately. Each of the elements was corrected by a factor

$$\frac{c_i}{c_{67-68}}$$

where e_i is the per capita consumption expenditure in India at current prices for the year i, i = 1953-54, 1954-55 ———— 1964-65; and e_{67-68} is the per capita consumption expenditure during 1967-68 at current prices (Appendix 6). This gave age, sex distribution of per capita consumption expenditure for each of the years, 1953-54 to 1964-65.

An additional feature of original data set for females is that it included the economic valuation of household services of females*. Using the concept of Responsibility Units (Weisbrod, 1968), by age. These values have also been similarly corrected by wholesale price Index, to reflect current prices.

Thus sets of data, separately for males and females, have been obtained corresponding to each of the years 1953-54 to 1964-65, Appendix 7 and 8 present the data sets thus derived for males and females for 1964-65. For each of the years, the per capita earnings (average) net of consumption for age n (y_n) have been worked out, using

$$y_n = I_n \cdot e_n - c_n \quad \text{........} \quad (14)$$

where I_n is the average per capita earnings of those with age n,

e_n is the employment rate amongst those with age n, and

c_n is the average per capita consumption expenditure of those with age n.

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* The principle involved here is that, though the household services are financially unremunerative, it costs money to get them done by an employee and its cost is a function of the size of the family.

Given values of y_n by age for year i and sex group j, the present value of net future earnings lost as a result of premature mortality due to malaria, have been worked out using the formula (Weisbrod, 1968)

$$V_{aij} = \sum_{n=a+\frac{1}{2}}^{70} \left[y_{nij} \cdot p^{n}_{a+\frac{1}{2}} \cdot \frac{1}{(1+d)^{n-a}} \right] \quad \ldots. (15)$$

where a is the person's age at his last birthday;

d is the discount rate

$p^{n}_{a+\frac{1}{2}}$ is the probability that a person (of sex j) with age $a+\frac{1}{2}$ would survive to age n;

y_{nij} is the average earnings, net of consumption of a person of age n, sex j in year i;

i = 1953-54, 1954-55 ---------- 1964-65; and

j = the two sex groups.

The results for the year 1964-65 are presented in Appendix 7, for males and in Appendix 8 for females*.

The value of $p^{n}_{a+\frac{1}{2}j}$ are the survival probabilities based on the mortality experiences of Indian population during the decade 1961-71 (R.G. of India, 1971).

The choice of a discount rate (d) is a debatable issue. There are a host of possible discount rates that can be used. While the long term market loans floated by the government offer an interest rate of 6 per cent which can be taken as one extreme

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* Data set of one year only is presented as a sample, in view of the size.

possible value of discount rate, many others (Cohn, 1973; O.E.C.D. 1973; Little and Mirrless, 1974; George Irwin, 1978) argue that 12 to 15 per cent might be a reasonable one for developing countries. It is, however, considered reasonable to assume a middle value of 10 per cent as the discount rate since its choice depends more on the value judgment involving the relative wellbeing of the present generation vis-a-vis future generations.

Given these estimates of present value of future earnings by age and sex, the same have been averaged out into two age groups, namely 15 and less, and 16+ (children and adults) since the data of malaria-specific deaths are available by these two age groups only and unaffected by sex. The column 3 of Appendix 9 presents the imputed cost per death by age and sex groups for each of the years, 1953-54 to 1964-65. The monetary cost of premature mortality (C_{pm}) is, then, calculated using the formula,

$$C_{pm} = \sum_{i} \sum_{j} C_{ij} \cdot n_{ij} \quad \ldots\ldots. (16)$$

where C_{ij} = Imputed cost per death of a person of age group i and sex group j;

n_{ij} = number of deaths amongst persons of age group i and sex group j.

Table 8 summaries the monetary costs due to premature mortality under conditions of 'with' and 'without' programme.

Table 8 : Monetary costs due to premature mortality - with and without NMCP/NMEP - yearwise.

Year	Monetary costs with NMCP/NMEP (Rs.millions)		Monetary costs without NMCP/NMEP		Monetary benefits (at constant prices)
	at current prices	at constant prices (1978-79=100)	at current prices	at constant prices (1978-79=100)	
1953-54	879.77	3779.09	1099.45	4722.71	943.62
1954-55	605.24	2717.76	775.42	3481.89	764.13
1955-56	519.96	2541.34	698.26	3412.82	871.48
1956-57	729.79	3181.95	919.61	4008.76	825.82
1957-58	527.36	2169.31	721.65	2968.53	799.22
1958-59	514.24	2071.86	733.58	2955.58	883.72
1959-60	399.09	1545.68	696.26	2696.58	1150.90
1960-61	111.13	404.40	567.41	2064.81	1660.41
1961-62	62.98	223.89	506.91	1802.04	1578.15
1962-63	-	-	427.54	1503.32	1503.32
1963-64	-	-	379.43	1280.56	1280.56
1964-65	-	-	212.86	641.92	641.92
Total		18635.29		31539.52	12904.23

- No deaths and hence zero monetary costs.

