Chapter 6 – The Economic Impact of Malaria[a]

6.1 Introduction

This chapter summarizes the available evidence on the economic impact of malaria in SSA, and specifically considers evidence on:

- the economic costs of malaria in terms of labour efficiency and land use
- the effect of malaria on school attendance, performance and cognitive impairment
- the economic costs of malaria in terms of expenditures by households and the public health sector.

While it would have been desirable to include literature on the economic benefits of malaria control and cost-benefit analyses, only one study was identified, for Sudan(1), contained in a government document and of doubtful quality[b].

The literature regards the two key determinants of the economic costs of malaria as the direct costs of prevention and treatment and the indirect costs of productive factor time lost due to malaria. The latter draws on the human capital approach, which has been widely used to assess the productivity losses from illness or injury as measured by income forgone due to morbidity, disability and mortality. In developed societies, labour force participation rates and earnings of affected individuals are used to calculate the value of productivity losses due to morbidity and premature mortality. In developing societies with more informal employment arrangements, various proxies for the labour force and earnings have been used.

A central problem in assessing the impact of malaria, worth highlighting in advance, is the identification of a suitable indicator for the presence of disease. On the one hand, studies of indirect costs have tended to use parasitaemia, although this may bear an unclear relationship to clinical disease. On the other hand, studies of direct costs of treatment usually assess expenditure on fever as a proxy for malaria. This creates a major difficulty in interpreting and extrapolating from the existing literature.

6.2 Review of studies

6.2.1 Effect of malaria on labour productivity

Most studies on the economic impact of malaria in SSA have focused on the informal traditional sector and only a few have considered the formal industrial, agricultural and service sectors of the economy(2). Two analytical approaches have been used to assess the effects of malaria on labour productivity: the production function method, which relies on models of the Cobb-Douglas type, and the wage rate method, which relies on the relationship between the wage and the value of labour.

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[a] This chapter is based on the research done and the report written by Reginald Ikechukwu Chima, Lecturer, Department of Economics, University of Nigeria, when he was a WHO/TDR Post-doctoral Fellow and Visiting Scientist at the London School of Hygiene and Tropical Medicine.

[b] It gave a benefit-cost ratio of 4.6.

Production function method
A couple of studies have applied this method with specifications of models of the Cobb-Douglas production function. The main study of this type is by Audibert (1986)[3], who estimated the relationship between health status and agricultural non-wage peasant production using a generalized production function and data from rice farmers in Cameroon. The area was said to be meso-endemic for malaria. The key variables were output of rice (kg/acre); number of seasons of experience in specific crop farming; family size; the size of the working population as measured by the total number of persons who effectively work in the farms (this may include children) and by the number of adults working in the farms; prevalence of malaria and schistosomiasis among adults and family members; duration of transplanting for rice farmers; surface area of cultivated land; fertility of cultivated soil; millet output; and number of millet fields. A seasonal dummy variable was incorporated to explain the various effects of changes in climatic conditions on rice growing and output. Capital inputs such as mechanical ploughing, seedlings, water and fertilisers were not included as determinants of individual production because the rice farmers studied received equal amounts of these capital inputs.

Audibert found that malaria prevalence was not a significant explanation of rice output, whereas schistosomiasis prevalence did significantly affect output. However, this conclusion should be regarded with caution: the study appears to base prevalence of malaria on levels of parasitaemia, though how these data were obtained was not explained and they seem to apply to the dry season (when prevalence would have been lower than during the rainy season when crops are cultivated). The level of parasitaemia is anyway likely to be a poor proxy of the physiological effects of malaria, since immune adults may have parasites but experience no clinical symptoms.

Wage rate method
Most studies of the economic impact of malaria have based their estimates on the amount of time lost by the sick person (or the carer in the case of child illness) multiplied by some value of a day of work. Key variables are thus the amount of time lost and the assumed value of that time. Table 6.1 summarizes these variables for the studies located by the review. Table 6.2 lists studies that measured time lost but did not attempt valuation.