Expenditure on funerals : Sinton (1938) argues that Indian society has been incurring a large unprofitable expenditure on funerals and associated ceremonies and rituals connected with the religion of the deceased. It is estimated that its cost was Rs.12 per adult death and Rs.4 in the case of child. While an adult might have earned enough to cover his funeral expenses, the expenses incurred as a consequence of deaths amongst children would constitute, he argues, an unprofitable loss to the society. He estimated that such loses to Indian society to be a sum between Rs. 40 lakhs and Rs.100 lakhs every year. Bhombore et al (1952), based on a survey of theirs in 25 villages of the then Mysore State estimated the average annual expenditures per family on funerals attributed to deaths due to malaria to be Rs.173.8 before experimental malaria control activities through residual spraying were launched and Rs.27.1 after intensive spraying for a year. They ascribed this reduction to reduction in deaths amongst surveyed families. Viswanathan (1950) also made similar estimates of savings to Indian society as a consequence of reduction in mortality due to malaria in Bombay state. It is however to be recognised that every individual born has to die sometime or the other and the malaria control or eradication activities have helped towards postponoment of death (or prolongation of life). The expenditures on funerals and associated ceremonies and rituals, therefore, would only get 'deferred' and head of account might change. Consideration of the same as a component of costs due to malaria and hence inclusion in monetary benefits acrued in Indian society as a consequence of control or eradication of malaria introduces a fallacy. In view of this, this component of expenditure is excluded in the present analysis.

8. Benefit and Cost Streams

We have, in the earlier sections, estimated the monetary costs under 'with' NMCP/NMEP and 'without' NMCP/NMEP conditions, of five different outcomes of malaria in India, namely,

i) treatment costs of the sick;

ii) transportation costs to and from the places or treatment;

iii) costs of special foods;

iv) productivity losses due to temporary absenteism from work; and

v) the future earnings lost due to premature mortality directly ascribable to malaria.

Table 9 presents their totals for each of the years, 1953-54 to 1976-77. It can be seen that malaria consted India during this period, despite a highly organised programme, a sum of Rs.39005.24 millions. However, if this programme were not to be launched, its cost to the nation would have been Rs.129769.74 millions. In other words, the National Malaria Control Programme and National Malaria Eradication Programme together have led to the saving of a sum of Rs.90,764.50 millions. This has been made possible through the direct expenditures incurred on different activities of NMCP/NMEP during successive years, whose sum at constant prices (1978-79 = 100) works out to Rs.9,789.32 millions. Thus, the investment of Rs.9,789.32 millions has resulted in a benefit of Rs.90,764.50 millions, giving a benefit cost ratio of Rs.9.27 per one rupee of investment.

Benefit cost ratios* worked out for each of years from 1953-54 to 1976-77 present certain interesting findings. This period can be classified into four distinct time phases, namely, 1953-54 to 1958-59; 1959-60 to 1961-62; 1962-63 to 1967-68; and 1968-69 to 1976-77. As one would recall, the period 1953-54 to 1958-59 was the 'control' phase of the programme when the programme administrators and staff worked relentlessly to curb the disease, the programme having been gradually expanded all over the country. As a consequence, while there were increasing programme expenditures, the benefits increased at a faster rate resulting in gradually increasing benefit-cost ratios, year-after-year. Enthused by the results obtained during this phase, the programme was upgraded to one of eradication with increased monetary allocations. However, the phase 1959-60 to 1961-62 recorded declining benefits-cost ratios. In other words, the increase in funds was higher than the benefits. This could possibly be because of the fact that the maximum possible results were already attained by 1958-59 and the additional investments did not do anything more than maintainance of general statusquo (or was it that general inefficiency and complacency set in by that time itself?). During the third phase (1962-63 to 1967-68), however, there was general decline in programme expenditures from Rs.712.41 millions in 1961-62 to Rs.298.43 millions in 1967-68. Though there were some increases in malaria morbidity during this period, this decline in funds tended to record increasing values of benefit-cost ratios. In other words,

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* These ratios are based on cumulative totals because the performance during a given year is not independent of the performance during the preceeding years.

the increasing trend in benefit-cost ratios during the period 1962-63 to 1967-68 was not real and was more an art-effect. Similar picture emerges during the phase 1968-69 to 1976-77. It can, therefore, be said that the maximum possible results of NMCP/NMEP were achieved as long back as 1958-59. The subsequent efforts though have been able to bring about positive benefits, do not appear to have been commensurate with the programme expenditures.

Table 9: Benefit-cost Ratios of NMCP/NMEP 1953-54 to 1976-77

Year	Total disease costs at constant prices (millions rupees)		Monetary benefits due to NMCP/NMEP (million Rs.)	Cumulative totals of benefits (million rupees)	Cumulative programme costs (million Rs.)	Benefit cost ratio
	with NMCP/NMEP	without NMCP/NMEP				
1953-54	7800.59	8842.92	1042.33	1042.33	153.98	6.77
1954-55	5907.11	7573.10	1666.02	2708.35	338.08	8.01
1955-56	5262.12	7555.03	2292.91	5001.26	528.21	9.47
1956-57	5446.70	8144.97	2698.27	7699.50	762.73	10.09
1957-58	4133.87	7069.74	2935.87	10635.37	1040.80	10.22
1958-59	3817.95	7084.79	3266.84	13302.21	1442.09	9.64
1959-60	2834.74	6812.79	3978.05	17880.26	2002.51	8.93
1960-61	1147.30	6148.02	5000.72	22880.98	2646.25	8.65
1961-62	446.71	5891.25	5444.54	28325.52	3358.66	8.43
1962-63	18.29	5603.53	5585.24	33910.76	4013.37	8.45
1963-64	22.06	5414.79	5392.73	39303.49	4575.64	8.48
1964-65	21.99	4789.13	4767.14	44070.63	5070.81	8.69
1965-66	16.66	4109.21	4092.55	48163.18	5507.18	8.75
1966-67	16.70	4052.41	4035.71	52198.89	5856.70	8.91
1967-68	29.82	4049.17	4019.35	56218.24	5155.00	9.13
1968-69	39.92	4052.41	4012.49	60230.73	6556.31	9.13
1969-70	50.37	4107.85	4057.48	64288.21	6951.30	9.25
1970-71	99.71	4083.01	3983.30	68271.51	7349.51	9.29
1971-72	178.84	4083.73	3904.89	72176.40	7792.11	9.26
1972-73	178.98	4083.37	3904.38	76080.78	8218.08	9.26
1973-74	195.28	4096.33	3901.05	79981.83	8566.78	9.33
1974-75	277.74	4052.05	3774.31	83756.14	8847.09	9.46
1975-76	470.60	4044.85	3574.25	87330.39	9274.06	9.42
1976-77	591.18	4025.29	3434.11	90764.50	9789.32	9.27
Total	39005.24	129769.74	90764.50		9789.32	9.27

In other words, the diseconomics had set in during 1959-60 and the highest benefit-cost ratio of Rs.10.22 of 1957-58 could have been made possible to maintain with less investments but with more efficient use of the resources.

On the other hand, the examination of absolute net benefits (at constant prices) show that it gradually increased from Rs.1042.33 millions during 1953-54 to Rs.5585.24 millions during 1962-63 and thereafter presented a gradual declining trend until 1976-77. This pattern generally compares with that of programme expenditures except in the later years, when the programme expenditures fluctuated. Further analysis indicated that benefits accrued during a year bear strong positive correlation with programme expenditures (r = 0.8686*). About 75 per cent of variation in benefits can be explained only by the variations in programme expenditure (R^2 = 0.7544). Further the linear regression of monetary benefits on programmes expenditures show that, during the period of analysis, an increase of one million rupees in programme expenditure brought about an increase of about Rs.6.5568 millions in benefits (a = 1086.6; b = 6.5568*). This has certain important implications for control or eradication of malaria in future, when examined in the context of the epidemiology of the disease, particularly the role of exogenous factors in vector control. If the vector and hence the disease are to be controlled it requires continuous investment of large monetary resources in the form of NMCP/NMEP activities for years to come. It does not

* highly significant

however, mean that the disease cannot eradicated, as it happened elsewhere. Nevertheless, it raises an important question "how long can we afford to sustain such a large programme with the existing technology and strategies?"

Table 10: Costs and benefits by components

Components	Costs (1978-79=100) (Rs. millions)		Net monetary benefits (Rs.millions)
	with NMCP/ NMEP	without NMCP/NMEP	
Morbidity			
1. Treatment	15,203.35	77,231.76	62,028.41 (68.30)
2. Transportation	405.33	2,658.44	2,253.11 (2.48)
3. Special foods	1,662.01	7,042.80	5,380.79 (5.93)
4. Productivity losses	3,051.82	11,297.16	8,245.34 (9.08)
Mortality			
5. Future earnings lost	18,635.29	31,539.52	12,904.23 (14.21)
Total	39,005.24	129,769.74	90,764.50 (100)

Figures in brackets are percentages.

If we examine the net benefits by different components (Table 10), about 68.3 percent of the total benefits is ascribable to reduction in treatment costs because of the reduction in the number of cases of malaria. The remaining components together have contributed 32.7 percent of the total benefits. This clearly points out that the benefits of the programme can be maximised by minimising the treatment costs through NMCP/ NMEP. In other words, the emphasis of the programme has to be on the reduction of case load in the country for which a number of alternative strategies are available, under the existing technology. Their evaluation based on cost-effectiveness criteria may facilitate choice from amongst the feasible alternatives.