Sauerborn *et al.* (1995)[4] provided a detailed specification of the wage rate method of assessing the time costs of illness. The time cost was defined as the sum of the opportunity cost of wages forgone by the sick individual due to illness, and the opportunity costs of healthy household members' time spent on treating or attending to the sick person or accompanying them for treatment. Sauerborn *et al.* equated the opportunity cost of time with the marginal cost of labour, approximated by the price of hired labour.

As Table 6.1 indicates, other authors have made similarly approximate estimates of the value of time. Most studies have used some estimate of the average wage, adjusted or unadjusted, with the implicit assumption that wages reflected marginal product[5]. One study used the market value of the average output per person of the main produce in each of two seasons[6].

All studies assumed that the value of a day of work lost could be treated as the gain that would result if malaria were reduced or eliminated. There are two key problems with this assumption. First, the potential for substitution of labour crucially affects whether or not the loss of time is translated into a loss of output. At times of the year when there is underemployment or unemployment, substitution may be feasible without any consequent loss of output. Only one study was located that examined this issue in Africa (Nur 1993[7]; Nur and Mahran 1988[8]). The latter paper showed that in the Gezira in the Sudan, 62% of the loss of work hours due to malaria and schistosomiasis was compensated for by family members. In the case of malaria, labour hours lost to agriculture were completely compensated for, though primarily by women and children whose household activities and schooling suffered as a result.

Secondly, estimates of loss based on the average product or wage may also be an overestimate of the actual gains because the increase in labour supply would not be accompanied by changes in other factors of production.

Conversely, however, there are good grounds for believing that these estimates (including any derived from a production function approach) underestimate the impact of malaria. In particular, malaria (and poor health status more generally) may have a pervasive effect on the economic incentives, behaviour and strategies of households[9, 10]. Thus the long run effect of improved health status may be quite different from the effect predicted from observing the current impact of ill health. Recent work that uses economic growth models to assess the effect of malaria prevalence on depressing economic growth rates suggests that this is likely to be the case[11] (see section 6.3).

The productivity consequences of mortality – as opposed to morbidity – have received relatively little attention, probably because in areas of stable transmission, adult mortality from malaria is very rare. Shepard *et al.* (1991)[12] included in their calculations the present value of future earnings lost due to mortality. In two of the four country case studies it was possible to assess the relative importance of morbidity as opposed to mortality as a cause of loss of work time. The value of loss of time due to mortality accounted for 74% of total indirect costs in Rwanda[13], and 88% in a district in Burkina Faso[6]. Adult deaths in Rwanda amounted to around 50% of all deaths attributed to malaria, whereas adult deaths attributed to malaria in Burkina Faso were very unusual. It is therefore surprising that mortality contributed more to indirect costs in the latter. However, these studies do indicate that more attention should be paid to the mortality consequences of malaria in areas where adults are at risk.

Malaria may also affect productivity through its effect on:
- work capacity (since repeated malaria attacks may cause debility)
- decisions on land use (in terms both of extent of land cultivated and choice of crops[c])
- labour quality (since malaria can affect the cognitive development and school performance of children).

Evidence on these is examined in the following sections.

6.2.2 Impact of malaria on physical work capacity

For some diseases such as schistosomiasis, research has explored their impact on physical capacity to work, but similar literature on malaria is scanty. Brohult *et al.* 1981[15] looked at the impact of malaria on the working capacity of Liberian males living in areas with different

[c] As found by Conly (1975)[14] in Paraguay.

malario-metric indices. They found no major differences between farmers living in holo-endemic areas and mining company workers living in meso-endemic areas. A further study by Pehrson *et al.* 1984[16] found no difference in the work capacity of industrial workers who received malaria prophylaxis and those who did not.

6.2.3 Impact of malaria on land use

Malaria also affects productivity through its impact on agricultural land use, but the literature on this relationship is virtually non-existent. Wang'ombe and Mwabu (1993)[17] examined the extent to which malaria affected agricultural land use patterns in several districts in Kenya. The study related the total cultivated acreage of cassava to total family size and the total number of malaria cases in households over a period of three months. They concluded that malaria had no statistically significant effect on cassava production nor the acreage cultivated. They suggested that this may be explained by coping strategies of households including household labour hiring practices aimed at cushioning the effects of malaria on income; and increased efforts made by other household members at the time of the illness. As in the case of Audibert (1986)[3], the study suffers from using prevalence of parasites as indicative of the level of illness due to malaria. Moreover, it is possible that malaria has long term effects on economic strategies relating to land exploitation at the community level; these are unlikely to be identifiable through a study of households living within a similar disease and economic environment.

6.2.4 Impact of malaria on children's school attendance, performance and cognitive skills

A number of studies have associated malaria with anaemia, epileptic convulsions and growth faltering during the first three years of life[18, 19]. Shiff *et al.* (1996)[18] found that children unprotected by impregnated bednets grew less in a 5-month period and were twice as likely to be anaemic as protected children, although presumptive treatment was available to both groups. There is good evidence on the association between iron deficiency anaemia (IDA) and poor performance in infant development scales, IQ and learning tasks in pre-school children and educational achievement among school-age children[20-22]. Lozoff *et al.* (1991)[23] observed that IDA among infants predicted poorer performance in cognitive tests at a later developmental period. Iron supplementation has been associated with improvement in mental development scale scores in infants[24] and significant increases in school achievement scores[25]. It is not clear whether these findings for IDA apply equally to children with the type of anaemia[26] associated with malaria. Children presenting with severe anaemia associated with malaria might develop secondary loss of iron through severe loss of appetite and very poor nutrition, although there is no evidence on this. Anaemia within the first two years of life would have serious developmental consequences that might include cognitive impairment[21].

In Africa, malaria is considered the single most important cause of seizures in early childhood. In Kenya, Waruiru *et al.* (1996)[19] found that malaria accounted for 31.3% cases of seizures. Asindi *et al.* (1993)[27] and Axton and Siebert (1982)[28] have provided further evidence on the proportion of seizures attributed to malaria, ranging from 70% in Nigeria to 16% in Zimbabwe. Epileptic seizures can cause serious learning disabilities in children, resulting in poor cognitive performance and reduced school attendance[29].

Around 10% of children with cerebral malaria and 1% to 3% of adults have residual neurological sequelae[30]. Brewster *et al.* (1990)[31] followed up Gambian children with cerebral malaria, and found that 11% of survivors had neurological sequelae at discharge, of whom half made a full recovery and 26% had major residual handicaps, mainly severe cerebral palsy and blindness. They suggested that the possibility that cerebral malaria produced intellectual impairment in children who have apparently recovered could not be discounted.

Leighton and Foster (1993)[2] provided evidence on the number of school days lost due to malaria in Kenya and Nigeria, based largely on information from focus group discussions. Efforts were made to ensure that responses related to malaria rather than just "fever". In Kenya, primary school students were considered to have on average four episodes of malaria per year and to miss five school days per episode, amounting to 20 school days missed per child per year and 11% out of Kenya's 186 day school year. For secondary schoolchildren, the numbers were eight days lost per year or 4.3% of a school year. In the case of Nigeria, school days missed varied between the rural and urban primary and secondary schools within the range of 3 to 12 days per year per student or 2% to 6% of the school year. Primary school teachers in Nigeria were considered to experience three episodes of malaria per year and to miss two days per episode: 6 days of school days missed in total. A study in The Gambia of the effects of insecticide-treated mosquito nets found that whereas before the intervention there was no significant difference between control and intervention areas in school absenteeism due to fever, in the year of the intervention, absenteeism because of fever was significantly higher in the control group[32].

Variations in reasoning ability, cognitive skill, and years of schooling are considered to be important explanations for future variations in productivity and earnings of individuals[33, 34]. Thus it is very likely that the effect of malaria on children, mediated via severe anaemia, epilepsy, seizures, and school absenteeism, will affect their productivity in later life. However, there is currently no direct evidence to support this assertion, and even the effects of severe malaria and anaemia on cognitive development are only beginning to be explored.