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Appendix 1

Population distribution under different phases of NMEP - 1962-63 to 1976-77, year-wise

Year	Population (millions) under			Total Population (millions)
	Attack phase	Consolidation phase	Maintainance phase	
1962-63	249	157	-	406
1963-64	166	260	-	426
1964-65	120	288	47	455
1965-66	93	203	170	466
1966-67	66	169	241	476
1967-68	83	147	259	489
1968-69	141	112	249	502
1969-70	136	114	264	514
1970-71	136	120	271	527
1971-72	138	93	312	535
1972-73	132	98	322	547
1973-74	135	93	322	559
1974-75	141	92	335	568
1975-76	141	92	335	568
1976-77	575	-	-	575

Source: NMEP (1976)

Appendix 2

Rate of increase of health institutions in India - 1951 to 1977

Year	No. of hospitals, dispensaries and PHCs	Per cent increase over 1951	Reporting rates of malaria (%)
1951	8,600	-	10
1956	10,067	117.1	11.71
1961	14,498	168.6	16.86
1966	19,231	223.6	22.36
1974	20,554	239.0	23.90
1977	20,610	240.0	24.00

Source: National Institute of Health and Family Welfare (1977), Health Sector of India - an overview

Appendix 3

Estimates of Malaria-specific deaths in India based on reported deaths due to Malaria, year-wise, from 1953-54 to 1965-66

Year	Crude Death Rate (a)		Percent enume-rated	Reported No.of deaths due to Malaria (b)	Estimated no- of deaths due to malaria (millions)
	Census*	Civil Registration			
1	2	3	4	5	6
1953-54	23.5	13.0	55.32	453,796	0.8203
1954-55	23.0	12.5	54.35	379,450	0.6982
1955-56	22.4	11.7	52.23	207,691	0.3976
1956-57	22.0	10.6	48.18	339,267	0.7042
1957-58	21.6	11.5	53.24	60,172	0.1131
1958-59	21.2	11.9	56.13	127,831	0.2277
1959-60	21.0	9.9	47.14	326,574	0.6928
1960-61	20.6	9.7	47.09	218,970	0.4650
1961-62	20.4	10.1	49.51	120,553	0.2435
1962-63	20.0	9.7	48.50	117,906	0.2431
1963-64	19.7	9.6	48.73	135,698	0.2785
1964-65	19.5	17.0	87.18	115,228	0.1322
1965-66	19.2	17.2	89.58	67,707	0.0756

Sources: (a) Chandrasekhar, S. (1972)

(b) Central Bureau of Health Intelligence

* Estimated

Appendix 4

Age-wise distribution of average wages lost per day - Males

Year	15-19	20-24	25-29	30-39	40-49	50-59	60+
1953-54	1.44	1.62	1.77	1.95	2.14	2.11	1.83
1954-55	1.29	1.45	1.59	1.75	1.92	1.90	1.64
1955-56	1.32	1.48	1.62	1.79	1.96	1.90	1.64
1956-57	1.46	1.65	1.80	1.99	2.18	2.15	1.80
1957-58	1.44	1.62	1.78	1.96	2.15	2.12	1.86
1958-59	1.56	1.76	1.93	2.12	2.33	2.29	1.99
1959-60	1.57	1.77	1.94	2.14	2.34	2.31	2.00
1960-61	1.58	1.78	1.95	2.14	2.35	2.31	2.01
1961-62	1.63	1.83	2.01	2.21	2.42	2.39	2.07
1962-63	1.69	1.89	2.08	2.28	2.50	2.47	2.14
1963-64	1.89	2.13	2.33	2.56	2.81	2.77	2.40
1964-65	2.17	2.44	2.68	2.95	3.23	3.19	2.76
1965-66	2.19	2.47	2.70	2.97	3.26	3.22	2.79
1966-67	2.94	2.81	3.08	3.38	3.71	3.71	3.17
1967-68	2.87	3.22	3.54	3.90	4.27	4.21	3.65
1968-69	2.85	3.21	3.52	3.87	4.24	4.19	3.63
1969-70	3.08	3.47	3.80	4.18	4.58	4.52	3.92
1970-71	3.29	3.70	4.05	4.46	4.89	4.82	4.04
1971-72	3.42	3.85	4.22	4.64	5.04	5.09	4.35
1972-73	3.69	4.15	4.54	5.00	5.48	5.41	4.69
1973-74	4.52	5.08	5.57	6.12	6.72	6.62	5.75
1974-75	5.20	5.85	6.41	7.05	7.73	7.62	6.61
1975-76	5.20	5.85	6.41	7.05	7.73	7.62	6.61
1976-77	5.42	6.06	6.69	7.36	8.06	7.96	6.90