6.2.5 Impact of malaria on household expenditure

Household expenditures on malaria consist of two main components: expenditure on malaria (and mosquito nuisance) prevention; and expenditure on treatment. With respect to malaria prevention, preventive measures such as mosquito coils, aerosol sprays, bednets and mosquito repellents are used, to very differing degrees in different areas and by different households. Figure 6.1 shows the available evidence on monthly per capita household expenditures, which ranged between $0.05 and $2.08 per person, equivalent to between $0.23 and $15 per household. Expenditures tend to be highly skewed: for example, in Malawi, only 10% of households reported any preventive expenditures in the preceding month[35].

Household expenditure on malaria-related treatment includes out-of-pocket expenditures for treatment fees, drugs, transport and the cost of subsistence at a distant health facility. Figure 6.2 shows available data on monthly per capita expenditure on malaria-related treatment, which ranged between $0.39 and $3.84 per person, equivalent to between $1.79 and $25 per household. These data derive from household surveys and thus include all sources of care accessible to households.

These data are inadequate to permit generalization beyond the original setting. It is likely that expenditure levels are affected by per capita income - for example, in Malawi, only 4% of very low income households spent money on malaria prevention as opposed to 16% of other households[(35)] - but the data are inadequate to explore this fully. Most studies have been done in urban areas, and thus are unlikely to represent expenditure in rural areas. In addition they report expenditure in a specific time period (usually a month) which cannot be extrapolated to an annual figure without good information on the seasonal distribution of malaria and cash availability.

6.2.6 Public health sector expenditures on malaria

No attempts have been made to estimate overall public expenditure on malaria prevention and treatment. Most expenditure is incurred by health facilities providing treatment, and thus malaria-related expenditures are not disaggregated from other health service costs in budgeting and accounting systems. Where governments have a budget line for malaria, this generally relates to specific preventive expenditures (e.g. purchase of insecticide) which are likely to be a very small percentage of total malaria-related expenditures. The numbers of patients seeking care for suspected malaria and estimates of the unit cost of treatment suggest that public expenditure on malaria is likely to be substantial. For example, around 20% to 40% of outpatient visits in SSA are for 'fever'[d], and suspected malaria amongst inpatients ranges in different studies from between 0.5% to 50% of admissions[(36-38)]. Very few studies are available on the unit costs of malaria treatment. The average recurrent cost per outpatient visit for suspected malaria was $0.96 in government and mission facilities in Malawi[(39)], and inpatient treatment for severe malaria cost $35 per admission in a typical Kenyan district hospital (1995 US dollars)[(40)]. Ettling *et al.* (1991)[(13)] estimated that approximately 19% of the operating budget of the Rwandan MOH was spent on malaria treatment in public facilities. Kirigia *et al.* (1998)[(40)] estimated that 15% of the annual recurrent costs of inpatient care in the Kilifi district hospital, and 9% in the adjacent Malindi sub-district hospital (both on the Kenyan coast) were absorbed by paediatric malaria admissions. A small portion of these costs may be recouped through user fees, which would be also recorded as a household expenditure, but the majority of the costs would be borne by the government.

6.2.7 Overall economic cost of malaria in Africa

Only one study, by Shepard *et al.* 1991[(12)], has attempted to put data together to estimate the overall economic cost of malaria in Africa. Based on extrapolations from four country case studies[e], the total direct and indirect cost in 1987 was estimated to be $791 million, $2.34 per capita, and 0.6% of the sub-Saharan Africa gross domestic product (GDP). These data are reported here since they have been widely quoted, but it should be noted that first, the results are based on many assumptions and approximations, and secondly the methodology for valuing indirect costs has all the problems associated with the wage-rate method.

Two further studies providing country-specific estimates also relied on the wage-rate method to estimate indirect costs. Ettling *et al.* (1994)[(35)], in a study on the economic impact of malaria on Malawian households, which relied to a greater extent than Shepard *et al.* (1991) on specially collected data, found that direct costs of treatment amounted to 28% of

[d] The proportion of these that are actually malaria will vary greatly by area and season.
[e] Burkina Faso (one district); Chad (one district); Brazzaville, Congo; Rwanda.

household income among very low income households, and 2% among the rest. Indirect costs were 3.1% and 2.2% for the same income groups, and total costs 32% and 4.2%[f].