Appendix 5

Age-wise distribution of average wages lost per day - Females

Year	15-19	20-24	25-29	30-39	40-49	50-59	60+
1953-54	0.72	0.81	0.88	0.97	1.07	10.5	0.91
1954-55	0.65	0.73	0.80	0.88	0.96	0.95	0.82
1955-56	0.66	0.74	0.81	0.89	0.98	0.95	0.82
1956-57	0.73	0.82	0.90	0.99	0.99	1.18	0.93
1957-58	0.72	0.81	0.86	0.98	1.07	1.06	0.92
1958-59	0.78	0.88	0.97	10.6	10.60	11.5	1.00
1959-60	1.00	0.89	0.97	1.07	1.17	1.15	1.00
1960-61	0.79	0.88	0.98	1.07	1.17	1.04	1.00
1961-62	0.81	0.92	1.01	1.10	1.21	1.19	1.03
1962-63	0.82	0.95	1.02	1.14	1.25	1.23	1.07
1963-64	0.66	1.06	1.17	1.10	1.40	1.39	1.20
1964-65	0.74	1.22	1.34	1.47	1.61	1.47	1.38
1965-66	0.75	1.23	1.36	1.45	1.63	1.48	1.39
1966-67	0.85	1.40	1.54	1.69	1.85	1.69	1.59
1967-68	1.01	1.61	1.77	1.94	2.12	1.93	1.82
1968-69	1.01	1.61	1.77	1.94	2.12	1.93	1.82
1969-70	1.05	1.73	1.91	2.09	2.29	2.08	1.96
1970-71	1.12	1.85	2.04	2.23	2.44	2.22	2.09
1971-72	1.17	1.87	2.12	2.32	2.54	2.31	2.18
1972-73	1.26	2.07	2.28	2.50	2.74	2.49	2.34
1973-74	1.54	2.54	2.80	3.06	3.36	3.05	2.87
1974-75	1.78	2.93	3.22	3.53	3.86	3.51	3.31
1975-76	1.78	2.93	3.22	3.53	3.86	3.51	3.31
1976-77	1.85	3.05	3.36	3.68	4.03	3.67	3.45

Appendix 6

Per-capita Income and Per-capita Consumption Expenditure - All India, 1953-54 to 1976-77

Yeat	Percapita Income[1]		Percapita comsumptic Expenditure[2]	
	at current prices (Rs)	correction factor	at current prices (Rs)	correction factor
1953-54	278.1	0.5016	184	0.4588
1954-55	250.3	0.4515	196	0.4888
1955-56	255.0	0.4600	211	0.5262
1956-57	283.4	0.5112	206	0.5137
1957-58	279.6	0.5043	223	0.5561
1958-59	303.0	0.5465	242	0.6034
1959-60	304.7	0.5496	243	0.6035
1960-61	305.6	0.5512	257	0.6409
1961-62	315.0	0.5682	261	0.6509
1962-63	325.9	0.5878	264	0.6583
1963-64	365.9	0.6600	268	0.6683
1964-65	422.0	0.7612	317	0.7905
1965-66	425.5	-	314	-
1966-67	481.8	-	317	-
1967-68	554.4	-	401	-
1968-69	552.3	-	-	-
1969-70	597.5	-	-	-
1970-71	636.1	-	-	-
1971-72	663.0	-	-	-
1972-73	713.6	-	-	-
1973-74	873.7	-	-	-
1974-75	1007.0	-	-	-
1975-76	1000.3	-	-	-
1976-77	1049.0	-	-	-

Source: 1. For years 1953-54 to 1960-61, estimates of National product 1948-49 to 1960-61; For years 1961-62 to 1976-77 Economic Survey, 1977-78 and National Accounts Statistics Jan. 1978.

2. National Sample Survey

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Appendix 7

1964-65

EARNINGS CORRECTION FACTOR(FEMALE) = 0.761200
CONSUMPTION CORRECTION FACTOR(FEMALES) = 0.7?0580

AGE ON LAST BIRTHDAY	EARNINGS (RUPEES)	EMPLOYMENT RATE	CONSUMP (RUPEES)	EXCESS OF INCOME OVER CONSUMPTION	PROBABILITY OF SURVIVAL	PRESENT VALUE OF FUTURE EARNINGS
69	856.4	0.330	259.3	23.3	0.93030	19.7
68	898.2	0.370	275.1	57.2	0.93205	63.8
67	943.9	0.425	291.7	109.5	0.93437	140.7
66	989.6	0.480	309.1	165.9	0.93728	246.9
65	1020.0	0.530	320.9	219.7	0.94079	375.2
64	1046.7	0.575	331.2	270.6	0.94432	519.4
63	1065.7	0.620	338.3	322.4	0.94748	676.2
62	1084.7	0.670	345.4	381.3	0.95062	845.3
61	1096.1	0.720	349.4	439.8	0.95374	1023.2
60	1115.2	0.775	356.5	507.7	0.95684	1210.5
59	1126.6	0.810	361.3	551.3	0.96059	1396.1
58	1134.2	0.855	363.6	606.1	0.96437	1582.3
57	1149.5	0.895	370.0	658.8	0.96720	1766.9
56	1160.8	0.920	373.9	694.1	0.96908	1944.0
55	1164.6	0.93[illegible]	375.5	713.4	0.9706[illegible]	2109.7
54	1176.1	0.950	379.4	737.8	0.97103	2265.6
53	1179.9	0.955	381.0	745.7	0.97270	2409.1
52	1187.5	0.960	384.2	755.8	0.97422	2541.5
51	1191.3	0.962	385.9	760.2	0.97560	2662.8
50	1193.6	0.965	386.6	765.2	0.97682	2773.9
49	1195.1	0.968	386.6	770.3	0.97820	2875.7
48	1198.9	0.970	388.1	774.8	0.97968	2969.0
47	1198.9	0.972	388.1	777.2	0.98093	3054.1
46	1195.1	0.975	386.6	778.7	0.98196	3131.7
45	1191.3	0.978	385.8	779.3	0.98276	3202.4
44	1187.5	0.980	384.2	779.5	0.98373	3266.8
43	1179.9	0.980	381.0	775.2	0.98485	3325.0
42	1168.4	0.982	377.1	770.3	0.98572	3377.7
41	1160.8	0.980	373.9	763.7	0.98635	3425.1
40	1149.4	0.980	370.0	756.5	.98673	3467.9
39	1138.0	0.980	365.2	750.0	0.98705	3506.5
38	1122.6	0.980	359.7	740.6	0.98755	3541.1
37	1115.2	0.980	356.5	736.3	0.98812	3572.5
36	1096.1	0.978	349.4	722.6	0.98874	3600.4
35	1084.7	0.976	345.4	713.2	0.98949	3625.5
34	1069.5	0.975	339.1	703.6	0.99017	3648.1
33	1058.1	0.974	335.2	695.4	0.99080	3668.7
32	1046.7	0.972	331.2	686.1	0.99149	3686.5
31	1039.0	0.970	328.1	679.8	0.99225	3702.9
30	1023.8	0.970	322.5	670.6	0.99270	3717.6
29	1012.4	0.968	317.8	662.2	0.99311	3730.8
28	997.2	0.965	312.2	650.0	0.99364	3742.6
27	978.[illegible]	0.960	305.1	633.9	0.99414	3753.1
26	966.7	0.955	300.4	622.8	0.99462	3762.4
25	947.7	0.950	293.3	607.0	0.99507	3770.7
24	932.5	0.940	287.7	588.8	0.99566	3778.8
23	913.4	0.930	280.6	568.9	0.99627	3784.5
22	894.4	0.920	273.5	549.3	0.99667	3790.1
21	876.9	0.910	266.4	531.6	0.99674	3795.1
20	856.4	0.880	259.3	494.3	0.99686	3799.3
19	829.7	0.865	249.6	452.1	0.99688	3802.8
18	814.5	0.790	243.5	400.0	0.99703	3805.6
17	784.0	0.735	231.6	344.6	0.99715	3807.8
16	753.6	0.665	220.5	280.6	0.99722	3809.4
15	0.0	0.000	220.5	-220.5	0.99724	3808.2
14	0.0	0.000	220.5	-220.5	0.99739	3807.2
13	0.0	0.000	220.5	-270.5	0.99756	3806.2
12	0.0	0.000	220.5	-220.5	0.99755	3805.3
11	0.0	0.000	220.5	-220.5	0.99736	3804.5
10	0.3	0.000	20.5	-229.5	0.99698	3803.8
9	0.0	0.000	20.5	-220.5	0.99672	3803.2
	0.0	0.000	220.5	-220.5	0.99659	3802.6

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AGE ON LAST BIRTHDAY	EARNINGS (RUPEES)	EMPLOYMENT RATE	CONSUMP (RUPEES)	EXCESS OF INCOME OVER CONSUMPTION	PROBABILITY OF SURVIVAL	PRESENT VALUE OF FUTURE EARNINGS
7	0.0	0.000	220.5	-220.5	0.99627	3802.8
6	0.0	0.000	220.5	-220.5	0.99577	3801.5
5	0.0	0.000	220.6	-220.5	0.99509	3801.1
4	0.0	0.000	220.5	-220.5	0.99422	3800.7
3	0.0	0.000	220.5	-220.5	0.99315	3800.3
2	0.0	0.000	220.6	-220.5	0.98744	3800.0
1	0.0	0.000	220.5	-220.5	0.95944	3799.7
0	0.0	0.000	220.6	-220.5	0.86500	3799.4