Leighton and Foster (1993)[2] used rapid assessment methods based on focus group discussions and interviews to produce high and low estimates for days lost from morbidity[g], decreased productivity, and value of production lost by economic sector, urban and rural populations, and sex for Kenya and Nigeria. They estimated that the total annual value of malaria-related production loss was 2% to 6% of GDP in Kenya and 1% to 5% in Nigeria, and that 3% to 14% of workdays were lost in Kenya and 1% to 8% in Nigeria. 58% of losses were in the agricultural sector in Kenya and 7% in the industrial sector: in Nigeria these figures were 50% and 10%. Total household costs as a percentage of annual income for rural small farmers amounted to 8.8% to 17.6% in Kenya, and 7.2% to 13.2% in Nigeria. These figures for agribusiness labourers in Kenya were 0.8% to 5.2%, and for urban self-employed in Nigeria 11.2% to 18.7%. As with other studies, since these proportions were calculated by aggregating up from information on days lost per episode and values of days lost, there is the potential for minor errors in unit values to have a major effect on totals. Moreover, no validation was done of the focus group approach to obtaining this sort of data, so it is not possible to assess whether the estimates are of the correct order of magnitude.

The widely different methodologies, sources of data, and often heroic assumptions make it impossible to draw conclusions from these studies. Even judgements of the relative importance of direct and indirect costs varied greatly, with Ettling *et al.* (1991)[13] and Sauerborn *et al.* (1991)[6] showing that indirect costs dominated, and Leighton and Foster (1993)[2] arguing that if mortality costs were ignored as being of little relevance to households in the short term, direct costs represented a greater burden to households than indirect costs.

6.3 Overall comments on the literature

The human capital approach to assessing the economic impact of malaria has very limited value, and it does not adequately measure an individual's contribution to society. The approach largely excludes benefits experienced by those who are not part of the labour force. It values earnings and housekeeping services but not leisure time, and it may undervalue the productivity of groups whose productivity value is not fully reflected in earnings (Haddix and Shaffer, 1996[42]).

The economic setting of SSA poses considerable challenges to the human capital approach. Seasonal unemployment is prevalent and farming is often undertaken communally, in households or extended families. This means that in the event of temporary or permanent disability of any member of the household, the family workforce provides a cushion for the period of absence of the disabled member and allowances need to be made for this. Child-care is often shared among the extended family, making it difficult to discern the impact on adults of a child's illness[32]. Not all production in SSA is peasant production. Small modern sectors do exist such as mining and quarrying, manufacturing, building and construction,

[f] Costs per episode were used to make annual estimates based on average household size and average predicted episodes per year: there is thus the possibility that the annual estimates are inaccurate, especially given seasonal differences in both malaria and cash availability (Sauerborn, 1996[41]).
[g] Mortality effects were excluded.

commercial large-scale agriculture, and general commercial services. However, most studies have looked at the impact of malaria on the rural, subsistence farming sector.

The alternative to the human capital approach for valuing benefits, the willingness to pay (WTP) approach, has theoretical attractions, but its value as a practical tool is severely limited by difficulties in obtaining relevant data. So far WTP studies in the malaria field, and in the health field more broadly, have concentrated on using WTP estimates to set prices rather than to value benefits, although work is forthcoming using WTP methods to value malaria prevention in Ethiopia[(43)].

A holistic view of the productivity effects of malaria should incorporate the implications of depleted capital stock and lost savings due to indebtedness or expenditures on prevention and treatment of malaria; the labour supply responses including limiting specialization of labour and maintaining labour reserves to reduce the risk of labour shortages at key times of the year; and the pervasive influence of risk of ill health on the incentive to invest[(10)]. At very low levels of income, the approach of households to prevention and treatment costs may be to sell arable land, economic trees and livestock[(44)]. This ultimately affects supply or production through low saving and investment. Furthermore, it means that the direction of causality of the economic impact of malaria may not necessarily be through uncultivated arable land and sick labour only, but also through lost capital and purchasing power. However, what happens on the demand-side has been left out of considerations of the economic impact of malaria, except in including estimates of actual expenditure on prevention and treatment.

An important first step in determining the economic impact of disease on individuals in any environment is to delineate and characterize the type of economy in which they function as economic agents. However, in most analyses of the economics of malaria there is a gross lack of definition and characterization of the nature and structure of the economies in which malaria is prevalent. Typically, studies move rapidly from a brief description of the epidemiological background to conclusions on economic costs of malaria.

Studies have also suffered from insufficient attention given to the nature of malaria and how it might affect economic activity. The few studies that seek to study directly the impact of malaria (as opposed to estimating it from data on days lost and wage rates) all encounter the problem of the measurement of health status. This is a particular difficulty in the case of malaria since those who are regularly exposed to infection are known to develop immunity, which shortens the period of illness for adults compared with children (see Tables 6.1 and 6.2). The impact of malaria on adults in a high transmission area may be more manifest in the costs of caring for sick children, though this has still to be fully explored. Brinkmann and Brinkmann (1991)[(37)] suggest that approximately 60% of the population of SSA lives in areas of stable malaria transmission where protective immunity develops from about the age of 5; 30% live in areas of seasonal transmission where protection is gained rather later (around the age of 10); and 10% live in areas of unstable transmission where epidemics may occur with substantial consequences for adult morbidity and mortality. Immunity is gradually lost in the absence of reinfection; thus the population of large cities where transmission does not occur are at risk when travelling outside the city. Future research needs to explore the implications of malaria for these population groups exposed to malaria in different ways and thus likely both to suffer and to respond differently.

Work in progress by Gallup and Sachs is exploring the macro-economic impact of malaria by including the amount of malaria as an explanatory variable in economic growth models. The amount of malaria was proxied by a “malaria index”, which was calculated as the product of the fraction of land area with endemic malaria and the fraction of malaria cases that are *P. falciparam*. Preliminary results suggest that countries with a substantial amount of malaria grew 1.3% per year less (controlling for other influences on growth), and that a 10% reduction in malaria was associated with 0.3% higher growth per year[(11)]. These findings reinforce the concerns presented here on the value of past micro-economics work, and further highlight the need to develop a detailed understanding of the mechanisms by which malaria affects households and economies.

6.4 Conclusion

The weakness of the literature available on the economic impact of malaria is clearly evident. No studies can be highlighted as models of good methodology. Excessive effort has been devoted to indirect studies that use often very weak data on earnings and days lost to make gross and potentially misleading estimates. Studies often ignore both the detailed economic circumstances and behaviour of rural households, and the specific characteristics of malaria - especially in relation to incidence by age and immune status. Much more sophisticated approaches to research are required. A key deficiency is the complete absence of studies that attempt to address the benefits from malaria control.