RNINGS CORRECTION FACTOR(FeMALES) = 0.761200
NSUMPTION CORRECTION FACTOR(FeMALES) = 0.790500

1964-65 Appendix E

ON LAST THDAY	EARNINGS (RUPEES)	EMPLOYMENT RATE	CONSUMP (RUPEES)	EXCESS OF INCOME OVER CONSUMPTION	PROBABILITY OF SURVIVAL	HOUSEHOLD SERVICE EARNINGS	PRESENT VALUE FUTURE EARNIN
69	428.5	0.130	259.3	-203.6	0.93381	0.	-172.8
68	449.1	0.150	275.1	-116.4	0.93663	91.	-262.9
67	471.9	0.170	291.7	-89.7	0.93940	122.	-326.2
66	494.8	0.190	309.1	-81.9	0.94223	133.	-378.9
65	510.0	0.210	320.2	-45.6	0.94512	167.	-435.6
64	523.7	0.230	331.2	17.6	0.94815	228.	-396.2
63	532.8	0.250	338.3	30.8	0.95132	236.	-381.2
62	542.7	0.270	345.4	48.5	0.95450	247.	-359.6
61	548.1	0.290	349.4	98.8	0.95758	289.	-319.5
60	558.0	0.310	356.5	136.2	0.96044	320.	-269.0
59	563.3	0.330	361.3	212.8	0.96312	388.	-197.2
58	567.1	0.350	363.6	276.3	0.96570	441.	-112.2
57	574.7	0.370	370.0	329.9	0.96812	487.	-19.7
56	580.8	0.390	373.9	377.8	0.97030	525.	76.9
55	582.3	0.410	375.5	434.2	0.97218	571.	177.9
54	588.4	0.420	379.4	476.7	0.97368	609.	278.9
53	589.9	0.430	381.0	527.3	0.97485	655.	380.6
52	593.7	0.440	384.2	581.2	0.97580	704.	482.6
51	596.0	0.450	385.8	628.4	0.97663	746.	583.0
50	596.8	0.460	386.6	656.8	0.97745	769.	678.4
49	597.5	0.470	386.6	689.7	0.97825	795.	769.6
48	599.9	0.480	388.1	714.3	0.97894	814.	855.5
47	599.8	0.485	388.1	736.3	0.97957	834.	936.0
46	597.5	0.491	386.6	763.2	0.98071	850.	1012.0
45	596.0	0.500	385.8	783.8	0.98079	872.	1083.0
44	593.7	0.505	384.2	798.6	0.98123	883.	1148.7
43	589.9	0.505	381.0	807.5	0.98161	891.	1203.2
42	584.6	0.501	377.1	810.2	0.98218	894.	1264.4
41	580.8	0.495	373.9	804.2	0.98295	891.	1314.2
40	574.7	0.490	370.0	794.6	0.98390	883.	1359.0
39	569.4	0.485	365.2	782.5	0.98479	872.	1399.2
38	561.8	0.480	359.7	766.3	0.98555	856.	1434.9
37	558.0	0.475	349.4	749.1	0.98642	834.	1466.7
36	548.1	0.470	345.4	726.6	0.98738	814.	1494.8
35	542.7	0.465	339.1	708.7	0.98845	795.	1519.8
34	535.1	0.458	335.2	678.7	0.98977	769.	1541.5
33	529.0	0.455	331.2	655.5	0.99102	746.	1560.6
32	523.7	0.450	328.1	611.7	0.99190	704.	1576.4
31	519.9	0.450	322.5	566.1	0.99241	655.	1590.8
30	512.3	0.448	317.8	520.7	0.99253	609.	1601.9
29	506.2	0.447	312.2	484.9	0.99267	571.	1611.5
28	498.6	0.445	305.1	442.0	0.99306	525.	1619.6
27	489.5	0.443	300.4	403.6	0.99343	487.	1626.2
26	483.4	0.440	293.3	360.9	0.99379	441.	1631.6
25	483.4	0.440	287.7	313.1	0.99412	388.	1635.9
24	466.6	0.440	280.6	244.4	0.99451	320.	1638.9
23	456.7	0.438	273.5	215.8	0.99491	289.	1641.4
22	447.6	0.432	266.4	174.3	0.99523	247.	1643.2
21	438.5	0.430	259.3	165.2	0.99548	236.	1644.7
20	428.6	0.425	249.0	161.5	0.99565	228.	1646.1
19	414.9	0.420	243.5	98.2	0.99588	167.	1645.8
18	407.2	0.418	231.6	71.8	0.99616	133.	1647.3
17	392.0	0.413	220.5	63.1	0.99636	122.	1647.7
16	376.8	0.410	220.5	-66.1	0.99647	0.	1647.3
15	0.0	0.000	220.5	-220.5	0.99650	0.	1646.2
14	0.0	0.000	220.5	-220.5	0.99660	0.	1645.1
13	0.0	0.000	220.5	-220.5	0.99676	0.	1644.2
12	0.0	0.000	220.5	-220.5	0.99660	0.	1643.3
11	0.0	0.000	220.5	-220.5	0.99673	0.	1642.5
10	0.0	0.000	220.5	-220.5	0.99656	0.	1641.8
9	0.0	0.000	220.5	-220.5	0.99597	0.	1641.1
8	0.0	0.000	220.5	-220.5	0.99537	0.	1640.5
7	0.0	0.000	220.5	-220.5	0.99485	0.	1640.0
6	0.0	0.000	220.5	-220.5	0.99423	0.	1639.5
5	0.0	0.000	220.5	-220.5	0.99338	0.	1639.0
4	0.0	0.000	220.5	-220.5	0.99230	0.	1638.6
3	0.0	0.000	220.5	-220.5	0.99100	0.	1638.3
2	0.0	0.000	270.5	-220.5	0.98281	0.	1637.9
1	0.0	0.000	220.5	-220.5	0.95174	0.	1637.6
0	0.0	0.000	220.5	-220.5	0.87000	0.	1637.4