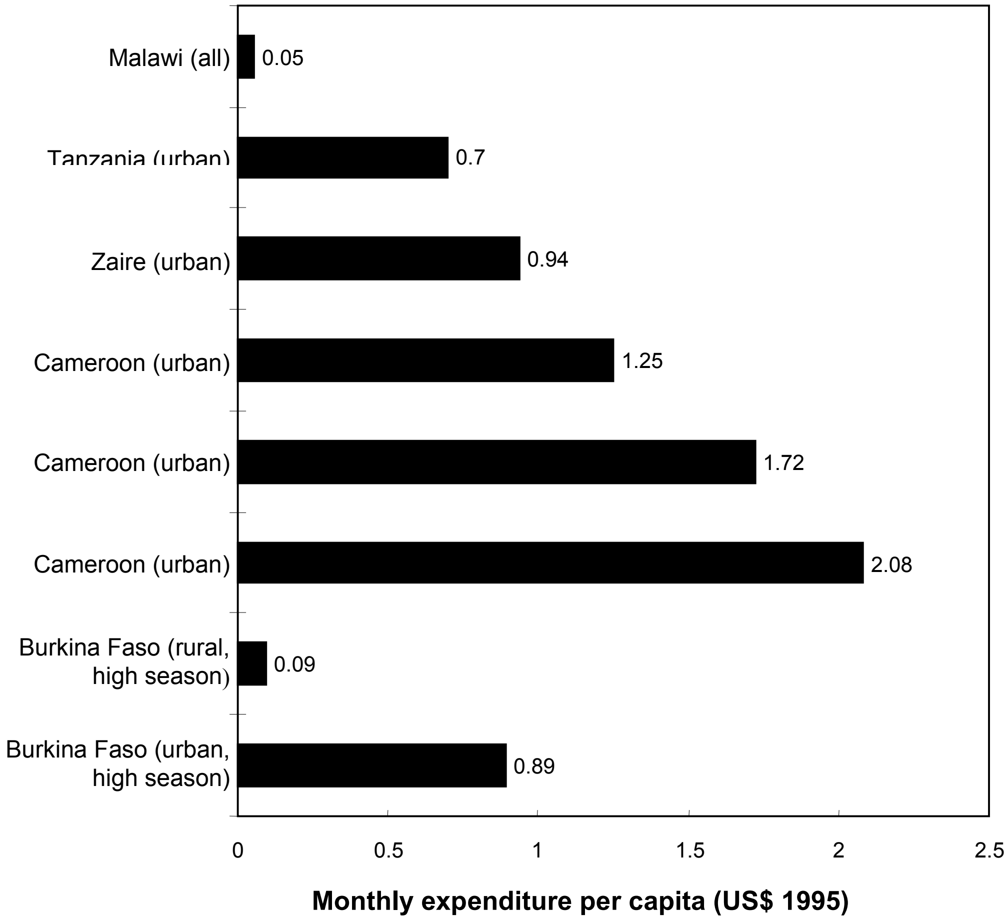
Studies that estimate economic costs of malaria are of limited relevance on a number of grounds. In particular, studies fail to consider:

- the coping strategies of households that reduce the impact (but which may also have costs)
- the possible pervasive effect of malaria in affecting the productive environment and production possibilities and incentives of households
- the extent to which resources devoted to treatment might be released or diverted to other high priority health problems if the burden of malaria were reduced.

In addition, given the known variations in transmission levels and health impact of malaria across Africa, the haphazard set of country and area data reviewed here are of little use in making generalizations. A much more systematic and carefully thought through effort is required to ensure that key differences in economic environments and malaria epidemiology are taken into account, and that both shorter and longer run consequences of malaria are considered.