Appendix 9

Premature mortality losses resulting from malaria deaths 'with' and 'without' NMCP/NMEP – by year, age and sex

Year	Age, sex groups		Imputed cost per death* (Rs)	with NMCP/NMEP		without NMCP/NMEP	
				No.of deaths (millions)	Total cost (million Rs.current prices)	No.of deaths (millions)	Total cost)Rs.million current prices)
1	2		3	4	5	6	7
1953-54	0 – 15	M	2755	0.1480	407.7400	0.1849	509.3995
		F	1330	0.1480	196.8400	0.1849	245.9170
	16+	M	2004	0.0986	197.5944	0.1233	247.0932
		F	787	0.0986	77.5982	0.1233	97.0371
1954-55	0 – 15	M	2176	0.1370	298.112	0.1755	381.8880
		F	893	0.1370	122.341	0.1755	156.7215
	16+	M	1560	0.0913	142.4280	0.1170	182.5200
		F	464	0.0913	42.3632	0.1170	54.2880
1955-56	0 – 15	M	2104	0.1251	263.2104	0.1680	353.4720
		F	797	0.1251	99.7047	0.1680	133.8960
	16+	M	1499	0.0834	125.0166	0.1120	167.8880
		F	384	0.0834	32.0256	0.1120	43.0080
1956-57	0 – 15	M	2623	0.1162	304.79	0.1590	417.0570
		F	1170	0.1162	135.95	0.1590	186.0300
	16+	M	2295	0.0968	222.16	0.1060	243.2700
		F	691	0.0968	66.89	0.1060	73.2500
1957-58	0 – 15	M	2390	0.1096	261.9440	0.1500	358.5000
		F	957	0.1096	104.8872	0.1500	143.5500
	16+	M	1710	0.0731	125.0010	0.1000	171.0000
		F	486	0.0731	35.5266	0.1000	48.6000
1958-59	0 – 15	M	2586	0.1040	268.9440	0.1410	364.6260
		F	1034	0.1040	107.5360	0.1410	145.7940
	16+	M	1850	0.0694	128.3900	0.0940	173.9000
		F	524	0.0694	36.3656	0.0940	49.2560

* obtained from computations of present values of the future earnings.

Appendix 9 contd.

1	2		3	4	5	6	7
1959-60	0 - 15	M	2615	0.0768	200.8320	0.1320	345.1800
		F	1053	0.0768	80.8704	0.1320	138.9960
	16+	M	1872	0.0512	95.8464	0.0880	164.7360
		F	538	0.0512	27.5456	0.0880	47.3440
1960-61	0 - 15	M	2478	0.0229	56.7462	0.1170	289.9260
		F	913	0.0229	20.9077	0.1170	106.8210
	16+	M	1763	0.0153	26.9739	0.0780	137.5140
		F	425	0.0153	6.5025	0.0780	33.1500
1961-62	0 - 15	M	2595	0.0123	31.9185	0.0990	256.9050
		F	980	0.0123	12.0540	0.0990	97.0200
	16+	M	1849	0.0082	15.1618	0.0660	122.0340
		F	469	0.0082	3.8458	0.0660	30.9540
1962-63	0 - 15	M	2744	-	-	0.0780	214.0320
		F	1074	-	-	0.0780	83.7720
	16+	M	1961	-	-	0.0520	101.9720
		F	534	-	-	0.0520	27.7680
1963-64	0 - 15	M	3365	-	-	0.0540	181.7100
		F	1491	-	-	0.0540	80.5140
	16+	M	2429	-	-	0.0360	87.4440
		F	828	-	-	0.0360	29.8080
1964-65	0 - 15	M	3803	-	-	0.0270	102.6810
		F	1640	-	-	0.0270	44.2800
	16+	M	2739	-	-	0.0180	49.3020
		F	922	-	-	0.0180	16.6000