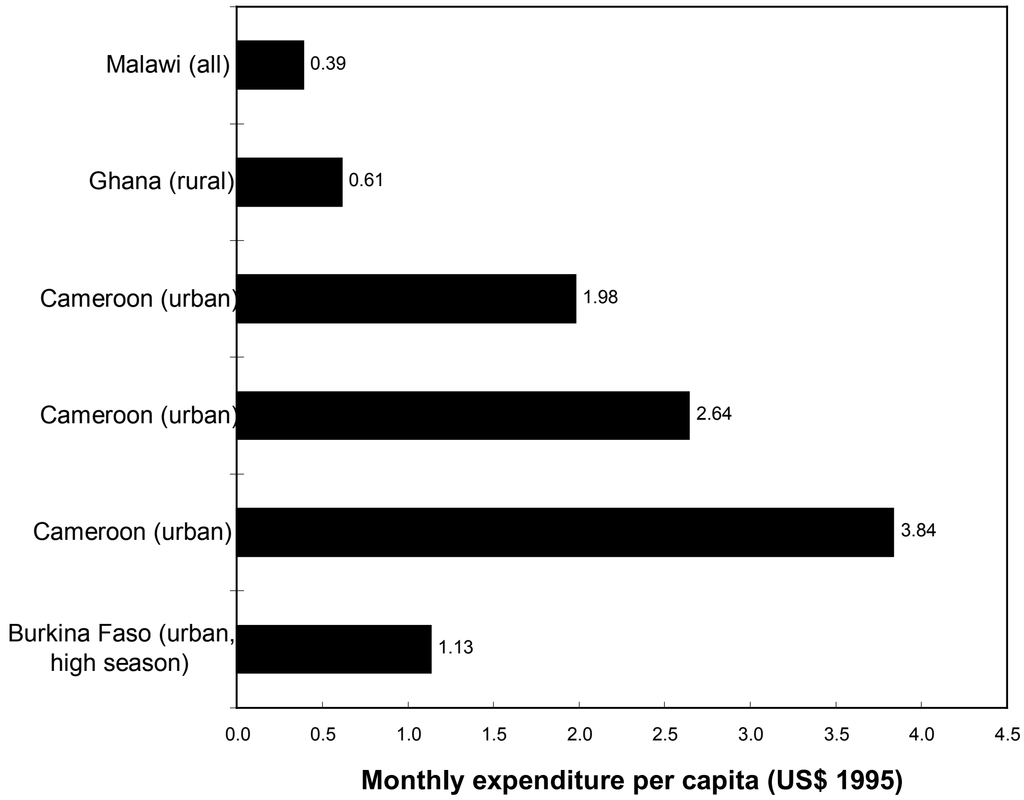
Such research should help to publicize and justify a major malaria control effort. However, this information, if suitably disaggregated, can also be used to design and target control interventions. Better information on economic impact is required to identify the population groups and regions most at risk of adverse economic effects. In particular, it is remarkable that good information is lacking on the relative incidence of malaria by socio-economic group, and especially its impact on the poorest. Furthermore, economic impact data could be used to identify the control interventions that make the largest contribution to reducing the economic burden. For example, anti-vector interventions, such as residual spraying or ITNs, are likely to act as substitutes to some degree for expenditure on coils and sprays, but this is unlikely to be the case for chemoprophylaxis. Preventive interventions that reduce transmission levels could have a significant impact on prevailing economic incentives for investment and saving. The improvement of treatment services may have little impact on direct preventive expenditure, but may lead to a change in the risks faced by households and therefore their productive and demographic decisions. The addition of these considerations to current knowledge on the gross costs and health effects of control interventions would enrich the planning process, and facilitate the identification of packages of interventions that have the greatest community-wide benefits.

Figure 6.1. Monthly per capita expenditure by households on prevention-related activities



Source: Mills (1998)[45].

Figure 6.2. Monthly per capita expenditure on malaria-related treatment by households



Source: Mills (1998)[(45)].

Table 6.1. Estimates used to calculate productivity costs of a malaria episode using the wage rate method

Authors	Country	Method of valuing time	Period of time lost: By sick adult	Period of time lost: By child carer
Aikins (1995)[32]	The Gambia	marginal value of work time on crops cultivated by women		2.16 hours per day per child for 4 days
Ettling *et al.* (1991)[13]	Rwanda	marginal product proxied by average rural wage x .85[h]	3 days	1 day
Ettling *et al.* (1994)[35]	Malawi	mean per capita income from survey	2.7 days	1.2 days
Guiguemdé *et al.* (1997)[46]	Burkina Faso	mean annual income per worker by occupational group	4 days (all ages; 73% were <5)	Assumed to be 1.2 days
Leighton and Foster (1993)[2]	Kenya	average wage by sector	2-4 days (plus allowance for lower productivity for 2 days)	2-4 days
Leighton and Foster (1993)[2]	Nigeria	average wage by sector	1-3 days (plus allowance for lower productivity for 2 days)	1-3 days
Sauerborn *et al.* (1995)[4]	Burkina Faso	local wage for hired labour	3.5 days	2.7 days
Sauerborn *et al.* (1991)[6]	Burkina Faso	market value of average output per person for main produce in each of 2 seasons	mild illness 1 day; severe 5 days	1/3 of adult illness time

Table 6.2. Other estimates of period of illness caused by malaria

Authors	Country	Period of time lost
Bruce-Chwatt (1963)[47]	Nigeria (psychiatric patients, Lagos)	2.6 days (untreated)
Gazin *et al.* (1988)[48]	Burkina Faso (factory)	3.5 days
Hall and Wilkes (1967)[49]	Tanzania	1.16 days per person per year
Miller (1958)[50]	West African men	4.2 days per episode; 3 workdays lost per year
Nur and Mahran (1988)[8]	Gezira, Sudan	6 days of disability, plus 5 at 50% productivity

[h] Justification not provided.

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